

CHAPTER II

THEORY AND LITERATURE REVIEW

2.1 Superabsorbent Polymers (SAPs)

2.1.1 General Properties of Superabsorbent Polymers

Superabsorbents can absorb a large amount of water compared with general water-absorbing materials in which the absorbed water is hardly removable even under some pressure (5). Because of their excellent characteristics, superabsorbents are widely used in many fields, such as agriculture, horticulture, sanitary goods, and medicine (6). The most commonly available superabsorbent polymers are hard, dry, granule powders that look much like clean, white sand or granule table sugar. Other shapes, such as microspherical powders and fine fibers, are also known.

From a material resource point of view, SAP can also be divided into natural macromolecules, semi-synthesized polymer, and synthesized polymers. From a preparation method point of view, it can be classified as graft polymerization, cross-linking polymerization, networks formation of water-soluble polymer and radiation cross-linking, etc. There are many types of SAPs in the present market. Mostly, they are crosslinked copolymer of acrylates and acrylic acid, and grafted starch-acrylic acid polymer prepared by reverse suspension and emulsion polymerization, aqueous solution polymerization, and starch graft polymerization (7).

Classification of SAPs from composition and preparation methods (networks formation, introduction of hydrophilic groups and product form) is indicated in Table 2.1 (8).

Table 2.1 Four Classifications of Superabsorbent Polymers**A. Polymer composition**

- | | |
|----------------------|----------------------|
| a) Starch | Graft polymerization |
| | Carboxymethylation |
| b) Cellulose | Graft Polymerization |
| | Carboxymethylation |
| c) Synthetic Polymer | Poly(acrylic acid) |
| | Poly(vinyl alcohol) |
| | Polyacrylamide |
| | Polyoxyethylene |

B. Network Formation

- a) Graft polymerization
- b) Crosslinked copolymerization
- c) Network forming reaction of water-soluble polymer
- d) Self-crosslinked polymerization
- e) Radiation crosslinking
- f) Introduction of crystal structure

C. Hydrophilic groups

- a) Polymerization of hydrophilic monomers
- b) Carboxymethylation of hydrophilic monomers
- c) Graft polymerization of hydrophobic polymer with hydrophilic monomers
- d) Hydrolysis of nitrile or ester group

D. Product form

a) Powder	Globular
	Amorphous
b) Film	
c) Fiber	Short fiber
	Long fiber
	Non-woven fiber

2.1.2 Physical Behavior of Superabsorbent Polymers

Superabsorbent polymers are crosslinked networks of flexible polymer chain. The most efficient water absorbers are polymer networks that carry dissociated, ionic functional groups. The factors that supply absorbing power to polymers are osmotic pressure based on movable counter-ions, and affinity between the polymer electrolyte and water. The factor that suppresses absorbing power, in contrast, is found in the elasticity of the gel resulting from its network structure.

Figures 2.1 and 2.2 show the absorption mechanism of an example of superabsorptive resin, in the case of a crosslinking polymer with sodium carboxylate groups. Before absorption, long chains of polymers are interwoven, and polymers make a three-dimensional structure by crosslinking between the chains to make a dense phase. These SAPs instantaneously absorb water and swell with dissolution of Na^+ , owing to the hydrophilic ionic groups, and becoming a gel (8). In contact with water, the hydrophilic polymer backbone containing hydrophilic functional groups interacts with the solvent accompanied by energy decrease and entropy increase. Hydration and the formation of hydrogen bonds are two sources for such

polymer/solvent interactions. The polymer chains also tend to disperse in the given volume of solvent. This leads to a higher number of allowed configurations for the system, which is equivalent to a higher degree of entropy.

Due to the presence of the crosslinks, the polymer chains are restricted in swelling by elastic forces of the network. The more the chains separate from each other, the more stiffness the originally coiled polymer chains become. This decreases the entropy of the chains. Finally, there is a balance between the infinite dilution of the chains and the retractive forces. Higher crosslink densities give networks with stronger retractive forces and SAPs with lower degrees of swelling at equilibrium.

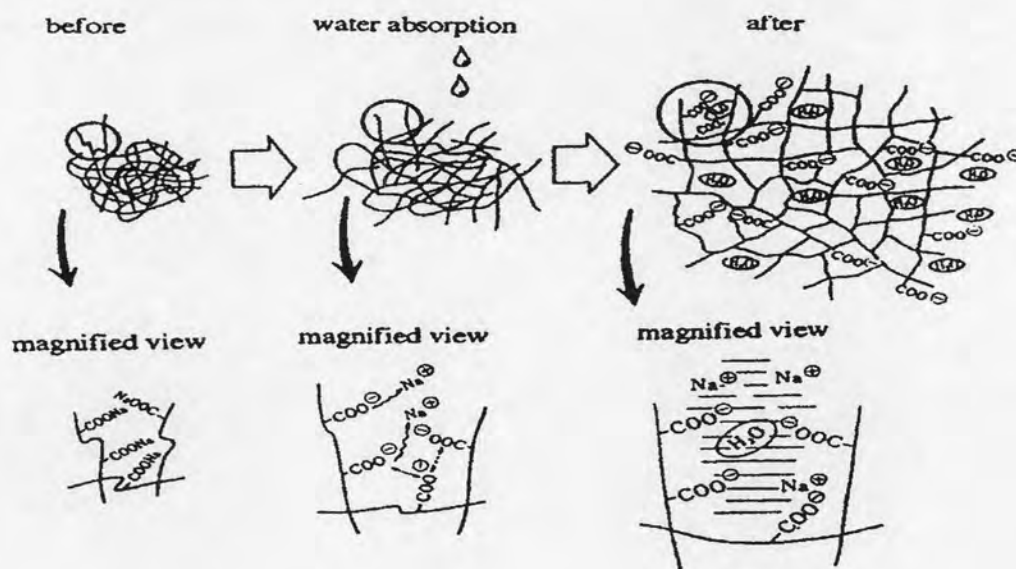


Figure 2.1 Water absorption in ionic polymer network.

For ionic polymers the solvent/polymer interactions include more than simple mixing term. These gels bear electrical charges along the polymer chains. The negative charges of the carboxyl groups repel one another and are compensated for by the positive charges of the sodium ions, in order to maintain electrical neutrality. When the polymer comes into contact with water, the solvent diffuses into the

polymer network and solvates the sodium ions, Water with its high dielectric constant lowers the attractive forces between the sodium ions and the negatively charged carboxylate groups. As in solutions of simple salts, the sodium ions are released and become freely moveable within the gel. Hence they contribute to the osmotic pressure. But for them it is impossible to leave the gel region due to the attraction forces of the negative charge, which are fixed along the polymer backbones. The driving force for swelling is then the difference between the osmotic pressure inside and outside of the gel. Increasing the salinity and the attraction force, the osmotic pressure of any external aqueous solutions lowers the absorption capacity of the gel for that fluid (9).

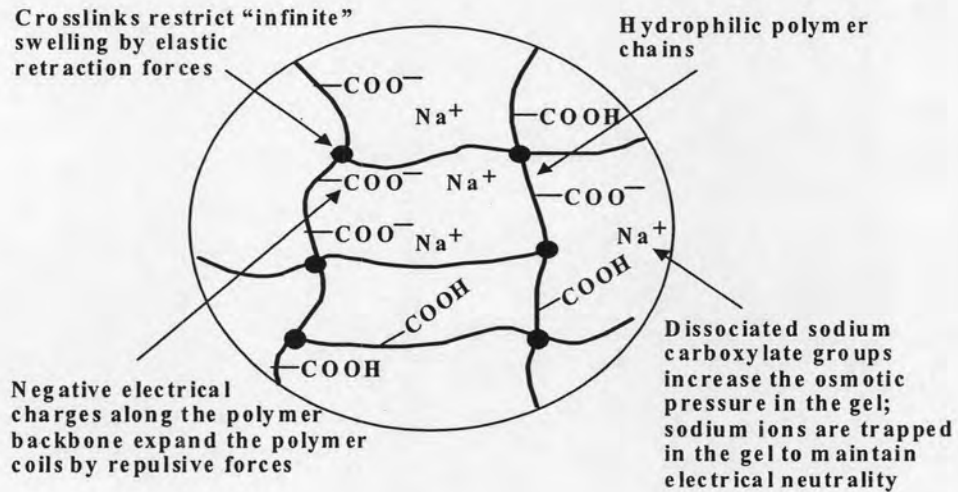


Figure 2.2 Mechanism of swelling of superabsorbent polymers.

The principle of water absorption by polymer can be illustrated by the Flory theory of an ionic network.

$$q_m^{5/3} \cong \frac{\left[\frac{1}{2} \frac{i}{v_u} \frac{1}{S^{*1/2}} \right]^2 + \left[\frac{1}{2} - \chi \right] / V_1}{v_e / V_0} \quad (2.1)$$

In Equation (2.1), q_m is maximum swelling ratio of SAP, i is electronic charge on the polymer structure per polymer unit, v_u is polymer repeating unit volume, S^* is ionic strength of solution, χ is interaction parameter of polymer with solvent, V_l is molar volume of solvent, in a real network, V_0 is un-swollen polymer volume, v_e is effective number of chains. These parameters in the equation formed a balance of the swelling which can be further defined as follows: $1/2 \times i/v_u \times 1/S^{*1/2}$ is ionic strength on both polymer structure and in the solution, $(1/2 - \chi_1)/V_l$ is the affinity of network with solvent, V_0/v_e is cross-linking density. The equation shows that the water absorption power derives mainly from the osmotic pressure, the affinity of water and polymer, and the cross-linking density of the network.

2.1.3 Cross-linking in Superabsorbent Polymers

There are two main types of crosslinking in most superabsorbent polymers.

- a) **Bulk or core crosslinking** – Such a crosslinking polymer normally takes place during the polymerization stage of superabsorbent production.
- b) **Surface crosslinking** – This type of surface crosslinking is a newer process that improves the absorption against a pressure profile of the polymer. In depth details for both types of crosslinking are given in the following sections.

2.1.3.1 Core Crosslinking

Crosslinking is the joining of molecules – generally joining two or more macromolecules with a smaller molecule. The most important type in the case of superabsorbents, and the most common, is the covalent cross-link. In SAP manufacture the most common types of cross-linker are organic molecules that

contain two or more polymerizable double bonds. These molecules are incorporated into the backbone of the polymer chains as they grow during the polymerization reaction shown in Figure 2.3. Several factors determine the incorporation of the cross-linkers into the polymer and their distribution along the polymer backbone. The molecules of monomer and polymerization double bonds are incorporated into the backbone of the polymer chains as they grow during the polymerization reaction.

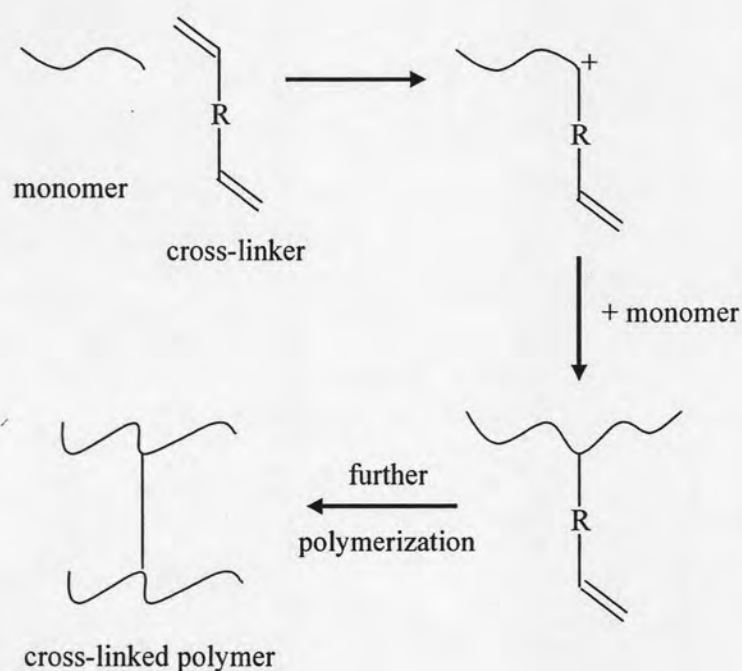


Figure 2.3 Schematic illustration of core crosslinking reaction.

2.1.3.2 Surface Crosslinking of Superabsorbent Polymers

Historically, it is known that SAPs with no surface treatment and low internal cross-linking tend to show high swelling capacities but poor absorption against pressure. Improving the swelling capacity of SAP by decreasing the core crosslinking, i.e. decreasing the crosslinking density, is limited by the accompanying increase in extractable polymer content of the gel. Likewise, the increase in capacity would lead to a decrease in the uptake of liquid when the SAP was under load, for

example a baby sitting on its diaper. This means that when a pressure is applied on the SAP, liquid is not absorbed effectively in these areas. Moreover the pressure on the semi-swollen gel can cause a blockage in the area preventing further liquid entering the gel bed and being absorbed by dry SAP underneath. This phenomenon is called gel blocking and causes diapers to leak. Hence, increasing the swelling capacity using conventional means (lowering core crosslinker) leads to an overall decrease in capacity under load.

Improving the absorption against pressure and the swelling rate of a SAP can be achieved by crosslinking the surface of the particles. Post crosslinking is normally performed on the dried, milled and sized SAP as the final stage of the process. A crosslinking solution is applied to the particles, which are then 'cured' normally through heating. The chemicals that perform the crosslinking usually have at least two functional groups capable of reacting with the carboxyl groups on the polymer backbone for example polyhydric alcohols such as glycerin.

The result of this process is an increase in the density of cross-linking on the surface of the particles giving what can be described as a core-shell particle. The core of the particle is the lightly crosslinked polymer and the shell represents the higher cross-linking density on the surface. This is visually described in Figure 2.4 (10).

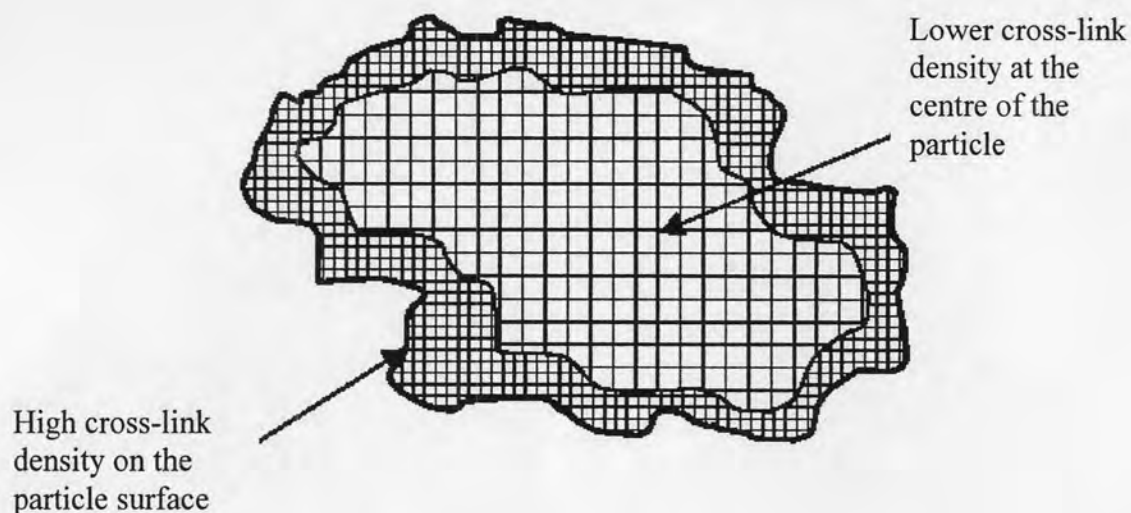


Figure 2.4 A surface crosslinked superabsorbent particle.

2.1.4 Applications of Superabsorbent Polymers

Superabsorbent polymers possess a number of attributes that make them attractive in many different applications. Superabsorbent polymers have supplanted much of the traditional absorbents in infant diapers and have made significant improvements in the performance of feminine hygiene products and adult incontinence products as a result of superior water-absorbing properties. The basic property of water absorption has suggested the use of superabsorbent polymers in many other applications, including paper towels, surgical sponges, meat trays, disposable mats for outside doorways and in bathrooms, and for household pet litter, bandages and wound dressings. The ability of the swollen gels to release the water to the surroundings as vapor has also been used in various ways, for example, as humidity-controlling products or as soil conditioners. Superabsorbent polymers may also be used to release water-soluble substances from within the network structure into the surroundings as a solution. For example, pharmaceuticals and fertilizers may be incorporated into superabsorbent polymer to yield controlled release products. Another characteristic of the swollen

polymer is its rubbery nature, which has been used to control the consistency of products as diverse cosmetics or concrete or to contribute a soft, yet dry, feel to a product like a hot or cold pack for sore muscles. The soft, rubbery nature may also be employed to impart sealing properties to products that are in contact with water or aqueous solutions, for example, underground wires and cables (11).

2.2 Superabsorbent Polymer Nanocomposites

2.2.1 Structure and Properties of Layered Silicate

The commonly used layered silicate for the preparation of polymer/layered silicate nanocomposites belongs to the same general family of 2:1 layered or phyllosilicates. Their crystal structure consists of layers made up of two tetrahedrally coordinated silicon atom fused to an edge-shared octahedral sheet of aluminium or magnesium hydroxide. The layer thickness is around 1 nm, and the lateral dimensions of these layers may vary from 30 nm to several microns or larger, depending on the particular layered silicate. Stacking of the layers leads to a regular van der Waals gap between the layers called the interlayer or gallery. Isomorphic substitution within the layers (for example, Al^{3+} is replaced by Mg^{2+} or Fe^{2+} , or Mg^{2+} is replaced by Li^+) generates negative charges that are counterbalanced by alkali and alkali earth cations situated inside the galleries.

Layered silicates have two types of structure: tetrahedral-substituted and octahedral-substituted. In the case of tetrahedrally substituted layered silicates the negative charge is located on the surface of silicate layers, and hence, the polymer matrices can react interact more readily with these than with octahedrally-substituted material. Details regarding the structure and chemistry for these layered are provided in Figure 2.5 (12).

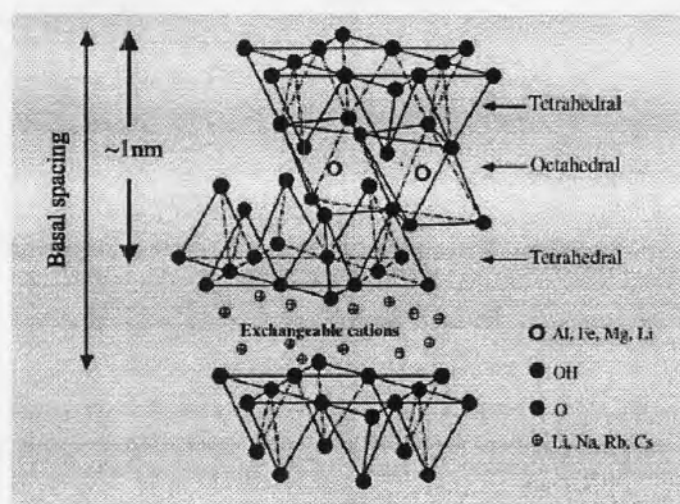


Figure 2.5 Structure of 2:1 phyllosilicates.

2.2.2 Types of Nanocomposites

Depending on the strength of interfacial interactions between the polymer matrix and layered silicates (modified or not), three different types of polymer layered silicate nanocomposites are thermodynamically achievable as shown in Figure 2.6.

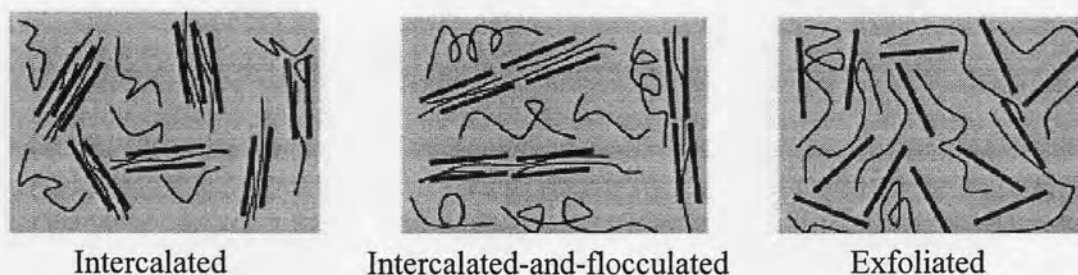


Figure 2.6 Schematic illustration of three different types of thermodynamically achievable polymer/layered silicate nanocomposites.

- a) **Intercalated nanocomposites:** in intercalated nanocomposites, the insertion of the polymer matrix into the layered silicate structure occurs in a crystallographically regular fashion, regardless of the clay-to-polymer ratio. Intercalated nanocomposites are normally interlayer by a

few molecular layers of polymer. Properties of the composites typically resemble those of ceramic materials.

- b) **Flocculated nanocomposites:** conceptually this is same as intercalated nanocomposites. However, silicate layers are some times flocculated due to hydroxylated edge-edge interaction of the silicate layers.
- c) **Exfoliated nanocomposite:** in an exfoliated nanocomposite, the individual clay layers are separated in a continuous polymer matrix by an average distance that depends on clay loading. Usually, the clay content of an exfoliated nanocomposite is much lower than that of an intercalated nanocomposite.

2.2.3 Techniques Used for the Characterization of Nanocomposites

Generally, the structure of nanocomposites has typically been established using wide angle X-ray diffraction (WAXD) analysis and transmission electron micrographic (TEM) observation. Due to its easiness and availability WAXD is most commonly used to probe the nanocomposite structure. By monitoring the position, shape and intensity of the basal reflections from the distributed silicate layers, the nanocomposite structure may be identified. For example, in an exfoliated nanocomposite, the extensive layer separation associated with the delamination of the original silicate layers in the polymer matrix results in the eventual disappearance of any coherent X-ray diffraction from the distributed silicate layers. On the other hand, for intercalated nanocomposites, the finite layer expansion associated with the polymer intercalation results in the appearance of a new basal reflection corresponding to the larger gallery height (12).

2.3 Free Radical Polymerization

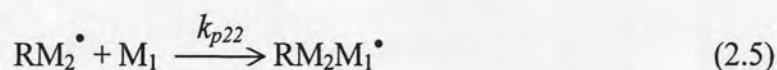
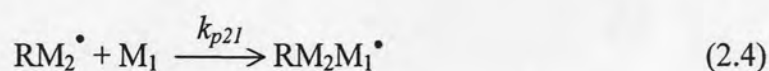
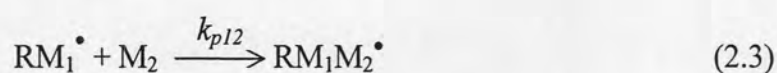
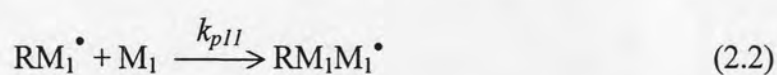
2.3.1 Characteristic of Free Radical Crosslinking Polymerizations

When a monomer containing one polymerizable double bond is copolymerized with small amounts of a divinyl crosslinking agent, simultaneous copolymerization and crosslinking reactions take place. For example, a growing radical may react with one of the double bonds of crosslinker agent to form a polymer chain with a pendant double bond. This pendant double bond may react with a second growing chain to form a crosslink between chains. It is the presence of the crosslinks between chains that leads to the most notable characteristic of this polymerization: the possible formation of a three-dimensional polymer network. At a conversion called the gel point, enough chains are linked together to form a large macromolecular network that spans the entire reaction system (its size limited only by the size of the system). The gel point is of considerable practical importance because the characteristic of the reaction system change considerably: the system undergoes a transition from a viscous liquid to an elastic solid (the viscosity diverges), the weight-average molecular weight diverges, and the first formation of an insoluble gel phase occurs. It is worth noting that despite the large change in physical properties at the gel point, the initial gel molecule (the first spanning structure) is only a very small fraction of the reaction system (in fact, the gel weight is nearly zero) After the gel point, the gel fraction grows as monomer units and polymer chains are rapidly incorporated into the network structure (13).

2.3.2 Crosslinked Gels by Free Radical Copolymerization

Adequate description of a crosslinking copolymerization requires at least a summary of copolymerization in general. The model outlined here was developed by Alfrey and Goldfinger and extended to systems containing many monomers by Walling and Briggs (14). The model itself is known as the Mayo-Lewis model and is the most widely used model for copolymer systems.

The model is based on the concept that the nature of the very last monomer added to the growing chain controls its reactivity. In a simple copolymerization of two monomers, M_1 and M_2 , there are four possible propagation events. The growing chain with a monomer 1 moiety on the end RM_1^\bullet can react with another molecule M_1 with a rate constant k_{p11} or with a molecule M_2 with a rate constant k_{p12} . Likewise, when monomer 2 moiety RM_2^\bullet is at the end of the growing chain, it can add to M_1 with a rate constant k_{p21} or to M_2 with a rate constant k_{p22} as shown in Equations. 2.2 to 2.5:



The reactivity ratios r_1 and r_2 are defined by Equations. 2.6 and 2.7:

$$r_1 = \frac{k_{p11}}{k_{p12}} \quad (2.6)$$

$$r_2 = \frac{k_{p22}}{k_{p21}} \quad (2.7)$$

When $r_1 > 1$, radical RM_1^\bullet preferentially reacts with monomer M_1 (i.e., homopolymerized), instead of monomer M_2 . Very frequently $r_1 < 1$, which indicates RM_1^\bullet preferentially reacts with monomer M_2 . This latter behavior can lead to alternating copolymers. The reactivity ratio can also be zero, indicating that a monomer will not homopolymerize. The composition of a co-polymer is controlled by both the reactivity ratios of the monomers and their concentration (15).

2.4 Rheological Studies

Rheology is defined as the science of deformation and flow of matter. The term itself originates from Greek rheos meaning to flow. Rheology is applicable to all types of materials, from gases to solids.

Rheologically the consistency is described by two components, the viscosity ("thickness", lack of slipperiness) and the elasticity ("stickiness" structure). In practice, therefore, rheology stands for viscosity measurements, characterization of flow behavior and determination of material structure. A number of material shows viscous as well as elastic properties, i.e. they store some of the deformation energy in their structure while some is lost by flow. These materials are called viscoelastic (16).

Viscoelastic materials simultaneously exhibit a combination of elastic and viscous behavior. While all substances are viscoelastic to some degree, this behavior is especially prominent in polymers.

When swollen superabsorbent particles are subjected to sinusoidal shear oscillation at a certain angular frequency and amplitude, the real part G' and

imaginary part G'' of complex shear modulus, G^* are measured ($G^* = G' + iG''$), G' is known as storage modulus, and is proportional to the elastic energy, whereas the loss modulus (G'') is proportional to the dissipated or lost energy during the oscillation process (17).

2.5 Literature Survey

Recent researches on the synthesis of superabsorbent composite and important physical properties development are listed as below:

Karadag et al. (18) prepared acrylamide/Itaconic acid hydrogels (AM/IA hydrogels) in the form of rods by γ -irradiation of ternary mixtures of AM/IA/water with 2.00-5.71 kGy γ -rays. The FT-IR spectra of AM/IA copolymeric samples obtained by using a photoacoustic cell showed that the polymerization reaction of AM and IA monomers takes place at the double bonds. DSC thermograms showed that the glass transition temperature of AM hydrogels is decreased by the plasticizer effect of IA. AM/IA hydrogels are swelled among 900-2100%, whereas AM hydrogels are swelled among 650-700%.

Wu et al. (19) synthesized starch-graft-polyacrylamide/clay superabsorbent composite by graft copolymerization reaction reaction of acrylamide, potato starch and clay mineral micropowders, followed by hydrolysis with sodium hydroxide. The water absorbency of the composite reaches 4000 g per g of H_2O . It is found that the composites doped with kaolinite powder possess higher water absorbency than those doped with bentonite or sercite powder, since the kaolinite powder can moderately disperse in the water and crosslink reaction with acrylamide and starch. By controlling the amount of NaOH and reaction time during saponification process, the hydrophilic group on the composites can be adjusted, it is found that the collaborative

absorbent effect of $-\text{CONH}_2$, $-\text{COONa}$ and $-\text{COOH}$ groups is superior to that of single $-\text{CONH}_2$, $-\text{COONa}$ or $-\text{COOH}$ group. By the IR characterization, the polymerization reaction mechanism and structure of the composites are proposed, i.e., the mineral ultrafine powder as a crosslinking point playing an important role in the formation of network structured superabsorbent composites.

Lee et al. (5) synthesized a series of superabsorbent polymer based on sodium acrylate (NaAc), mica (MI), and *N,N'*-methylenebisacrylamide (N-MBA) by inverse suspension polymerization. The results showed that the water absorbency with an the initial absorbency with an initial absorption rate gradually decrease with increasing amounts of pure K^+ -MI and intercalated-MI. In addition, the water absorbency of the composites gels obtained from K^+ - mica is higher than that those gels from intercalated-mica. However, the water absorbency of these gels decreased with increase in the ionic strength of external salt solution.

Zhang et al. (20) synthesized hydrogel nanocomposites based on sepiolite, acrylic acid (AA), acrylamide (AM), and *N,N'*-methylenebisacrylamide (N-MBA), by solution copolymerization. The influences of sepiolite and crosslinker contents, initiator dosage, neutralization degree of AA and molar ratio of AA/AM on distilled water absorbency (Q_w), physiological saline solution absorbency (Q_p) were investigated. According to FTIR, grafting reaction occurs between silanol (SiOH) on sepiolite surface and acrylic network through an ester formation. As a reactive additive, sepiolite may disaggregate and disperse at the scale of nanometer in the copolymer substrate. Compared with the sepiolite-free hydrogel, sepiolite contribution to liquid absorbency, and at its weight content of 15%, Q_w and Q_p were enhanced as high as 11.6% and 14.5%, respectively.

Li and Wang (21) synthesized superabsorbent composites based on acrylic acid, acrylamide, and inorganic clay mineral-attapulgite through a solution polymerization to improve water and saline absorbencies. The water retention tests of superabsorbent composites were also carried out. The results obtained from their study show that the superabsorbent composite has a good water retention capacity. The water absorbency of the superabsorbent composite synthesized under the optimal synthesized conditions with an attapulgite content of 10% is higher than 1400 g g^{-1} and 110 g g^{-1} in 0.9% NaCl solution, respectively.

Tasdelen et al. (22) investigated the drug uptake and release of anticancer drug from N-isopropylacrylamide/itaconic acid copolymeric hydrogels (NIPAAm/IA copolymeric hydrogels) containing 0-3% of itaconic acid irradiated at 48 kGy. 5-Fluoruracil (5-FU) is as a modeling anticancer drug. Their study has shown that the equilibrium percentage swelling of the P(NIPAAm/IA) hydrogels in 5-FU solutions increased from 470 to 7580 g g^{-1} as the mol% of IA content increased from 0 to 3. Furthermore, it has been found that the drug uptake capacity of the hydrogels both increases with increasing IA content in the gel. This has been explained as that the incorporation of more specific acidic groups into the network gives a consequent higher swelling capacity of the gels. Diffusions of 5-FU solution into the hydrogels have been found to be of the non-Fickian type.

Ramazani-Harandi et al. (17) investigated the swollen gel strength of superabsorbent polymers (SAPs). Firstly, they determined absorbency under load (AUL) of a typical SAP sample and then the mechanical strength of the swollen sample was measured by a rheological method. The characterization was conducted by a controlled strain rheometer at $25 \text{ }^\circ\text{C}$. Dependency of the rheological properties of the sample on strain and frequency was investigated. To determine the linear

viscoelastic (LVE) zone, dynamic storage modulus (G') and loss modulus (G'') measurements were carried out at a constant frequency and in a range of strains on the SAP sample. Furthermore, G' was obtained at constant strain over a range of frequencies. The storage modulus of the swollen SAP gel (already absorbed saline under 0.3–0.9 psi) was measured to be above 1000 Pa at 25 °C.

Lanthong et al. (23) synthesized biodegradable superabsorbent polymers by graft copolymerization of acrylamide(AM)/itaconic acid (IA) onto cassava starch via a redox initiator system of ammonium persulfate (APS) and N, N, N', N' -tetramethylethylenediamine (TEMED), in the presence of N, N' -methylenebisacrylamide (N-MBA) crosslinking agent, sodium bicarbonate foaming agent, a triblock copolymer of polyoxyethylene/polyoxypropylene/polyoxyethylene as a foam stabilizer. The water equilibrium swelling of starch-*g*-PAM was 39 g g⁻¹ while the starch-*g*-P(AM-*co*-IA) with the IA content of 0.02-0.15% mole gave the water swelling value in the range of 70-390 g g⁻¹. By products of the reaction were removed by water extraction. The starch grafted composites were characterized by FTIR and SEM. Thermal gravimetric analysis was also used for determining the percentage of grafting ratio. Biodegradation of the starch grafted copolymer was carried out using α -amylase. After the α -amylase hydrolysis, the Benedict's solution was used to identify the existence of glucose as the decomposition of the starch backbone.

Zhang et al. (24) prepared polyacrylate intercalated bentonite superabsorbent hybrid in a solution medium for with intercalating, polymerizing and crosslinking reactions. The partially neutralized acrylic acid (NaAc) was intercalated, polymerized and crosslinked to bentonite. The initiator was potassium persulfate and the crosslinking agent was sugar. The structure of the polyacrylate hybrid was determined by FT-IR and XRD. The results showed that bentonite was intercalated by

polyacrylate. The layers spacing of bentonite was enlarged. The various factors, such as, the degree of neutralization, the consumption of monomer, the amounts of initiator and crosslinking agent, and bentonite affecting the resin water absorbency, were studied through orthogonal experiments. The optimum conditions showed that the ratio (wt) of bentonite-to-monomer was 1/2, the degree of neutralization was 75% mol, the initiator content was 3%, and the crosslinker content was 5%. The cost of the superabsorbent has decreased by 30%, whereas its water absorbency was about 120 g g⁻¹ for water, and 30–36 g g⁻¹ for saline solution.

Zhang et al. (25) prepared polyacrylamide/organo-attapulgite from acrylamide (AM) and attapulgite (APT) by aqueous polymerization, using *N, N'*-methylenebisacrylamide (N-MBA) as a crosslinker and ammonium persulfate (APS) as an initiator. The APT was organified with five different degrees of hexadecyltrimethyl ammonium bromide (HDTMABr), and the organification degree of the APT was proved by FTIR, TGA and XRD. The results indicate that the organification degree of APT had a remarkable influence on swelling behaviors of the superabsorbent composites. The superabsorbent composite acquired its highest water absorbency when the organification degree of APT is 8.02 wt.%. The examination of swelling rate and reswelling ability of the superabsorbent composite reveals that the composite incorporated with organo-attapulgite exhibits a higher swelling rate and a better reswelling capability, comparing with that doped with natural attapulgite. Appropriate organification degree of attapulgite is needed to enhance water absorbency, swelling rate and reswelling capability to the maximum values.