สมบัติเชิงกลของไม้ยางพารา-คอมโพสิตที่ประกอบด้วยพอลิ (สไตรีน-*โค*-อะคริโลไนทริล) และพอลิ (เมทิลเมทาคริเลต-*โค*-อะคริโลไนทริล)

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MECHANICAL PROPERTIES OF RUBBERWOOD-COMPOSITES CONTAINING POLY(STYRENE-*CO*-ACRYLONITRILE) AND POLY(METHYLMETHACRYLATE-*CO*-ACRYLONITRILE)

Miss Siriluck Boonkrai

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Petrochemistry and Polymer Science
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Thesis Title	Mechanical Properties of Rubberwood-Composites Containing Poly(styrene-*co*-acrylonitrile) and Poly(methylmethacrylate-*co*-acrylonitrile)
By	Miss Siriluck Boonkrai
Field of Study	Petrochemistry and Polymer Science
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ศิริลักษณ์ บุญไกร : สมบัติเชิงกลของไม้ยางพารา-คอมโพสิตที่ประกอบด้วยพอลิ (สไตรีน-*โค*-อะคริโลไนทริล) และพอลิ (เมทิลเมทาคริเลต-*โค*-อะคริโลไนทริล) (Mechanical Properties of Rubberwood-Composites Containing Poly(styrene-*co*-acrylonitrile) and Poly (methylmethacrylate-*co*-acrylonitrile))

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งานวิจัยนี้ได้เตรียมไม้ยางพารา-คอมโพสิตที่ประกอบด้วยพอลิ (สไตรีน-*โค*-อะคริโลไนทริล) และพอลิ (เมทิลเมทาคริเลต-*โค*-อะคริโลไนทริล) ด้วยวิธีการแช่ไม้ให้ชุ่มด้วยโมโนเมอร์ภายใต้การลดความดัน โดยศึกษาปริมาณของตัวริเริ่มปฏิกิริยา อัตราส่วนผสมของโมโนเมอร์ที่ใช้แช่ชิ้นไม้ และอุณหภูมิที่ใช้ในการทำให้เกิดปฏิกิริยาพอลิเมอไรเซชัน รวมทั้งศึกษาภาวะที่เหมาะสมของกระบวนการเตรียมไม้ยางพารา-คอมโพสิต เช่น เวลาที่ใช้ดึงอากาศออกจากช่องว่างในเซลล์ไม้ เวลาที่ใช้แช่ชิ้นไม้ โดยแปรเปลี่ยนค่าเหล่านั้นให้แตกต่างกันในการเตรียมแต่ละตัวอย่าง ศึกษาสมบัติกายภาพและเชิงกลของตัวอย่างที่เตรียมขึ้นเปรียบเทียบกับไม้ยางพาราธรรมชาติ ไม้เต็ง และไม้มะค่าโมง

ผลการศึกษานี้พบว่า 90 ส่วนของสไตรีนต่อเรซิน 100 ส่วนและ 10 ส่วนของอะคริโลไนทริลต่อเรซิน 100 ส่วนเหมาะสำหรับวิธีใช้ความร้อน สำหรับวิธีใช้ตัวช่วยเร่งปฏิกิริยาที่อุณหภูมิห้องใช้ 80 ส่วนของเมทิลเมทาคริเลตต่อเรซิน 100 ส่วนและ 20 ส่วนของอะคริโลไนทริลต่อเรซิน 100 ส่วน และภาวะที่เหมาะสมในการเตรียมดังนี้ คือ เวลาที่ใช้ดึงอากาศออกจากช่องว่างในเซลล์ไม้ 2 ชั่วโมง, เวลาที่ใช้แช่ชิ้นไม้ 4 ชั่วโมง ความดันที่ใช้ดึงอากาศออกจากเซลล์ไม้ $5x10^{-3}$ ทอร์ และความเข้มข้นของตัวริเริ่มปฏิกิริยา 2 ส่วนต่อเรซิน 100 ส่วน ตัวอย่างไม้ยางพารา-คอมโพสิตที่เตรียมขึ้นจากสภาวะดังกล่าวให้ค่าการดูดซับน้ำและการพองตัวทางความหนาหลังแช่น้ำต่ำกว่าไม้ยางพาราธรรมชาติและไม้มะค่าโมงที่ระดับความเชื่อมั่น 95 เปอร์เซ็นต์อย่างมีนัยสำคัญยิ่งและสามารถทนต่อเชื้อราและปลวกดีพอๆ กับไม้เต็งและไม้มะค่าโมง ความสามารถในการต้านแรงดัด มอดูลัสยืดหยุ่น ความสามารถในการต้านแรงอัดทางขนานแนวเสี้ยนได้รับการปรับปรุงดีกว่าไม้ยางพาราธรรมชาติ ไม้เต็ง และไม้มะค่าโมง

สาขาวิชา .....ปิโตรเคมีและวิทยาศาสตร์พอลิเมอร์..... ลายมือชื่อนิสิต ...ศิริลักษณ์....บุญไกร...........

หลักสูตร .....ปิโตรเคมีและวิทยาศาสตร์พอลิเมอร์..... ลายมือชื่ออาจารย์ที่ปรึกษา ....

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SIRILUCK BOONKRAI : MECHANICAL PROPERTIES OF RUBBERWOOD-COMPOSITES CONTAINING POLY(STYRENE-*CO*-ACRYLONITRILE) AND POLY (METHYLMETHACRYLATE-*CO*-ACRYLONITRILE) THESIS ADVISOR : ASSOC. PROF. AMORN PETSOM, Ph.D., 129 pp. ISBN 974-13-1320-9

This research involves the preparation of rubberwood–composites containing poly(styrene-*co*-acrylonitrile) and poly(methylmethacrylate-*co*-acrylonitrile) by impregnation of rubberwood with mixture of monomers under reduced pressure. The effect of initiator contents, mixture ratio of monomer, and temperature for curing were studied. Impregnation parameters such as evacuating time, soaking time were varied to various conditions in the preparation process. Physical and mechanical properties of impregnated samples were compared with natural rubberwood, Teng, and Makah-mong.

Results of this study showed that 90 phr. of styrene monomer and 10 phr. of acrylonitrile monomer were suitable for use in the catalyst-heat technique. For the catalyst-accelerator technique, 80 phr. Of methylmethacrylate monomer and 20 phr. of acrylonitrile monomer were used in this technique. The optimum parameters were 2 hours evacuating time, 4 hours soaking time and 5×10^{-3} torr evacuating pressure and 2 phr initiator content. Impregnated samples obtained from the optimum conditions gave significantly lower water absorption and thickness swelling in water than natural rubberwood and Makah-mong at 95% confidence and they resisted to fungi and termite as well as Teng and Makah-mong. Flexure stress, modulus of elasticity, compression parallel to grain could be improved better than natural rubberwood, Teng and Makah-mong.

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LIST OF ABBREVIATIONS

WPC	Wood polymer composites
COMPRESS	Compression
SEM	Scanning electron microscopy
MPa	Mega Pascal
N/mm^2	Newton per square millimeter
WA	Water absorption
SW	Thickness swelling in water
MEKPO	Methyl ethyl ketone peroxide
MOE	Modulus of elasticity
AN	Acrylonitrile monomer
F	Flexure stress
T	Tangential
R	Radial
L	Longitudinal
S	Volumetric swelling coefficient
SG	Specific gravity
ST	Styrene monomer
MMA	Methylmethacrylate monomer
MAN	Methylmethacrylate-acrylonitrile copolymer
SAN	Styrene-acrylonitrile copolymer
PAN	Polyacrylonitrile
Phr	Per hundred resin

CHAPTER 1

INTRODUCTION

Wood is a renewable natural resource and it possesses many desirable physical properties which make it an ideal material for many different applications such as kitchen equipment, furniture, construction materials, and etc. As compared to other building materials, wood is structurally strong, may be finished to a pleasing appearance and is easily shaped. But nowadays, wood used in the field of industry is the shortage for domestic use. Since government policy from National Land Management Committee has set target to expand area for forestation every year. By increasing forest area in Thailand from 26.64% of the whole country area or approximately 85 million rais in 1991 to 40% of the whole country area or approximately 128.3 million rais. Thai government supports planting for forest garden, planting for high economic value trees and fast-growing trees to replace using natural tree in short and long term and enforcing the legal measures to completely terminate the concession all over the country on 15th January, 1989 to seriously conserve the remaining forestry. Consequently, the measure affects the lumber shortage for domestic use severely.[1] There are still demands from domestic and internationals in wooden furniture industry. Therefore, searching to substitute materials in place of the traditional uses of wood has been the focus of renewed interest. Rubberwood, in particular, is considered a promising alternate raw material because of its fast growth rate and short rotation rate.

The term, "rubber" is usually given to the timber of the species *Heavea Brasiliensis* Mull.Arg.[2] The most important product of the rubber tree is the latex. After exploitation, the rubber tree is felled for replanting with high yielding clones, therefore the rubber timbers are available to be advantageous for industrial and engineering uses.

Presently, rubberwood are derived from felling the old type of rubber and replacing the new type of rubberwoods, which it has been set by Rubber Plantation Association to achieve approximately 230,000 rais per year. The rubber tree will be cut down for utilization by 22 cubic metres per rai. The total rubber cuts expected by the association are about 5 million cubic metres per annum. Forest Department in 2000 report that we can use the rubberwood for about 70-75% of total cuts per rai. Rubber will be manufactured for furniture and other products for exports. Currently, Thailand has the second largest rubber plantation area in the world. In 1989, Thailand has total area of rubber plantation to 11.5 million rais. In 1993, Thailand has rubber plantation area of 12.12 million rais and in 1996 with total area of 13.12 million rais. Most of the rubber plantation in Thailand is in the south and the eastern part, especially in 14 provinces of southern part starting from the lower part of Prachuabkireekhan down to the border area of Malaysia, which accounts for 84.7% of total rubber plantation area. For the eastern part of Thailand, the rubber plantation accounts for 12.9% whereas the remaining is in northeastern part. At the moment, the government tries to promote more rubber plantation in the northeastern for future rubber resources, so rubberwood increases continually.[3] This can regularly provide the raw material for the wooden furniture industry. In addition, the rubberwood could be expected to meet a major part of the future need in Thailand because of the good working qualities of rubberwood, its durability, pleasant appearance, and beautiful grains make it suitable for numerous end uses. It is an ideal wood that can be potentially transformed into household furnitures, tools, and construction materials with high quality.

However, rubberwood has several physical properties which limits its use in a number of different applications. These properties include the relative softness of wood, poor dimensional stability toward moisture absorption, and low fungi and insect resistance. It must be protected from the attack by insects and fungi for many of the applications. Increased research during recent years has improved the mechanical and physical properties of wood by impregnation. For this research, rubberwood was used for wood impregnation because it has a great number of supplies, good appearance of the whitened cream on the wooden surface with the beauty, and it is relatively cheaper than other hard woods. Nevertheless, rubberwood as a substitute for Teaks or Pradu type is not so easy. This research aims to develope rubberwood as a replacement by looking at quality to be last long, strong and resistant to fungi and termite. One convenient way is to impregnate the wood with a suitable chemical such as a monomer that can be polymerized *in situ* either using a catalyst-heat technique or a catalyst-accelerator technique to give a wood-polymer composite (WPC) which could be the way to reduce the problems.

1.1 Objectives

1. To study the factor influencing in the preparation of acrylonitrile copolymer rubberwood composites.
2. To determine the physical and mechanical properties of acrylonitrile copolymer rubberwood composites and compare them to natural rubberwood, Teng, and Makah-mong.

1.2 Scopes of the Research

In this research work, the wood polymer composites were prepared from acrylonitrile (AN), styrene-acrylonitrile (SAN) and methylmethacrylate-acrylonitrile (MAN) mixtures and rubberwood by impregnating under reduced pressure. Suitable monomer mixtures and various impregnation conditions in the preparation of SAN, MAN and PAN rubberwood composites such as soaking time, evacuating time, temperature, the mixture ratio, and initiator content were investigated. The physical and mechanical properties of specimens such as polymer loading, modulus of elasticity, flexural strength, compressive strength, dimensional stability, water absorption, thickness swelling in water, volumetric swelling coefficient, termite resistance and SEM of microstructure figure were studied.

CHAPTER 2

THEORY AND LITERATURE REVIEW

According to the National policy to conserve the forested area by canceling the forest concession on 15th January, 1989. There has been a timber or log shortage for wooden furniture or construction materials such as Teak, Pradu, Chingchan, etc. Imports from neighbour countries, Burma, Laos, Cambodia, creates troubles and inconvenience to businessman. The shortage becomes severe and impacts furniture and construction industry. There are still demands from domestic and internationals in wooden furniture because it retains the natural looks and beauty. Consequently, wooden furniture industry tries to look for a substitute, especially rubberwood because of a number of supplies, the whitened cream look on the wooden surface with the beauty. Moreover, rubberwood is relatively cheaper than other hard woods. Nevertheless, rubberwood as a substitute for Teak or Pradu type is not so easy. There is still some needs to develop other soft woods for replacement by looking at quality to be last long, strong and resistant to fungi and termite with the application of wood-polymer composites (WPC) by impregnation.[1]

2.1 Rubberwood

2.1.1 Technical properties and utilization of rubberwood

The most important product of rubber tree is the latex and all efforts to improve the rubber tree have been from the point of obtaining higher yield of latex. After exploitation, the rubber tree is felled for replanting with high yielding clones. Till recently, most of the wood from the felled trees was used as fuel. With the depletion of forests in many parts of tropical regions, leading to shortage of wood for many industrial and engineering uses, attention has been given to rubber wood as an alternative source of timber. Research and development activities on the industrial applications of rubberwood are only of recent origin. New developments indicate the possibility of wider use of rubberwood for a variety of purposes.

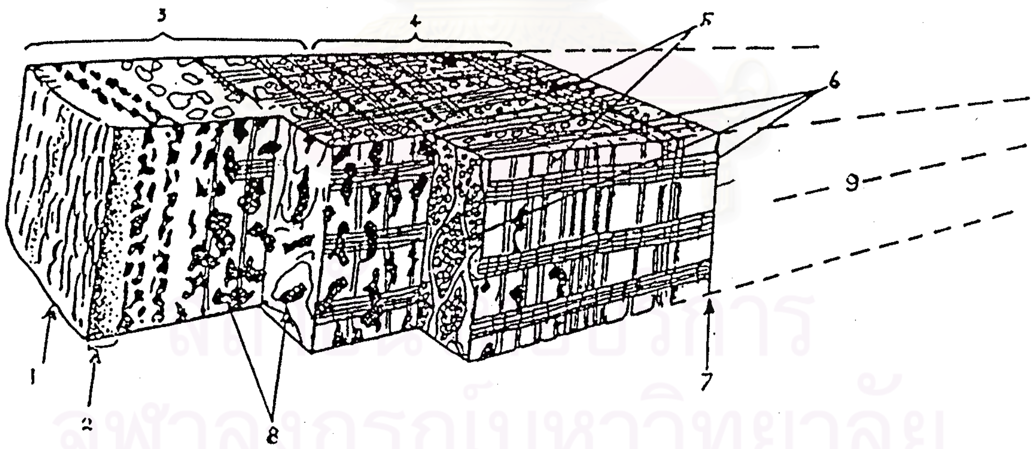
Rubber trees grow to a height of 25 meters and generally have straight trunks. Usually, at the time of felling, the girth varies between 100 to 110 centimeters, at a height of 125 centimeters above the ground and gives 0.62 cubic meters of stump wood and 0.40 cubic meters of branch wood. At the time of felling, usually it contains 180 to 185 trees per hectare.[4]

2.1.2 Anatomy of Rubberwood

Rubber tree is divided in sort of softwood. The stem consists of the texture of wood which is the center of stem called "Central axis or Pith (medulla)". The next layer is wood or xylem, the next one is ring of cells or called "Cambium", then the next of cambium is soft bark which contains phloem. The next of soft bark is hard bark and the inner of hard bark, combined with soft bark, contains latex vessels that twisted on the right hand. And then, it is cork cambium and cork, respectively.[5]

The texture of the wood is fairly even with moderately straight and slightly interlocking grain. From whitish yellow when freshly cut, the wood turns to light brown as drying progresses. Latex vessels can be found with characteristic smell in some parts of the wood. The wood is soft to moderately hard with an average weight of 515 kilograms per cubic meters at 12 % moisture content. Pores on the cross section are diffused and of medium to large size, mostly solitary but sometimes in short multiples of two to three, filled with tyloses. Vessel tissues are conspicuous in radial and tangential faces and the diameter of vessel tissues are about 200 microns. Wood parenchyma are abundantly visible to the naked eye appearing as narrow, irregular and somewhat closely spaced bands forming a net like pattern with rays. The rays of the wood are moderately broad, rather few and fairly wide spread. The pits found between the vessels and rays are half-bordered with narrow width. The length of the fibres is more than 1.0 millimeters on the average and the width is about 22 microns when it dried. The cell wall also thickness after it dried, about 2.8 microns.[6]

There is insignificant heart wood formation and no transition appears between sapwood and heart wood, which is confined near the pith. Growth rings or annual rings are not visible in rubberwood, unlike many other wood (ring porous woods). However, concentric false rings sometimes appear on the wood, depending on the presence of tension wood (gelatinous cells) which are fairly common in most of the clones. Maximum number of such rings are found in the basal portions with decreasing number towards the top. The tension wood may vary from 15 to 65 % and such erratic distribution and variation are supposed to be responsible for some of the commonly observed defects that may occur during drying and processing.



1. **Cork**
2. **Cork cambium** (between cork and hard bark)
3. **Hard bark** (consist of stone cells, parenchyma, disorganised sieve tubes, and latex vessels)

4. **Soft bark** (mainly vertical rows of sieve tubes and many latex vessels)
5. **Latex vessels**
6. **Medullary rays**
7. **Cambium**
8. **Stone cells**
9. **Sapwood**

Figure 2.1 Anatomy and physiology of rubberwood

2.1.3 Physical and Mechanical Properties of Rubberwood

Wood, when dry, has unique physical and mechanical properties in that its tensile strength, flexural strength, compressive strength, impact resistance, and hardness per unit weight are the highest of all construction materials. The hydrogen bonding, the unique helical structure of the cell walls, the combination of the linear cellulose molecules impregnated with low molecular weight extractives, and all of the varying amounts of crosslinked lignin make wood an infinitely resource.

Like the other wood species, rubberwood also exhibits orthotropicity in its properties, i.e., its properties are different and independent in the three principal direction of growth: longitudinal, radial, and tangential. Being non-homogeneous in its structure, its density also varies from site to site inside the material. The variations in properties are attributable not only to the variations in density but also to the presence of latex particles in some locations and to the predominance of tension wood. Like most of the wood species, the dynamic properties of rubberwood (i.e. mechanical behavior of rubberwood under dynamic forces) are higher than the static properties. In other words, under impact loads, rubberwood is capable of taking loads nearly twice that under slowly applied loads. However, it may be noted that the static properties of rubberwood in dry condition are higher than those in green condition.[7]

2.2 Wood Properties [8, 9]

That area of wood science concerned with the physical and mechanical properties of wood and the factors which affect them. Since wood consists of aggregates of long tubular cells, most of which are oriented longitudinally in the tree, whereas the ray cells are oriented radially, wood is an ortho-tropic material and exhibits different physical behavior in the three main structural directions, longitudinal, radial, and tangential.

2.2.1 Density and Specific Gravity

Density is the weight or mass of a unit volume of wood, and specific gravity the ratio of the density of wood to that of water. In the metric system of measurement, density and specific gravity are numerically identical. Determination of the density of wood in relation to that of other materials is difficult because wood is hygroscopic, and both its weight and volume are greatly influenced by moisture content. With specimens regular in shape, volume may be calculated on the basis of their dimensions. Differences among species, or samples of the same species, are due to different proportions of wood substance and void volume, and to content of extractives. Density affects the amount of moisture that wood can hold, its shrinkage, swelling, mechanical and other properties; in general, density measures the quality of wood without defects.

2.2.2 Hygroscopicity

Wood can absorb water as a liquid, if in contact with it, or in the form of vapour from the surrounding atmosphere. Though wood may absorb other liquids and gases, water is the most important. Because of its hygroscopicity, wood, either as a part of the living tree or as a material, always contains moisture. This moisture affects all wood properties. Dimensions change and decay resistance are greatly affected.

2.2.3 Shrinkage and Swelling

Wood is subject to dimensional changes when its moisture fluctuates below the fibre saturation point. Loss of moisture results in shrinkage, and gain in swelling. It is characteristic that dimensional changes are anisotropic-different in axial, radial, and tangential directions. Cell wall shrinkage is somewhat less than the volume of water desorbed.

2.2.4 Deterioration of Wood

Wood is subject to deterioration by fungi, insects, marine organisms, fire, and other destructive agencies. By far the most important cause of wood loss is decay. Wood decays if the conditions are suitable for growth and activity of fungi. Such conditions include favourable moisture, air, and temperature.

The interesting technique of modified wood, through chemical treatment, from dimensional changes, from deterioration by the biological agencies of fungi and insect, is impregnation under pressure called impreg-wood or wood-polymer composite (WPC).

2.3 Definition of Wood Polymer Composites (WPC)

Wood polymer composite (WPC) is a wood impregnated with a polymerizable monomer (mainly vinyl monomer) in order to strengthen the properties of the natural wood.[10]

2.3.1 Impregnation Process

The impregnation process of wood is carried out by first evacuating the air from the wood vessels and cell lumens. Any type of mechanical vacuum pump is adequate if it can reduce the pressure in the apparatus to 7×10^{-3} torr or less. Experience has shown that the air in the cellular structure of most woods is removed as fast as the pressure in the evacuation vessel is reduced. After that, the vacuum pump is disconnected from the system at this point. The monomer or prepolymer containing crosslinking agents as well as catalyst, and on occasion dyes, is introduced into the evacuated chamber through a reservoir at atmospheric pressure. The wood must be weighed so that it dose not float in the monomer solution. Alternatively the system can be pumped as the monomer is admitted into the evacuated vessel. After the wood is covered with monomer solution, atmospheres pressure is regained. Immediately the monomer solution begins to flow into the evacuated wood structure to fill the void spaces. The soaking period, like the evacuation period, depends on the structure of wood. After the monomer impregnation is completed, the wood polymer composite is removed and placed in an explosion-proof oven for curing.[11]

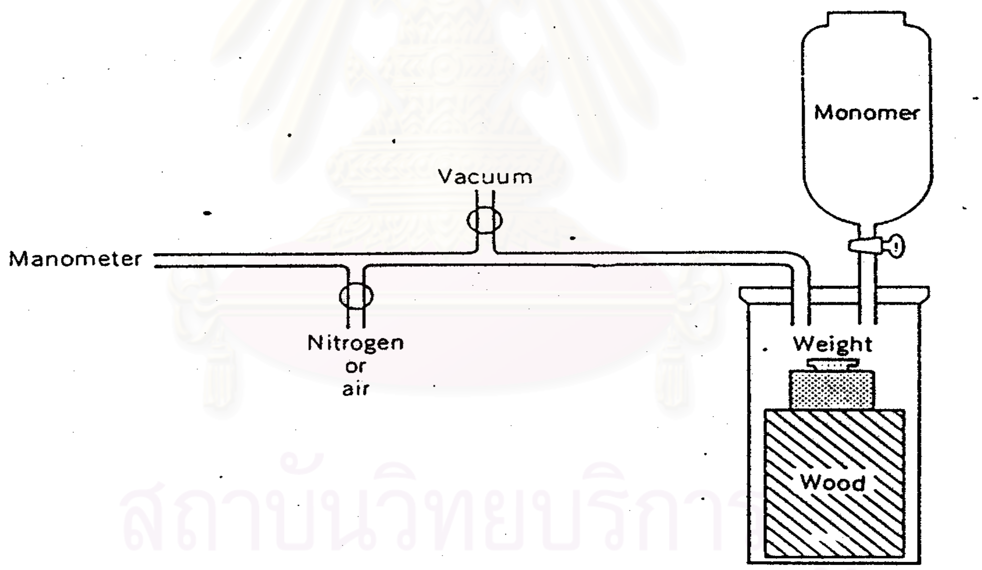


Figure 2.2 The apparatus of impregnation process

2.3.2 The Chemicals Used for Modifying Wood

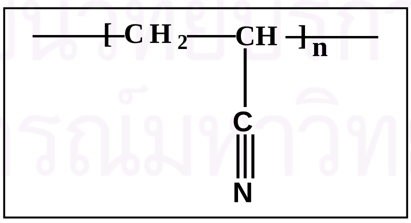
Treatment of wood to improve its physical and mechanical properties and dimensional stabilization due to moisture content and impart resistance to termites, decay, and marine organisms has been carried out via chemical modification or chemical impregnation. In chemical modification, compounds highly reactive to the hydroxyl groups of cellulose, hemicellulose, and lignin components of wood. Several liquid monomers such as styrene (SM), acrylonitrile (AN), and methylmethacrylate (MMA) were also incorporated into wood samples by means of chemical impregnation. Crosslinking of wood material in wood samples provides good dimensional stability to the wood-polymer composites.

2.3.2.1 Acrylonitrile

Acrylonitrile is polymerized to polyacrylonitrile through suspension methods using free-radical initiators. Most of the polymer produced is employed in acrylic fibres, which are defined as fibres that contain 85 percent or more PAN. A copolymer containing PAN and 2 to 7 percent of a vinyl comonomer such as vinyl acetate can be readily spun to fibres that are soft enough to allow penetration by dyestuffs.

2.3.2.1.1 Polyacrylonitrile

Polyacrylonitrile (PAN) is a vinyl polymer. It made from the monomer acrylonitrile by free radical vinyl polymerization. Polyacrylonitrile is tough, good resistance to organic solvent. Moreover, it offers good tensile strength.

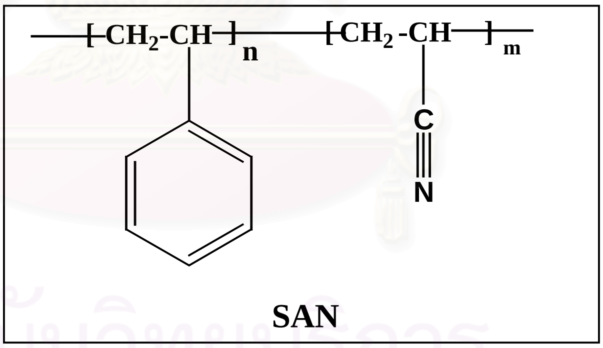


2.3.2.2 Styrene

An outstanding characteristic of styrene monomer is its ability to be polymerized readily by a variety of methods and with a large variety of other monomers. Styrene monomer is successfully polymerized and copolymerized by both batch and continuous mass polymerization and by solution, suspension, and emulsion processes, as well as by various modifications and combinations of these techniques. Styrene responds to a large number of initiators such as peroxides and other free radical initiators, redox initiator systems, ionic initiators, and others. Styrene is copolymerized to form commercial copolymers with the acrylates and methacrylates, acrylonitrile, divinylbenzene, and others.

2.3.2.2.1 Poly(styrene-*co*-acrylonitrile)

Poly(styrene-*co*-acrylonitrile) or SAN is a simple random copolymer of styrene and acrylonitrile. It is tough, rigid, and transparent thermoplastic that displays better resistance to heat and solvents than polystyrene. It has good dimensional stability. Besides, it can improve impact strength and offers excellent chemical and heat resistance.

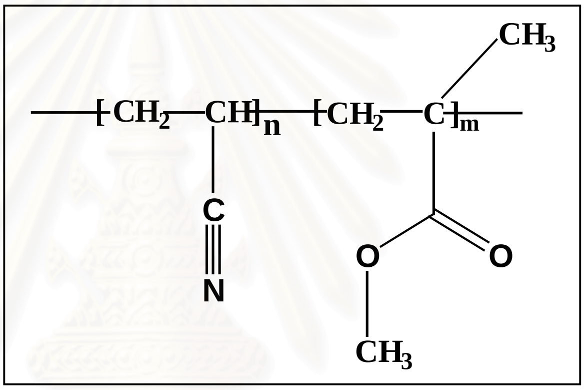


2.3.2.3 Methyl Methacrylate (MMA)

Methyl methacrylate is clear liquid. Boiling point is 100.5(C at 760 mm Hg. Commercially, the most important chemical property of methyl methacrylate is its ability to polymerize through the vinyl group to give homopolymers and copolymers. Methyl methacrylate will also take part in many other reactions associated with a carbon-carbon double bond. The polymer of methyl methacrylate is a clear colorless resin. For polymerization or copolymerization with other monomers, such as other methacrylates, acrylonitrile, styrene, etc. Copolymers can be used in adhesives, lacquers, and paper treatments.

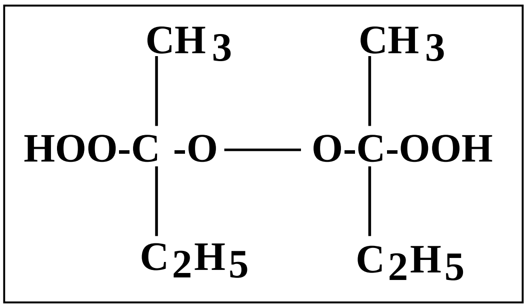
2.3.2.3.1 Poly(acrylonitrile-*co*-methyl methacrylate)

Poly(acrylonitrile-*co*-methyl methacrylate) or MAN is a copolymer of methyl methacrylate and acrylonitrile that made from acrylonitrile and methylmethacrylate monomer by free radical vinyl polymerization. It is tough and good compression and impact resistance.



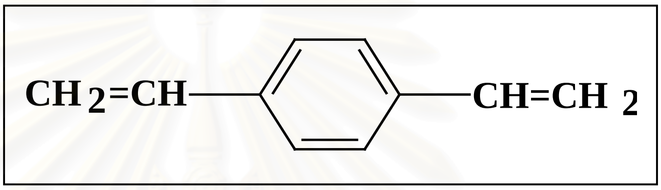
2.3.2.4 Methyl Ethyl Ketone Peroxide (MEKPO)

Methyl ethyl ketone peroxide is clear, colorless liquid, and insoluble in water. It is most widely used for curing of gelcoat resins, laminating resins, and lacquers. Self accelerating decomposition temperature is 60(C. For room temperature application it is necessary to use MEKPO together with a cobalt octoate to react with the peroxide to generate free radicals at lower temperature.



2.3.2.5 Divinyl benzene

Divinyl benzene (DVB) is used extensively in the plastics industry to crosslink and modify materials and to aid in copolymerization. It can also increase stress crack resistance, resistance to some chemicals, hardness, and impact strength. DVB helps improve the polymer properties through its action as a crosslinking agent. For instance, in crosslinking polystyrene, it increases solvent resistance, impact strength, tensile strength, and hardness.



2.3.2.6 Cobalt Octoate

Cobalt Octoate is a highly active oxidizing material suspended in a liquid carrier used to accelerate the decomposition of peroxide catalysts into highly reactive free radicals. These free radicals react readily with polymer and monomer molecules to cure a resin.

$$Co\ [COO.\ (CH_2)_6CH_3]_2$$

The chemicals used for modifying wood must be capable of swelling the wood to facilitate penetration and can react with the hydroxyl groups in cell wall. These can improve the mechanical and physical properties. Furthermore, The chemicals should react quickly with the hydroxyl groups to yield stable chemical bonds with no by-products.

Figure 2.3 is an example of the prepolymer mixture preparation for wood impregnation in catalyst-accelerator technique.

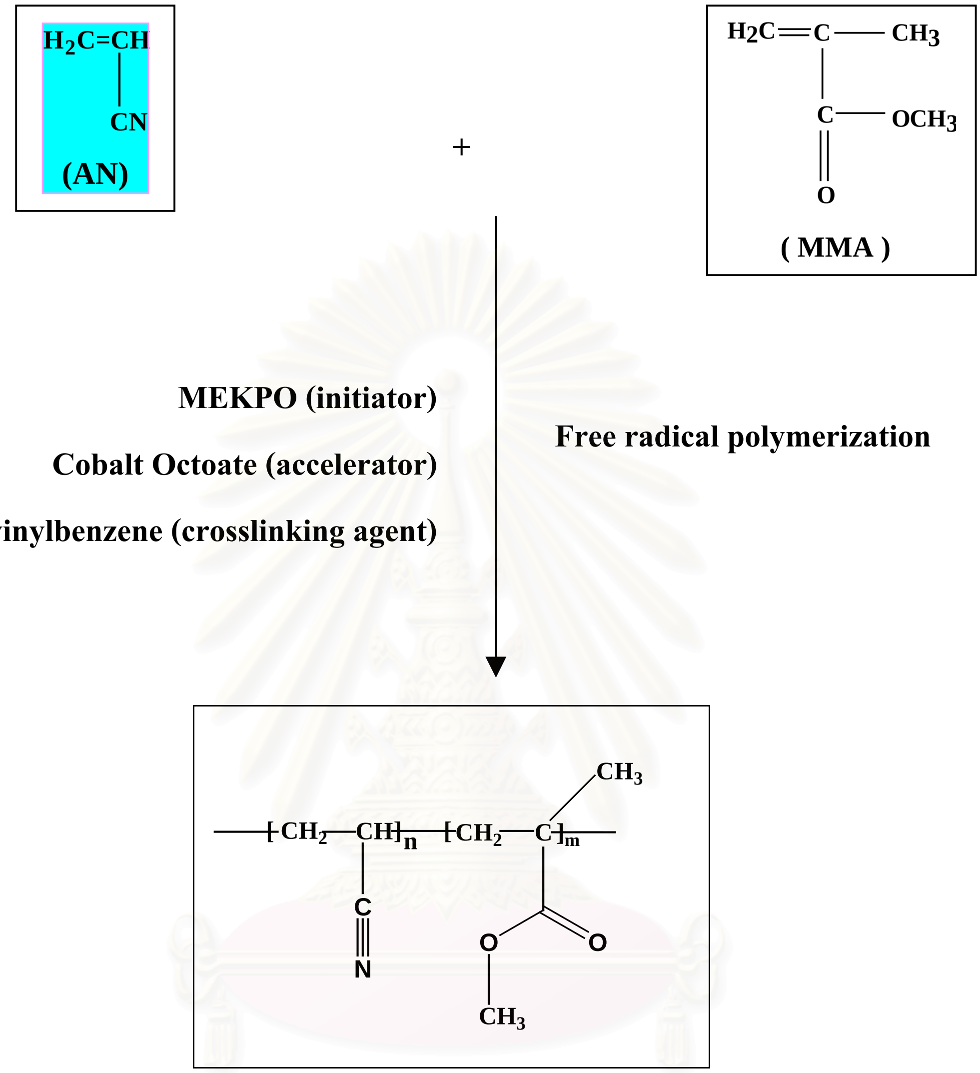


Figure 2.3 Preparation of crosslinked poly(acrylonitrile-*co*-methyl methacrylate)

2.4 Properties of WPC [12]

Wood-polymer composite (WPC) can modify undesirable properties of wood, such as poor dimensional stability, easy to fungi attack and low termite resistance. Thus, WPC can reduce these deficiencies when compared with untreated wood. Moreover, WPC can increase the static strength and other mechanical properties.

2.4.1 Mechanical Properties

The mechanical or strength properties of wood measure its ability to resist applied forces that might tend to change its shape and size. Resistance to such forces depends on their magnitude and manner of application, and to various characteristics of the wood such as density, moisture content, etc. Besides, wood strength varies with direction of application of load; i.e., axially (parallel to grain), and transversely (perpendicular to grain). The mechanical properties of WPC are improved to enhance such as compressive strength is improved 4 to 5 times that of untreated wood.

2.4.2 Dimensional Stability

Many treatments have been devised to reduce swelling of wood in contact with moisture. These treatments are, in most cases, based on bulking the wood cell walls with some material to keep wood in the swollen state as long as the chemical is retained. In this swollen condition, wood cannot expand or contract further in response to contact with water. Chemicals that have been chemically reacted with cell wall components also bulk the cell wall. Permanence depends on chemical stability of the bonds formed. When the monomer was impregnated into wood and polymerized, it can increase the weight of the wood considerably. Although polymerized chemical cannot be leached by water, very little dimensional stability results from chemical treatment. The small amount of stability that is achieved may be due to some cell wall penetration by the chemical or to physical blocking of moisture (water repellency) from the cell wall.

2.4.3 Termite Resistance

Left unprotected or unpreserved, wood will decay and deteriorate anywhere from a few months to a few years, depending upon climate condition. Wood preservatives have proven to be effective in preventing the invasion of biological agents and wood destroying organisms, such as wood decay fungi, bacteria, and wood destroying insects, including termites.

2.5 Literature Reviews

Several approaches have been taken in the past in attempts to improve mechanical properties, dimensional stability, and decay resistance of wood product. These attempts have included impregnation of the wood with various materials. The extent of improvement in mechanical and physical properties was directly related to the polymer content, the nature of the polymer, the type of wood, and the processing applied. In this literature reviews are summarized as follows:

Hazer, B., et. al.[13] prepared Scotch pine, eastern spruce, and eastern beech samples sawed longitudinally by impregnating with macroinimer and styrene, leading to crosslinked block copolymer of styrene and poly(ethylene glycol). The specimens impregnated with the mixture of macroinimer and styrene showed a water-repellent effectiveness of 35.14-58.15% after a water soaking test of 144 h. The highest values of water repellent effectiveness were found for spruce, while the lowest values were obtained for pine. ASE of 42.43% was obtained for spruce, followed in order by beech and pine, respectively. The ASE value increases with an increase in percentage of weight gain.

Rozman, H.D., et. al.[14] studied the wood polymer composites of rubberwood *Hevea brasiliensis*, prepared by impregnating the wood with methyl methacrylate (MMA), and the combinations of MMA and diallyl phthalate (MMA/DAP). Polymerization was carried out by catalytic heat treatment in the presence of catalyst. The result showed significant improvements in compressive and impact strengths, hardness, and dimensional stability (toward water) over that of the untreated rubberwood.

Fuller, B.S., et. al. [15] studied wood products impregnated with 30 to 80% of a polymerizable monomer selected from the group consisting of hexanediol diacrylate and hexanediol dimethacrylate. They found excellent indent resistance when using 0.5 to 2% of a thermally activated free radical source as a polymerization initiator for a period sufficient to achieve the desired polymer loading. The wood is heated under pressure to polymerize or cure the monomers.

Rozman, H.D., et. al. [16] prepared WPC of rubberwood by impregnating the wood with glycidyl methacrylate (GMA), combination of glycidyl methacrylate (GMA-DAP) or diallyl phthalate (DAP) alone. Polymerization was carried out by catalytic heat treatment. The results showed that WPC based on GMA exhibited greater dimensional stability. Flexural, compressive and impact properties for all the samples tested were improved, especially for those with higher chemical loading.

Yalinkilic, M.K., et. al. M. [17] prepared wood impregnated with boric acid, styrene, methylmethacrylate and their mixtures. Polymerization was conducted by heat radiation method at 90(C for 4 h. Treated specimens were then subjected to decay and termite tests, as well as oxygen index (O.I.) determination. Anti-swelling efficiency (ASE) and water absorption levels (WA) were also measured. The treated wood proved to be resistant against decay fungi. Moreover, boric acid increased the L.O.I. levels of monomer-treated wood, which resulted in a lower flame spread index.

Kasamchainanta, B. [18] prepared durianwood-polyester resins composites by impregnation under reduced pressure. Treated specimens gave significant lower water absorption, higher antishrink efficiency than natural durianwood. Modulus of elasticity, flexure stress, compression parallel to grain were improved and the density were higher than natural durianwood.

Rungvichaniwat, C. [19] prepared para rubberwood-epoxy resins composites by impregnation under reduced pressure. Treated specimens gave significant lower water absorption, higher antishrink efficiency than natural para rubberwood. Modulus of elasticity, flexure stress, compression parallel to grain were improved and specific gravity was higher than natural para rubberwood.

CHAPTER 3

EXPERIMENTAL PROCEDURES

3.1 Materials

3.1.1 Rubberwood

The rubberwood was obtained from Bangkok Shuttle Industry, Co., Ltd. The samples used in this study were sawn into specimens of 10 (T) x 10 (R) x 30 (L) mm for compression tests; 20 (T) x 20 (R) x 10 (L) mm for termite tests; 25 (T) x 5 (R) x 100 (L) mm for flexural strength tests; 25 (T) x 5 (R) x 25 (L) mm for dimensional stability tests.

3.1.2 Monomer

3.1.2.1 Acrylonitrile monomer, commercial grade, was supplied from Siam Chemical Industry Co., Ltd.

3.1.2.2 Styrene monomer, commercial grade, was supplied from Siam Chemical Industry Co., Ltd.

3.1.2.3 Methylmethacrylate monomer, commercial grade, was supplied from Siam Chemical Industry Co., Ltd.

3.1.3 Initiator

Methyl ethyl ketone peroxide was supplied from Siam Chemical Industry Co., Ltd.

3.1.4 Accelerator

In this study, cobalt octoate with 10% cobalt metal supplied from Siam Chemical Industry Co., Ltd. was used as accelerator.

3.1.5 Crosslinking Agent

Divinyl benzene was obtained from the Fluka Co., Ltd. and it was used as crosslinking agent.

3.2 Apparatus and Equipments

1. Vacuum Chamber : modified from 8 inches diameter dessicator
2. Vacuum Pump : MAKASHI OIL ROTARY, $5x10^{-3}$ torr., Japan
3. Vernier : MITUTOYO, Japan
4. Electric Saw : PEHAKA, England
5. Universal Testing Machine : HOUNDFIELD H10KM, England
6. Vacuum Oven : MUTTER, Germany
7. Balance : METTLER, Switzerland
8. Scanning Electron Microscope : JSM-6400, JEOL Co., Ltd,. Japan
9. Desiccator
10. Sandpaper

3.3 Experimental Procedures

3.3.1 Preparation of Rubberwood Composites Containing Poly(styrene-co-acrylonitrile) and Poly(methylmethacrylate-co-acrylonitrile)

3.3.1.1 Preparation of Wood Specimens

The wood samples used for testing were sawn into specimens for each type of test by using electric saw as mentioned in 3.1.1. These samples were randomly assigned to treatment. There were 5 replications for each treatment. The rough surface of samples was polished by sandpaper in order to remove the woolly fiber and made smooth surface.

3.3.1.2 Preparation of Prepolymer Mixture

3.3.1.2.1 For Catalyst-accelerator Technique

Styrene and acrylonitrile monomer were weighed and mixed homogeneously in ratio of ST:AN (90:10, 80:20, and 70:30, respectively) for SAN preparation. For MAN preparation, mix methylmethacrylate and acrylonitrile (MMA:AN) in the same ratio as SAN. Methyl ethyl ketone peroxide and cobalt octoate were used as an initiator and accelerator, respectively. Initiator, accelerator and crosslinking agent (divinyl benzene) were added into the mixtures and mixed slowly. The mixtures led to crosslinked copolymer of styrene and acrylonitrile (SAN) and methylmethacrylate and acrylonitrile (MAN).

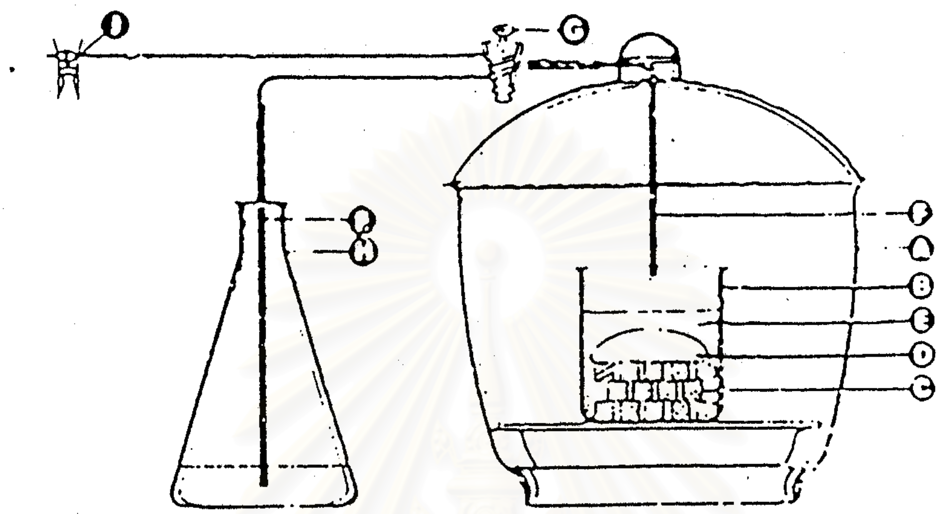
3.3.1.2.2 For Catalyst-heat Technique

The prepolymer mixtures were prepared as described in 3.3.1.2.1 but the accelerator was not added in this technique.

3.3.1.3 Impregnation in Catalyst-heat and Catalyst-accelerator Technique

3.3.1.3.1 Catalyst-accelerator technique

All wood specimens for impregnation were firstly dried in oven to constant weight at 103(2(C, the dimensions and weight were then measured. Wood samples were placed in a vacuum chamber and evacuated to $5x10^{-3}$ torr vacuum pressure. When evacuating time for full impregnation was reached, the prepolymer mixture was introduced into the vacuum chamber until the wood samples were covered. The chamber was left at atmospheric pressure at room temperature for the specified time. Impregnated wood samples were removed from the chamber, wiped off the excess monomer mixture from wood surfaces, and weighed immediately to determine the monomer uptake. The impregnated wood specimens were then wrapped in aluminium foil to minimize loss of monomer by evaporation. Then, they were placed immediately into the desiccator to complete the curing process at room temperature for 2 h. After unwrapping, the samples were dried in oven at 100(C for 24 h to remove excess monomer and then cooled down in the desiccator. The wood samples were determined polymer loading and tested mechanical and physical properties.



A – Vacuum desiccator

B – Plastic or glass treatment beaker

C – Test wood blocks

D – Glass or other suitable weight

E – Treating solution

F – Polyethylene tubing

G – Three-way stopcock

H – Flask containing treating solution

I - Line to source of vacuum

Figure 3.1 Apparatus for vacumm impregnation

3.3.1.3.2 Catalyst-heat technique

Dried wood samples were evacuated in a vacuum chamber to remove air from the pores of the wood and impregnated with the prepolymer mixture for catalyst-heat technique as described in 3.3.1.2.2. Impregnated wood specimens were then wrapped in aluminium foil and sealed to minimize the monomer loss by evaporation. After that, they were placed in an explosion-proof oven to complete the curing process at 70°C. After unwrapping, the wood samples were dried in oven at 100(C for 24 h to remove excess monomer and then cooled down in the desiccator. The wood samples were determined polymer loading and tested mechanical and physical properties.

3.3.2 Factors Influencing in the Preparation of Rubberwood Composites Containing Acrylonitrile Copolymer

3.3.2.1 Effect of Evacuating time on the Properties

Rubberwood composites containing acrylonitrile were prepared from prepolymer mixtures as follow: various ratio of styrene and acrylonitrile (90:10, 80:20, and 70:30) and ratio of methyl methacrylate and acrylonitrile (90:10, 80:20, and 70:30), 2 phr initiator, 0.1 phr accelerator, and 0.1 phr crosslinking agent. The impregnation parameters were as follow: $5x10^{-3}$ torr evacuating pressure, and 4 hours soaking time. Different evacuating time at 0.5, 1, 2, and 3 hours were studied.

3.3.2.2 Effect of Soaking time on the Properties

Rubberwood composites containing acrylonitrile were prepared from prepolymer mixtures as follow: various ratio of styrene and acrylonitrile (90:10, 80:20, and 70:30) and ratio of methyl methacrylate and acrylonitrile (90:10, 80:20, and 70:30), 2 phr initiator, 0.1 phr accelerator, and 0.1 phr crosslinking agent. The impregnation parameters were as follow: $5x10^{-3}$ torr evacuating pressure, and 2 hours degasing time. Different soaking time at 1, 2, 3, and 4 hours were studied.

3.3.2.3 Effect of Initiator Contents on the Properties

Rubberwood composites containing acrylonitrile were prepared from prepolymer mixtures as follow: various ratio of styrene and acrylonitrile (90:10, 80:20, and 70:30) and ratio of methyl methacrylate and acrylonitrile (90:10, 80:20, and 70:30), 0.1 phr accelerator and 0.1 phr crosslinking agent. Initiator contents at 1, 2, and 3 phr were added to prepolymer mixtures. For impregnation parameters, degasing time was 2 hours, soaking time was 4 hours, and evacuating pressure was $5x10^{-3}$ torr.

3.3.2.4 Effect of Mixture Ratio of Monomer on the Properties

Rubberwood composites containing acrylonitrile were prepared from prepolymer mixtures as follow: 2 phr initiator, 0.1 phr accelerator, and 0.1 phr crosslinking agent. The impregnation parameters were as follow: $5x10^{-3}$ torr evacuating pressure, 2 hours degasing time, and 4 hours soaking time. Different various ratios of styrene and acrylonitrile as 90:10, 80:20, and 70:30, respectively, were studied as well as ratios of methyl methacrylate and acrylonitrile.

3.3.2.5 Effect of Temperature on the Properties

Rubberwood composites containing acrylonitrile were prepared from prepolymer mixtures as follow: various ratio of styrene and acrylonitrile (90:10, 80:20, and 70:30) and ratio of methyl methacrylate and acrylonitrile (90:10, 80:20, and 70:30), 2 phr initiator, 0.1 phr accelerator, and 0.1 phr crosslinking agent. The impregnation parameters were as follow: $5x10^{-3}$ torr evacuating pressure, 2 hours degasing time, and 4 hours soaking time. Different temperatures at 70(C and room temperature were studied.

3.3.3 Testing for Physical Properties.

Wood composites specimens were tested for the following properties:

3.3.3.1 Determination of Moisture Content [ASTM D4442-92 (method A)] and Specific Gravity [ASTM D2395-93] [12, 20]

Each of the prepared test specimens was weighed and measured for the dimension accurately, then dried overnight in oven at 103(2(C. After that, the dried specimens were cooled down in the dessicator, weighed and measured again. The weight and dimension or volumetric of wood composites specimens were calculated for moisture content and specific gravity using the following formula:

$$\textbf{Moisture Content} = [W_0 - W_1 / W_1] \times 100$$

Where W_o = Weight before drying

W_1 = Weight after drying

$$\textbf{Specific Gravity} = KW / [1 + (M/100)]\ LBT$$

Where W = Weight of specimen

M = Moisture content of sample, %

L = Length of specimen

B = Width of specimen

T = Thickness of specimen

K = Constant

= 1 when weight is in g. and volume is in cm^3

3.3.3.2 Monomer Uptake and Polymer Loading (PL) [14]

Before impregnation, the specimens were dried in an oven at 105(C overnight and weighed. After impregnation, the wood composites specimens were obtained. They were weighed again, then the monomer uptake were calculated. After that, impregnated wood specimens were then wrapped in aluminium foil and sealed to minimize loss of monomer by evaporation, and then placed in an explosion-proof oven to polymerize the monomer. The obtained wood composites were weighed and calculated for the polymer loading as follows:

Monomer Uptake (%) = $[W-W_o] / W_o$

Where W = Weight of wood after soaking

W_o = Weight of untreated wood (oven dry)

Polymer Loading (%) = $[W_t-W_o] / W_o$

Where W_t = Weight of treated wood or WPC

W_o = Weight of untreated wood (oven dry)

3.3.3.3 Dimensional Stability [12, 20] The test times were investigated as follows:

Water Absorption (WA)

Wood composite specimens were weighed to 0.1 gram accuracy. Then, they were placed vertically in the vessel. The distilled water was added until the upper surface of specimens was about 25 millimeters under the surface of water. All samples were immersed in water at room temperature for various periods. After each soaking period, the samples were wiped of excess water and weighed. The water absorption value was determined for 2, 4, 8, 24, 48, 72, 144 and 168 h and calculated from the following equation:

Water Absorption (%) = $[(W_1 - W_0)/ W_0] \times 100$

Where W_1 = Weight of specimens after water soaking

W_0 = Weight of specimens before water soaking

Volumetric Swelling Coefficient (S)

The dimensional stability of impregnated wood samples, cut from longitudinally, was evaluated with volumetric swelling coefficient (S) values and thickness swelling in water values using changes in tangential, radial, and longitudinal dimensions after 7 days of soaking in water. Dimensional stability was expressed as S and thickness swelling in water values was determined from the following equation:

$$\textbf{Volumetric Swelling Coefficient (S)} = [V - V_0] / V_0$$

Where V = Wood volume after water soaking

V_0 = Wood volume before water soaking

$$\textbf{Thickness Swelling in Water (\%)} = [(T - T_0 / T_0)] \times 100$$

Where T = Thickness after water soaking

T_0 = Thickness before water soaking

The dimension of specimens used to test for water absorption, volumetric swelling coefficient, thickness swelling in water, and specific gravity were shown in Figure 3.2

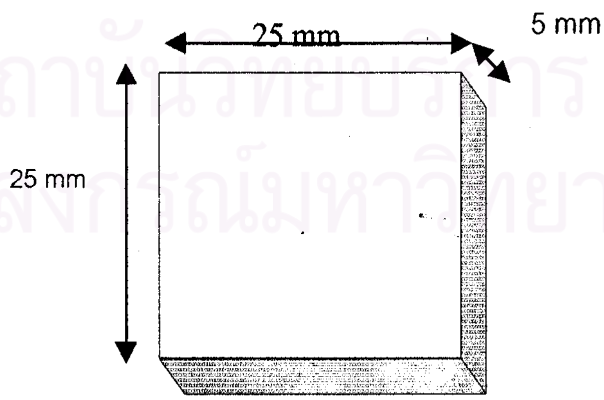


Figure 3.2 Dimensions of testing specimen

3.3.4 Mechanical Properties

Mechanical properties are measured as follows:

3.3.4.1 Flexural Strength and Modulus of Elasticity (MOE) [ASTM D3043-87]

Width and thickness of wood composites specimens were measured and entered these values to the software of testing machine before running the test. Then flexure stress and modulus of elasticity values were obtained. The MOE corresponds to the slope of the linear portion of the stress-strain relationship from zero to the proportional limit, can be calculated from the stress – strain curve as the change in stress causing a corresponding change in strain, as follows:

$$\textbf{Modulus of Elasticity (MOE)} = \frac{L^3 (W}{4bd^3 (S}$$

Where L = The span between the centers of supports (m)

(W = The increment in load (N)

b = The mean width (tangential direction) of the sample (m)

d = The mean thickness (radial direction) of the sample (m)

(S = The increment in deflection (m)

The dimension of testing specimen is shown in Figure 3.3

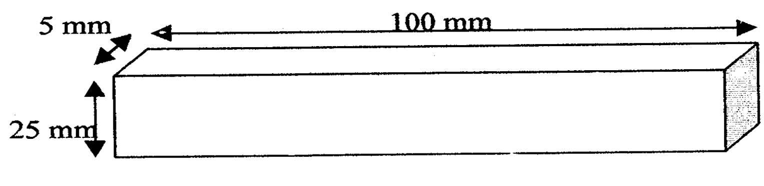


Figure 3.3 Dimension for flexure stress and MOE testing specimen

3.3.4.2 Compressive Strength [ASTM D3501]

The width and thickness of wood composites specimens were measured. Maximum load were obtained after tested. The compression parallel to grain value was calculated as follows:

$$\text{Compression parallel to grain} = \frac{P_{max}}{a \times b}$$

Where

P_{max} = The maximum load, (N)

a, b = The cross sectional dimensions of the test piece, (mm.)

The dimension of testing specimen is shown in Figure 3.4

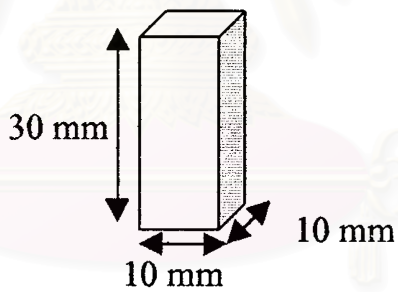


Figure 3.4 Dimension for compression parallel to grain testing specimen

3.3.5 Microstructure of WPC Specimens. [21]

Microstructure of wood – polymer composites specimens were observed by scanning electron microscope and compared with microstructure figure of natural rubberwood. The specimens were dried, then coated with gold before scanning for the observation.

3.3.6 Termite Resistance [ASTM D3345]

In this study, three types of wood, Makah-mong, Teng, and natural rubberwood were compared with treated rubberwood specimens. Prior to test, the container was prepared by washing and rinsing with antiseptic solution and dried. Each specimen was prepared as 20 (T) x 20 (R) x 10 (L) mm and then weighed before testing. The prepared specimens were placed in the bottom of containers. The cleaned sand (200 g.) was added in the container, followed by sufficient distilled water as determined by the equation below:

% water to add = % saturation – 7.0

Calculate the percent saturation as follows:

% saturation = (weight of water / oven dry weight of sand) x 100

After addition of water, the container was left overnight. The termites was weighed to 1(0.05 g. and added into prepared container with loosely closed tops. The container was maintained at room temperature for 4 weeks. After 4 weeks, the containers were disassembled and the wood blocks were removed and cleaned. The test blocks were weighed again for %weight loss and then examined visually at each block using the following rating system in Figure 3.5.

10 = Sound, surface nibbles permitted

9 = Light attack

7 = Moderate attack, penetration

4 = Heavy

0 = Failure

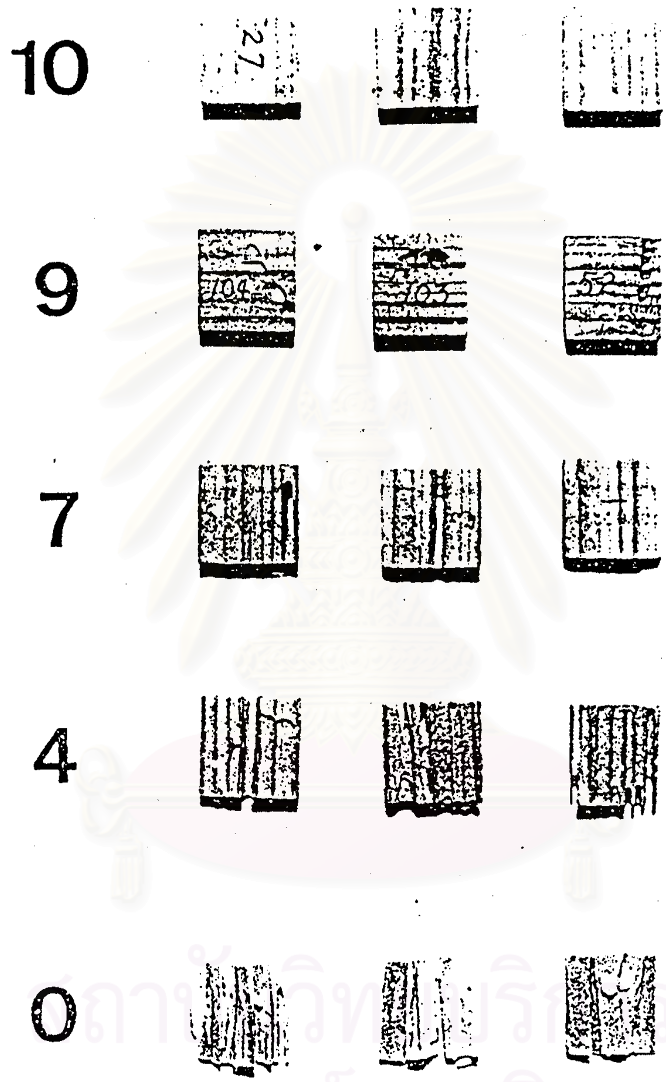


Figure 3.5 Typical ratings of termite attack on test blocks

CHAPTER 4

RESULT AND DISCUSSION

Rubberwood composites containing acrylonitrile were prepared by impregnation under reduced pressure and using either catalyst-heat or catalyst-accelerator technique to improve and enhance dimensional stability, mechanical properties, and biological resistance. The suitable conditions for preparation were investigated. Mechanical and physical properties of rubberwood composites containing acrylonitrile were tested and compared with the natural rubberwood, Teng, and Makah-mong wood.

4.1 Characteristics of Natural Rubberwood, Teng and Makah-mong

In this thesis, natural rubberwood was chosen for wood-composites and compared with Teng and Makah-mong, therefore, they should be characterized for both physical and mechanical properties before study. The results of characterization are presented in Table 4.1.

Table 4.1 Characteristic of natural rubberwood, Teng and Makah-mong

Properties	Rubberwood	Teng	Makah-mong
Specific gravity	1.18	1.44	1.26
MOE (MPa)	19,172.8	38,692.20	25,886.90
Flexure stress (MPa)	222.70	325.50	266.80
Compression (N/mm^2)	5,248	5,721	5,676

- Average data from 5 specimens for each treatment (2 replicates)

4.2 Effect of Evacuating time on the Properties of WPC

Evacuating time was the times used to evacuate air from the void spaces of wood cells. It was assumed that the longer evacuating times the more void space free of air was obtained. So it was benefit for prepolymer mixtures to penetrate the wood cells. In this study the evacuating time was varied from 0.5, 1, 2, 3 hours. The results of this experiments are shown in Table 4.2 and illustrate in Figure 4.1.

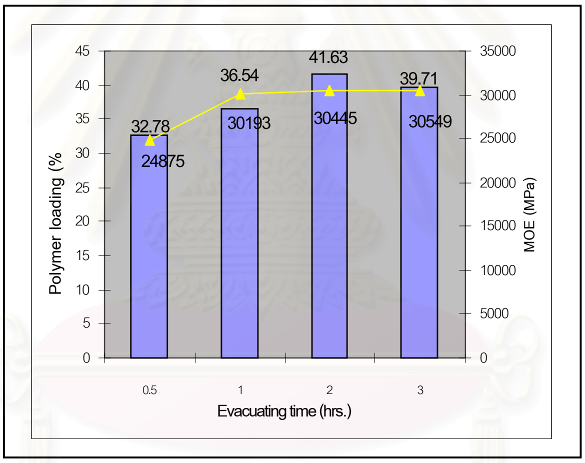
Table 4.2 Properties of rubberwood composites containing acrylonitrile prepared by varying evacuating times.

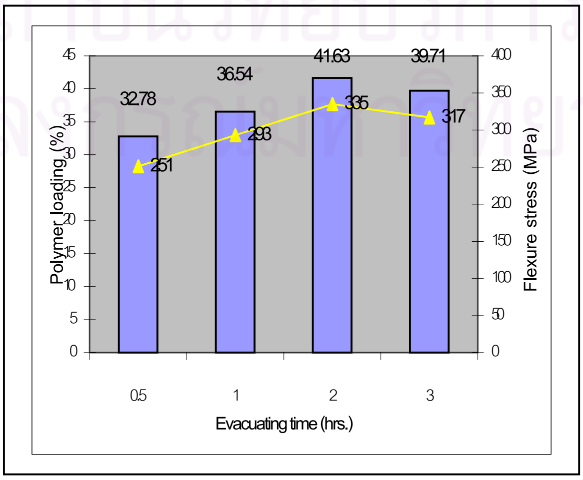
Mechanical Properties	Evacuating time (hrs.)			
	0.5	1.0	2.0	3.0
Polymer loading (%)	38.79	41.27	45.14	43.58
Specific gravity	1.31	1.38	1.42	1.40
Polymer loading (%)	32.78	36.54	41.63	39.71
MOE (MPa)	24,875	30,193	30,445	30,549
Flexure stress (MPa)	251	293	335	317
Polymer loading (%)	30.03	33.19	39.92	36.55
Compession (N/mm^2)	6,433	6,818	7,904	7,180

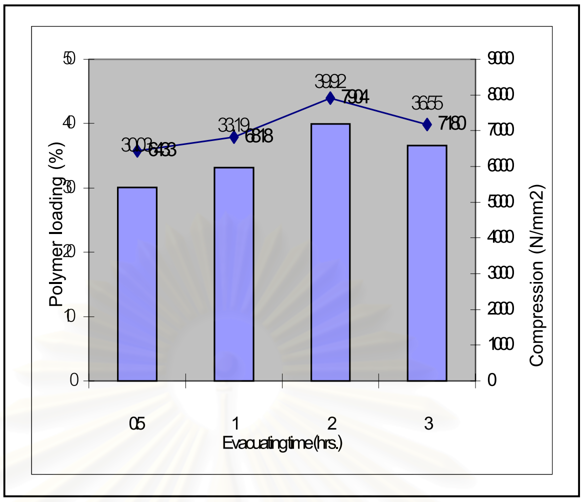
*Average data from 5 specimens for each treatment (2 replicates)

The results of mechanical properties test indicated that 2 hours evacuating time samples gave higher polymer loading than 0.5, 1, and 3 hours evacuating time. The longer evacuating time gave the ability to evacuate more air from the wood cells. This led to allow the opportunity for prepolymer mixture to penetrate into empty wood cells and retained in there. The more polymer filled in the wood cells, the higher polymer loading was obtained. Generally, samples with higher polymer loading showed greater strength than the ones with lower polymer loading. Therefore, MOE, flexure stress, and compression increased proportionally with polymer loading as shown in Figure 4.1. In addition, it was found that polymer loading was increased in accordance with specific gravity.

From all of the test results, evacuating time of 2 hours enhanced the mechanical properties of treated samples. The evacuating time at 3 hours did not give significant improvement of WPC compared to 2 hours evacuating time. Thus, the evacuating time of 2 hours was used for the preparation of rubberwood-impregnated samples in this study.







- △ = MOE, Flexure stress, and Compression values
- □ = Polymer loading

Figure 4.1 Effect of evacuating time on the mechanical properties of impregnated sample

4.3 Effect of Soaking time on the Properties of WPC

Soaking time is substantial in the impregnation process. It is the periods used to soak the sample specimens in the prepolymer mixtures. The soaking times were varied from 1, 2, 3 and 4 hours. Another impregnation parameters were fixed at 2 hours evacuating time, 5×10^{-3} torr evacuating pressure. The prepolymer mixtures contained 0.1 phr divinyl benzene, 70 phr styrene, 30 phr acrylonitrile, and 2 phr MEKPO. Properties of the impregnated samples were shown in Table 4.3 and illustrate in Figure 4.2.

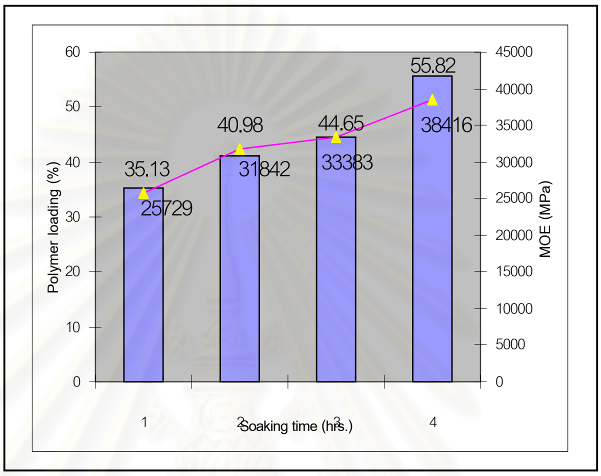
Table 4.3 Properties of rubberwood composites containing acrylonitrile prepared by varying soaking times

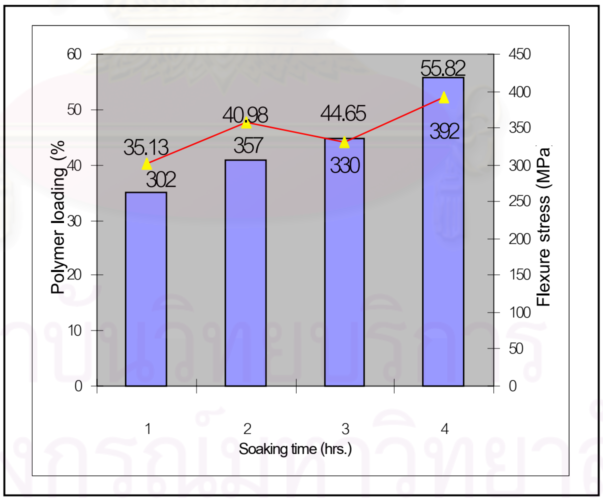
Mechanical Properties	Soaking time (hrs.)			
	1.0	2.0	3.0	4.0
Polymer loading (%)	39.24	43.10	46.68	53.47
Specific gravity	1.29	1.39	1.44	1.46
Polymer loading (%)	35.13	40.98	44.65	55.82
MOE (MPa)	25,729	31,842	33,383	38,416
Flexure stress (Mpa)	302	357	330	392
Polymer loading (%)	31.03	34.64	38.74	43.75
Compession (N/mm^2)	5,700	7,580	7,874	8,682

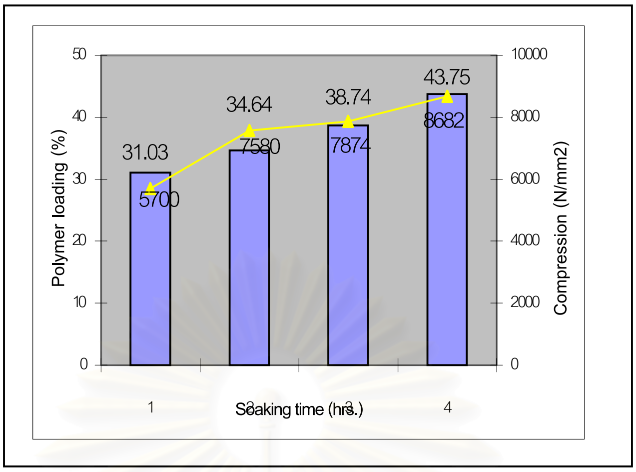
* Average data from 5 specimens for each treatment (2 replicates)

The mechanical properties of rubberwood-impregnated samples were listed in Table 4.3. Results indicated that polymer loading increased in accordance with specific gravity and MOE increased with increasing polymer loading. Notably at 3.0 hours soaking time, the flexure stress value of 44.65% polymer loading was lower than the one of 40.98% polymer loading obtained at 2.0 hours soaking time due to the difference in nature of used wood.

Compression parallel to grain of testing samples that were soaked at 1, 2, 3, and 4 hours gave 5700, 7580, 7874, and 8682 N/mm^2 compression values, respectively. The polymer loading was increased in accordance with soaking time. The higher polymer loading obtained from longer soaking time, the higher compression parallel to grain values the sample had. If the polymer contained in wood cells was high, the stiffness of the straws was increased and resulted in high compression values. But if soaking time was too long, the viscosity of prepolymer mixtures would increase. This led to the partial polymerization on the surface of wood specimen and inhibition of the monomer to penetrate into the wood cells.







- △ = MOE, Flexure stress, and Compression values
- □ = Polymer loading

Figure 4.2 Effect of soaking time on the mechanical properties of impregnated sample

Soaking time at 4 hours was the periods that treated samples showed the highest polymer loading. Therefore, 4 hours soaking time was selected to study for other impregnation parameters in the next experiment.

4.4 Effect of Initiator Content on the Properties of WPC

Methyl ethyl ketone peroxide (MEKPO) is the most widely used low temperature peroxide (20-70(C) initiators. It generates free radicals in vinyl polymerization. In this study, the prepolymer mixtures contained 0.1 phr divinyl benzene and varying initiator content from 1, 2, and 3 phr, respectively. Parameters of impregnation process were as follows: 2 hours evacuating time, 4 hours soaking time, $5x10^{-3}$ torr evacuating pressure. Impregnated samples gave the properties which presented in Table 4.4 and illustrate in Figure 4.3.

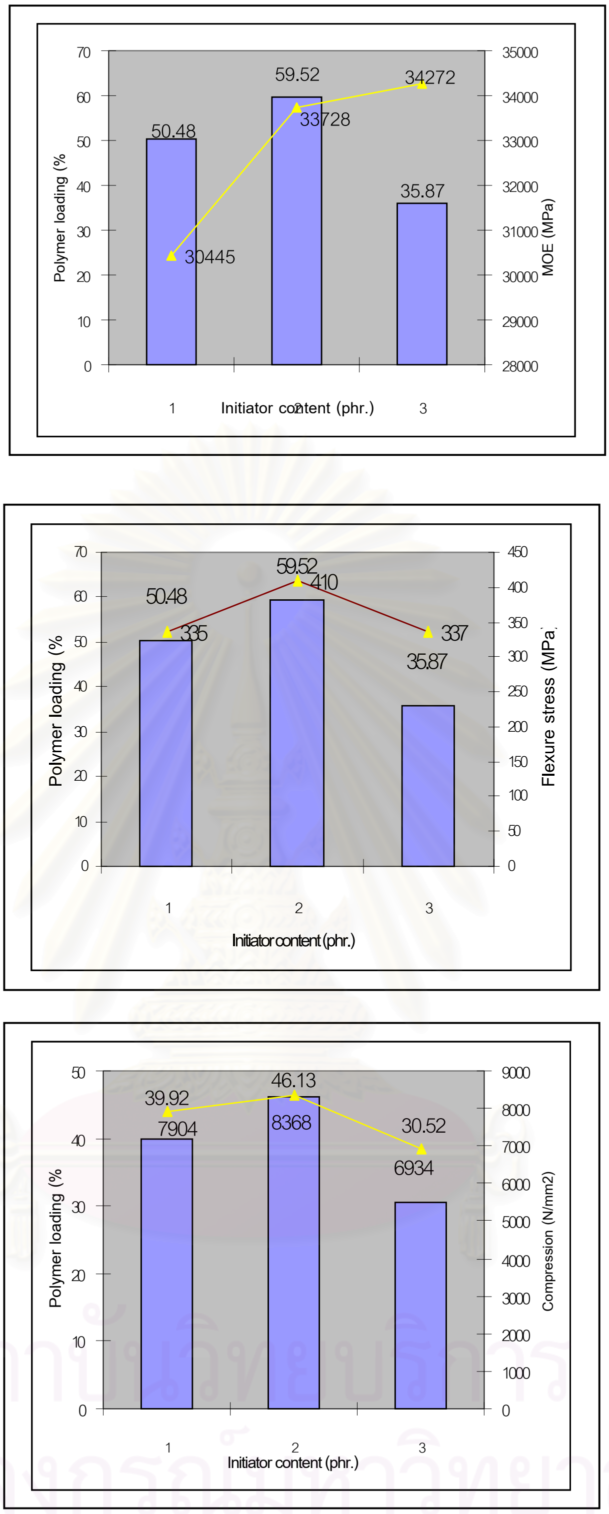
Table 4.4 Properties of rubberwood composites containing acrylonitrile prepared from various initiator content

Mechanical Properties	Initiator content (phr.)		
	1.0	2.0	3.0
Polymer loading (%)	40.89	45.73	36.51
Specific gravity	1.37	1.41	1.30
Polymer loading (%)	50.48	59.52	35.87
MOE (MPa)	30,445	33,728	34,272
Flexure stress (MPa)	335	410	337
Polymer loading (%)	39.92	46.13	30.52
Compession (N/mm^2)	7,904	8,368	6,934

* Average data from 5 specimens for each treatment (2 replicates)

The results in Table 4.2 indicated that samples with higher polymer loading showed greater compressive strength than the ones with lower polymer loading and specific gravity increased proportionally with polymer loading.

Mechanical properties of impregnated samples such as flexure stress and compression parallel to grain of samples impregnated with 2.0 phr initiator, showed the highest values. For 2.0 phr initiator which gave the highest polymer loading, but MOE values was less than MOE values at 3.0 phr initiator because of lower polymer loading. At 3.0 phr was found that viscosity of prepolymer mixture increased. This caused difficulty to penetrate of prepolymer mixture to wood cells. Thus, 2.0 phr initiator was enough for preparing of impregnated samples in this study.



- Δ = MOE, Flexure stress, and Compression values
- □ = Polymer loading

Figure 4.3 Effect of initiator content on the mechanical properties of impregnated sample

4.5 Effect of Temperature and Mixture Ratio on the Properties of WPC

The monomer ratio and temperature for WPC preparation were speculated that they had influence on the physical and mechanical properties of WPC. In this study, the impregnation parameters were fixed at 2 hours evacuating time, 4 hours soaking time, and $5x10^{-3}$ torr evacuating pressure. For catalyst-heat technique, methyl ethyl ketone peroxide (MEKPO) was used as initiators together with heat treatment at 70(C for curing and different ratios of monomer as 90:10, 80:20, and 70:30 were studied. For catalyst-accelerator technique, it was necessary to use MEKPO together with a cobalt octoate in order to cause gelation and almost complete curing at room temperature. The comparison results between a catalyst-heat method and a catalyst-accelerator method are shown in Table 4.5.

Table 4.5 Comparison on the mechanical properties between a catalyst-heat and a catalyst-accelerator technique

Sample	Catalyst-heat technique			Catalyst-accelerator technique		
	MOE (MPa)	Flexure stress (MPa)	Compression (N/mm^2)	MOE (MPa)	Flexure stress (MPa)	Compression (N/mm^2)
MAN						
90/10	**32,635.9** 10.47*	**327.8** 10.47*	**8,493** 8.11*	**62,955.8** 42.54*	**355.6** 42.54*	**9,223** 39.19*
80/20	**28,242.3** 6.61*	**284.3** 6.61*	**7,016** 4.82*	**76,715.7** 43.08*	**460.1** 43.08*	**8,521** 45.29*
70/30	**102,677.7** 7.45*	**450.1** 7.45*	**7,202** 6.26*	**33,588.8** 40.83*	**354.8** 40.83*	**8,245** 37.24*

* Polymer loading in each sample

** Average data from 5 specimens for each treatment (2 replicates)

* Polymer loading in each sample

Sample	Catalyst-heat technique			Catalyst-accelerator technique		
	MOE (MPa)	Flexure stress (MPa)	Compression (N/mm^2)	MOE (MPa)	Flexure stress (MPa)	Compression (N/mm^2)
SAN						
90/10	**37,373.3** 50.27*	**386.2** 50.27*	**9,473** 49.08*	**35,001.2** 45.90*	**347.8** 45.90*	**8,948** 50.76*
80/20	**29,696.2** 43.62*	**338.2** 43.62*	**8,676** 42.81*	**30,785.0** 48.98*	**356.6** 48.98*	**8,588** 48.46*
70/30	**31,387.8** 44.44*	**350.8** 44.44*	**8,575** 44.00*	**30,861.5** 35.47*	**363.6** 35.47*	**8,592** 40.97*

** Average data from 5 specimens for each treatment (2 replicates)

In this study, it was found that polymer loading of MAN-rubberwood composites prepared by catalyst-heat method was lower than the catalyst-accelerator method because there was a significant loss of monomer due to vaporization. This led to a much lower polymer loading and mechanical strength of these composites. Thus, MOE, flexure stress, and compression values of 80:20 and 90:10 MAN prepared using the catalyst-accelerator technique showed greater strength than the catalyst-heat technique. In some case, it would not follow the same trend, for instance, MOE and flexure stress values of 70:30 MAN by catalyst-heat method gave higher values, whereas polymer loading of this ratio was lower due to the nature of wood obtained from different parts of wood structure. Therefore, 80:20 by ratio of MAN, prepared using a catalyst-accelerator method was suitable for prepolymer mixture preparation in this experiment.

For the polymer loading of SAN-rubberwood composites prepared using the two methods, it gave similar result, at 44.78-46.02%. Moreover, it was found that this 90:10 by ratio of SAN prepared using a catalyst-heat method, was suitable for the prepolymer mixture preparation.

4.6 Study on Behavior of Dimensional Stability after Water Soaking of MAN, SAN-Rubberwood Composites, and Other Woods

In principle, dimensional stability of wood depends on many factors such as moisture content, specific gravity, wood structure, type and content of chemicals, etc. In addition, dimensional stability of wood that impregnated with SAN and MAN depended upon penetration of mixture solution into wood cells and grain orientation.

Table 4.6 Water absorption of MAN, SAN-rubberwood composites, and other woods after water-soaking test

Sample	Water Absorption (%)				
	Soaking time (hrs.)				
	24	48	72	144	168
Untreated	51.47	54.35	57.43	66.78	71.38
80:20 MAN (R.T.)	29.49	34.33	37.53	41.66	43.46
90:10 SAN (70°C)	17.67	21.51	25.11	29.65	30.85
Teng	14.73	18.08	21.38	26.11	28.19
Makah-mong	22.83	29.46	35.85	48.02	51.10

* Average data from 5 specimens for each treatment (2 replicates)

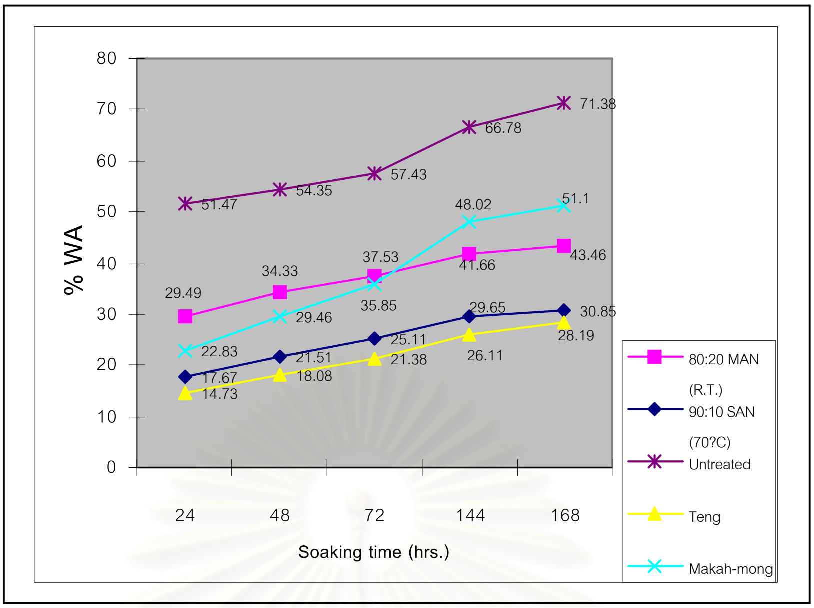


Figure 4.4 Water Absorption of treated and untreated rubberwood

The results of water absorption shown in Table 4.6 indicated that the wood impregnated with MAN and SAN gave lower water absorption values (%) than those of untreated rubberwood and Makah-mong but higher than Teng. During the first 24 hrs. of water soaking, untreated rubberwood, Teng, and Makah-mong absorbed water at about 51, 15, and 23%, respectively, whereas wood impregnated with MAN and SAN absorbed water at about 29 and 18%, respectively. During 168 hrs of water soaking, untreated rubberwood, Teng, and Makah-mong absorbed water at about 71, 28, and, 51%, respectively, whereas wood impregnated with MAN and SAN absorbed water at about 43 and 31%, respectively. From graph, it was found that the water absorption had a tendency to increase with increasing soaking time. When the fiber saturation point has been reached, the water absorption value decreased apparently as shown in Figure 4.4.

Thickness swelling in water of this study was a part of dimensional stability. Thus, thickness of samples before and after water-soaking test was determined as in the formula. The results of thickness swelling in water, percentage of water absorption, specific gravity, MOE, flexure stress, and compression were analyzed with statistic to study relationships and to compare the various properties of wood impregnated with MAN and SAN to untreated rubberwood, Teng, and Makah-mong.

4.7 Results of Analysis of Variance

Hypothesis in this study, $\mathbf{H_0 : \mu_1 = \mu_2 = \mu_3}$ (The same mean)

$\mathbf{H_1 : \mu_i \neq \mu_j \ ; i \neq j \ ; i,j = 1,2,3}$ (Mean Difference)

Significance (α) = 0.05

- Example of code 1703030 = 1 meant MAN, **7030** meant (70:30) MMA:AN and 30 meant catalyst-accelerator method

  2802070 = 2 meant SAN, **8020** meant (80:20) ST:AN and 70 meant catalyst-heat method

Code **1703070** = 70:30 MAN, catalyst-heat method

Code **1802070** = 80:20 MAN, catalyst-heat method

Code **1901070** = 90:10 MAN, catalyst-heat method

Code **1802030** = 80:20 MAN, catalyst- accelerator method

Code **1901030** = 90:10 MAN, catalyst- accelerator method

Code **2703070** = 70:30 SAN, catalyst- heat method

Code **2901070** = 90:10 SAN, catalyst-heat method

Code **2703030** = 70:30 SAN, catalyst- accelerator method

Code **2802030** = 80:20 SAN, catalyst- accelerator method

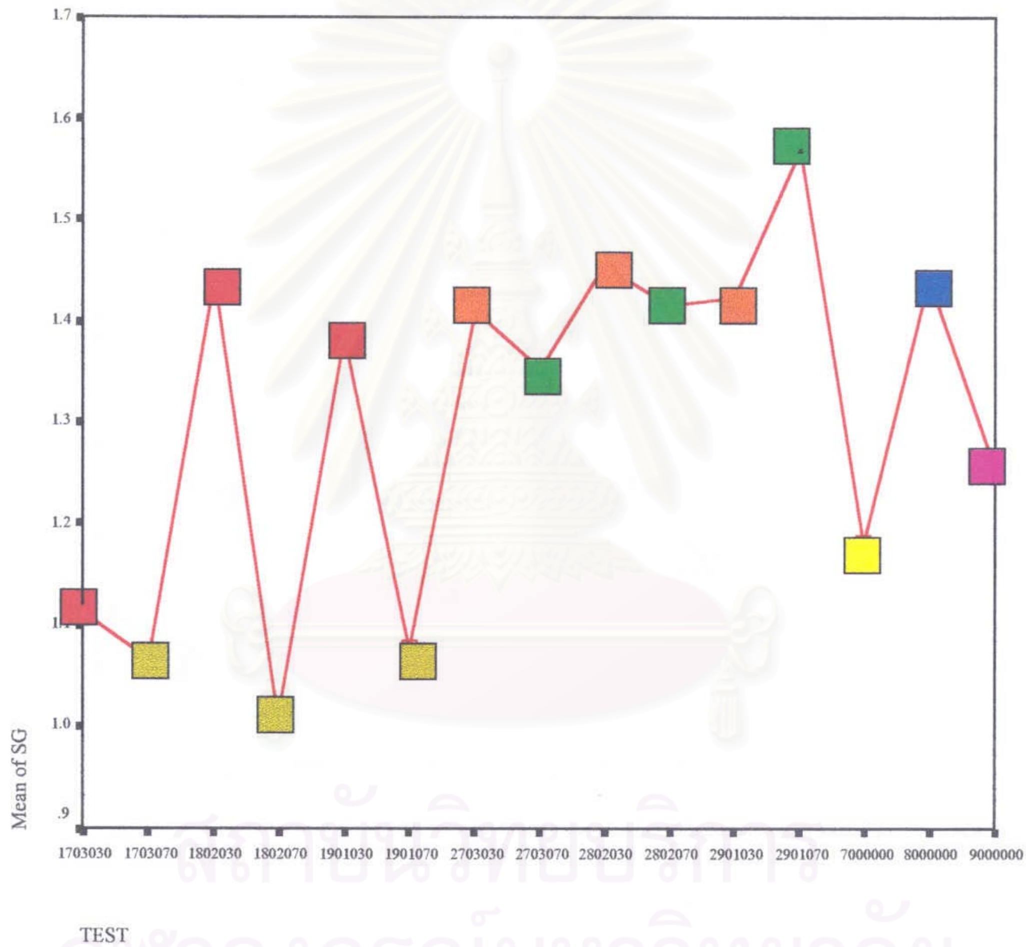
Code **2901030** = 90:10 SAN, catalyst- accelerator method

Code **7000000** = Natural rubberwood

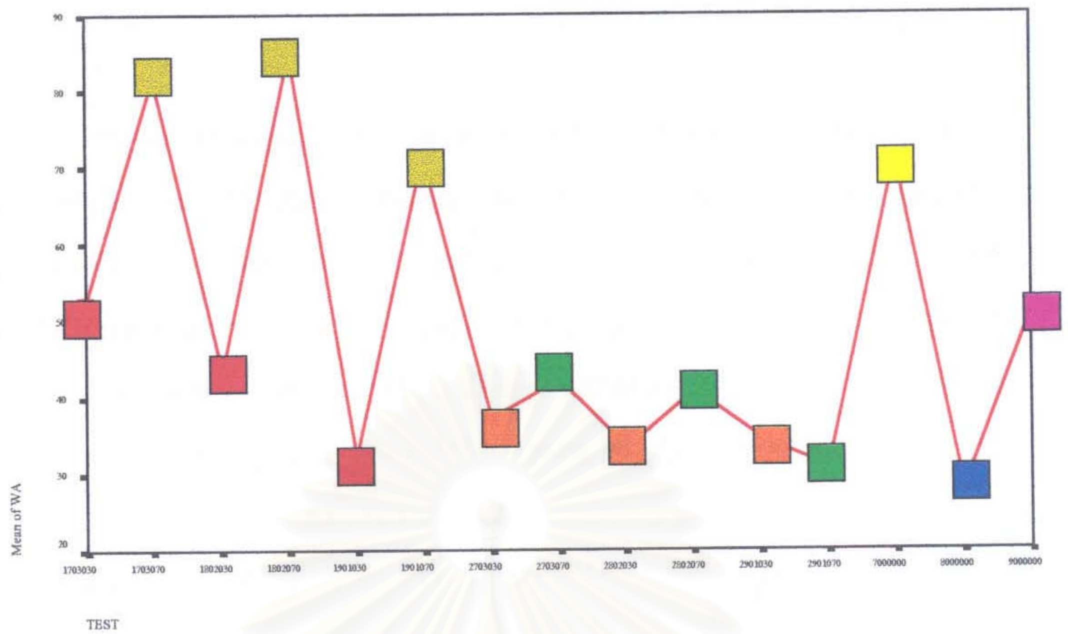
Code **8000000** = Teng wood

Code **9000000** = Makah-mong wood

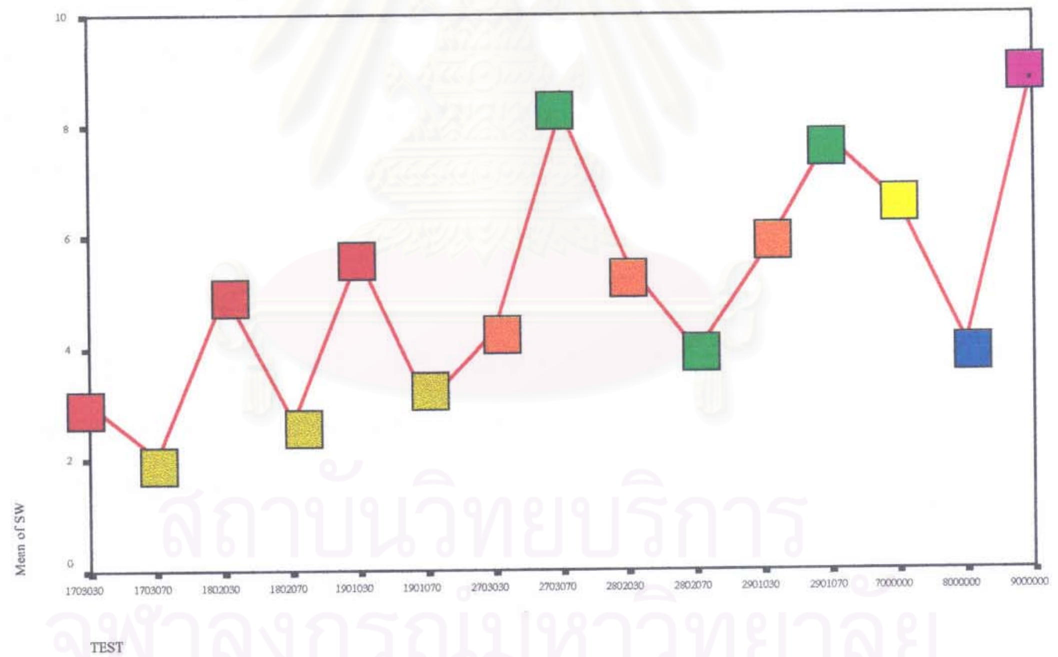
The results of analysis at 95% confidence interval were found that the mean of MOE, specific gravity, thickness swelling in water, water absorption, flexure stress, and compression of various monomer ratio and untreated rubberwood including mean of Teng and Makah-mong were different at 0.05 significance level. Thus, we could plot graph in order to gain the optimum mixture ratio for application and compare them to hardwood and untreated wood as shown Figures 4.5, 4.6, and 4.7.



a



b



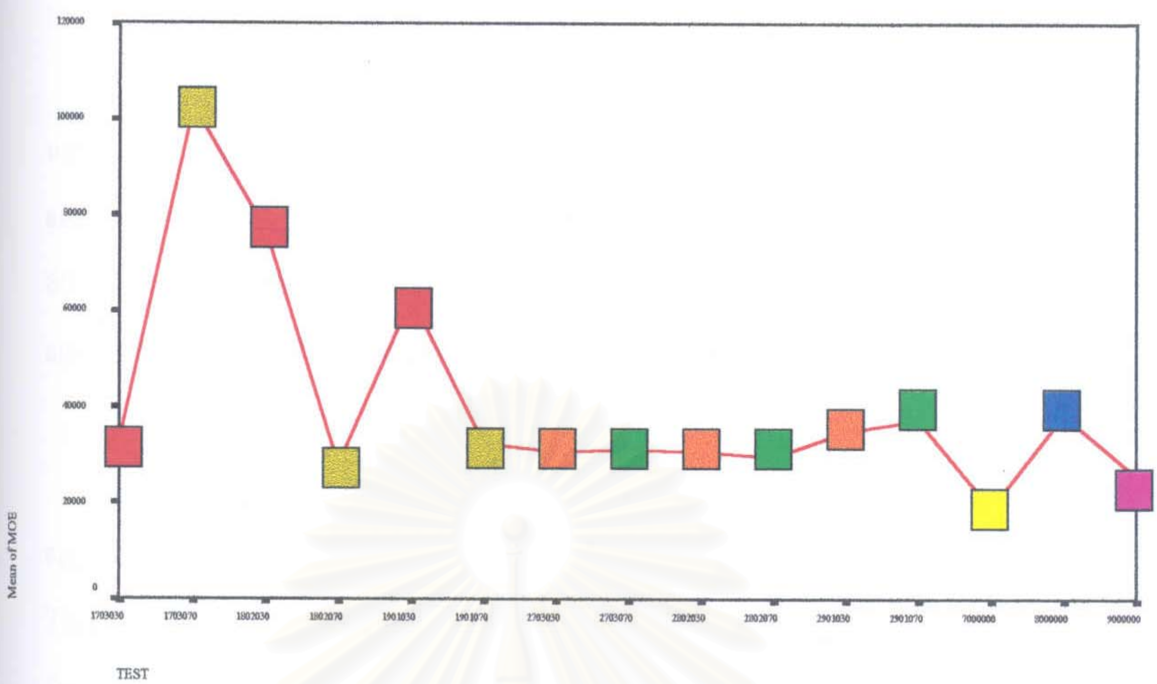
c

Figure 4.5 Graphs of specific gravity (a), water absorption (b) and swelling in water (c) of treated and untreated rubberwood

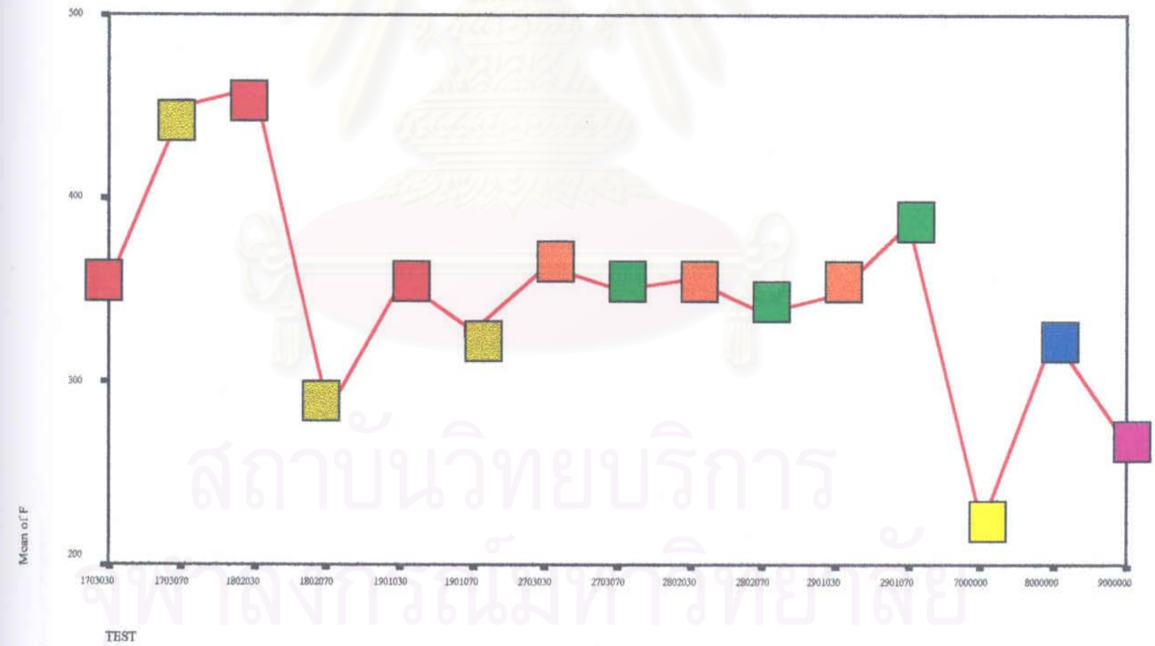
From graphs (a) and (b), it was found that the relation of specific gravity (SG) and water absorption (WA) showed the opposite trend, whereas specific gravity increased as water absorption was decreased. The reduction in WA might be due to the following causes: there was fewer void spaces in high specific gravity than in low specific gravity. As a result, less water was absorbed. For the results shown in graph (b), it indicated that %WA of wood impregnated with MAN using catalyst-accelerator method was significantly decreased as the proportion of MMA increased. This reduction of WA was due to increase in hydrophobicity, because ST and MMA were non-polar, and they hardly reacted with hydroxyl groups of cellulose molecules in wood.

When considered graphs (a) and (c), the thickness swelling in water (SW) values of treated wood increased with the increase of specific gravity due to polarity of acrylonitrile. Our findings were in agreement with the study reported by Nugroho and Ando [22] in which they indicated that SW had a tendency to increase with increasing specific gravity.

From Figure 4.5, it was found that most wood impregnated with MAN and SAN could improve dimensional stability and gave the lower WA and SW values than natural rubberwood and Makah-mong.



a



b

Figure 4.6 Graphs of MOE (a) and Flexure stress (b) of treated wood and untreated rubberwood

The result in Figure 4.6 indicated that the mixture ratio of 70:30 MAN prepared using catalyst-heat technique gave the highest MOE value and 80:20 MAN by catalyst-accelerator gave the second highest value. For flexure stress (F) value, the mixture ratio of 80:20 MAN prepared using catalyst-accelerator technique gave the highest F value. In addition, it was found that MOE and F increased with the increase of specific gravity.

The results of MOE and Flexure stress (F) value of treated rubberwood wes apparently better than natural rubberwood and Makah-mong. When they were compared to Teng, it was found that most treated rubberwood gave higher strength. Moreover, it was found that the relationships of MOE and flexure stress were in the same trend.

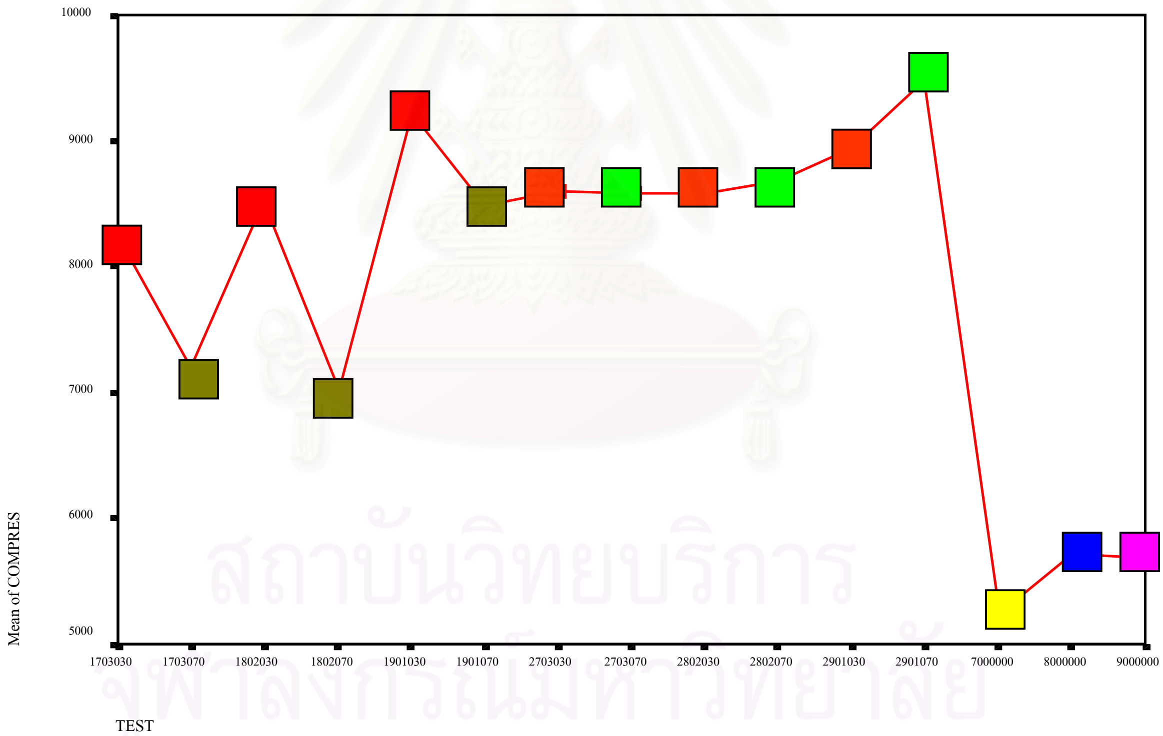


Figure 4.7 Graph of compression parallel to grain of treated and untreated rubberwood

The result in Figure 4.7 indicated that the compression of treated rubberwood were higher than natural rubberwood, Makah-mong, and Teng. The mixture ratio of 90:10 SAN prepared using catalyst-heat method gave the highest compression value due to strength of styrene. and 90:10 MAN by catalyst-accelerator gave the second highest value. Moreover, it was found that compression parallel to grain increased in accordance with specific gravity.

The catalyst–accelerator method is superior to the catalyst-heat method because there is no significant loss of monomer due to vaporization and this method is easy to operate and save the energy because it can operate at room temperature. The preparation time for WPC using the catalyst-accelerator method is shorter than catalyst-heat method.

4.8 Evaluation of WPC Specimens for Fungi and Termite Resistance

Wood is subject to deterioration by fungi, insects, marine organisms, and other destructive agencies. The most important cause of wood loss is the decay. Wood preservatives have proven to be effective in preventing the invasion of biological agents and wood destroying organisms, such as wood decay fungi, bacteria, and wood destroying insects, including termites. In this experiment, four types of woods were controlled in the same condition such as untreated rubberwood, Teng, Makah-mong, treated rubberwood. The results are shown in Table 4.7 and 4.8.

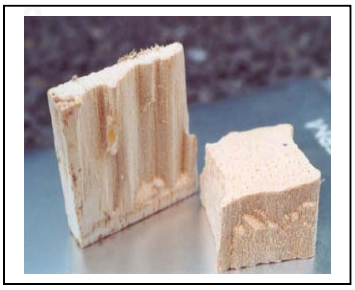
Table 4.7 The results of wood before and after testing for termite resistance

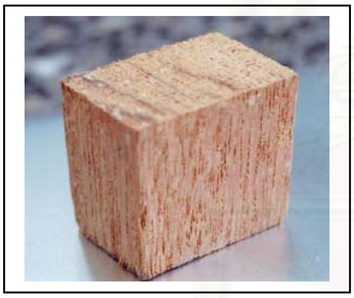
Types of wood	Weight before test (g.)	Weight after test (g.)	Weight loss (%)
Untreated rubberwood	3.29	2.07	37.08
MAN-treated rubberwood	4.30	4.28	0.47
Makah-mong	4.27	4.26	0.23
Teng	4.49	4.47	0.45

* Average data from 2 specimens for each treatment (2 replicates)

From Table 4.7 the results of termite resistance were found that the weight loss of untreated rubberwood was the highest value about 37.08% by weight. MAN-treated rubberwood, Makah-mong, and Teng was about 0.47, 0.23, and 0.45% by weight, respectively.

Table 4.8 The results of rating of termite attack

Types of wood	Rating of termite attack*
 **Untreated rubberwood**	**4**

Types of wood	Rating of termite attack*
 **MAN-treated rubberwood**	**10**
 **Makah-mong**	**10**
 **Teng**	**10**

*Typical ratings of termite attack on test blocks (**10** = sound, surface nibbles permitted, **9** = light attack, **7** = moderate attack, penetration, **4** = heavy, and 0 = failure)

From this experiment, in the container that contained untreated rubberwood, rubberwood treated with MAN, Teng, and Makah-mong, it was found that untreated rubberwood was more susceptible to fungal and termites attack than others. The MAN-treated rubberwood was quite resistant to fungal and termites attack because it had hardly been damaged. Remarkable percentage weight loss of MAN-treated rubberwood, at about 0.47% by weight, supported the earlier conclusions on termite resistance of treated rubberwood.[17] Moreover, it attributed to a physical reduction of wood hygroscopicity and inhibition of fungal spread. For Teng and Makah-mong, it was found that weight losses were about the same as treated rubberwood. Therefore, the rubberwood impregnated with MAN was more resistant to fungi and termites than untreated rubberwood.

Figure 4.8 Deterioration of untreated rubberwood by fungi

4.9 Scanning Electron Microscopy (SEM) of WPC

The microstructure of rubberwood-composites containing acrylonitrile (SAN and MAN)were examined by scanning electron microscopy (SEM) of transverse sections of the specimens. The microstructure of untreated rubberwood cells were shown in Figure

4.9 and the microstructures of impregnated rubberwood cells were shown in Figures 4.10 and 4.11 for comparison.

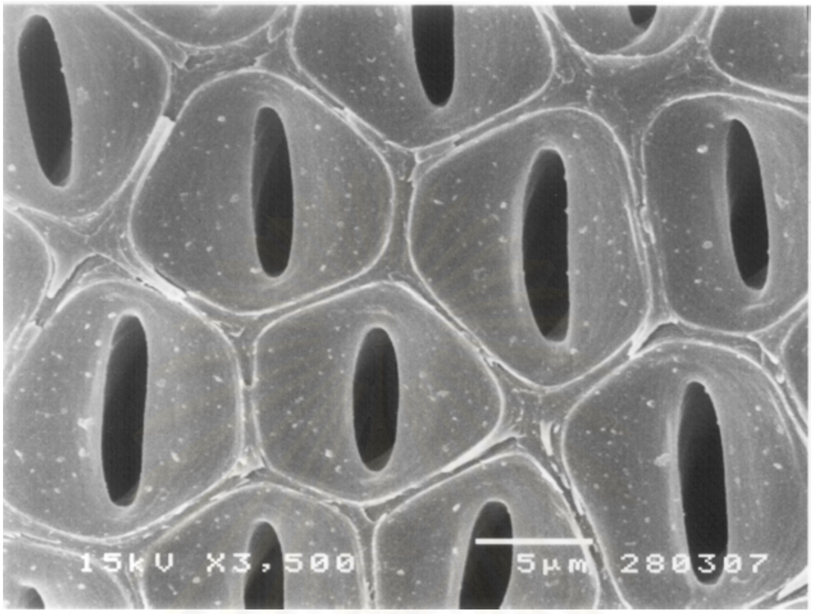


Figure 4.9 Scanning electron microscopy of transverse section of empty rubberwood cells (5,000X).

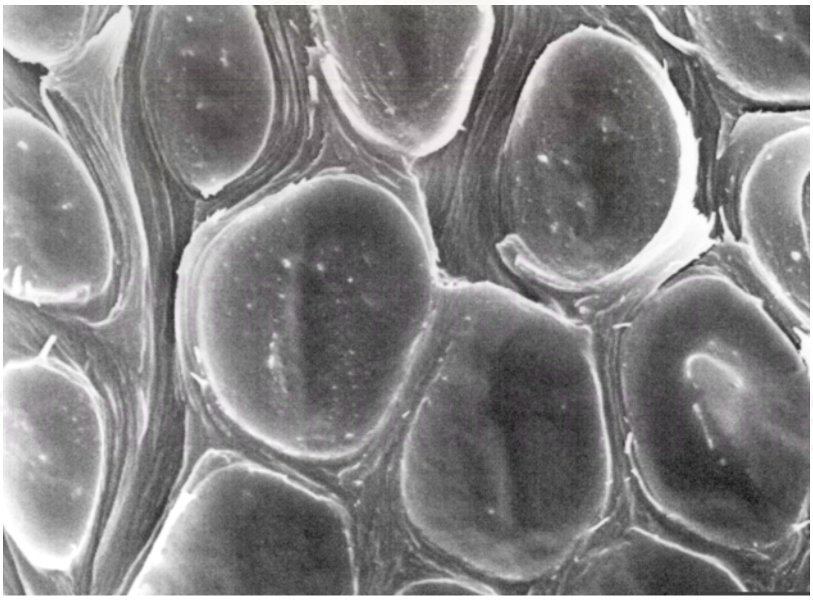


Figure 4.10 Scanning electron microscopy of transverse section of MAN-treated rubberwood cells (3,500X).

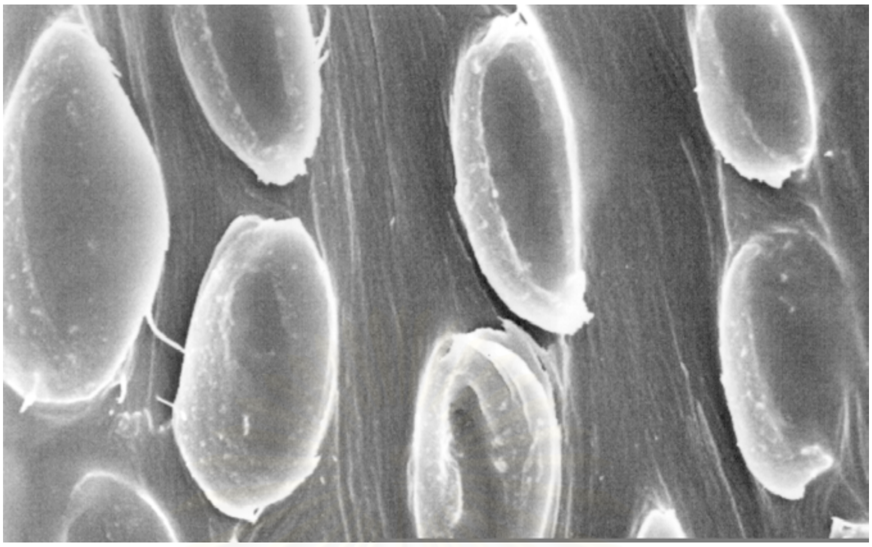


Figure 4.11 Scanning electron microscopy of transverse section of SAN-treated rubberwood cells (3,500X).

The microstructure of untreated rubberwood cells in Figure 4.9 showed the empty void spaces in wood cells. The test pieces for the SEM in Figures 4.10 and 4.11 are shown that wood cells were filled to the same extent in all parts of this specimen and that the polymer is distributed uniformly throughout the treated specimen. This observation was agreed well with the work of Kasamchainanta on durianwood.[19] There was important consequence on improvement in dimensional stability and mechanical properties of natural wood.

4.10 Application of Rubberwood-Composites Containing Acrylonitrile

In this study, the rubberwood impregnated with MAN and SAN could be improved both physical and mechanical properties better than some hardwoods as shown in Table 4.9

Table 4.9 Comparison of the properties of MAN-rubberwood composites with other woods

Properties	Specific gravity (g/cm^3)	MOE (MPa)	Flexure stress (MPa)	Compression (N/mm^2)
Makah-mong	1.26	25,886.9	266.8	5,676
Teng	1.44	38,692.2	325.5	5,721
Untreated rubberwood	1.18	19,172.8	222.7	5,248
MAN-rubberwood composites	1.44	76,715.7	460.1	8,521
SAN-rubberwood composites	1.57	37,373.3	386.2	9,473
PAN-rubberwood composites	1.01	25,241.4	258.6	5,711
PMMA-rubberwood composites	1.55	27,993.5	342.2	9,471
PS-rubberwood composites	1.57	27,606.9	328.7	9,138
Epoxy-rubberwood composites [18]	0.86	9,271.0	154.0	7,200
UPR-durianwood composites [19]	0.84	11,790.0	180.0	7,590

* Average data from 5 specimens for each treatment (2 replicates)

From Table 4.9 it indicated apparently that the rubberwood impregnated with MAN could enhance the mechanical and physical properties better than other woods.

Therefore, treated rubberwood had good potential to be applied as construction material, furniture, household equipment, etc.

Figure 4.12 is an example of parquet that prepared from rubberwood impregnated with MAN.

Figure 4.12 Parquet production from MAN-rubberwood composites

CHAPTER 5

CONCLUSION

In this research, the wood-polymer composites that prepared from rubberwood impregnated with MAN and SAN could improve both physical and mechanical properties. The chosen technique is the impregnation under reduced pressure followed by resin curing using either a catalyst-accelerator or a catalyst-heat method to obtain rubberwood-composites that have good properties.

The catalyst–accelerator method is superior to the catalyst–heat method as it allows the *in situ* polymerization of the monomer to be initiated at room temperature, resulting in virtually no loss of monomer during the initiation process since heating is not required to decompose the peroxide initiators. This reduced the potential for damage to wood, for instance, not to change its color. In addition, the selected method depended on monomer used.

The optimum condition for MAN-rubberwood composites prepared using catalyst-accelerator method was as follows:

Methylmethacrylate monomer	80 phr.
Acrylonitrile monomer	20 phr.
Methyl ethyl ketone peroxide	2 phr.
Divinyl benzene	0.1 phr.
Cobalt octoate	0.1 phr.
Evacuating time	2 hrs.
Soaking time	4 hrs.
Evacuating pressure	$5x10^{-3}$ torr.

The optimum condition for SAN-rubberwood composites prepared using catalyst-heat method was as follows:

Styrene monomer	90	phr.
Acrylonitrile monomer	10	phr.
Methyl ethyl ketone peroxide	2	phr.
Divinyl benzene	0.1	phr.
Evacuating time	2	hrs.
Soaking time	4	hrs.
Evacuating pressure	$5x10^{-3}$	torr.

The method of treating the rubberwood-composites to achieve the desired level of penetration may vary depending upon the kind of wood, grain orientation, soaking time, evacuating time, concentration of monomer mixture.

SAN and MAN-rubberwood composites had better dimensional stability, MOE, flexure stress, and compression parallel to grain than natural rubberwood and Makah-mong wood at 95% confidence significantly.

Resistance to fungi and termite of WPC was improved after testing compared with untreated rubberwood, Teng, and Makah-mong. The results showed that wood impregnated with monomer could resist termite and fungi attack remarkably in one month as well as Teng and Makah-mong.

Expected benefits

The obtained rubberwood is very environmentally resistant and has good potential to be used for furniture, household appliances, toys, parquet, picture frame, and construction materials. This can expand rubberwood market and makes rubberwood more popular in wood industry. Additionally, this will increase export value and greatly generate national income. Moreover, this research gives a guideline in development of rubberwood-polymer composites in the future.

Suggestion for Future Work

The manufacture of rubberwood-composites containing acrylonitrile appears to be technically feasible. It is recommended that further work should be done to improve in the impregnation process and enlarge scale for parquet production including toys and household appliances, etc.

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APPENDICES

APPENDIX A

DATA OF TESTING PROPERTIES

Table A The parameters for preparation of rubberwood - composites containing acrylonitrile

WPC	Temperature	Initiator content(%)	Monomer ratio	Evacuating time (hrs.)	Soaking time(hrs.)
A	R.T.	2%	70:30	0.5	1.0
B	R.T.	2%	70:30	0.5	2.0
C	R.T.	2%	70:30	0.5	2.0
D	R.T.	2%	70:30	0.5	3.0
E	R.T.	2%	70:30	0.5	4.0
F	R.T.	2%	70:30	1.0	2.0
G	R.T.	2%	70:30	1.0	3.0
H	R.T.	2%	70:30	1.0	4.0
I	R.T.	2%	70:30	2.0	2.0
J	R.T.	3%	70:30	2.0	3.0
K	R.T.	2%	70:30	2.0	4.0
L	R.T.	2%	80:20	2.0	4.0
M	R.T.	2%	90:10	2.0	4.0
N	R.T.	2%	70:30	3.0	2.0
O	R.T.	2%	70:30	3.0	3.0
P	R.T.	2%	70:30	3.0	4.0
Q	R.T.	2%	70:30	2.0	3.0
R	R.T.	1%	70:30	2.0	3.0
S	R.T.	3%	70:30	2.0	4.0
T	R.T.	1%	70:30	2.0	4.0

Table A - 1 Testing properties of natural rubberwood

Physical properties					Mechanical properties		
Sample / piece	Specific gravity	Water absorption	Swelling Coefficient	Swelling in water	Modulus of elasticity	Flexure stress	compression
(unit)	(g/cm)	(%)	(%)	(%)	(Mpa)	(Mpa)	(N/mm)
1./1	1.26	82.17	12.75	3.70	7807	112	6000
1./2	1.17	72.20	7.21	3.37	23821	282	5040
1./3	1.1	81.89	11.76	6.25	13556	201	4940
1./4	1.04	92.34	13.66	8.64	20129	200	5160
1./5	1.29	63.44	9.58	8.33	20107	252	5100
average.	1.17	78.41	10.99	6.06	17084.00	209.40	5248.00
2./1	1.24	51.77	8.57	7.67	20529	226	5140
2./2	1.25	68.91	7.37	4.17	17540	184	5360
2./3	1.11	67.44	11.11	7.33	21737	263	5100
2./4	1.16	65.74	8.87	8.33	25260	272	5300
2./5	1.19	67.92	10.93	8.33	21242	235	5340
average.	1.19	64.36	9.37	7.17	21261.60	236.00	5248.00
average.	1.18	71.38	10.18	6.61	19172.80	222.70	5248.00
S.D.	0.01	9.94	1.15	0.78	2954.01	18.81	0.00

Table A - 2 Testing properties of Teng wood

Physical properties					Mechanical properties		
Sample / piece	Specific gravity	Water absorption	Swelling Coefficient	Swelling in water	Modulus of elasticity	Flexure stress	compression
(unit)	(g/cm)	(%)	(%)	(%)	(Mpa)	(Mpa)	(N/mm)
1./1	1.42	27.68	6.40	2.39	35144	320	6260
1./2	1.46	27.99	13.11	9.55	28403	288	5060
1./3	1.36	28.72	2.90	0.51	31311	299	5540
1./4	1.5	28.46	7.30	3.06	72933	338	5110
1./5	1.52	28.32	8.51	4.75	30082	319	5900
average.	1.45	28.23	7.64	4.05	39574.60	312.80	5574.00
2./1	1.42	27.96	5.61	2.94	34052	309	5250
2./2	1.45	28.02	7.46	4.11	33389	312	7170
2./3	1.43	28.67	8.26	5.28	34217	337	5180
2./4	1.38	27.98	8.94	4.87	38308	351	5940
2./5	1.48	28.14	9.63	3.72	49083	382	5800
average.	1.43	28.15	7.98	4.18	37809.80	338.20	5868.00
average.	1.44	28.19	7.81	4.12	38692.20	325.50	5721.00
S.D.	0.01	0.06	0.24	0.09	1247.90	17.96	207.89

Table A - 3 Testing properties of Makah - mong wood

	Physical properties				Mechanical properties		
Sample / piece	Specific gravity	Water absorption	Swelling Coefficient	Swelling in water	Modulus of elasticity	Flexure stress	compression
(unit)	(g/cm)	(%)	(%)	(%)	(Mpa)	(Mpa)	(N/mm)
1./1	1.34	47.86	1.04	10.74	27375	250	5440
1./2	1.33	51.52	10.00	9.67	22324	250	5860
1./3	1.22	48.39	12.32	12.46	28399	274	5540
1./4	1.15	52.57	6.31	6.67	22558	270	6140
1./5	1.29	52.87	0.99	11.90	27577	292	5370
average.	1.27	50.64	6.13	10.29	25646.60	267.20	5670.00
2./1	1.12	53.38	2.88	5.39	32713	312	5840
2./2	1.24	51.19	6.89	8.17	19825	246	5320
2./3	1.29	50.63	7.65	7.14	27375	250	5660
2./4	1.31	51.95	4.36	9.25	22324	250	5560
2./5	1.28	50.68	5.67	8.48	28399	274	6030
average.	1.25	51.57	5.49	7.69	26127.20	266.40	5682.00
average.	1.26	51.10	5.81	8.99	25886.90	266.80	5676.00
S.D.	0.01	0.65	0.45	1.84	339.84	0.57	8.49

Table A-4 Testing Properties of Rubberwood - MAN (80:20) Composites. (Temp = 70)

Dimensional Stability						Mechanical Properties				
Sample / piece	Polymer Loading	Moisture Content	Specific Gravity	Water Absorption	Swelling in water	Polymer Loading	Modulus of Elasticity	Flexure stress	Polymer Loading	Compressive Strength
unit	%	%	(g./cm.)	%	%	%	MPa	MPa	%	N / mm2
1./1	5.53	6.91	0.97	91.7	4.80	6.20	30114	284	4.31	9210
1./2	5.12	6.69	1.06	76.78	1.92	7.16	24360	291	4.21	8440
1./3	5.49	7.17	0.98	85.1	5.39	8.14	17212	198	3.70	6580
1./4	4.93	5.83	1.03	88.03	1.54	5.17	24790	288	4.30	7780
1./5	7.00	5.35	1.03	86.92	0.24	6.49	31226	267	4.94	5790
Averg.	5.61	6.39	1.01	85.71	2.78	6.63	25540.40	265.60	4.29	7560.00
2./1	5.65	7.51	0.98	82.14	2.55	6.26	27867	281	5.05	7200
2./2	5.72	6.94	1.04	86.27	3.89	8.26	29204	284	6.22	5920
2./3	5.98	6.22	1.01	85.96	2.95	4.98	27268	263	5.42	7380
2./4	6.28	5.93	0.97	84.02	2.04	7.03	29580	295	5.82	6840
2./5	6.97	6.26	1.02	83.59	1.56	6.42	40802	392	4.23	5020
Averg.	6.12	6.57	1.00	84.40	2.60	6.59	30944.20	303.00	5.35	6472.00
Averg.	5.87	6.48	1.01	85.05	2.69	6.61	28242.30	284.30	4.82	7016.00
SD.	0.36	0.13	0.01	0.93	0.13	0.03	3821.06	26.45	0.75	769.33

Table A-5 Testing Properties of Rubberwood - SAN (80:20) Composites. (Temp = 70)

	Dimensional Stability					Mechanical Properties				
Sample / piece	Polymer Loading	Moisture Content	Specific Gravity	Water Absorption	Swelling in water	Polymer Loading	Modulus of Elasticity	Flexure stress	Polymer Loading	Compressive Strength
unit	%	%	(g./cm.)	%	%	%	MPa	MPa	%	N / mm2
1./1	35.48	6.45	1.34	47.02	4.98	41.73	19892	297	42.93	7060
1./2	34.60	8.02	1.45	42.63	1.65	40.89	43474	387	41.12	9150
1./3	33.19	10.92	1.32	43.22	4.53	40.90	25192	283	45.45	9150
1./4	36.72	7.81	1.38	41.43	3.73	40.78	25199	336	44.69	7300
1./5	35.82	9.70	1.49	36.54	5.70	41.96	43906	366	41.46	8920
Averg.	35.16	8.58	1.40	42.17	4.12	41.25	31532.60	333.80	43.13	8316.00
					4.71					
2./1	33.21	7.55	1.52	32.29	5.20	46.45	27783	337	45.45	9150
2./2	28.27	6.33	1.34	49.34	4.71	46.82	30228	368	40.18	9940
2./3	36.76	8.30	1.49	32.95	3.41	43.88	26302	306	42.65	8900
2./4	37.60	6.61	1.43	42.94	2.71	47.90	35401	409	42.94	7210
2./5	36.25	9.17	1.40	41.90	2.87	44.87	19585	293	41.20	9980
Averg.	34.42	7.59	1.44	39.88	3.78	45.98	27859.80	342.60	42.48	9036.00
Averg.	34.79	8.09	1.42	41.03	3.95	43.62	29696.20	338.20	42.81	8676.00
SD.	0.53	0.70	0.03	1.62	0.24	3.35	2597.06	6.22	0.46	509.12

Table A-6 Testing Properties of Rubberwood - SAN (70:30) Composites. (Temp = 70)

Dimensional Stability						Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g /cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	34.45	8.77	1.41	40.13	11.11	44.78	29697	298	44.81	8240
1./2	35.71	9.12	1.28	39.08	7.32	40.32	29096	360	44.02	9220
1./3	39.74	8.69	1.35	40.63	12.12	45.89	31583	373	43.92	8740
1./4	34.84	8.04	1.32	46.44	6.97	47.21	42672	428	46.24	8500
1./5	55.90	8.72	1.35	45.57	6.87	45.24	27145	359	43.78	7580
Averg.	40.13	8.67	1.34	42.37	8.88	44.69	32038.60	363.60	44.55	8456.00
2./1	36.49	9.05	1.39	42.59	7.49	44.59	34369	369	38.54	7900
2./2	38.57	8.54	1.32	44.01	7.33	46.76	31564	356	41.38	8850
2./3	39.45	8.72	1.40	43.85	7.28	42.48	26279	336	43.56	9840
2./4	38.62	9.02	1.37	40.52	7.89	48.16	26998	308	49.13	8740
2./5	39.08	8.23	1.34	40.31	8.26	38.99	34475	321	44.57	8140
Averg.	38.44	8.71	1.36	42.26	7.65	44.20	30737.00	338.00	43.44	8694.00
Averg.	39.29	8.69	1.35	42.31	8.26	44.44	31387.80	350.80	44.00	8575.00
SD.	1.19	0.03	0.02	0.08	0.87	0.35	920.37	18.10	0.79	168.29

Table A-7 Testing Properties of Rubberwood - MAN (90:10) Composites. (Temp = 70)

Dimensional Stability						Mechanical Properties				
Sample / piece	Polymer Loading	Moisture Content	Specific Gravity	Water Absorption	Swelling in water	Polymer Loading	Modulus of Elasticity	Flexure stress	Polymer Loading	Compressive Strength
unit	%	%	(g./cm.)	%	%	%	MPa	MPa	%	N / mm2
1./1	8.37	7.17	1.16	65.59	2.66	9.97	30979	332	7.31	9000
1./2	18.40	8.02	1.04	75.94	2.87	8.34	27835	300	8.99	8120
1./3	9.22	6.91	1.05	79.18	1.74	8.28	38868	356	8.05	7620
1./4	9.12	7.30	1.02	72.09	6.17	8.24	29204	335	7.43	9430
1./5	7.59	7.59	1.09	70.59	1.98	11.32	36006	382	7.41	8720
Averg.	10.54	7.40	1.07	72.68	3.08	9.23	32578.40	341.00	7.84	8578.00
2./1	11.32	8.02	1.10	71.32	2.33	9.88	28716	323	10.34	8650
2./2	6.90	9.96	0.98	73.71	2.89	11.57	29865	320	6.86	8420
2./3	5.56	9.92	0.98	86.92	3.56	9.97	40643	294	9.57	8600
2./4	6.52	10.00	1.20	62.88	3.09	14.65	35133	342	8.61	7750
2./5	6.17	9.88	1.15	57.68	3.12	12.51	29110	294	6.57	8620
Averg.	7.29	9.56	1.08	70.50	3.00	11.72	32693.40	314.60	8.39	8408.00
Averg.	8.92	8.48	1.08	71.59	3.04	10.47	32635.90	327.80	8.11	8493.00
SD.	2.30	1.53	0.01	1.54	0.06	1.76	81.32	18.67	0.39	120.21

Table A-8 Testing Properties of Rubberwood - MAN (70:30) Composites. (Temp = 70)

Dimensional Stability						Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	11.33	8.53	0.97	82.42	1.85	6.72	126313	498	6.08	8160
1./2	6.36	8.47	1.01	94.42	0.76	7.85	60455	323	5.88	7540
1./3	8.33	7.50	1.13	80.00	2.90	15.52	124364	592	5.38	6400
1./4	5.77	8.46	1.07	80.00	0.72	6.20	136171	453	5.91	6780
1./5	6.99	8.46	1.15	74.57	4.07	4.64	98986	504	8.65	6460
Averg.	7.76	8.28	1.07	82.28	2.06	8.19	109257.80	474.00	6.38	7068.00
2./1	8.59	8.68	1.10	80.02	1.98	6.51	90997	416	5.82	6970
2./2	7.62	8.45	1.02	81.84	1.99	6.08	122570	525	5.64	6990
2./3	7.28	8.67	1.06	82.69	2.09	8.81	78345	398	5.91	6600
2./4	7.17	8.92	1.04	81.46	2.12	6.78	140824	479	7.18	9090
2./5	6.49	8.00	1.11	80.87	1.94	5.43	47752	313	6.15	7030
Averg.	7.43	8.54	1.07	81.38	2.02	6.72	96097.60	426.20	6.14	7336.00
Averg.	7.59	8.41	1.07	81.83	2.04	7.45	102677.70	450.10	6.26	7202.00
SD.	0.23	0.18	0.00	0.64	0.03	1.04	9305.67	33.80	0.17	189.50

Table A-9 Testing Properties of Rubberwood - SAN (90:10) Composites. (Temp = R.T.)

Dimensional Stability						Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	63.51	9.95	1.32	39.13	6.10	43.79	22914	270	50.00	8500
1./2	43.71	9.79	1.55	28.47	6.10	46.96	39951	359	49.73	9780
1./3	41.63	10.20	1.42	37.46	3.75	56.23	34500	363	44.02	7470
1./4	65.73	9.86	1.42	26.91	7.50	44.93	38943	352	52.06	9780
1./5	43.64	10.17	1.36	41.89	5.00	41.02	29838	305	49.22	8540
Averg.	51.64	9.99	1.41	34.77	5.69	46.59	33229.20	329.80	49.01	8814.00
2./1	50.23	9.21	1.43	32.86	5.06	46.41	40984	413	53.68	9790
2./2	51.17	9.36	1.44	33.69	5.87	45.23	35002	409	55.74	9160
2./3	49.85	9.78	1.51	34.71	6.01	39.18	34358	322	52.43	7700
2./4	48.76	9.94	1.41	35.26	5.95	44.74	32269	383	49.47	8710
2./5	50.41	9.87	1.38	36.23	5.98	50.54	41253	302	51.23	10050
Averg.	50.08	9.63	1.43	34.55	5.77	45.22	36773.20	365.80	52.51	9082.00
Averg.	50.86	9.81	1.42	34.66	5.73	45.90	35001.20	347.80	50.76	8948.00
SD.	1.10	0.26	0.01	0.16	0.06	0.97	2505.99	25.46	2.48	189.50

	Dimensional Stability					Mechanical Properties				
Sample / piece	Polymer Loading	Moisture Content	Specific Gravity	Water Absorption	Swelling in water	Polymer Loading	Modulus of Elasticity	Flexure stress	Polymer Loading	Compressive Strength
unit	%	%	(g./cm.)	%	%	%	MPa	MPa	%	N / mm2
1./1	36.21	9.31	1.62	26.63	11.25	49.49	40969	411	48.69	9470
1./2	39.08	9.20	1.47	36.72	1.90	45.28	45958	388	46.70	7950
1./3	60.87	9.18	1.65	22.53	4.26	51.14	38867	396	52.91	8620
1./4	36.82	9.03	1.63	29.58	9.97	48.68	55904	504	41.06	10090
1./5	44.23	9.13	1.47	32.95	7.06	50.06	43752	389	41.63	10010
Averg.	43.44	9.17	1.57	29.68	6.89	48.93	45090.00	417.60	46.20	9228.00
2./1	50.21	9.36	1.56	28.14	9.64	50.28	22399	363	55.33	8950
2./2	50.25	8.37	1.59	28.69	8.96	58.78	25298	314	50.25	10010
2./3	50.19	7.60	1.65	32.63	9.33	47.31	45070	426	50.24	10090
2./4	46.09	7.82	1.58	35.54	6.22	45.16	31970	312	53.40	10000
2./5	51.07	9.01	1.47	35.10	8.99	56.52	23546	359	50.55	9540
Averg.	49.56	8.43	1.57	32.02	8.63	51.61	29656.60	354.80	51.95	9718.00
Averg.	46.50	8.80	1.57	30.85	7.76	50.27	37373.30	386.20	49.08	9473.00
SD.	4.33	0.52	0.00	1.65	1.23	1.90	10913.06	44.41	4.07	346.48

Table A-11 Testing Properties of Rubberwood - SAN (80:20) Composites. (Temp = R.T.)

	Dimensional Stability					Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	55.45	10.91	1 32	36.84	4.60	47.39	24741	295	42.05	7800
1./2	51.89	8.02	1.33	38.82	0.00	41.69	39378	393	37.97	7120
1./3	42.63	9.96	1.43	34.92	6.74	41.93	40134	449	41.99	7550
1./4	40.87	9.52	1.48	32.39	5.88	46.25	49121	465	52.88	9340
1./5	51.93	9.44	1.60	30.51	5.19	45.96	25953	325	35.00	7320
Averg.	48.55	9.57	1.43	34.70	4.48	44.64	35865.40	385.40	41.98	7826.00
2./1	53.75	8.75	1.51	29.54	7.14	53.93	25935	322	55.61	8210
2./2	54.59	7.42	1.50	31.64	7.32	52.68	19965	298	54.97	9820
2./3	53.21	7.34	1.46	33.53	7.23	56.04	26209	333	53.26	10020
2./4	41.30	9.31	1.51	34.67	7.41	51.00	30156	335	57.81	9500
2./5	38.58	8.61	1.41	32.70	3.33	52.90	26258	351	53.09	9200
Averg.	48.29	8.29	1.48	32.42	6.49	53.31	25704.60	327.80	54.95	9350.00
Averg.	48.42	8.93	1.46	33.56	5.48	48.98	30785.00	356.60	48.46	8588.00
SD.	0.19	0.91	0.03	1.61	1.42	6.13	7184.77	40.73	9.17	1077.63

Table A-12 Testing Properties of Rubberwood - SAN (70:30) Composites. (Temp = R.T.)

Dimensional Stability						Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	53.31	9.50	1.22	35.60	4.89	31.68	31764	395	36.79	7580
1./2	60.87	9.18	1.53	35.58	4.17	36.89	30158	362	43.30	7600
1./3	47.64	9.06	1.50	42.64	4.41	34.42	22527	306	40.72	9040
1./4	63.56	8.44	1.43	32.27	4.43	36.15	34268	384	35.68	7530
1./5	68.58	9.73	1.34	50.16	4.21	31.01	27269	342	45.55	9260
Averg.	58.79	9.18	1.40	39.25	4.42	34.03	29197.20	357.80	40.41	8202.00
2./1	41.22	9.89	1.45	24.41	4.27	37.51	37150	431	41.31	8340
2./2	42.50	6.67	1.50	40.81	4.12	33.40	42825	419	47.69	9240
2./3	39.91	7.73	1.32	36.84	2.94	39.87	31508	353	45.60	8880
2./4	43.21	8.23	1.49	36.20	6.41	37.03	23737	301	36.67	10020
2./5	41.02	7.81	1.32	39.08	3.25	36.76	27409	343	36.41	8430
Averg.	41.57	8.07	1.42	35.47	4.20	36.91	32525.80	369.40	41.54	8982.00
Averg.	50.18	8.62	1.41	37.36	4.31	35.47	30861.50	363.60	40.97	8592.00
SD.	12.18	0.79	0.01	2.67	0.16	2.04	2353.68	8.20	0.80	551.54

Table A-13 Testing Properties of Rubberwood - MAN (90:10) Composites. (Temp = R.T.)

	Dimensional Stability					Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	38.89	9.88	1.25	46.15	5.24	49.90	29820	337	34.54	8180
1./2	45.65	10.58	1.43	25.37	5.68	35.35	32314	277	41.00	9240
1./3	59.83	10.05	1.42	32.79	5.71	32.26	35384	354	39.52	8730
1./4	48.97	11.00	1.33	27.35	6.02	49.85	322893	369	46.38	10050
1./5	40.34	9.16	1.45	29.73	6.27	46.58	41537	370	40.87	10070
Averg.	46.74	10.13	1.38	32.28	5.78	42.79	92389.60	341.40	40.46	9254.00
2./1	40.71	10.66	1.43	33.48	5.04	42.58	36595	409	41.09	9200
2./2	45.91	11.12	1.42	34.29	5.89	58.93	30108	390	42.21	9030
2./3	46.26	10.27	1.42	31.64	5.23	37.64	33636	321	34.03	9290
2./4	42.44	9.72	1.38	32.03	5.98	34.19	31270	342	33.00	9520
2./5	43.68	10.28	1.31	31.18	5.67	38.07	36001	387	39.30	8920
Averg.	43.80	10.41	1.39	32.52	5.56	42.28	33522.00	369.80	37.93	9192.00
Averg.	45.27	10.27	1.38	32.40	5.67	42.54	62955.80	355.60	39.19	9223.00
SD.	2.08	0.20	0.01	0.17	0.16	0.36	41625.68	20.08	1.79	43.84

Table A-14 Testing Properties of Rubberwood - MAN (80:20) Composites. (Temp = R.T.)

Dimensional Stability						Mechanical Properties				
Sample / piece	Polymer Loading	Moisture Content	Specific Gravity	Water Absorption	Swelling in water	Polymer Loading	Modulus of Elasticity	Flexure stress	Polymer Loading	Compressive Strength
unit	%	%	(g./cm.)	%	%	%	MPa	MPa	%	N / mm2
1./1	42.69	9.88	1.55	36.57	5.06	37.61	39238	472	41.53	7780
1./2	35.68	9.13	1.45	41.59	3.85	42.27	35810	421	43.98	9180
1./3	30.16	9.13	1.32	48.78	5.06	49.20	31463	384	46.80	9060
1./4	22.53	9.09	1.30	52.26	3.75	34.66	25541	352	50.72	10000
1./5	34.88	9.25	1.56	37.20	7.41	35.91	35516	397	44.97	7220
Averg.	33.19	9.30	1.44	43.28	5.03	39.93	33513.60	405.20	45.60	8648.00
2./1	35.69	9.73	1.56	42.68	4.59	43.65	115121	547	46.97	8700
2./2	37.48	9.36	1.52	43.72	5.02	42.84	112498	484	41.48	7690
2./3	38.41	9.45	1.43	44.88	5.03	43.30	123520	510	51.55	8400
2./4	35.93	9.22	1.40	45.36	5.24	58.70	108532	486	44.00	8640
2./5	36.44	9.08	1.34	41.55	5.11	42.66	139918	548	40.93	8540
Averg.	36.79	9.37	1.45	43.64	5.00	46.23	119917.80	515.00	44.99	8394.00
Averg.	34.99	9.33	1.44	43.46	5.01	43.08	76715.70	460.10	45.29	8521.00
SD.	2.55	0.05	0.01	0.25	0.02	4.45	61097.00	77.64	0.43	179.61

Table A-15 Testing Properties of Rubberwood - MAN (70:30) Composites. (Temp = R.T.)

	Dimensional Stability					Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	32.43	9.91	1.02	69.23	2.35	39.11	26454	372	31.22	8180
1./2	31.58	8.65	1.19	60.40	4.92	45.62	38049	371	31.22	7140
1./3	56.28	9.77	1.08	62.50	4.37	35.21	33343	355	35.96	9280
1./4	47.87	9.95	1.12	60.29	3.29	36.47	33537	318	38.00	7800
1./5	30.98	9.41	1.14	67.48	3.66	47.74	35232	398	36.32	7640
Averg.	39.83	9.54	1.11	63.98	3.72	40.83	33323.00	362.80	34.54	8008.00
2./1	48.54	8.79	1.11	40.56	3.19	33.09	43907	352	37.61	9320
2./2	38.01	9.05	1.11	53.11	2.08	37.91	34958	345	45.95	8500
2./3	41.38	8.81	1.09	33.60	2.04	43.08	36190	353	40.56	6500
2./4	43.33	9.63	1.13	33.07	2.04	51.75	26349	383	39.49	8070
2./5	47.41	9.05	1.15	42.40	2.25	38.35	27869	301	36.02	10020
Averg.	43.73	9.07	1.12	40.55	2.32	40.84	33854.60	346.80	39.93	8482.00
Averg.	41.78	9.30	1.11	52.26	3.02	40.83	33588.80	354.80	37.24	8245.00
SD.	2.76	0.33	0.01	16.57	0.99	0.00	375.90	11.31	3.81	335.17

Table A-16 Testing Properties of Rubberwood - PAN Composites. (Temp = R.T.)

	Dimensional Stability					Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	9.38	10.71	0.94	81.63	5.52	25.25	29916	270	9.05	5970
1./2	9.78	11.56	0.94	80.56	5.91	15.54	27042	288	8.46	5810
1./3	9.66	12.18	1.00	75.09	6.14	13.12	24875	251	7.85	4940
1./4	8.16	10.61	1.04	68.68	7.39	17.32	27076	259	7.94	5820
1./5	7.38	11.07	1.11	61.17	7.23	26.91	29736	293	11.05	6940
Averg.	3.87	11.23	1.01	73.43	6.44	19.63	27729.00	272.20	8.87	5896.00
2./1	11.24	11.48	1.02	75.02	3.68	12.09	23339	243	7.77	4580
2./2	9.95	10.95	1.05	78.35	3.77	13.86	28975	260	7.94	5780
2./3	9.27	11.02	1.03	77.61	5.81	11.03	19765	239	8.19	4570
2./4	9.11	10.39	0.98	70.32	4.02	10.96	16978	235	9.07	5960
2./5	9.06	10.41	0.94	68.78	5.03	12.78	24712	248	10.96	6740
Averg.	9.73	10.85	1.00	74.02	4.46	12.14	22753.80	245.00	8.79	5526.00
Averg.	9.30	11.04	1.01	73.72	5.45	15.89	25241.40	258.60	8.83	5711.00
SD.	0.60	0.27	0.00	0.42	1.40	5.29	3518.00	19.23	0.06	261.63

Table A-17 Testing Properties of Rubberwood - PMMA Composites. (R.T.)

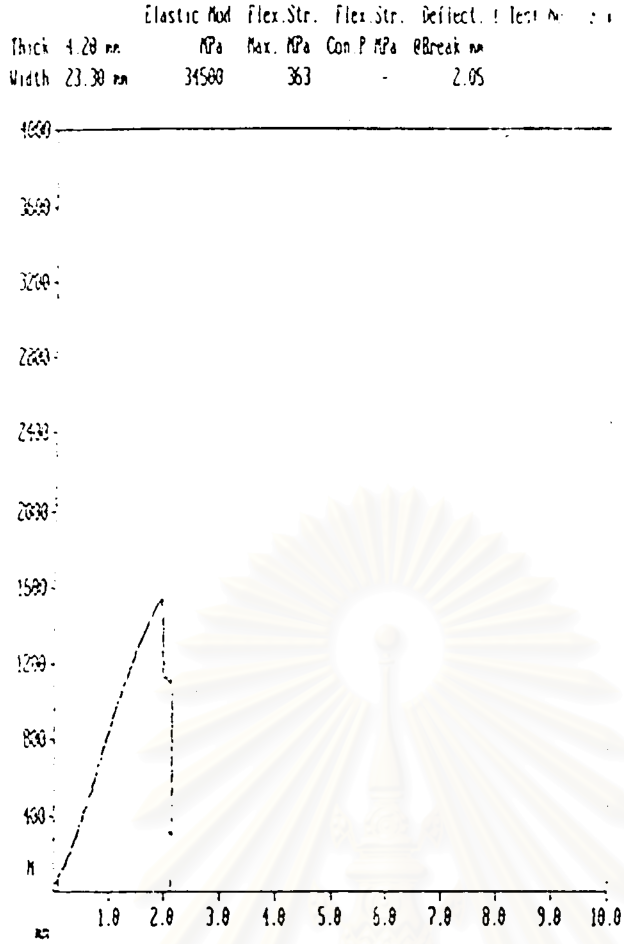
	Dimensional Stability					Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	38.55	9.64	1.43	44.06	4.17	31.33	42714	487	46.43	10060
1./2	44.14	6.75	1.52	45.31	3.38	62.78	30959	326	36.36	8910
1./3	46.84	10.13	1.57	41.38	3.19	41.54	26752	334	50.00	9530
1./4	40.16	9.45	1.49	42.13	4.21	38.70	28681	348	40.00	10160
1./5	40.00	9.80	1.67	17.09	4.73	59.36	26550	350	39.67	8380
Averg.	41.94	9.16	1.54	37.99	3.94	46.74	31131.20	369.00	42.49	9408.00
2./1	38.40	9.51	1.54	40.66	4.97	26.99	29229	372	48.69	10020
2./2	37.32	9.86	1.57	35.90	3.22	36.87	34416	418	53.04	7520
2./3	40.39	7.84	1.48	40.78	4.34	33.85	20277	208	60.42	10070
2./4	41.09	8.14	1.63	32.97	4.06	55.39	22850	293	41.35	10040
2./5	37.90	8.87	1.61	38.89	4.29	25.27	17507	286	43.75	10020
Averg.	39.02	8.84	1.57	37.84	4.18	35.67	24855.80	315.40	49.45	9534.00
Averg.	40.48	9.00	1.55	37.92	4.06	41.21	27993.50	342.20	45.97	9471.00
SD.	2.06	0.22	0.02	0.11	0.17	7.83	4437.38	37.90	4.92	89.10

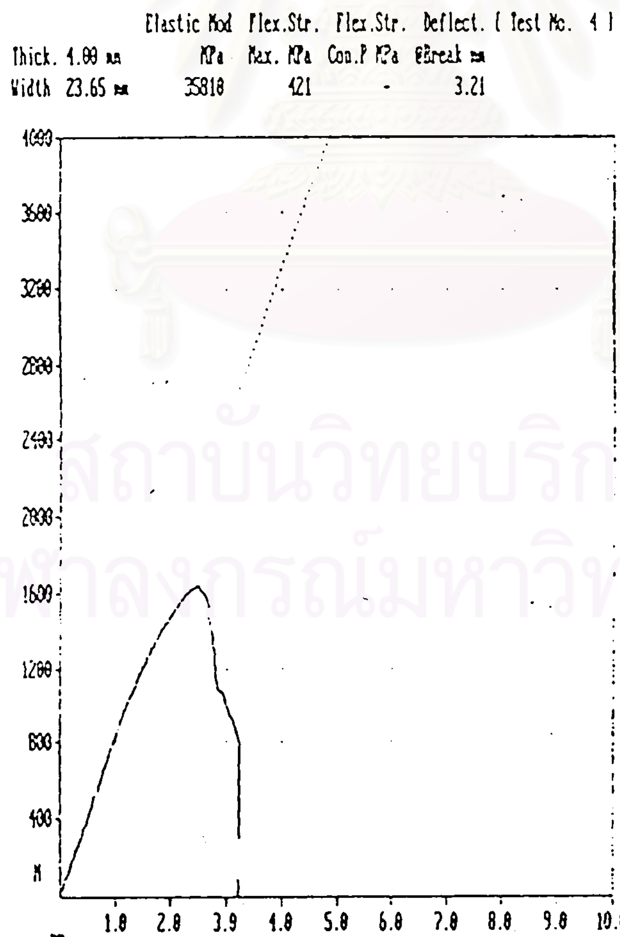
Table A-18 Testing Properties of Rubberwood - PS Composites. (Temp = R.T)

Dimensional Stability						Mechanical Properties				
Sample / piece unit	Polymer Loading %	Moisture Content %	Specific Gravity (g./cm.)	Water Absorption %	Swelling in water %	Polymer Loading %	Modulus of Elasticity MPa	Flexure stress MPa	Polymer Loading %	Compressive Strength N / mm2
1./1	36.02	9.20	1.51	35.49	1.31	43.85	27533	356	34.74	10080
1./2	48.35	9.92	1.57	33.15	2.22	51.35	23344	324	42.72	10100
1./3	34.62	10.77	1.49	39.43	4.12	43.36	24764	301	43.35	8160
1./4	36.47	10.15	1.61	32.23	6.58	37.26	29462	278	50.00	7520
1./5	51.21	10.63	1.61	30.35	5.82	53.10	27328	352	36.74	10100
Averg.	41.33	10.13	1.56	34.13	4.01	45.78	26486.20	322.20	41.51	9192.00
2./1	42.86	9.52	1.73	27.69	9.30	47.61	28927	344	64.48	9180
2./2	43.91	8.26	1.61	33.53	5.53	41.20	30092	360	37.88	8890
2./3	34.27	8.87	1.42	40.24	7.14	46.30	30285	325	52.25	8900
2./4	34.21	9.21	1.59	39.54	4.28	47.11	29146	325	37.31	8440
2./5	47.85	10.05	1.55	38.19	9.30	44.43	25188	322	40.98	10010
Averg.	40.62	9.18	1.58	35.84	7.11	45.33	28727.60	335.20	46.58	9084.00
Averg.	40.98	9.66	1.57	34.98	5.56	45.56	27606.90	328.70	44.05	9138.00
SD.	0.50	0.67	0.02	1.21	2.19	0.32	1584.91	9.19	3.59	76.37

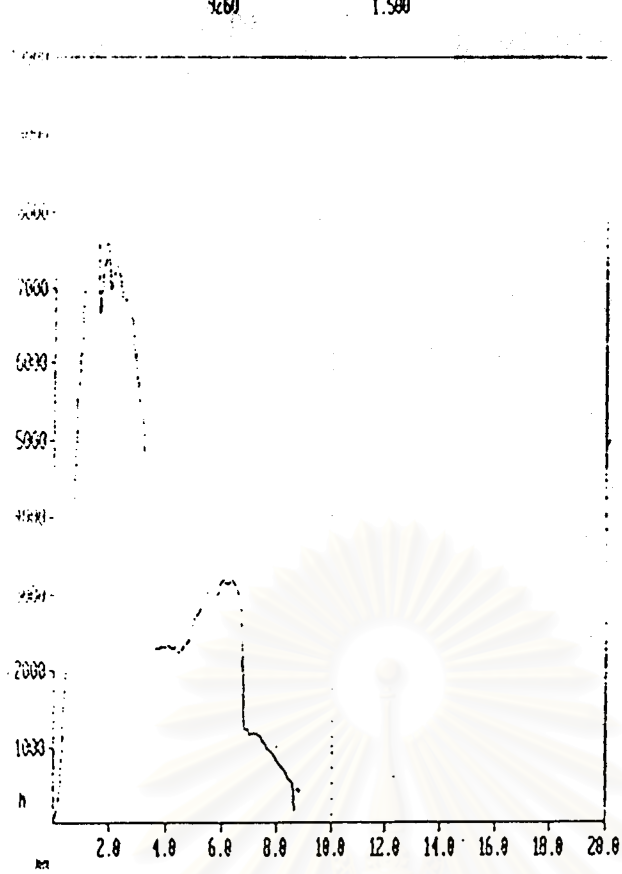
APPENDIX B

Graphs of Testing Results





<u>Figure B-1</u> Graph of Flexural Strength Testing of WPC Prepared by Varying Soaking times, 3 hrs. (up) and 4 hrs. (down)



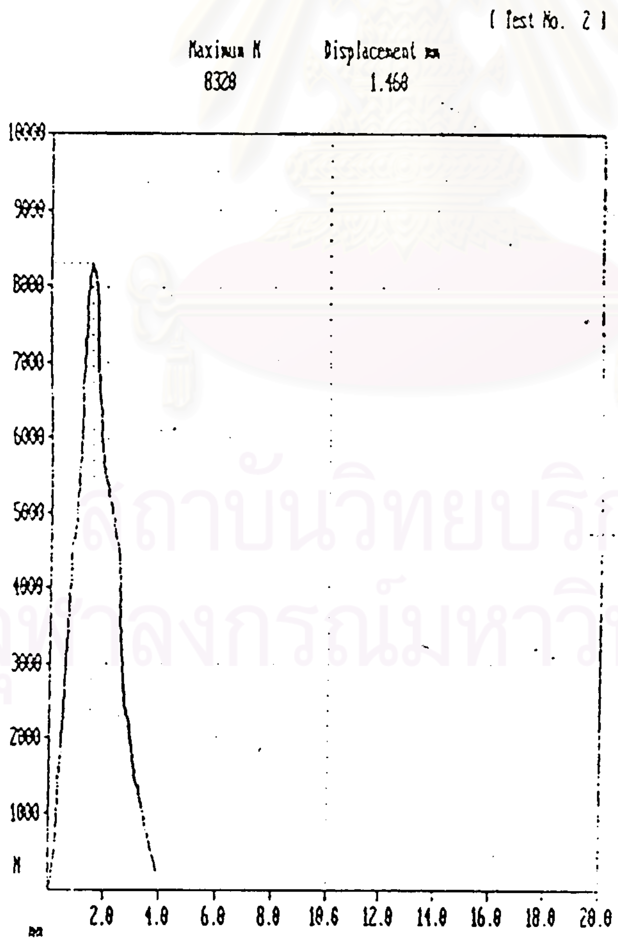


Figure B-2 Graph of Compressive Strength Testing of WPC prepared by Varying Soaking times, 4 hrs. (up) and 3 hrs. (down)

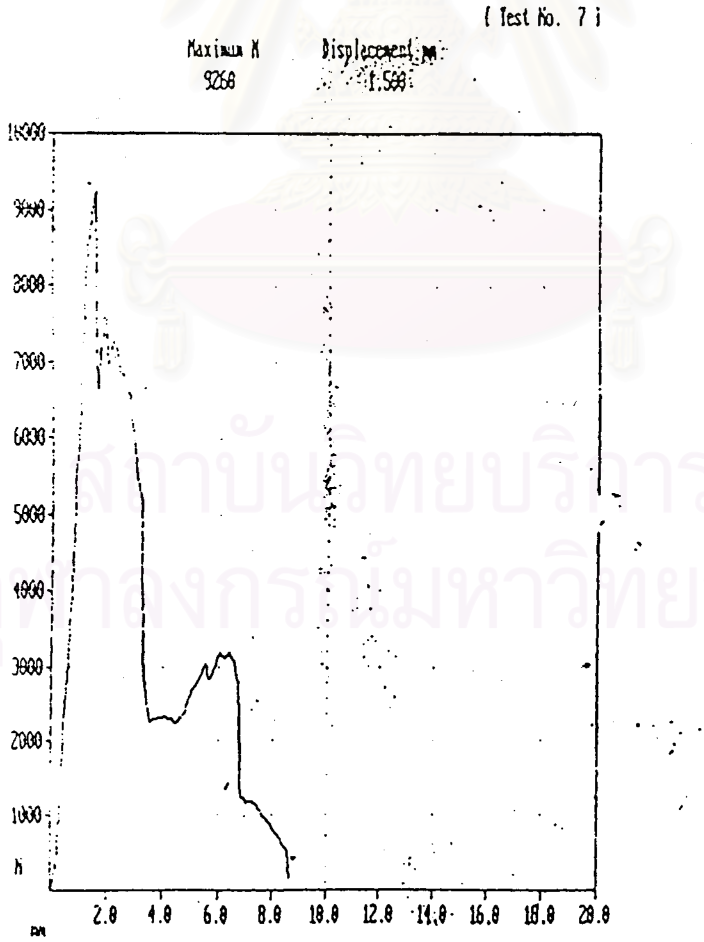
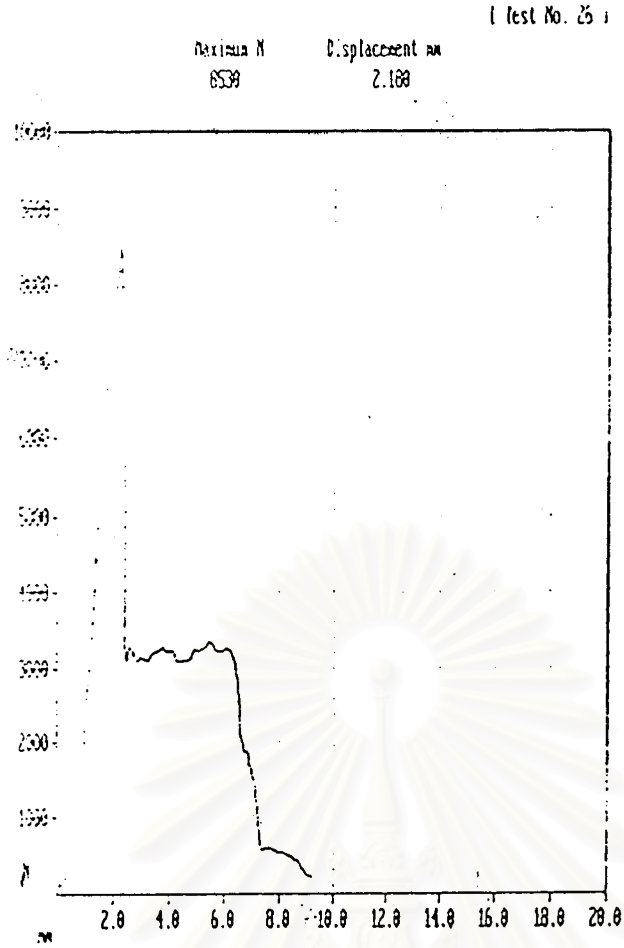


Figure B-3 Graph of Compressive Strength Testing of WPC prepared by Varying Evacuating times, 3 hrs. (up) and 2 hrs. (down)



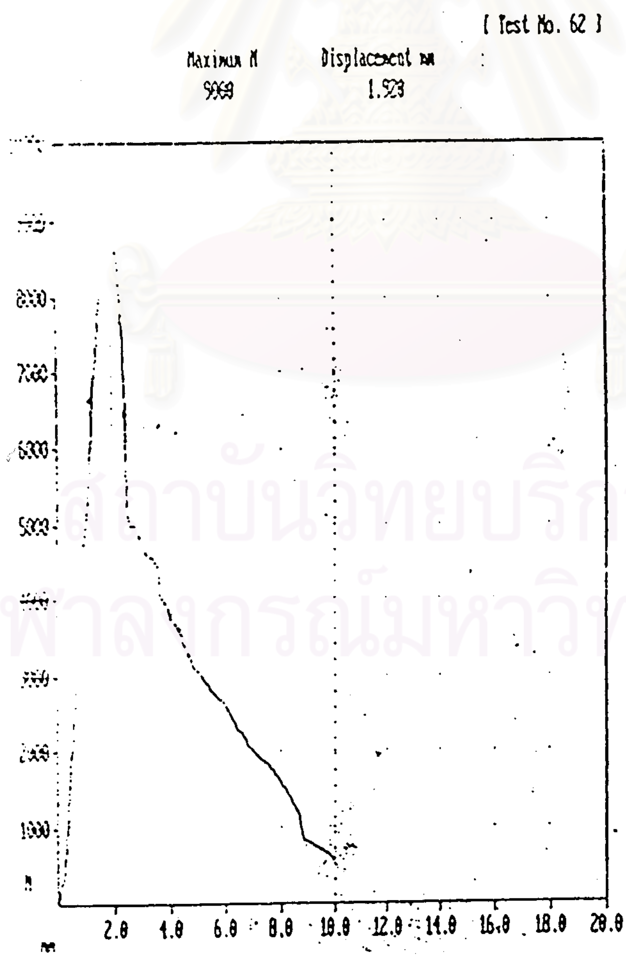
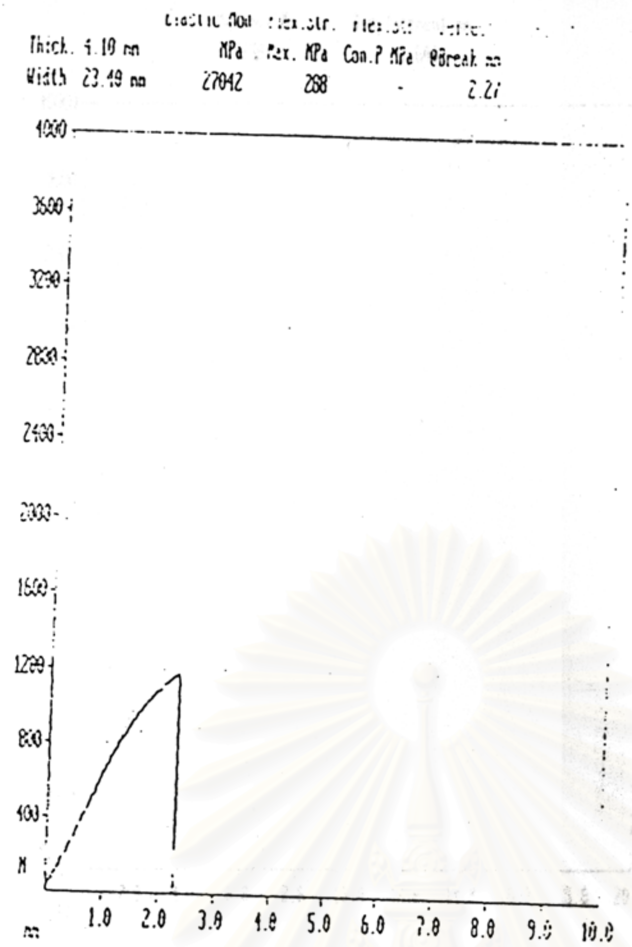


Figure B-4 Graph of Compressive Strength Testing of WPC prepared by Varying Initiator contents, 3 phr. (up) and 2 phr. (down)



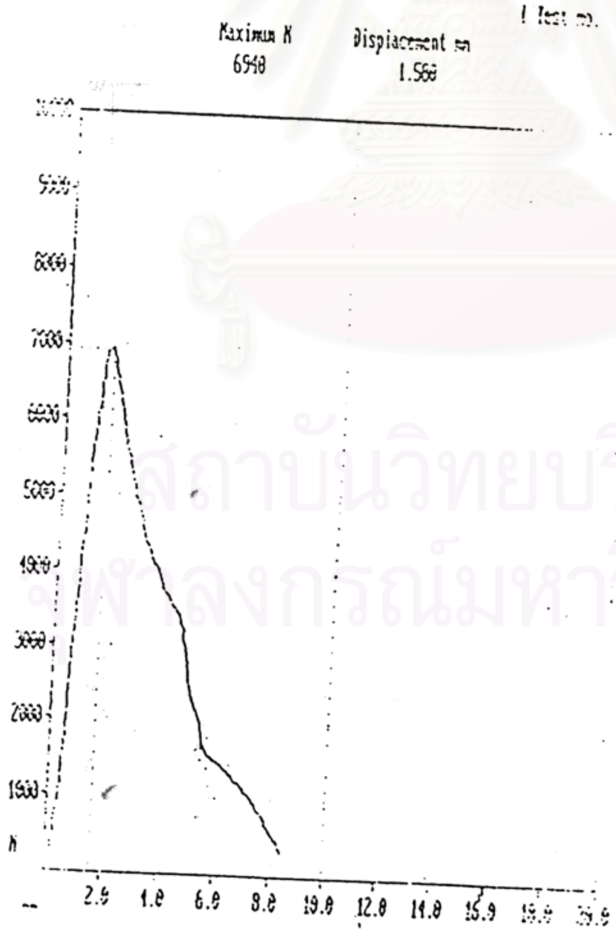


Figure B-5 Graph of Flexural Strength (up) and Compressive Strength (down) Testing of Rubberwood – PAN Composites

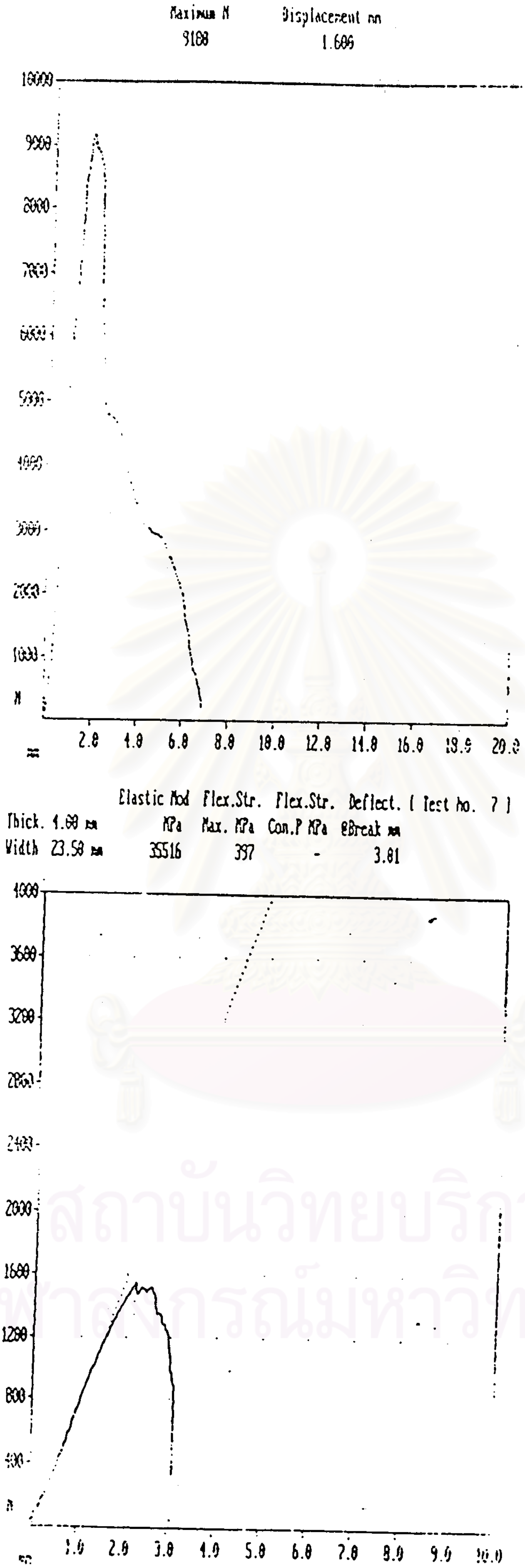


Figure B-6 Graph of Compressive Strength (up) and Flexural Strength (down) Testing of Rubberwood-MAN (80:20) Composites

APPENDIX C

DATA OF ANALYSIS OF VARIANCE

Oneway

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
SG	1703030	10	1.1140	4.551E-02	1.439E-02	1.0814	1.1466
	1703070	10	1.0660	5.719E-02	1.809E-02	1.0251	1.1069
	1802030	10	1.4430	.1017	3.215E-02	1.3703	1.5157
	1802070	10	1.0090	3.213E-02	1.016E-02	.9860	1.0320
	1901030	10	1.3840	6.569E-02	2.077E-02	1.3370	1.4310
	1901070	10	1.0770	7.617E-02	2.409E-02	1.0225	1.1315
	2703030	10	1.4100	.1034	3.269E-02	1.3360	1.4840
	2703070	10	1.3530	4.057E-02	1.283E-02	1.3240	1.3820
	2802030	10	1.4550	8.580E-02	2.713E-02	1.3936	1.5164
	2802070	10	1.4160	7.106E-02	2.247E-02	1.3652	1.4668
	2901030	10	1.4240	6.720E-02	2.125E-02	1.3759	1.4721
	2901070	10	1.5690	7.415E-02	2.345E-02	1.5160	1.6220
	7000000	10	1.1810	8.062E-02	2.549E-02	1.1233	1.2387
	8000000	10	1.4420	5.051E-02	1.597E-02	1.4059	1.4781
	9000000	10	1.2570	7.424E-02	2.348E-02	1.2039	1.3101
	Total	150	1.3067	.1823	1.489E-02	1.2772	1.3361
WA	1703030	10	52.2640	13.7700	4.3544	42.4136	62.1144
	1703070	10	81.8290	4.9815	1.5753	78.2655	85.3925
	1802030	10	43.4590	4.7825	1.5124	40.0378	46.8802
	1802070	10	85.0510	3.9296	1.2426	82.2400	87.8620
	1901030	10	32.4010	5.5599	1.7582	28.4237	36.3783
	1901070	10	71.5900	8.3180	2.6304	65.6396	77.5404
	2703030	10	37.3590	6.7336	2.1294	32.5421	42.1759
	2703070	10	42.3130	2.5438	.8044	40.4933	44.1327
	2802030	10	33.5560	2.8434	.8992	31.5219	35.5901
	2802070	10	41.0260	5.5647	1.7597	37.0-53	45.0067
	2901030	10	34.6610	4.5397	1.4356	31.4135	37.9085
	2901070	10	30.8510	4.5061	1.4250	27.6275	34.0745
	7000000	10	71.3820	11.4498	3.6207	63.1913	79.5727
	8000000	10	28.1940	[illegible]	.1069	27.9521	28.4359
	9000000	10	51.1040	1.8147	.5739	49.8058	52.4022
	Total	150	49.1360	19.5883	1.5994	45.9756	52.2964

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
SW	1703030	10	3.0190	1.0430	.3298	2.2729	3.7651
	1703070	10	2.0420	.9605	.3037	1.3549	2.7291
	1802030	10	5.0120	.9965	.3151	4.2991	5.7249
	1802070	10	2.6880	1.5947	.5043	1.5472	3.8288
	1901030	10	5.6730	.3950	.1249	5.3905	5.9555
	1901070	10	3.0410	1.2288	.3886	2.1620	3.9200
	2703030	10	4.3100	.9332	.2951	3.6424	4.9776
	2703070	10	8.2640	1.8275	.5779	6.9567	9.5713
	2802030	10	5.4840	2.3614	.7468	3.7947	7.1733
	2802070	10	3.9490	1.2881	.4073	3.0275	4.8705
	2901030	10	5.7320	.9728	.3076	5.0361	6.4279
	2901070	10	7.7580	2.8957	.9157	5.6865	9.8295
	7000000	10	6.6120	2.0999	.6641	5.1098	8.1142
	8000000	10	4.1180	2.3686	.7490	2.4236	5.8124
	9000000	10	8.9870	2.2803	.7211	7.3558	10.6182
	Total	150	5.1126	2.6022	.2125	4.6928	5.5324
MOE	1703030	10	33588.8000	5515.6241	1744.1935	29643.1602	37534.4398
	1703070	10	102677.7000	32563.2795	10297.4131	79383.3331	125972.0669
	1802030	10	76715.7000	46421.6384	14679.8110	43507.6604	109923.7396
	1802070	10	28242.3000	5987.1562	1893.3050	23959.3465	32525.2535
	1901030	10	62955.8000	91401.0028	28903.5349	-2428.5386	128340.1386
	1901070	10	32635.9000	4637.9255	1466.6408	29318.1280	35953.6720
	2703030	10	30861.5000	6155.8499	1946.6507	26457.8703	35265.1297
	2703070	10	31387.8000	4913.7377	1553.8603	27872.7238	34902.8762
	2802030	10	30785.0000	9066.1431	2866.9662	24299.4719	37270.5281
	2802070	10	29696.2000	8683.4837	2745.9586	23484.4100	35907.9900
	2901030	10	35001.2000	5733.0045	1812.9352	30900.0556	39102.3444
	2901070	10	37373.3000	11168.4254	3531.7662	29383.8898	45362.7102
	7000000	10	19172.8000	5126.6048	1621.1748	15505.4478	22840.1522
	8000000	10	38692.2000	13322.1058	4212.8198	29162.1396	48222.2604
	9000000	10	25886.9000	3940.0927	1245.9667	23068.3275	28705.4725
	Total	150	41044.8733	34819.2119	2842.9767	35427.1138	46662.6328

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
F	1703030	10	354.8000	29.0126	9.1746	334.0456	375.5544
	1703070	10	450.1000	88.5795	28.0113	386.7341	513.4659
	1802030	10	460.1000	68.4259	21.6382	411.1511	509.0489
	1802070	10	284.3000	47.1217	14.9012	250.5912	318.0088
	1901030	10	355.6000	38.4656	12.1639	328.0834	383.1166
	1901070	10	327.8000	28.1772	8.9104	307.6432	347.9568
	2703030	10	363.6000	43.7879	13.8469	332.2760	394.9240
	2703070	10	350.8000	37.5494	11.3742	323.9388	377.6612
	2802030	10	356.6000	59.7145	18.8834	313.8828	399.3172
	2802070	10	338.2000	43.3149	13.6974	307.2144	369.1856
	2901030	10	347.8000	47.4431	15.0028	313.8613	381.7387
	2901070	10	386.2000	55.9559	17.6948	346.1715	426.2285
	7000000	10	222.7000	50.9140	16.1004	186.2783	259.1217
	8000000	10	325.5000	27.4196	8.6708	305.8852	345.1148
	9000000	10	266.8000	21.9939	6.9551	251.0665	282.5335
	Total	150	346.0600	75.2817	6.1467	333.9140	358.2060
COMPRES	1703030	10	8245.0000	1070.1739	338.4187	7479.4437	9010.5563
	1703070	10	7202.0000	847.1626	267.8963	6595.9764	7808.0236
	1802030	10	8521.0000	810.0542	256.1616	7941.5221	9100.4779
	1802070	10	7016.0000	1269.3323	401.3981	6107.9744	7924.0256
	1901030	10	9223.0000	572.9854	181.1939	8813.1110	9632.8890
	1901070	10	8493.0000	547.4598	173.1220	8101.3709	8884.6291
	2703030	10	8592.0000	844.2459	266.9740	7988.0629	9195.9371
	2703070	10	8575.0000	658.2004	208.1412	8104.1518	9045.8482
	2802030	10	8588.0000	1102.7420	348.7177	7799.1459	9376.8541
	2802070	10	8676.0000	1092.1864	345.3797	7894.6969	9457.3031
	2901030	10	8948.0000	913.9998	289.0321	8294.1640	9601.8360
	2901070	10	9473.0000	740.9461	234.3077	8942.9591	10003.0409
	7000000	10	5248.0000	296.3781	93.7230	5035.9839	5460.0161
	8000000	10	5721.0000	652.6774	206.3947	5254.1027	6187.8973
	9000000	10	5676.0000	280.8004	88.7969	5475.1275	5876.8725
	Total	150	7879.8000	1542.2560	125.9247	7630.9712	8128.6288

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
SG	2.375	14	135	.006
WA	6.051	14	135	.000
SW	3.455	14	135	.000
MOE	6.151	14	135	.000
F	2.636	14	135	.002
COMPRES	3.020	14	135	.000

ANOVA

		Sum of Squares	df	Mean Square	F	Sig
SG	Between Groups	4.269	14	.305	60.068	.000
	Within Groups	.685	135	5.076E-03		
	Total	4.954	149			
WA	Between Groups	51599.258	14	3685.661	89.295	.000
	Within Groups	5572.127	135	41.275		
	Total	57171.385	149			
SW	Between Groups	620.037	14	44.288	15.374	.000
	Within Groups	388.889	135	2.881		
	Total	1008.927	149			
MOE	Between Groups	70360224538.693	14	5025730324.192	6.152	.000
	Within Groups	110284025577.9	135	816918707.984		
	Total	180644250116.6	149			
F	Between Groups	521843.560	14	37274.540	15.599	.000
	Within Groups	322588.900	135	2389.547		
	Total	844432.460	149			
COMPRES	Between Groups	261791464.000	14	18699390.286	27.258	.000
	Within Groups	92613030.000	135	686022.444		
	Total	354404494,000	149			

Post Hoc Tests

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SG	1703030	1703070	4.800E-02	3.186E-02	.134	-1.5016E-02	.1110
		1802030	-.3290*	3.186E-02	.000	-.3920	-.2660
		1802070	.1050*	3.186E-02	.001	4.198E-02	.1680
		1901030	-.2700*	3.186E-02	.000	-.3330	-.2070
		1901070	3.700E-02	3.186E-02	.248	-2.6016E-02	.1000
		2703030	-.2960*	3.186E-02	.000	-.3590	-.2330
		2703070	-.2390*	3.186E-02	.000	-.3020	-.1760
		2802030	-.3410*	3.186E-02	.000	-.4040	-.2780

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	1703030	2802070	-.3020*	3.186E-02	.000	-.3650	-.2390
		2901030	-.3100*	3.186E-02	.000	-.3730	-.2470
		2901070	-.4550*	3.186E-02	.000	-.5180	-.3920
		7000000	-6.7000E-02*	3.186E-02	.037	-.1300	-3.9836E-03
		8000000	-.3280*	3.186E-02	.000	-.3910	-.2650
		9000000	-.1430*	3.186E-02	.000	-.2060	-7.9984E-02
	1703070	1703030	-4.8000E-02	3.186E-02	.134	-.1110	1.502E-02
		1802030	-.3770*	3.186E-02	.000	-.4400	-.3140
		1802070	5.700E-02	3.186E-02	.076	-6.0164E-03	.1200
		1901030	-.3180*	3.186E-02	.000	-.3810	-.2550
		1901070	-1.1000E-02	3.186E-02	.730	-7.4016E-02	5.202E-02
		2703030	-.3440*	3.186E-02	.000	-.4070	-.2810
		2703070	-.2870*	3.186E-02	.000	-.3500	-.2240
		2802030	-.3890*	3.186E-02	.000	-.4520	-.3260
		2802070	-.3500*	3.186E-02	.000	-.4130	-.2870
		2901030	-.3580*	3.186E-02	.000	-.4210	-.2950
		2901070	-.5030*	3.186E-02	.000	-.5660	-.4400
		7000000	-.1150*	3.186E-02	.000	-.1780	-5.1984E-02
		8000000	-.3760*	3.186E-02	.000	-.4390	-.3130
		9000000	-.1910*	3.186E-02	.000	-.2540	-.1280
	1802030	1703030	.3290*	3.186E-02	.000	.2660	.3920
		1703070	.3770*	3.186E-02	.000	.3140	.4400
		1802070	.4340*	3.186E-02	.000	.3710	.4970
		1901030	5.900E-02	3.186E-02	.066	-4.0164E-03	.1220
		1901070	.3660*	3.186E-02	.000	.3030	.4290
		2703030	3.300E-02	3.186E-02	.302	-3.0016E-02	9.602E-02
		2703070	9.000E-02*	3.186E-02	.005	2.698E-02	.1530
		2802030	-1.2000E-02	3.186E-02	.707	-7.5016E-02	5.102E-02
		2802070	2.700E-02	3.186E-02	.398	-3.6016E-02	9.002E-02
		2901030	1.900E-02	3.186E-02	.552	-4.4016E-02	8.202E-02
		2901070	-.1260*	3.186E-02	.000	-.1890	-6.2984E-02
		7000000	.2620*	3.186E-02	.000	.1990	.3250
		8000000	1.000E-03	3.186E-02	.975	-6.2016E-02	6.402E-02
		9000000	.1860*	3.186E-02	.000	.1230	.2490

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
SG	1802070	1703030	-.1050*	3.186E-02	.001	-.1680	-4.1984E-02
		1703070	-5.7000E-02	3.186E-02	.076	-.1200	6.016E-03
		1802030	-.4340*	3.186E-02	.000	-.4970	-.3710
		1901030	-.3750*	3.186E-02	.000	-.4380	-.3120
		1901070	-6.8000E-02*	3.186E-02	.035	-.1310	-4.9836E-03
		2703030	-.4010*	3.186E-02	.000	-.4640	-.3380
		2703070	-.3440*	3.186E-02	.000	-.4070	-.2810
		2802030	-.4460*	3.186E-02	.000	-.5090	-.3830
		2802070	-.4070*	3.186E-02	.000	-.4700	-.3440
		2901030	-.4150*	3.186E-02	.000	-.4780	-.3520
		2901070	-.5600*	3.186E-02	.000	-.6230	-.4970
		7000000	-.1720*	3.186E-02	.000	-.2350	-.1090
		8000000	-.4330*	3.186E-02	.000	-.4960	-.3700
		9000000	-.2480*	3.186E-02	.000	-.3110	-.1850
	1901030	1703030	.2700*	3.186E-02	.000	.2070	.3330
		1703070	.3180*	3.186E-02	.000	.2550	.3810
		1802030	-5.9000E-02	3.186E-02	.066	-.1220	4.016E-03
		1802070	.3750*	3.186E-02	.000	.3120	.4380
		1901070	.3070*	3.186E-02	.000	.2440	.3700
		2703030	-2.6000E-02	3.186E-02	.416	-8.9016E-02	3.702E-02
		2703070	3.100E-02	3.186E-02	.332	-3.2016E-02	9.402E-02
		2802030	-7.1000E-02*	3.186E-02	.028	-.1340	-7.9836E-03
		2802070	-3.2000E-02	3.186E-02	.317	-9.5016E-02	3.102E-02
		2901030	-4.9000E-02	3.186E-02	.212	-.1030	2.302E-02
		2901070	-.1850*	3.186E-02	.000	-.2480	-.1220
		7000000	.2030*	3.186E-02	.000	.1400	.2660
		8000000	-5.8000E-02	3.186E-02	.071	-.1210	5.016E-03
		9000000	.1270*	3.186E-02	.000	6.398E-02	.1900
	1901070	1703030	-3.7000E-02	3.186E-02	.248	-.1000	2.602E-02
		1703070	1.100E-02	3.186E-02	.730	-5.2016E-02	7.402E-02
		1802030	-.3660*	3.186E-02	.000	-.4290	-.3030
		1802070	6.800E-02*	3.186E-02	.035	4.984E-03	.1310
		1901030	-.3070*	3.186E-02	.000	-.3700	-.2440
		2703030	-.3330*	3.186E-02	.000	-.3960	-.2700
		2703070	-.2760*	3.186E-02	.000	-.3390	-.2130
		2802030	-.3780*	3.186E-02	.000	-.4410	-.3150
		2802070	-.3390*	3.186E-02	.000	-.4020	-.2760
		2901030	-.3470*	3.186E-02	.000	-.4100	-.2840
		2901070	-.4920*	3.186E-02	.000	-.5550	-.4290
		7000000	-.1040*	3.186E-02	.001	-.1670	-4.0984E-02
		8000000	-.3650*	3.186E-02	.000	-.4280	-.3020
		9000000	-.1800*	3.186E-02	.000	-.2430	-.1170

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Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
	2703030	1703030	.2960*	3.186E-02	.000		.3590
		1703070	.3440*	3.186E-02	.000		.4070
		1802030	-3.3000E-02	3.186E-02	.302	-9.6016E-02	3.002E-02
		1802070	.4010*	3.186E-02	.000	.3380	.4640
		1901030	2.600E-02	3.186E-02	.416		8.902E-02
		1901070	.3330*	3.186E-02	.000	.2700	.3960
		2703070	5.700E-02	3.186E-02	.076	-6.0164E-03	.1200
		2802030	-4.5000E-02	3.186E-02	.160	-.1080	1.802E-02
		2802070	-6.0000E-03	3.186E-02		-6.9016E-02	5.702E-02
		2901030	-1.4000E-02	3.186E-02	.661	-7.7016E-02	4.902E-02
		2901070	-.1590*	3.186E-02	.000		-9.5984E-02
		7000000	.2290*	3.186E-02	.000	.1660	.2920
		8000000	-3.2000E-02	3.186E-02	.317	-9.5016E-02	3.102E-02
		9000000	.1530*	3.186E-02	.000	8.998E-02	.2160
	2703070	1703030	.2390*	3.186E-02	.000	.1760	.3020
		1703070	.2870*	3.186E-02	.000	.2240	.3500
		1802030	-9.0000E-02*	3.186E-02	.005		-2.6984E-02
		1802070	.3440*	3.186E-02	.000		.4070
		1901030	-3.1000E-02	3.186E-02	.332	-9.4016E-02	3.202E-02
		1901070	.2760*	3.186E-02	.000	.2130	.3390
		2703030	-5.7000E-02	3.186E-02	.076	-.1200	6.016E-03
		2802030	-.1020*	3.186E-02	.002	-.1650	-3.8984E-02
		2802070	-6.3000E-02	3.186E-02	.050	-.1260	1.639E-05
		2901030	-7.1000E-02*	3.186E-02	.028	-.1340	-7.9836E-03
		2901070	-.2160*	3.186E-02	.000	-.2790	-.1530
		7000000	.1720*	3.186E-02	.000	.1090	.2350
		8000000	-8.9000E-02*	3.186E-02	.006	-.1520	-2.5984E-02
			9.600E-02*	3.186E-02	.003	3.298E-02	.1590
	2802030	1703030	.3410*	3.186E-02	.000	.2780	.4040
		1703070	.3890*	3.186E-02	.000	.3260	.4520
		1802030	1.200E-02	3.186E-02	.707	-5.1016E-02	7.502E-02
		1802070	.4460*	3.186E-02	.000	.3830	.5090
		1901030	7.100E-02*	3.186E-02	.028	7.984E-03	.1340
		1901070	.3780*	3.186E-02	.000	.3150	.4410
		2703030	4.500E-02	3.186E-02	.160	-1.8016E-02	.1080
		2703070	.1020*	3.186E-02	.002	3.898E-02	.1650
		2802070	3.900E-02	3.186E-02	.223	-2.4016E-02	.1020
		2901030	3.100E-02	3.186E-02	.332	-3.2016E-02	9.402E-02
		2901070	-.1140*	3.186E-02	.000	-.1770	-5.0984E-02
			.2740*	3.186E-02	.000	.2110	.3370
		8000000	1.300E-02	3.186E-02	.684	-5.0016E-02	7.602E-02
		9000000	.1980*	3.186E-02	.000	.1350	.2610

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SG	2802070	1703030	.3020*	3.186E-02	.000	.2390	.3650
		1703070	.3500*	3.186E-02	.000	.2870	.4130
		1802030	.7000E-02	3.186E-02	.398	-9.0016E-02	3.602E-02
		1802070	.4070*	3.186E-02	.000	.3440	.4700
		1901030	3.200E-02	3.186E-02	.317	-3.1016E-02	9.502E-02
		1901070	.3390*	3.186E-02	.000	.2760	.4020
		2703030	6.000E-03	3.186E-02	.851	5.7016E-02	6.902E-02
		2703070	6.300E-02	3.186E-02	.050	-1.6392E-05	.1260
		2802030	-3.9000E-02	3.186E-02	.223	-.1020	2.402E-02
		2901030	-8.0000E-03	3.186E-02	.802	-7.1016E-02	5.502E-02
		2901070	-.1530*	3.186E-02	.000	-.2160	-8.9984E-02
		7000000	.2350*	3.186E-02	.000	.1720	.2980
		8000000	-2.6000E-02	3.186E-02	.416	-8.9016E-02	3.702E-02
		9000000	.1590*	3.186E-02	.000	9.598E-02	.2220
	2901030	1703030	.3100*	3.186E-02	.000	.2470	.3730
		1703070	.3580*	3.186E-02	.000	.2950	.4210
		1802030	-1.9000E-02	3.186E-02	.552	-8.2016E-02	4.402E-02
		1802070	.4150*	3.186E-02	.000	.3520	.4780
		1901030	4.000E-02	3.186E-02	.212	-2.3016E-02	.1030
		1901070	.3470*	3.186E-02	.000	.2840	.4100
		2703030	1.400E-02	3.186E-02	.661	-4.9016E-02	7.702E-02
		2703070	7.100E-02*	3.186E-02	.028	7.984E-03	.1340
		2802030	-3.1000E-02	3.186E-02	.332	-9.4016E-02	3.202E-02
		2802070	8.000E-03	3.186E-02	.802	-5.5016E-02	7.102E-02
		2901070	-.1450*	3.186E-02	.000	-.2080	-8.1984E-02
		7000000	.2430*	3.186E-02	.000	.1800	.3060
		8000000	1.8000E-02	3.186E-02	.573	-8.1016E-02	7.502E-02
		9000000	.1670*	3.186E-02	.000	.1040	.2300
	2901070	1703030	.4550*	3.186E-02	.000	.3920	.5180
		1703070	.5030*	3.186E-02	.000	.4400	.5660
		1802030	.1260*	3.186E-02	.000	6.298E-02	[illegible]
		1802070	.5600*	3.186E-02	.000	.4970	.6230
		1901030	.1850*	3.186E-02	.000	.1220	.2480
		1901070	.4920*	3.186E-02	.000	.4290	.5550
		2703030	.1590*	3.186E-02	.000	9.598E-02	.2220
		2703070	.2160*	3.186E-02	.000	.1530	.2790
		2802030	.1140*	3.186E-02	.000	5.098E-02	.1770
		2802070	.1530*	3.186E-02	.000	8.998E-02	.2160
		2901030		3.186E-02	.000	8.198E-02	.2080
		7000000	.3880*	3.186E-02	.000	.3250	.4510
		8000000	.1270*	3.186E-02	.000	6.398E-02	.1900
		9000000	.3120*	3.186E-02	.000	.2490	.3750

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SG	7000000	1703030	6.700E-02*	3.186E-02		3.984E-03	1300
		1703070	1150*	3.186E-02	000	5.198E-02	180
		1802030	-.2620*	3.186E-02	000		1990
		1802070	.1720*	3.186E-02	000	1090	2350
		1901030	-.2030*	3.186E-02	.000	.2660	1400
		1901070	.1040*	3.186E-02	.001	4.098E-02	1670
		2703030	-.2290*	3.186E-02	.000	.2920	1660
		2703070	-.1720*	3.186E-02	.000	2350	1090
		2802030	-.2740*	3.186E-02	.000	.3370	2110
		2802070	-.2350*	3.186E-02	.000	.2980	1720
		2901030	-.2430*	3.186E-02	.000	.3060	1800
		2901070	-.3880*	3.186E-02	.000	.4510	3250
		8000000	-.2610*	3.186E-02	.000	.3240	-.1980
		9000000	-7.6000E-02*	3.186E-02	.018	.1390	1.2984E-02
	8000000	1703030	.3280*	3.186E-02	.000	.2650	.3910
		1703070	.3760*	3.186E-02	.000	.3130	.4390
		1802030	-1.0000E-03	3.186E-02	.975	-6.4016E-02	6.202E-02
		1802070	.4330*	3.186E-02	.000	.3700	.4960
		1901030	5.800E-02	3.186E-02	.071	-5.0164E-03	.1210
		1901070	.3650*	3.186E-02	.000	.3020	.4280
		2703030	3.200E-02	3.186E-02	.317	-3.1016E-02	9.502E-02
		2703070	8.900E-02*	3.186E-02	.006	2.598E-02	.1520
		2802030	-1.3000E-02	3.186E-02	.684	-7.6016E-02	5.002E-02
		2802070	2.600E-02	3.186E-02	.416	-3.7016E-02	8.902E-02
		2901030	1.800E-02	3.186E-02	.573	-4.5016E-02	8.102E-02
		2901070	-.1270*	3.186E-02	.000	-.1900	6.3984E-02
		7000000	.2610*	3.186E-02	.000	.1980	.3240
		9000000	.1850*	3.186E-02	.000	.1220	.2480
	9000000	1703030	.1430*	3.186E-02	.000	7.998E-02	.2060
		1703070	.1910*	3.186E-02	.000	.1280	.2540
		1802030	-.1860*	3.186E-02	.000	-.2490	-.1230
		1802070	.2480*	3.186E-02	.000	.1850	.3110
		1901030	-.1270*	3.186E-02	.000	.1900	-6.3984E-02
		1901070	.1800*	3.186E-02	.000	1170	.2430
		2703030	-.1530*	3.186E-02	.000	.2160	-8.9984E-02
		2703070	-9.6000E-02*	3.186E-02	003	1590	-3.2984E-02
		2802030	-.1980*	3.186E-02	.000	.2610	-.1350
		2802070	-.1590*	3.186E-02		-.2220	-9.5984E-02
		2901030	-.1670*	3.186E-02	000	-.2300	-.1040
		2901070	-.3120*	3.186E-02	.000	-.3750	-.2490
			7.600E-02*	3.186E-02	.018	1.298E-02	.1390
		8000000	-.1850*	3.186E-02	.000	-.2480	-.1220

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	1703030	1703070	-29.5650*	2.8732	.000	-35.2472	-23.8828
		1802030	8.8050*	2.8732	.003	3.1228	14.4872
		1802070	-32.7870*	2.8732	.000	-38.4692	-27.1048
			19.8630*	2.8732	.000	14.1808	25.5452
		1901070	-19.3260*	2.8732	.000	-25.0082	-13.6438
			14.9050*	2.8732	.000	9.2228	20.5872
		2703070	9.9510*	2.8732	.001	4.2688	15.6332
		2802030	18.7080*	2.8732	.000	13.0258	24.3902
		2802070	11.2380*	2.8732	.000	5.5558	16.9202
		2901030	17.6030*	2.8732	.000	11.9208	23.2852
		2901070	21.4130*	2.8732	.000	15.7308	27.0952
		7000000	-19.1180*	2.8732	.000	-24.8002	-13.4358
			24.0700*	2.8732	.000	18.3878	29.7522
		9000000	1.1600	2.8732	.687	-4.5222	6.8422
	1703070	1703030	29.5650*	2.8732	.000	23.8828	35.2472
		1802030	38.3700*	2.8732	.000	32.6878	44.0522
		1802070	-3.2220	2.8732	.264	-8.9042	2.4602
		1901030	49.4280*	2.8732	.000	43.7458	55.1102
		1901070	10.2390*	2.8732	.001	4.5568	15.9212
		2703030	44.4700*	2.8732	.000	38.7878	50.1522
		2703070	39.5160*	2.8732	.000	33.8338	45.1982
			48.2730*	2.8732	.000	42.5908	53.9552
		2802070	40.8030*	2.8732	.000	35.1208	46.4852
		2901030	47.1680*	2.8732	.000	41.4858	52.8502
		2901070	50.9780*	2.8732	.000	45.2958	56.6602
			10.4470*	2.8732	.000	4.7648	16.1292
		8000000	53.6350*	2.8732	.000	47.9528	59.3172
		9000000	30.7250*	2.8732	.000	25.0428	36.4072
	1802030	1703030	-8.8050*	2.8732	.003	-14.4872	-3.1228
		1703070	-38.3700*	2.8732	.000	-44.0522	-32.6878
			-41.5920*	2.8732	.000	-47.2742	-35.9098
		1901030	11.0580*	2.8732	.000	5.3758	16.7402
		1901070	-28.1310*	2.8732	.000	-33.8132	-22.4488
		2703030	6.1000*	2.8732	.036	.4178	11.7822
		2703070	1.1460	2.8732	.691	-4.5362	6.8282
		2802030	9.9030*	2.8732	.001	4.2208	15.5852
		2802070	2.4330	2.8732	.399	-3.2492	8.1152
		2901030	8.7980*	2.8732	.003	3.1158	14.4802
		2901070	12.6080*	2.8732	.000	6.9258	18.2902
			-27.9230*	2.8732	.000	-33.6052	-22.2408
		8000000	15.2650*	2.8732	.000	9.5828	20.9472
			-7.6450*	2.8732	.009	-13.3272	-1.9628

Multiple Comparison

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
WA	1802070	1703030	32.7870*	2.8732	.000	27.1048	38.4692
		1703070	3.2220	2.8732	.264	-2.4602	8.9042
		1802030	41.5920*	2.8732	.000	35.9098	47.2742
		1901030	52.6500*	2.8732	.000	46.9678	58.3322
		1901070	13.4610*	2.8732	.000	7.7788	19.1432
		2703030	47.6920*	2.8732	.000	42.0098	53.3742
		2703070	42.7380*	2.8732	.000	37.0558	48.4202
		2802030	51.4950*	2.8732	.000	45.8128	57.1772
		2802070	44.0250*	2.8732	.000	38.3428	49.7072
		2901030	50.3900*	2.8732	.000	44.7078	56.0722
		2901070	54.2000*	2.8732	.000	48.5178	59.8822
		7000000	13.6690*	2.8732	.000	7.9868	19.3512
		8000000	56.8570*	2.8732	.000	51.1748	62.5392
		9000000	33.9470*	2.8732	.000	28.2648	39.6292
	1901030	1703030	-19.8630*	2.8732	.000	-25.5452	-14.1808
		1703070	-49.4280*	2.8732	.000	-55.1102	-43.7458
		1802030	-11.0580*	2.8732	.000	-16.7402	-5.3758
		1802070	-52.6500*	2.8732	.000	-58.3322	-46.9678
		1901070	-39.1890*	2.8732	.000	-44.8712	-33.5068
		2703030	-4.9580	2.8732	.087	-10.6402	.7242
		2703070	-9.9120*	2.8732	.001	-15.5942	-4.2298
		2802030	-1.1550	2.8732	.688	-6.8372	4.5272
		2802070	-8.6250*	2.8732	.003	-14.3072	-2.9428
		2901030	-2.2600	2.8732	.433	-7.9422	3.4222
		2901070	1.5500	2.8732	.590	-4.1322	7.2322
		7000000	-38.9810*	2.8732	.000	-44.6632	-33.2988
		8000000	4.2070	2.8732	.145	-1.4752	9.8892
		9000000	-18.7030*	2.8732	.000	-24.3852	-13.0208
	1901070	1703030	19.3260*	2.8732	.000	13.6438	25.0082
		1703070	-10.2390*	2.8732	.001	-15.9212	-4.5568
		1802030	28.1310*	2.8732	.000	22.4488	33.8132
		1802070	-13.4610*	2.8732	.000	-19.1432	-7.7788
		1901030	39.1890*	2.8732	.000	33.5068	44.8712
		2703030	34.2310*	2.8732	.000	28.5488	39.9132
		2703070	29.2770*	2.8732	.000	23.5948	34.9592
		2802030	38.0340*	2.8732	.000	32.3518	43.7162
		2802070	30.5640*	2.8732	.000	24.8818	36.2462
		2901030	36.9290*	2.8732	.000	31.2468	42.6112
		2901070	40.7390*	2.8732	.000	35.0568	46.4212
		7000000	.2080	2.8732	.942	-5.4742	5.8902
		8000000	43.3960*	2.8732	.000	37.7138	49.0782
		9000000	20.4860*	2.8732	.000	14.8038	26.1682

Multiple C

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
WA	2703030	1703030	-14.9050*	2.8732	.000	-20.5872	-9.2228
		1703070	-44.4700*	2.8732	.000	-50.1522	-38.7878
		1802030	-6.1000*	2.8732	.036	-11.7822	-.4178
		1802070	-47.6920*	2.8732	.000	-53.3742	-42.0098
		1901030	4.9580	2.8732	.087	-.7242	10.6402
		1901070	-34.2310*	2.8732	.000	-39.9132	-28.5488
		2703070	-4.9540	2.8732	.087	-10.6362	.7282
		2802030	3.8030	2.8732	.188	-1.8792	9.4852
		2802070	-3.6670	2.8732	.204	-9.3492	2.0152
		2901030	2.6980	2.8732	.349	-2.9842	8.3802
		2901070	6.5080*	2.8732	.025	.8258	12.1902
			-34.0230*	2.8732	.000	-39.7052	-28.3408
			9.1650*	2.8732	.002	3.4828	14.8472
		9000000	-13.7450*	2.8732	.000	-19.4272	-8.0628
	2703070	1703030	-9.9510*	2.8732	.001	-15.6332	-4.2688
		1703070	-39.5160*	2.8732	.000	-45.1982	-33.8338
		1802030	-1.1460	2.8732	.691	-6.8282	4.5362
		1802070	-42.7380*	2.8732	.000	-48.4202	-37.0558
		1901030	9.9120*	2.8732	.001	4.2298	15.5942
		1901070	-29.2770*	2.8732	.000	-34.9592	-23.5948
		2703030	4.9540	2.8732	.087	-.7282	10.6362
		2802030	8.7570*	2.8732	.003	3.0748	14.4392
		2802070	1.2870	2.8732	.655	-4.3952	6.9692
		2901030	7.6520*	2.8732	.009	1.9698	13.3342
		2901070	11.4620*	2.8732	.000	5.7798	17.1442
			-29.0690*	2.8732	.000	-34.7512	-23.3868
		8000000	14.1190*	2.8732	.000	8.4368	19.8012
		9000000	-8.7910*	2.8732	.003	-14.4732	-3.1088
	2802030	1703030	-18.7080*	2.8732	.000	-24.3902	-13.0258
		1703070	-48.2730*	2.8732	.000	-53.9552	-42.5908
		1802030	-9.9030*	2.8732	.001	-15.5852	-4.2208
		1802070	-51.4950*	2.8732	.000	-57.1772	-45.8128
		1901030	1.1550	2.8732	.688	-4.5272	6.8372
		1901070	-38.0340*	2.8732	.000	-43.7162	-32.3518
		2703030	-3.8030	2.8732	.188	-9.4852	1.8792
		2703070	-8.7570*	2.8732	.003	-14.4392	-3.0748
		2802070	-7.4700*	2.8732	.010	-13.1522	-1.7878
		2901030	-1.1050	2.8732	.701	-6.7872	4.5772
		2901070	2.7050	2.8732	.348	-2.9772	8.3872
		7000000	-37.8260*	2.8732	.000	-43.5082	-32.1438
		8000000	5.3620	2.8732	.064	-.3202	11.0442
		9000000	-17.5480*	2.8732	.000	-23.2302	-11.8658

Multiple Compar

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	2802070	1703030	-11.2380*	2.8732	.000	-16.9202	-5.5558
		1703070	-40.8030*	2.8732	.000	-46.4852	-35.1208
		1802030	-2.4330	2.8732	.399	-8.1152	3.2492
		1802070	-44.0250*	2.8732	.000	-49.7072	-38.3428
		1901030	8.6250*	2.8732	.003	2.9428	14.3072
		1901070	-30.5640*	2.8732	.000	-36.2462	-24.8818
		2703030	3.6670	2.8732	.204	2.0152	9.3492
		2703070	-1.2870	2.8732	.655	-6.9692	4.3952
		2802030	7.4700*	2.8732	.010	1.7878	13.1522
		2901030	6.3650*	2.8732	.028	.6828	12.0472
		2901070	10.1750*	2.8732	.001	4.4928	15.8572
		7000000	-30.3560*	2.8732	.000	-36.0382	-24.6738
			12.8320*	2.8732	.000	7.1498	18.5142
		9000000	-10.0780*	2.8732	.001	-15.7602	-4.3958
	2901030	1703030	-17.6030*	2.8732	.000	-23.2852	-11.9208
		1703070	-47.1680*	2.8732	.000	-52.8502	-41.4858
		1802030	-8.7980*	2.8732	.003	-14.4802	-3.1158
		1802070	-50.3900*	2.8732	.000	-56.0722	-44.7078
		1901030	2.2600	2.8732	.433	-3.4222	7.9422
		1901070	-36.9290*	2.8732	.000	-42.6112	-31.2468
		2703030	-2.6980	2.8732	.349	-8.3802	2.9842
		2703070	-7.6520*	2.8732	.009	-13.3342	-1.9698
		2802030	1.1050	2.8732	.701	-4.5772	6.7872
		2802070	-6.3650*	2.8732	.028	-12.0472	-.6828
		2901070	3.8100	2.8732	.187	-1.8722	9.4922
		7000000	-36.7210*	2.8732	.000	-42.4032	-31.0388
		8000000	6.4670*	2.8732	.026	.7848	12.1492
		9000000	-16.4430*	2.8732	.000	-22.1252	-10.7608
	2901070	1703030	-21.4130*	2.8732	.000	-27.0952	-15.7308
		1703070	-50.9780*	2.8732	.000	-56.6602	-45.2958
		18020[illegible]	-12.6080*	2.8732	.000	-18.2902	-6.9258
		1802070	-54.2000*	2.8732	.000	-59.8822	-48.5178
		1901030	-1.5500	2.8732	.590	-7.2322	4.1322
		1901070	-40.7390*	2.8732	.000	-46.4212	-35.0568
		2703030	-6.5080*	2.8732	.025	-12.1902	-.8258
		2703070	-11.4620*	2.8732	.000	-17.1442	-5.7798
		2802030	-2.7050	2.8732	.348	-8.3872	2.9772
			-10.1750*	2.8732	.001	-15.8572	-4.4928
		2901030	-3.8100	2.8732	.187	-9.4922	1.8722
			-40.5310*	2.8732	.000	-46.2132	-34.8488
		8000000	2.6570	2.8732	.357	-3.0252	8.3392
		9000000	-20.2530*	2.8732	.000	-25.9352	-14.5708

Multiple Comp

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
WA	7000000	1703030	19.1180*	2.8732	.000	13.4358	24.8002
		1703070	-10.4470*	2.8732	.000	-16.1292	-4.7648
		1802030	27.9230*	2.8732	.000	22.2408	33.6052
		1802070	-13.6690*	2.8732	.000	-19.3512	-7.9868
		1901030	38.9810*	2.8732	.000	33.2988	44.6632
		1901070	-.2080	2.8732	.942	-5.8902	5.4742
		2703030	34.0230*	2.8732	.000	28.3408	39.7052
		2703070	29.0690*	2.8732	.000	23.3868	34.7512
		2802030	37.8260*	2.8732	.000	32.1438	43.5082
		2802070	30.3560*	2.8732	.000	24.6738	36.0382
		2901030	36.7210*	2.8732	.000	31.0388	42.4032
		2901070	40.5310*	2.8732	.000	34.8488	46.2132
		8000000	43.1880*	2.8732	.000	37.5058	48.8702
		9000000	20.2780*	2.8732	.000	14.5958	25.9602
	8000000	1703030	-24.0700*	2.8732	.000	-29.7522	-18.3878
		1703070	-53.6350*	2.8732	.000	-59.3172	-47.9528
		1802030	-15.2650*	2.8732	.000	-20.9472	-9.5828
		1802070	-56.8570*	2.8732	.000	-62.5392	-51.1748
		1901030	-4.2070	2.8732	.145	-9.8892	1.4752
		1901070	-43.3960*	2.8732	.000	-49.0782	-37.7138
		2703030	-9.1650*	2.8732	.002	-14.8472	-3.4828
		2703070	-14.1190*	2.8732	.000	-19.8012	-8.4368
		2802030	-5.3620	2.8732	.064	-11.0442	.3202
		2802070	-12.8320*	2.8732	.000	-18.5142	-7.1498
		2901030	-6.4670*	2.8732	.026	-12.1492	-.7848
		2901070	-2.6570	2.8732	.357	-8.3392	3.0252
		7000000	-43.1880*	2.8732	.000	-48.8702	-37.5058
		9000000	-22.9100*	2.8732	.000	-28.5922	-17.2278
	9000000	1703030	-1.1600	2.8732	.687	-6.8422	4.5222
		1703070	-30.7250*	2.8732	.000	-36.4072	-25.0428
		1802030	7.6450*	2.8732	.009	1.9628	13.3272
		1802070	-33.9470*	2.8732	.000	-39.6292	-28.2648
		1901030	18.7030*	2.8732	.000	13.0208	24.3852
		1901070	-20.4860*	2.8732	.000	-26.1682	-14.8038
		2703030	13.7450*	2.8732	.000	8.0628	19.4272
		2703070	8.7910*	2.8732	.003	3.1088	14.4732
		2802030	17.5480*	2.8732	.000	11.8658	23.2302
		2802070	10.0780*	2.8732	.001	4.3958	15.7602
		2901030	16.4430*	2.8732	.000	10.7608	22.1252
		2901070	20.2530*	2.8732	.000	14.5708	25.9352
		7000000	-20.2780*	2.8732	.000	-25.9602	-14.5958
		8000000	22.9100*	2.8732	.000	17.2278	28.5922

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SW	1703030	1703070	.9770	.7590	.200	-.5241	2.4781
		1802030	-1.9930*	.7590	.010	-3.4941	-.4919
		1802070	.3310	.7590	.663	-1.1701	1.8321
		1901030	-2.6540*	.7590	.001	-4.1551	-1.1529
		1901070	-2.2000E-02	.7590	.977	-1.5231	1.4791
		2703030	-1.2910	.7590	.091	-2.7921	.2101
		2703070	-5.2450*	.7590	.000	-6.7461	-3.7439
		2802030	-2.4650*	.7590	.001	-3.9661	-.9639
		2802070	-.9300	.7590	.223	-2.4311	.5711
		2901030	-2.7130*	.7590	.000	-4.2141	-1.2119
		2901070	-4.7390*	.7590	.000	-6.2401	-3.2379
		7000000	-3.5930*	.7590	.000	-5.0941	-2.0919
		8000000	-1.0990	.7590	.150	-2.6001	.4021
		9000000	-5.9680*	.7590	.000	-7.4691	-4.4669
	1703070	1703030	-.9770	.7590	.200	-2.4781	.5241
		1802030	-2.9700*	.7590	.000	-4.4711	-1.4689
		1802070	-.6460	.7590	.396	-2.1471	.8551
		1901030	-3.6310*	.7590	.000	-5.1321	-2.1299
		1901070	-.9990	.7590	.190	-2.5001	.5021
		2703030	-2.2680*	.7590	.003	-3.7691	-.7669
		2703070	-6.2220*	.7590	.000	-7.7231	-4.7209
		2802030	-3.4420*	.7590	.000	-4.9431	-1.9409
		2802070	-1.9070*	.7590	.013	-3.4081	-.4059
		2901030	-3.6900*	.7590	.000	-5.1911	-2.1889
		2901070	-5.7160*	.7590	.000	-7.2171	-4.2149
		7000000	-4.5700*	.7590	.000	-6.0711	-3.0689
		8000000	-2.0760*	.7590	.007	-3.5771	-.5749
		9000000	-6.9450*	.7590	.000	-8.4461	-5.4439
	1802030	1703030	1.9930*	.7590	.010	.4919	3.4941
		1703070	2.9700*	.7590	.000	1.4689	4.4711
		1802070	2.3240*	.7590	.003	.8229	3.8251
		1901030	-.6610	.7590	.385	-2.1621	.8401
		1901070	1.9710*	.7590	.010	.4699	3.4721
		2703030	.7020	.7590	.357	-.7991	2.2031
		2703070	-3.2520*	.7590	.000	-4.7531	-1.7509
		2802030	-.4720	.7590	.535	-1.9731	1.0291
		2802070	1.0630	.7590	.164	-.4381	2.5641
		2901030	-.7200	.7590	.345	-2.2211	.7811
		2901070	-2.7460*	.7590	.000	-4.2471	-1.2449
		7000000	-1.6000*	.7590	.037	-3.1011	-9.8864E-02
		8000000	.8940	.7590	.241	-.6071	2.3951
		9000000	-3.9750*	.7590	.000	-5.4761	-2.4739

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SW	1802070	1703030	-.3310	.7590	.663	-1.8321	1.1701
		1703070	.6460	.7590	.396	-.8551	2.1471
		1802030	-2.3240*	.7590	.003	-3.8251	-.8229
		1901030	-2.9850*	.7590	.000	-4.4861	-1.4839
		1901070	-.3530	.7590	.643	-1.8541	1.1481
		2703030	-1.6220*	.7590	.034	-3.1231	-.1209
		2703070	-5.5760*	.7590	.000	-7.0771	-4.0749
		2802030	-2.7960*	.7590	.000	-4.2971	-1.2949
		2802070	-1.2610	.7590	.099	-2.7621	.2401
		2901030	-3.0440*	.7590	.000	-4.5451	-1.5429
		2901070	-5.0700*	.7590	.000	-6.5711	-3.5689
		7000000	-3.9240*	.7590	.000	-5.4251	-2.4229
		8000000	-1.4300	.7590	.062	-2.9311	7.114E-02
		9000000	-6.2990*	.7590	.000	-7.8001	-4.7979
	1901030	1703030	2.6540*	.7590	.001	1.1529	4.1551
		1703070	3.6310*	.7590	.000	2.1299	5.1321
		1802030	.6610	.7590	.385	-.8401	2.1621
		1802070	2.9850*	.7590	.000	1.4839	4.4861
		1901070	2.6320*	.7590	.001	1.1309	4.1331
		2703030	1.3630	.7590	.075	-.1381	2.8641
		2703070	-2.5910*	.7590	.001	-4.0921	-1.0899
		2802030	.1890	.7590	.804	-1.3121	1.6901
		2802070	1.7240*	.7590	.025	.2229	3.2251
		2901030	-5.9000E-02	.7590	.938	-1.5601	1.4421
		2901070	-2.0850*	.7590	.007	-3.5861	-.5839
		7000000	-.9390	.7590	.218	-2.4401	.5621
		8000000	1.5550*	.7590	.042	5.386E-02	3.0561
		9000000	-3.3140*	.7590	.000	-4.8151	-1.8129
	1901070	1703030	2.200E-02	.7590	.977	-1.4791	1.5231
		1703070	.9990	.7590	.190	-.5021	2.5001
		1802030	-1.9710*	.7590	.010	-3.4721	-.4699
		1802070	.3530	.7590	.643	-1.1481	1.8541
		1901030	-2.6320*	.7590	.001	-4.1331	-1.1309
		2703030	-1.2690	.7590	.097	-2.7701	.2321
		2703070	-5.2230*	.7590	.000	-6.7241	-3.7219
		2802030	-2.4430*	.7590	.002	-3.9441	-.9419
		2802070	-.9080	.7590	.234	-2.4091	.5931
		2901030	-2.6910*	.7590	.001	-4.1921	-1.1899
		2901070	-4.7170*	.7590	.000	-6.2181	-3.2159
		7000000	-3.5710*	.7590	.000	-5.0721	-2.0699
		8000000	-1.0770	.7590	.158	-2.5781	.4241
		9000000	-5.9460*	.7590	.000	-7.4471	-4.4449

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	2703030	1703030	1.2910	7590	.091	.2101	.7921
		1703070	2.2680*	.7590	.003	7669	.7691
		1802030	-.7020	.7590	.357	-2.2031	.7991
		1802070	1.6220*	7590	034	.1209	
		1901030	-1.3630	7590	075	-2.8641	.1381
		1901070	1.2690	.7590	.097	-.2321	2.7701
		2703070	-3.9540*	7590	.000	-5.4551	-2.4529
		2802030	-1.1740	.7590	.124	-2.6751	.3271
		2802070	.3610	.7590	.635	-1.1401	1.8621
		2901030	-1.4220	.7590	.063	-2.9221	7.914E-02
		2901070	-3.4480*	.7590	.000	-4.9491	-1.9469
		7000000	-2.3020*	.7590	.003	-3.8031	-.8009
			.1920	.7590	.801	-1.3091	1.6931
		9000000	-4.6770*	.7590	.000	-6.1781	-3.1759
	2703070	1703030	5.2450*	.7590	.000	3.7439	6.7461
		1703070	6.2220*	.7590	.000	4.7209	7.7231
		1802030	3.2520*	.7590	.000	1.7509	4.7531
		1802070	5.5760*	.7590	.000	4.0749	7.0771
		1901030	2.5910*	.7590	.001	1.0899	4.0921
		1901070	5.2230*	.7590	.000	3.7219	6.7241
		2703030	3.9540*	.7590	.000	2.4529	5.4551
		2802030	2.7800*	.7590	.000	1.2789	4.2811
		2802070	4.3150*	.7590	.000	2.8139	5.8161
		2901030	2.5320*	.7590	.001	1.0309	4.0331
		2901070	.5060	.7590	.506	-.9951	2.0071
		7000000	1.6520*	.7590	.031	.1509	3.1531
		8000000	4.1460*	.7590	.000	2.6449	5.6471
		9000000	-.7230	.7590	.343	-2.2241	.7781
	2802030	1703030	2.4650*	.7590	.001	.9639	3.9661
		1703070	3.4420*	.7590	.000	1.9409	4.9431
		1802030	.4720	.7590	.535	-1.0291	1.9731
		1802070	2.7960*	.7590	.000	1.2949	4.2971
		1901030	-.1890	.7590	.804	-1.6901	1.3121
		1901070	2.4430*	.7590	.002	.9419	3.9441
		2703030	1.1740	.7590	.124	.3271	2.6751
		2703070	-2.7800*	.7590	.000	-4.2811	-1.2789
		2802070	1.5350*	7590	.045	3.386E-02	3.0361
		2901030	-.2480	.7590	.744	-1.7491	1.2531
		2901070	-2.2740*	.7590	.003	-3.7751	-.7729
		7000000	-1.1280	.7590	.140	-2.6291	.3731
			1.3660	.7590	.074	-.1351	2.8671
		9000000	-3.5030*	.7590	.000	-5.0041	-2.0019

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SW	2802070	1703030	.9300	.7590	.223	-.5711	2.4311
		1703070	1.9070*	.7590	.013	.4059	3.4081
		1802030	-1.0630	.7590	.164	-2.5641	.4381
		1802070	1.2610	.7590	.099	-.2401	2.7621
		1901030	-1.7240*	.7590	.025	-3.2251	-.2229
		1901070	.9080	.7590	.234	-.5931	2.4091
		2703030	-.3610	.7590	.635	-1.8621	1.1401
		2703070	-4.3150*	.7590	.000	-5.8161	-2.8139
		2802030	-1.5350*	.7590	.045	-3.0361	-3.3864E-02
		2901030	-1.7830*	.7590	.020	-3.2841	-.2819
		2901070	-3.8090*	.7590	.000	-5.3101	-2.3079
		7000000	-2.6630*	.7590	.001	-4.1641	-1.1619
		8000000	-.1690	.7590	.824	-1.6701	1.3321
		9000000	-5.0380*	.7590	.000	-6.5391	-3.5369
	2901030	1703030	2.7130*	.7590	.000	1.2119	4.2141
		1703070	3.6900*	.7590	.000	2.1889	5.1911
		1802030	.7200	.7590	.345	-.7811	2.2211
		1802070	3.0440*	.7590	.000	1.5429	4.5451
		1901030	5.900E-02	.7590	.938	-1.4421	1.5601
		1901070	2.6910*	.7590	.001	1.1899	4.1921
		2703030	1.4220	.7590	.063	-7.9136E-02	2.9231
		2703070	-2.5320*	.7590	.001	-4.0331	-1.0309
		2802030	.2180	.7590	.744	-1.2531	1.7491
		2802070	1.7830*	.7590	.020	.2819	3.2841
		2901070	-2.0260*	.7590	.009	-3.5271	-.5249
		7000000	-.8800	.7590	.248	-2.3811	.6211
			1.6140*	.7590	.035	.1129	3.1151
		9000000	-3.2550*	.7590	.000	-4.7561	-1.7539
	2901070	1703030	4.7390*	.7590	.000	3.2379	6.2401
		1703070	5.7160*	.7590	.000	4.2149	7.2171
		1802030	2.7460*	.7590	.000	1.2449	4.2471
		1802070	5.0700*	.7590	.000	3.5689	6.5711
		1901030	2.0850*	.7590	.007	.5839	3.5861
		1901070	4.7170*	.7590	.000	3.2159	6.2181
		2703030	3.4480*	.7590	.000	1.9469	4.9491
		2703070	-.5060	.7590	.506	-2.0071	.9951
		2802030	2.2740*	.7590	.003	.7729	3.7751
		2802070	3.8090*	.7590	.000	2.3079	5.3101
		2901030	2.0260*	.7590	.009	.5249	3.5271
		7000000	1.1460	.7590	.133	-.3551	2.6471
		8000000	3.6400*	.7590	.000	2.1389	5.1411
		9000000	-1.2290	.7590	.108	-2.7301	.2721

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SW	7000000	1703030	3.5930*	.7590	.000	2.0919	5.0941
		1703070	4.5700*	.7590		3.0689	6.0711
		1802030	1.6000*	.7590		9.886E-02	3.1011
		1802070	3.9240*	.7590	.000	2.4229	5.4251
		1901030	.9390	.7590	.218	-.5621	2.4401
		1901070	3.5710*	.7590	.000	2.0699	5.0721
		2703030	2.3020*	.7590	.003	.8009	3.8031
		2703070	-1.6520*	.7590		-3.1531	-.1509
		2802030	1.1280	.7590	.140	-.3731	2.6291
		2802070	2.6630*	.7590	.001	1.1619	4.1641
		2901030	.8800	.7590	.248	-.6211	2.3811
		2901070	-1.1460	.7590	.133	-2.6471	.3551
		8000000	2.4940*	.7590	.001	.9929	3.9951
			-2.3750*	.7590	.002	3.8761	-.8739
		1703030	1.0990	.7590	.150	-.4021	2.6001
		1703070	2.0760*	.7590	.007	.5749	3.5771
		1802030	-.8940	.7590	.241	-2.3951	.6071
		1802070	1.4300	.7590	.062	-7.1136E-02	2.9311
		1901030	-1.5550*	.7590	.042	-3.0561	-5.3864E-02
		1901070	1.0770	.7590	.158	-.4241	2.5781
		2703030	-.1920	.7590	.801	-1.6931	1.3091
		2703070	-4.1460*	.7590	.000	-5.6471	-2.6449
		2802030	-1.3660	.7590	.074	-2.8671	.1351
		2802070	.1690	.7590	.824	-1.3321	1.6701
		2901030	-1.6140*	.7590	.035	-3.1151	-.1129
		2901070	-3.6400*	.7590	.000	-5.1411	-2.1389
		7000000	-2.4940*	.7590	.001	-3.9951	-.9929
		9000000	-4.8690*	.7590	.000	-6.3701	-3.3679
	9000000	1703030	5.9680*	.7590	.000	4.4669	7.4691
		1703070	6.9450*	.7590	.000	5.4439	8.4461
		1802030	3.9750*	.7590	.000	2.4739	5.4761
		1802070	6.2990*	.7590	.000	4.7979	7.8001
		1901030	3.3140*	.7590	.000	1.8129	4.8151
		1901070	5.9460*	.7590	.000	4.4449	7.4471
		2703030	4.6770*	.7590	.000	3.1759	6.1781
		2703070	.7230	.7590	.343	-.7781	2.2241
		2802030	3.5030*	.7590	.000	2.0019	5.0041
		2802070	5.0380*	.7590	.000	3.5369	6.5391
		2901030	3.2550*	.7590	.000	1.7539	4.7561
		2901070	1.2290	.7590	.108	-.2721	2.7301
		7000000	2.3750*	.7590	.002	.8739	3.8761
		8000000	4.8690*	.7590	.000	3.3679	6.3701

Multiple Compar

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MOE	1703030	1703070	-69088.9000*	12782.1650	000	-94368.0890	-43809.7110
		1802030	-43126.9000*	12782.1650	.001	-68406.0890	-17847.7110
		1802070	5346.5000	12782.1650	676	-19932.6890	30625.6890
		1901030	-29367.0000*	12782.1650	.023	-54646.1890	-4087.8110
		1901070	952.9000	12782.1650	941	-24326.2890	26232.0890
		2703030	2727.3000	12782.1650	.831	-22551.8890	28006.4890
		2703070	2201.0000	12782.1650	.864	-23078.1890	27280.1890
		2802030	2803.8000	12782.1650	.827	-22475.3890	28082.9890
		2802070	3892.6000	12782.1650	.761	-21386.5890	29171.7890
		2901030	-1412.4000	12782.1650	.912	-26691.5890	23866.7890
		2901070	-3784.5000	12782.1650	.768	-29063.6890	21494.6890
		7000000	14416.0000	12782.1650	.261	-10863.1890	39695.1890
		8000000	-5103.4000	12782.1650	.690	-30382.5890	20175.7890
		9000000	7701.9000	12782.1650	.548	-17577.2890	32981.0890
	1703070	1703030	69088.9000*	12782.1650	.000	43809.7110	94368.0890
		1802030	25962.0000*	12782.1650	.044	682.8110	51241.1890
		1802070	74435.4000*	12782.1650	.000	49156.2110	99714.5890
		1901030	39721.9000*	12782.1650	.002	14442.7110	65001.0890
		1901070	70041.8000*	12782.1650	.000	44762.6110	95320.9890
		2703030	71816.2000*	12782.1650	.000	46537.0110	97095.3890
		2703070	71289.9000*	12782.1650	.000	46010.7110	96569.0890
		2802030	71892.7000*	12782.1650	.000	46613.5110	97171.8890
		2802070	72981.5000*	12782.1650	.000	47702.3110	98260.6890
		2901030	67676.5000*	12782.1650	.000	42397.3110	92955.6890
		2901070	65304.4000*	12782.1650	.000	40025.2110	90583.5890
		7000000	83504.9000*	12782.1650	.000	58225.7110	108784.0890
		8000000	63985.5000*	12782.1650	.000	38706.3110	89264.6890
		9000000	76790.8000*	12782.1650	.000	51511.6110	102069.9890
	1802030	1703030	43126.9000*	12782.1650	.001	17847.7110	68406.0890
		1703070	-25962.0000*	12782.1650	.044	-51241.1890	-682.8110
		1802070	48473.4000*	12782.1650	.000	23194.2110	73752.5890
		1901030	13759.9000	12782.1650	.284	-11519.2890	39039.0890
		1901070	44079.8000*	12782.1650	.001	18800.6110	69358.9890
		2703030	45854.2000*	12782.1650	.000	20575.0110	71133.3890
		2703070	45327.9000*	12782.1650	.001	20048.7110	70607.0890
		2802030	45930.7000*	12782.1650	.000	20651.5110	71209.8890
		2802070	47019.5000*	12782.1650	.000	21740.3110	72298.6890
		2901030	41714.5000*	12782.1650	.001	16435.3110	66993.6890
		2901070	39342.4000*	12782.1650	.003	14063.2110	64621.5890
		7000000	57542.9000*	12782.1650	.000	32263.7110	82822.0890
		8000000	38023.5000*	12782.1650	.003	12744.3110	63302.6890
		9000000	50828.8000*	12782.1650	.000	25549.6110	76107.9890

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MOE	1802070	1703030	-5346.5000	12782.1650	.676	-30625.6890	19932.6890
		1703070	-74435.4000*	12782.1650	.000	-99714.5890	-49156.2110
		1802030	-48473.4000*	12782.1650	.000	-73752.5890	-23194.2110
		1901030	-34713.5000*	12782.1650	.007	-59992.6890	-9434.3110
		1901070	-4393.6000	12782.1650	.732	-29672.7890	20885.5890
		2703030	-2619.2000	12782.1650	.838	-27898.3890	22659.9890
		2703070	-3145.5000	12782.1650	.806	-28424.6890	22133.6890
		2802030	-2542.7000	12782.1650	.843	-27821.8890	22736.4890
		2802070	-1453.9000	12782.1650	.910	-26733.0890	23825.2890
		2901030	-6758.9000	12782.1650	.598	-32038.0890	18520.2890
		2901070	-9131.0000	12782.1650	.476	-34410.1890	16148.1890
		7000000	9069.5000	12782.1650	.479	-16209.6890	34348.6890
		8000000	-10449.9000	12782.1650	.415	-35729.0890	14829.2890
		9000000	2355.4000	12782.1650	.854	-22923.7890	27634.5890
	1901030	1703030	29367.0000*	12782.1650	.023	4087.8110	54646.1890
		1703070	-39721.9000*	12782.1650	.002	-65001.0890	-14442.7110
		1802030	-13759.9000	12782.1650	.284	-39039.0890	11519.2890
		1802070	34713.5000*	12782.1650	.007	9434.3110	59992.6890
		1901070	30319.9000*	12782.1650	.019	5040.7110	55599.0890
		2703030	32094.3000*	12782.1650	.013	6815.1110	57373.4890
		2703070	31568.0000*	12782.1650	.015	6288.8110	56847.1890
		2802030	32170.8000*	12782.1650	.013	6891.6110	57449.9890
		2802070	33259.6000*	12782.1650	.010	7980.4110	58538.7890
		2901030	27954.6000*	12782.1650	.030	2675.4110	53233.7890
		2901070	25582.5000*	12782.1650	.047	303.3110	50861.6890
		7000000	43783.0000*	12782.1650	.001	18503.8110	69062.1890
		8000000	24263.6000	12782.1650	.060	-1015.5890	49542.7890
		9000000	37068.9000*	12782.1650	.004	11789.7110	62348.0890
	1901070	1703030	-952.9000	12782.1650	.941	-26232.0890	24326.2890
		1703070	-70041.8000*	12782.1650	.000	-95320.9890	-44762.6110
		1802030	-44079.8000*	12782.1650	.001	-69358.9890	-18800.[illegible]
		1802070	4393.6000	12782.1650	.732	-20885.5890	29672.7890
		1901030	-30319.9000*	12782.1650	.019	-55599.0890	-5040.7110
		2703030	1774.4000	12782.1650	.890	-23504.7890	27053.5890
		2703070	1248.1000	12782.1650	.922	-24031.0890	26527.2890
		2802030	1850.9000	12782.1650	.885	-23428.2890	27130.0890
		2802070	2939.7000	12782.1650	.818	-22339.4890	28218.8890
		2901030	-2365.3000	12782.1650	.853	-27644.4890	22913.8890
		2901070	-4737.4000	12782.1650	.711	-30016.5890	20541.7890
		7000000	13463.1000	12782.1650	.294	-11816.0890	38742.2890
		8000000	-6056.3000	12782.1650	.636	-31335.4890	19222.8890
		9000000	6749.0000	12782.1650	.598	-18530.1890	32028.1890

Iultiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	'703030	1703030	-2727.3000	12782.1650		28006.4890	22551.8890
		1703070	-71816.2000*	12782.1650	000	-97095.3890	-46537.0110
		1802030	-45854.2000*	12782.1650		-71133.3890	-20575.0110
		1802070	2619.2000	12782.1650		-22659.9890	27898.3890
		1901030	-32094.3000*	12782.1650	.013	-57373.4890	-6815.1110
		1901070	-1774.5000	12782.1650	890	-27053.5890	23504.7890
		2703070	-526.3000	12782.1650	.967	-25805.4890	24752.8890
		2802030	76.5000	12782.1650	.995	-25202.6890	25355.6890
		2802070	1165.3000	12782.1650	.927	-24113.3890	26444.4890
		2901030	-4139.7000	12782.1650	.747	-29418.8890	21139.4390
		2901070	-6511.8000	12782.1650	.611	31790.9890	18767.3890
		7000000	11688.7000	12782.1650	.362	-13590.4890	36967.8890
			-7830.7000	12782.1650	.541	-33109.8890	17448.4890
			4974.6000	12782.1650	.698	-20304.5890	30253.7890
	2703070	1703030	-2201.0000	12782.1650	.864	-27480.1890	23078.1890
		1703070	-71289.9000*	12782.1650	.000	-96569.0890	-46010.7110
		1802030	-45327.9000*	12782.1650	.001	-70607.0890	-20048.7110
		1802070	3145.5000	12782.1650	.806	-22133.6890	28424.6890
		1901030	-31568.0000*	12782.1650	.015	-56847.1890	-6288.8110
		1901070	-1248.1000	12782.1650	.922	-26527.2890	24031.0890
		2703030	526.3000	12782.1650	.967	-24752.8890	25805.4890
		2802030	602.8000	12782.1650	.962	-24676.3890	25881.9890
		2802070	1691.6000	12782.1650	.895	-23587.5890	26970.7890
		2901030	-3613.4000	12782.1650	.778	-28892.5890	21665.7890
		2901070	-5985.5000	12782.1650	.640	-31264.6890	19293.6890
		7000000	12215.0000	12782.1650	.341	-13064.1890	37494.1890
		8000000	7304.4000	12782.1650	.569	-32583.5890	17974.7890
		9000000	5500.9000	12782.1650	.668	-19778.2890	30780.0890
	2802030	1703030	-2803.8000	12782.1650	.827	-28082.9890	22475.3890
		1703070	-71892.7000*	12782.1650	.000	-97171.8890	-46613.5110
		1802030	-45930.7000*	12782.1650	.000	-71209.8890	-20651.5110
		1802070	2542.7000	12782.1650	.843	-22736.4890	27821.8890
		1901030	-32170.8000*	12782.1650	.013	-57449.9890	-6891.6110
		1901070	-1850.9000	12782.1650	.885	-27130.0890	23428.2890
		2703030	-76.5000	12782.1650	.995	-25355.6890	25202.6890
		2703070	-602.8000	12782.1650	.962	-25881.9890	24676.3890
		2802070	1088.8000	12782.1650	.932	-24190.3890	26367.9890
		2901030	-4216.2000	12782.1650	.742	-29495.3890	21062.9890
		2901070	-6588.3000	12782.1650	.607	-31867.4890	18690.8890
		7000000	11612.2000	12782.1650	.365	-13666.9890	36891.3890
		8000000	-7907.2000	12782.1650	.537	-33186.3890	17371.9890
		9000000	4898.1000	12782.1650	.702	-20381.0890	30177.2890

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MOE	2802070	1703030	-3892.6000	12782.1650	.761	-29171.7890	21386.5890
		1703070	-72981.5000*	12782.1650	.000	-98260.6890	-47702.3110
		1802030	-47019.5000*	12782.1650	.000	-72298.6890	-21740.3110
		1802070	1453.9000	12782.1650	910	-23825.2890	26733.0890
		1901030	-33259.6000*	12782.1650	.010	-58538.7890	-7980.4110
		1901070	-2939.7000	12782.1650	.818	-28218.8890	22339.4890
		2703030	-1165.3000	12782.1650	.927	-26444.4890	24113.8890
		2703070	-1691.6000	12782.1650	.895	-26970.7890	23587.5890
		2802030	-1088.8000	12782.1650	.932	-26367.9890	24190.3890
		2901030	-5305.0000	12782.1650	.679	-30584.1890	19974.1890
		2901070	-7677.1000	12782.1650	.549	-32956.2890	17602.0890
		7000000	10523.4000	12782.1650	.412	-14755.7890	35802.5890
		8000000	-8996.0000	12782.1650	.483	-34275.1890	16283.1890
		9000000	3809.3000	12782.1650	.766	-21469.8890	29088.4890
	2901030	1703030	1412.4000	12782.1650	.912	-23866.7890	26691.5890
		1703070	-67676.5000*	12782.1650	.000	-92955.6890	-42397.3110
		1802030	-41714.5000*	12782.1650	.001	-66993.6890	-16435.3110
		1802070	6758.9000	12782.1650	.598	-18520.2890	32038.0890
		1901030	-27954.6000*	12782.1650	.030	-53233.7890	-2675.4110
		1901070	2365.3000	12782.1650	.853	-22913.8890	27644.4890
		2703030	4139.7000	12782.1650	.747	-21139.4890	29418.8890
		2703070	3613.4000	12782.1650	.778	-21665.7890	28892.5890
		2802030	4216.2000	12782.1650	.742	-21062.9890	29495.3890
		2602070	5305.0000	12782.1650	.679	-19974.1890	30584.1890
		2901070	-2372.1000	12782.1650	.853	-27651.2890	22907.0890
		7000000	15828.4000	12782.1650	.218	-9450.7890	41107.5890
		8000000	-3691.0000	12782.1650	.773	-28970.1890	21588.1890
		9000000	9114.3000	12782.1650	.477	-16164.8890	34393.4890
	2901070	1703030	3784.5000	12782.1650	.768	-21494.6890	29063.6890
		1703070	-65304.4000*	12782.1650	.000	-90583.5890	-40025.2110
		1802030	-39342.4000*	12782.1650	.003	-64621.5890	-14063.2110
		1802070	9131.0000	12782.1650	.476	-16148.1890	34410.1890
		1901030	-25582.5000*	12782.1650	.047	-50861.6890	-303.3110
		1901070	4737.4000	12782.1650	.711	-20541.7890	30016.5890
		2703030	6511.8000	12782.1650	.611	-18767.3890	31790.9890
		2703070	5985.5000	12782.1650	.640	-19293.6890	31264.6890
		2802030	6588.3000	12782.1650	.607	-18690.8890	31867.4890
		2802070	7677.1000	12782.1650	.549	-17602.0890	32956.2890
		2901030	2372.1000	12782.1650	.853	-22907.0890	27651.2890
		7000000	18200.5000	12782.1650	.157	-7078.6890	43479.6890
		8000000	-1318.9000	12782.1650	.918	-26598.0890	23960.2890
		9000000	11486.4000	12782.1650	.370	-13792.7890	36765.5890

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MOF	7000000	1703030	-14416.0000	12782.1650	.261	-39695.1890	10863.1890
		1703070	-83504.9000*	12782.1650	.000	-108784.0890	-58225.7110
		1802030	-57542.9000*	12782.1650	.000	-82822.0890	-32263.7110
		1802070	-9069.5000	12782.1650	.479	-34348.6890	16209.6890
		1901030	-43783.0000*	12782.1650	.001	-69062.1890	-18503.8110
		1901070	-13463.1000	12782.1650	.294	-38742.2890	11816.0890
		2703030	-11688.7000	12782.1650	.362	-36967.8890	13590.4890
		2703070	-12215.0000	12782.1650	.341	-37494.1890	13064.1890
		2802030	-11612.2000	12782.1650	.365	-36891.3890	13666.9890
		2802070	-10523.4000	12782.1650	.412	-35802.5890	14755.7890
		2901030	-15828.4000	12782.1650	.218	-41107.5890	9450.7890
		2901070	-18200.5000	12782.1650	.157	-43479.6890	7078.6890
		8000000	-19519.4000	12782.1650	.129	-44798.5890	5759.7890
		9000000	-6714.1000	12782.1650	.600	-31993.2890	18565.0890
	8000000	1703030	5103.4000	12782.1650	.690	-20175.7890	30382.5890
		1703070	-63985.5000*	12782.1650	.000	-89264.6890	-38706.3110
		1802030	-38023.5000*	12782.1650	.003	-63302.6890	-12744.3110
		1802070	10449.9000	12782.1650	.415	-14829.2890	35729.0890
		1901030	-24263.6000	12782.1650	.060	-49542.7890	1015.5890
		1901070	6056.3000	12782.1650	.636	-19222.8890	31335.4890
		2703030	7830.7000	12782.1650	.541	-17448.4890	33109.8890
		2703070	7304.4000	12782.1650	.569	-17974.7890	32583.5890
		2802030	7907.2000	12782.1650	.537	-17371.9890	33186.3890
		2802070	8996.0000	12782.1650	.483	-16283.1890	34275.1890
		2901030	3691.0000	12782.1650	.773	-21588.1890	28970.1890
		2901070	1318.9000	12782.1650	.918	-23960.2890	26598.0890
		7000000	19519.4000	12782.1650	.129	-5759.7890	44798.5890
		9000000	12805.3000	12782.1650	.318	-12473.8890	38084.4890
	9000000	1703030	-7701.9000	12782.1650	.548	-32981.0890	17577.2890
		1703070	-76790.8000*	12782.1650	.000	-102069.9890	-51511.6110
		1802030	-50828.8000*	12782.1650	.000	-76107.9890	-25549.6110
		1802070	-2355.4000	12782.1650	.854	-27634.5890	22923.7890
		1901030	-37068.9000*	12782.1650	.004	-62348.0890	-11789.7110
		1901070	-6749.0000	12782.1650	.598	-32028.1890	18530.1890
		2703030	-4974.6000	12782.1650	.698	-30253.7890	20304.5890
		2703070	-5500.9000	12782.1650	.668	-30780.0890	19778.2890
		2802030	-4898.1000	12782.1650	.702	-30177.2890	20381.0890
		2802070	-3809.3000	12782.1650	.766	-29088.4890	21469.8890
		2901030	-9114.3000	12782.1650	.477	-34393.4890	16164.8890
		2901070	-11486.4000	12782.1650	.370	-36765.5890	13792.7890
		7000000	6714.1000	12782.1650	.600	-18565.0890	31993.2890
		8000000	-12805.3000	12782.1650	.318	-38084.4890	12473.8890

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	1703030	1703070	-95.3000*	21.8611	.000	-138.5346	-52.0654
		1802030	-105.3000*	21.8611	000	-148.5346	-62.0654
		1802070	70.5000*	21.8611	002	27.2654	113.7346
		1901030	-.8000	21.8611		-44.0346	42.4346
		1901070	27.0000	21.8611	.219	-16.2346	70.2346
		2703030	-8.8000	21.8611	.688	-52.0346	34.4346
		2703070	4.0000	21.8611	.855	-39.2346	47.2346
		2802030	-1.8000	21.8611	.934	-45.0346	41.4346
		2802070	16.6000	21.8611	.449	-26.6346	59.8346
		2901030	7.0000	21.8611	.749	-36.2346	50.2346
		2901070	-31.4000	21.8611		-74.6346	11.8346
		7000000	132.1000*	21.8611	.000	88.8654	175.3346
		8000000	29.3000	21.8611	.182	-13.9346	72.5346
		9000000	88.0000*	21.8611	.000	44.7654	131.2346
	1703070	1703030	95.3000*	21.8611	.000	52.0654	138.5346
		1802030	-10.0000		.648	-53.2346	33.2346
		1802070	165.8000*	21.8611	.000	122.5654	209.0346
		1901030	94.5000*	21.8611	.000	51.2654	137.7346
		1901070	122.3000*	21.8611	.000	79.0654	165.5346
		2703030	86.5000*	21.8611	.000	43.2654	129.7346
		2703070	99.3000*	21.8611	.000	56.0654	142.5346
		2802030	93.5000*	21.8611	.000	50.2654	136.7346
		2802070	111.9000*	21.8611	.000	68.6654	155.1346
		2901030	102.3000*	21.8611	.000	59.0654	145.5346
		2901070	63.9000*	21.8611	.004	20.6654	107.1346
		7000000	227.4000*	21.8611	.000	184.1654	270.6346
		8000000	124.6000*	21.8611	.000	81.3654	167.8346
		9000000	183.3000*	21.8611	.000	140.0654	226.5346
	1802030	1703030	105.3000*	21.8611	.000	62.0654	148.5346
		1703070	10.0000	21.8611	.648	-33.2346	53.2346
		1802070	175.8000*	21.8611	.000	132.5654	219.0346
		1901030	104.5000*	21.8611		61.2654	147.7346
		1901070	132.3000*	21.8611	000	89.0654	175.5346
		2703030	96.5000*		000	53.2654	139.7346
		2703070	109.3000*	21.8611		66.0654	146
		2802030	103.5000*	21.8611		60.2654	146.7346
		2802070	121.9000	21.8611		78.6654	
		2901030	112.3000			69.0654	
		2901070	73.9000		(X)1	30.6654	117.1346
		7000000	237.4000*				
		8000000	134.6000*				77.8346
		9000000	193.3000*	21.8611		150.0654	236.5346

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	1802070	1703030	-70.5000*	21.8611	.002	-113.7346	-27.2654
		1703070	-165.8000*	21.8611	.000	-209.0346	-122.5654
		1802030	-175.8000*	21.8611	.000	-219.0346	-132.5654
		1901030	-71.3000*	21.8611	.001	-114.5346	-28.0654
		1901070	-43.5000*	21.8611	.049	-86.7346	-.2654
		2703030	-79.3000*	21.8611	.000	-122.5346	-36.0654
		2703070	-66.5000*	21.8611	.003	-109.7346	-23.2654
		2802030	-72.3000*	21.8611	.001	-115.5346	-29.0654
		2802070	-53.9000*	21.8611	.015	-97.1346	-10.6654
		2901030	-63.5000*	21.8611	.004	-106.7346	-20.2654
		2901070	-101.9000*	21.8611	.000	-145.1346	-58.6654
		7000000	61.6000*	21.8611	.006	18.3654	104.8346
		8000000	-41.2000	21.8611	.062	-84.4346	2.0346
		9000000	17.5000	21.8611	.425	-25.7346	60.7346
	1901030	1703030	.8000	21.8611	.971	-42.4346	44.0346
		1703070	-94.5000*	21.8611	.000	-137.7346	-51.2654
		1802030	-104.5000*	21.8611	.000	-147.7346	-61.2654
		1802070	71.3000*	21.8611	.001	28.0654	114.5346
		1901070	27.8000	21.8611	.206	-15.4346	71.0346
		2703030	-8.0000	21.8611	.715	-51.2346	35.2346
		2703070	4.8000	21.8611	.827	-38.4346	48.0346
		2802030	-1.0000	21.8611	.964	-44.2346	42.2346
		2802070	17.4000	21.8611	.427	-25.8346	60.6346
		2901030	7.8000	21.8611	.722	-35.4346	51.0346
		2901070	-30.6000	21.8611	.164	-73.8346	12.6346
			132.9000*	21.8611	.000	89.6654	176.1346
		8000000	30.1000	21.8611	.171	-13.1346	73.3346
		9000000	88.8000*	21.8611	.000	45.5654	132.0346
	1901070	1703030	-27.0000	21.8611	.219	-70.2346	16.2346
		1703070	-122.3000*	21.8611	.000	-165.5346	-79.0654
		1802030	-132.3000*	21.8611	.000	-175.5346	-89.0654
		1802070	43.5000*	21.8611	.049	.2654	86.7346
		1901030	-27.8000	21.8611	.206	-71.0346	15.4346
		2703030	-35.8000	21.8611	.104	-79.0346	7.4346
		2703070	-23.0000	21.8611	.295	-66.2346	20.2346
		2802030	-28.8000	21.8611	.190	-72.0346	14.4346
		2802070	-10.4000	21.8611	.635	-53.6346	32.8346
		2901030	-20.0000	21.8611	.362	-63.2346	23.2346
		2901070	-58.4000*	21.8611	.008	-101.6346	-15.1654
		7000000	105.1000*	21.8611	.000	61.8654	148.3346
		8000000	2.3000	21.8611	.916	-40.9346	45.5346
		9000000	61.0000*	21.8611	.006	17.7654	104.2346

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
F	2703030	1703030	8.8000	21.8611	.688	-34.4346	52.0346
		1703070	-86.5000*	21.8611	.000	-129.7346	-43.2654
		1802030	-96.5000*	21.8611	.000	-139.7346	-53.2654
		1802070	79.3000*	21.8611	.000	36.0654	122.5346
		1901030	8.0000	21.8611	.715	-35.2346	51.2346
		1901070	35.8000	21.8611	.104	-7.4346	79.0346
		2703070	12.8000	21.8611	.559	-30.4346	56.0346
		2802030	7.0000	21.8611	.749	-36.2346	50.2346
		2802070	25.4000	21.8611	.247	-17.8346	68.6346
		2901030	15.8000	21.8611	.471	-27.4346	59.0346
		2901070	-22.6000	21.8611	.303	-65.8346	20.6346
		7000000	140.9000*	21.8611	.000	97.6654	184.1346
		8000000	38.1000	21.8611	.084	-5.1346	81.3346
		9000000	96.8000*	21.8611	.000	53.5654	140.0346
	2703070	1703030	-4.0000	21.8611	.855	-47.2346	39.2346
		1703070	-99.3000*	21.8611	.000	-142.5346	-56.0654
		1802030	-109.3000*	21.8611	.000	-152.5346	-66.0654
		1802070	66.5000*	21.8611	.003	23.2654	109.7346
		1901030	-4.8000	21.8611	.827	-48.0346	38.4346
		1901070	23.0000	21.8611	.295	-20.2346	66.2346
		2703030	-12.8000	21.8611	.559	-56.0346	30.4346
		2802030	-5.8000	21.8611	.791	-49.0346	37.4346
		2802070	12.6000	21.8611	.565	-30.6346	55.8346
		2901030	3.0000	21.8611	.891	-40.2346	46.2346
		2901070	-35.4000	21.8611	.108	-78.6346	7.8346
		7000000	128.1000*	21.8611	.000	84.8654	171.3346
		8000000	25.3000	21.8611	.249	-17.9346	68.5346
		9000000	84.0000*	21.8611	.000	40.7654	127.2346
	2802030	1703030	1.8000	21.8611	.934	-41.4346	45.0346
		1703070	-93.5000*	21.8611	.000	-136.7346	-50.2654
		1802030	-103.5000*	21.8611	.000	-146.7346	-60.2654
		1802070	72.3000*	21.8611	001	29.0654	115.5346
		1901030	1.0000	21.8611	.964	-42.2346	44.2346
		1901070	28.8000	21.8611	.190	-14.4346	72.0346
		2703030	-7.0000	21.8611	749	-50.2346	36.2346
		2703070	5.8000	21.8611	791	-37.4346	49.0346
		2802070	18.4000	21.8611	401	-24.8346	61.6346
		2901030	8.8000	21.8611	688	-34.4346	52.0346
		2901070	-29.6000	21.8611	.178	-72.8346	13.6346
		7000000	133.9000*	21.8611	.000	90.6654	177.1346
		8000000	31.1000	21.8611	.157	-12.1346	74.3346
		9000000	89.8000*	21.8611	.000	46.5654	133.0346

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
	2802070	1703030	-16.6000	21.8611	.449	-59.8346	26.6346
		1703070	-111.9000*	21.8611	.000	-155.1346	-68.6654
		1802030	-121.9000*	21.8611	.000	-165.1346	-78.6654
		1802070	53.9000*	21.8611	.015	10.6654	97.1346
		1901030	-17.4000	21.8611	.427	-60.6346	25.8346
		1901070	10.4000	21.8611	.635	-32.8346	53.6346
		2703030	-25.4000	21.8611	.247	-68.6346	17.8346
		2703070	-12.6000	21.8611	.565	-55.8346	30.6346
		2802030	-18.4000	21.8611	.401	-61.6346	24.8346
		2901030	-9.6000	21.8611	.661	-52.8346	33.6346
		2901070	-48.0000*	21.8611	.030	-91.2346	-4.7654
			115.5000*	21.8611	.000	72.2654	158.7346
		8000000	12.7000	21.8611	.562	-30.5346	55.9346
		9000000	71.4000*	21.8611	.001	28.1654	114.6346
	2901030	1703030	-7.0000	21.8611	.749	-50.2346	36.2346
		1703070	-102.3000*	21.8611	.000	-145.5346	-59.0654
		1802030	-112.3000*	21.8611	.000	155.5346	-69.0654
		1802070	63.5000*	21.8611	.004	20.2654	106.7346
		1901030	-7.8000	21.8611	.722	-51.0346	35.4346
		1901070	20.0000	21.8611	.362	-23.2346	63.2346
		2703030	-15.8000	21.8611	.471	-59.0346	27.4346
		2703070	-3.0000	21.8611	.891	-46.2346	40.2346
		2802030	-8.8000	21.8611	.688	-52.0346	34.4346
		2802070	9.6000	21.8611	.661	-33.6346	52.8346
		2901070	-38.4000	21.8611	.081	-81.6346	4.8346
		7000000	125.1000*	21.8611	.000	81.8654	168.3346
		8000000	22.3000	21.8611	.310	-20.9346	65.5346
		9000000	81.0000*	21.8611	.000	37.7654	124.2346
	2901070	1703030	31.4000	21.8611		-11.8346	74.6346
		1703070	-63.9000*	21.8611	.004	-107.1346	-20.6654
		1802030	-73.9000*	21.8611	.001	-117.1346	-30.6654
		1802070	101.9000*	21.8611	.000	58.6654	145.1346
		1901030	30.6000	21.8611	164	-12.6346	73.8346
		1901070	58.4000*	21.8611		15.1654	101.6346
		2703030	22.6000	21.8611		-20.6346	65.8346
		2703070	35.4000	21.8611	108	-7.8346	78.6346
		2802030	29.6000	21.8611	178		72.8346
		2802070	48.0000*	21.8611	030	4.7654	91.2346
		2901030	38.4000	21.8611	081	-3.8346	81.6346
		7000000		21.8611		120.2654	206.7346
		8000000	60.7000	21.8611	.006	17.4654	103.9346
		9000000	119.4000*	21.8611	.000	76.1654	162.6346

Multiple Comparisons

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
F	7000000	1703030	-132.1000*	21.8611	.000	-175.3346	-88.8654
		1703070	-227.4000*	21.8611	.000	-270.6346	-184.1654
		1802030	-237.4000*	21.8611	.000	-280.6346	-194.1654
		1802070	-61.6000*	21.8611	.006	-104.8346	-18.3654
		1901030	-132.9000*	21.8611	.000	-176.1346	-89.6654
		1901070	-105.1000*	21.8611	.000	-148.3346	-61.8654
		2703030	-140.9000*	21.8611	.000	-184.1346	-97.6654
		2703070	-128.1000*	21.8611	.000	-171.3346	-84.8654
		2802030	-133.9000*	21.8611	.000	-177.1346	-90.6654
		2802070	-115.5000*	21.8611	.000	-158.7346	-72.2654
		2901030	-125.1000*	21.8611	.000	-168.3346	-81.8654
		2901070	-163.5000*	21.8611	.000	-206.7346	-120.2654
		8000000	-102.8000*	21.8611	.000	-146.0346	-59.5654
		9000000	-44.1000*	21.8611	.046	-87.3346	-.8654
	8000000	1703030	-29.3000	21.8611	.182	-72.5346	13.9346
		1703070	-124.6000*	21.8611	.000	-167.8346	-81.3654
		1802030	-134.6000*	21.8611	.000	-177.8346	-91.3654
		1802070	41.2000	21.8611	.062	-2.0346	84.4346
		1901030	-30.1000	21.8611	.171	-73.3346	13.1346
		1901070	-2.3000	21.8611	.916	-45.5346	40.9346
		2703030	-38.1000	21.8611	.084	-81.3346	5.1346
		2703070	-25.3000	21.8611	.249	-68.5346	17.9346
		2802030	-31.1000	21.8611	.157	-74.3346	12.1346
		2802070	-12.7000	21.8611	.562	-55.9346	30.5346
		2901030	-22.3000	21.8611	.310	-65.5346	20.9346
		2901070	-60.7000*	21.8611	.006	-103.9346	-17.4654
		7000000	102.8000*	21.8611	.000	59.5654	146.0346
		9000000	58.7000*	21.8611	.008	15.4654	101.9346
	9000000	1703030	-88.0000*	21.8611	.000	-131.2346	-44.7654
		1703070	-183.3000*	21.8611	.000	-226.5346	-140.0654
		1802030	-193.3000*	21.8611	.000	-236.5346	-150.0654
		1802070	-17.5000	21.8611	.425	-60.7346	25.7346
		1901030	-88.8000*	21.8611	.000	-132.0346	-45.5654
		1901070	-61.0000*	21.8611	.006	-104.2346	-17.7654
		2703030	-96.8000*	21.8611	.000	-140.0346	-53.5654
		2703070	-84.0000*	21.8611	.000	-127.2346	-40.7654
		2802030	-89.8000*	21.8611	.000	-133.0346	-46.5654
		2802070	-71.4000*	21.8611	.001	-114.6346	-28.1654
		2901030	-81.0000*	21.8611	.000	-124.2346	-37.7654
		2901070	-119.4000*	21.8611	.000	-162.6346	-76.1654
		7000000	44.1000*	21.8611	.046	.8654	87.3346
		8000000	-58.7000*	21.8611	.008	-101.9346	-15.4654

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
COMPRES	1703030	1703070	1043.0000*	370.4112	.006	310.4405	1775.5595
		1802030	-276.0000	370.4112	.457	-1008.5595	456.5595
		1802070	1229.0000*	370.4112	.001	496.4405	1961.5595
		1901030	-978.0000*	370.4112	.009	-1710.5595	-245.4405
		1901070	-248.0000	370.4112	.504	-980.5595	484.5595
		2703030	-347.0000	370.4112	.351	-1079.5595	385.5595
		2703070	-330.0000	370.4112	.375	-1062.5595	402.5595
		2802030	-343.0000	370.4112	.356	-1075.5595	389.5595
		2802070	-431.0000	370.4112	.247	-1163.5595	301.5595
		2901030	-703.0000	370.4112	.060	-1435.5595	29.5595
		2901070	-1228.0000*	370.4112	.001	-1960.5595	-495.4405
		7000000	2997.0000*	370.4112	.000	2264.4405	3729.5595
		8000000	2524.0000*	370.4112	.000	1791.4405	3256.5595
		9000000	2569.0000*	370.4112	.000	1836.4405	3301.5595
	1703070	1703030	-1043.0000*	370.4112	.006	-1775.5595	-310.4405
		1802030	-1319.0000*	370.4112	.001	-2051.5595	-586.4405
		1802070	186.0000	370.4112	.616	-546.5595	918.5595
		1901030	-2021.0000*	370.4112	.000	-2753.5595	-1288.4405
		1901070	-1291.0000*	370.4112	.001	-2023.5595	-558.4405
		2703030	-1390.0000*	370.4112	.000	-2122.5595	-657.4405
		2703070	-1373.0000*	370.4112	.000	-2105.5595	-640.4405
		2802030	-1386.0000*	370.4112	.000	-2118.5595	-653.4405
		2802070	-1474.0000*	370.4112	.000	-2206.5595	-741.4405
		2901030	-1746.0000*	370.4112	.000	-2478.5595	-1013.4405
		2901070	-2271.0000*	370.4112	.000	-3003.5595	-1538.4405
		7000000	1954.0000*	370.4112	.000	1221.4405	2686.5595
		8000000	1481.0000*	370.4112	.000	748.4405	2213.5595
		9000000	1526.0000*	370.4112	.000	793.4405	2258.5595
	1802030	1703030	276.0000	370.4112	.457	-456.5595	1008.5595
		1703070	1319.0000*	370.4112	.001	586.4405	2051.5595
		1802070	1505.0000*	370.4112	.000	772.4405	2237.5595
		1901030	-702.0000	370.4112	.060	-1434.5595	30.5595
		1901070	28.0000	370.4112	.940	-704.5595	760.5595
		2703030	-71.0000	370.4112	.848	-803.5595	661.5595
		2703070	-54.0000	370.4112	.884	-786.5595	678.5595
		2802030	-67.0000	370.4112	.857	-799.5595	665.5595
		2802070	-155.0000	370.4112	.676	-887.5595	577.5595
		2901030	-427.0000	370.4112	.251	-1159.5595	305.5595
		2901070	-952.0000*	370.4112	.011	-1684.5595	-219.4405
		7000000	3273.0000*	370.4112	.000	2540.4405	4005.5595
		8000000	2800.0000*	370.4112	.000	2067.4405	3532.5595
		9000000	2845.0000*	370.4112	.000	2112.4405	3577.5595

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
COMPRES	1802070	1703030	-1229.0000 *	370.4112	.001	-1961.5595	-496.4405
		1703070	-186.0000	370.4112	.616	-918.5595	546.5595
		1802030	-1505.0000 *	370.4112	.000	-2237.5595	-772.4405
		1901030	-2207.0000 *	370.4112	.000	-2939.5595	-1474.4405
		1901070	-1477.0000 *	370.4112	.000	-2209.5595	-744.4405
		2703030	-1576.0000 *	370.4112	.000	-2308.5595	-843.4405
		2703070	-1559.0000 *	370.4112	.000	-2291.5595	-826.4405
		2802030	-1572.0000 *	370.4112	.000	-2304.5595	-839.4405
		2802070	-1660.0000 *	370.4112	.000	-2392.5595	-927.4405
		2901030	-1932.0000 *	370.4112	.000	-2664.5595	-1199.4405
		2901070	-2457.0000 *	370.4112	.000	-3189.5595	-1724.4405
			1768.0000 *	370.4112	.000	1035.4405	2500.5595
		8000000	1295.0000 *	370.4112	.001	562.4405	2027.5595
		9000000	1340.0000 *	370.4112	.000	607.4405	2072.5595
	1901030	1703030	978.0000 *	370.4112	.009	245.4405	1710.5595
		1703070	2021.0000 *	370.4112	.000	1288.4405	2753.5595
		1802030	702.0000	370.4112	.060	-30.5595	1434.5595
		1802070	2207.0000 *	370.4112	.000	1474.4405	2939.5595
		1901070	730.0000	370.4112	.051	-2.5595	1462.5595
		2703030	631.0000	370.4112	.091	-101.5595	1363.5595
		2703070	648.0000	370.4112	.082	-84.5595	1380.5595
		2802030	635.0000	370.4112	.089	-97.5595	1367.5595
		2802070	547.0000	370.4112	.142	-185.5595	1279.5595
		2901030	275.0000	370.4112	.459	-457.5595	1007.5595
		2901070	-250.0000	370.4112	.501	-982.5595	482.5595
		7000000	3975.0000 *	370.4112	.000	3242.4405	4707.5595
		8000000	3502.0000 *	370.4112	.000	2769.4405	4234.5595
		9000000	3547.0000 *	370.4112	.000	2814.4405	4279.5595
	1901070	1703030	248.0000	370.4112	.504	-484.5595	980.5595
		1703070	1291.0000 *	370.4112	.001	558.4405	2023.5595
		1802030	-28.0000	370.411	940	-760.5595	704.5595
		1802070	1477.0000 *	370.4112	000	744.4405	2209.5595
		1901030	-730.0000	370.4112	.051	-1462.5595	2.5595
		2703030	-99.0000	370.4112	790	-831.5595	633.5595
		2703070	-82.0000	370.411		-814.5595	650.5595
		2802030	-95.0000			-827.5595	
		2802070	-183.0000			-915.5595	549.5595
		2901030	-455.0000			1187.5595	5595
		2901070	-980.0000 *		.009	1712.5595	247.4405
		7000000	3245.0000 *			2512.4405	
		8000000	2772.0000 *			2039.4405	504.559
		9000000	2817.0000 *		000	2084.4405	549.5595

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
COMPRES	2703030	1703030	347.0000	370.4112	.351	-385.5595	1079.5595
		1703070	1390.0000 *	370.4112	.000	657.4405	2122.5595
		1802030	71.0000	370.4112	.848	-661.5595	803.5595
		1802070	1576.0000 *	370.4112	.000	843.4405	2308.5595
		1901030	-631.0000	370.4112	.091	-1363.5595	101.5595
		1901070	99.0000	370.4112	.790	-633.5595	831.5595
		2703070	17.0000	370.4112	.963	-715.5595	749.5595
		2802030	4.0000	370.4112	.991	-728.5595	736.5595
		2802070	-84.0000	370.4112	.821	-816.5595	648.5595
		2901030	-356.0000	370.4112	.338	-1088.5595	376.5595
		2901070	-881.0000 *	370.4112	.019	-1613.5595	-148.4405
		7000000	3344.0000 *	370.4112	.000	2611.4405	4076.5595
		8000000	2871.0000 *	370.4112	.000	2138.4405	3603.5595
		9000000	2916.0000 *	370.4112	.000	2183.4405	3648.5595
	2703070	1703030	330.0000	370.4112	.375	-402.5595	1062.5595
		1703070	1373.0000 *	370.4112	.000	640.4405	2105.5595
		1802030	54.0000	370.4112	.884	-678.5595	786.5595
		1802070	1559.0000 *	370.4112	.000	826.4405	2291.5595
		1901030	-648.0000	370.4112	.082	-1380.5595	84.5595
		1901070	82.0000	370.4112	.825	-650.5595	814.5595
		2703030	-17.0000	370.4112	.963	-749.5595	715.5595
		2802030	-13.0000	370.4112	.972	-745.5595	719.5595
		2802070	-101.0000	370.4112	.786	-833.5595	631.5595
		2901030	-373.0000	370.4112	.316	-1105.5595	359.5595
		2901070	-898.0000 *	370.4112	.017	-1630.5595	-165.4405
		7000000	3327.0000 *	370.4112	.000	2594.4405	4059.5595
		8000000	2854.0000 *	370.4112	.000	2121.4405	3586.5595
		9000000	2899.0000 *	370.4112	.000	2166.4405	3631.5595
	2802030	1703030	343.0000	370.4112	.356	-389.5595	1075.5595
		1703070	1386.0000 *	370.4112	.000	653.4405	2118.5595
		1802030	67.0000	370.4112	.857	-665.5595	799.5595
		1802070	1572.0000 *	370.4112	.000	839.4405	2304.5595
		1901030	-635.0000	370.4112	.089	-1367.5595	97.5595
		1901070	95.0000	370.4112	.798	-637.5595	827.5595
		2703030	-4.0000	370.4112	.991	-736.5595	728.5595
		2703070	13.0000	370.4112	.972	-719.5595	745.5595
		2802070	-88.0000	370.4112	.813	-820.5595	644.5595
		2901030	-360.0000	370.4112	.333	-1092.5595	372.5595
		2901070	-885.0000 *	370.4112	.018	-1617.5595	-152.4405
		7000000	3340.0000 *	370.4112	.000	2607.4405	4072.5595
		8000000	2867.0000 *	370.4112	.000	2134.4405	3599.5595
		9000000	2912.0000 *	370.4112	.000	2179.4405	3644.5595

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
COMPRES	2802070	1703030	431.0000	370.4112	.247	-301.5595	1163.5595
		1703070	1474.0000*	370.4112	.000	741.4405	2206.5595
		1802030	155.0000	370.4112	.676	-577.5595	887.5595
		1802070	1660.0000*	370.4112	.000	927.4405	2392.5595
		1901030	-547.0000	370.4112	.142	-1279.5595	185.5595
		1901070	183.0000	370.4112	.622	-549.5595	915.5595
		2703030	84.0000	370.4112	.821	-648.5595	816.5595
		2703070	101.0000	370.4112	.786	-631.5595	833.5595
		2802030	88.0000	370.4112	.813	-644.5595	820.5595
		2901030	-272.0000	370.4112	.464	-1004.5595	460.5595
		2901070	-797.0000*	370.4112	.033	-1529.5595	-64.4405
		7000000	3428.0000*	370.4112	.000	2695.4405	4160.5595
		8000000	2955.0000*	370.4112	.000	2222.4405	3687.5595
		9000000	3000.0000*	370.4112	.000	2267.4405	3732.5595
	2901030	1703030	703.0000	370.4112	.060	-29.5595	1435.5595
		1703070	1746.0000*	370.4112	.000	1013.4405	2478.5595
		1802030	427.0000	370.4112	.251	-305.5595	1159.5595
		1802070	1932.0000*	370.4112	.000	1199.4405	2664.5595
		1901030	-275.0000	370.4112	.459	-1007.5595	457.5595
		1901070	455.0000	370.4112	.221	-277.5595	1187.5595
		2703030	356.0000	370.4112	.338	-376.5595	1088.5595
		2703070	373.0000	370.4112	.316	-359.5595	1105.5595
		2802030	360.0000	370.4112		-372.5595	1092.5595
		2802070	272.0000	370.4112	.464	-460.5595	1004.5595
		2901070	-525.0000	370.4112	.159	-1257.[illegible]	207.5595
		7000000	3700.0000*	370.4112	.000	2967.4405	4432.5595
		8000000	3227.0000*	370.4112	.000	2494.4405	3959.5595
		9000000	3272.0000*	370.411[illegible]	.000	2539.4405	4004.5595
	2901070	1703030	1228.0000*	370.4112	.001	495.4405	1960.5595
		1703070	2271.0000*	370.4112	.000	1538.4405	3003.5595
		1802030	952.0000*	370.41[illegible]	.011	219.4405	1684.5595
		1802070	2457.0000*			1724.4405	3189.5595
		1901030	250.0000	370.411[illegible]		-482.5595	982.5595
		1901070	980.0000*		.009	247.4405	1712.5595
		2703030	881.0000*	[illegible]70.411[illegible]	.019	148.4405	1613.5595
		2703070	898.0000*			165.4405	1630.5595
		2802030	885.0000*			152.4405	1617.5595
		2802070	797.0000*			64.4405	1529.5595
		2901030	525.0000				1257.5595
		7000000	4225.0000*				4957.5595
		8000000	3752.0000			3019.4405	4484.5595
		9000000	3797.0000			3064.4405	4529.5595

Multiple Comparisons

LSD

Dependent Variable	(I) TEST	(J) TEST	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
COMPRES	7000000	1703030	-2997.0000 *	370.4112	.000	-3729.5595	-2264.4405
		1703070	-1954.0000 *	370.4112	.000	-2686.5595	-1221.4405
		1802030	-3273.0000 *	370.4112	.000	-4005.5595	-2540.4405
		1802070	-1768.0000 *	370.4112	.000	-2500.5595	-1035.4405
		1901030	-3975.0000 *	370.4112	.000	-4707.5595	-3242.4405
		1901070	-3245.0000 *	370.4112	.000	-3977.5595	-2512.4405
		2703030	-3344.0000 *	370.4112	.000	-4076.5595	-2611.4405
		2703070	-3327.0000 *	370.4112	.000	-4059.5595	-2594.4405
		2802030	-3340.0000 *	370.4112	.000	-4072.5595	-2607.4405
		2802070	-3428.0000 *	370.4112	.000	-4160.5595	-2695.4405
		2901030	-3700.0000 *	370.4112	.000	-4432.5595	-2967.4405
		2901070	-4225.0000 *	370.4112	.000	-4957.5595	-3492.4405
		8000000	-473.0000	370.4112	.204	-1205.5595	259.5595
		9000000	-428.0000	370.4112	.250	-1160.5595	304.5595
	8000000	1703030	-2524.0000 *	370.4112	.000	-3256.5595	-1791.4405
		1703070	-1481.0000 *	370.4112	.000	-2213.5595	-748.4405
		1802030	-2800.0000 *	370.4112	.000	-3532.5595	-2067.4405
		1802070	-1295.0000 *	370.4112	.001	-2027.5595	-562.4405
		1901030	-3502.0000 *	370.4112	.000	-4234.5595	-2769.4405
		1901070	-2772.0000 *	370.4112	.000	-3504.5595	-2039.4405
		2703030	-2871.0000 *	370.4112	.000	-3603.5595	-2138.4405
		2703070	-2854.0000 *	370.4112	.000	-3586.5595	-2121.4405
		2802030	-2867.0000 *	370.4112	.000	-3599.5595	-2134.4405
		2802070	-2955.0000 *	370.4112	.000	-3687.5595	-2222.4405
		2901030	-3227.0000 *	370.4112	.000	-3959.5595	-2494.4405
		2901070	-3752.0000 *	370.4112	.000	-4484.5595	-3019.4405
		7000000	473.0000	370.4112	.204	-259.5595	1205.5595
		9000000	45.0000	370.4112	.903	-687.5595	777.5595
	9000000	1703030	-2569.0000 *	370.4112	.000	-3301.5595	-1836.4405
		1703070	-1526.0000 *	370.4112	.000	-2258.5595	-793.4405
		1802030	-2845.0000 *	370.4112	.000	-3577.5595	-2112.4405
		1802070	-1340.0000 *	370.4112	.000	-2072.5595	-607.4405
		1901030	-3547.0000 *	370.4112	.000	-4279.5595	-2814.4405
		1901070	-2817.0000 *	370.4112	.000	-3549.5595	-2084.4405
		2703030	-2916.0000 *	370.4112	.000	-3648.5595	-2183.4405
		2703070	-2899.0000 *	370.4112	.000	-3631.5595	-2166.4405
		2802030	-2912.0000 *	370.4112		-3644.5595	-2179.4405
		2802070	-3000.0000 *	370.4112		-3732.5595	-2267.4405
		2901030	-3272.0000 *	370.4112		-4004.5595	-2559.4405
		2901070	-3797.0000 *	370.4112	.000	-4529.5595	-3064.4405
		7000000	428.0000	370.4112		-304.5595	1160.5595
		8000000	-45.0000	370.4112		-777.5595	687.5595

* The mean difference is signific

Vita

Miss Siriluck Boonkrai was born on March 10, 1977 in Rachaburi province. She received a Bachelor's Degree of Science in Chemistry form Chulalongkorn University in 1999. She has been a student in the Program of Petrochemistry and Polymer Science, Faculty of Science, Chulalongkorn University since 1999.