CHAPTER 2

THEORETICAL AND LITERATURE REVIEW

2.1 Low density polyethylene (LDPE)

Low density polyethylene is a partially (50-60%) crystallinity solid melting at about 115 °C , with density in the range of 0.91-0.94 g/cm^3 . The simple structure for the polyethylene molecules is completely on branched chain of -CH_2- units. Both short and long branch chains are produced, example of which are shown in Figure 2.1 .

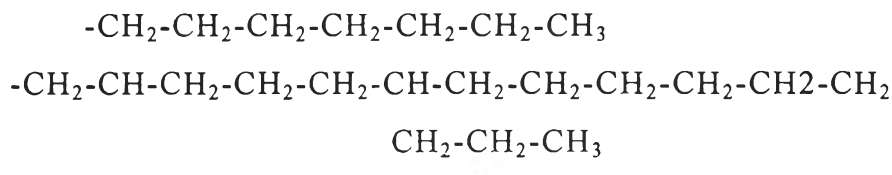

Figure 2.1 Both short and long branch chains in LDPE

LDPE is a tough, slightly translucent material and waxy to touch. LDPE films has a good balance of properties such as tensile strength, tear strength and impact strength . Almost two-third of low density polyethylene produced has gone into film and sheet . LDPE film constitutes the major of total film market . The overwhelming porportion uses in field of packaging (Briston , 1983).

2.2 Constituents of starch

Among the natural materials used for biodegradable purpose , starch is the most naturally abundant and economically feasible because it forms a melt and can be processed like a thermoplastic although it is not thermoplastic in dry form .

Starch can be generally described by the formula $(C_6H_{10}O_5)_n$. Starch can be considered a condensation polymer of glucose , consisting of anhydroglucose units. Most common ones contains 17-20% amylose , a linear polysaccharide consisting of 1,4-D-glucose units (Figure 2.2) , and amylopectin , branched molecule consisting of both 1,4-D-glucose and 1,6-D-glucose units (Figure 2.3) . The starch molecule has two important functional groups, the hydroxyl group (-OH) that is susceptible to substitution reaction , hydrophilic character , and ether group (-C-O-C-) that is susceptible to chain breakage . The glucose units are linked to one another through the C1 oxygen , known as glucosidic bond . The glucoside linkage is stable under alkaline condition and hydrolyzable under acid conditions .

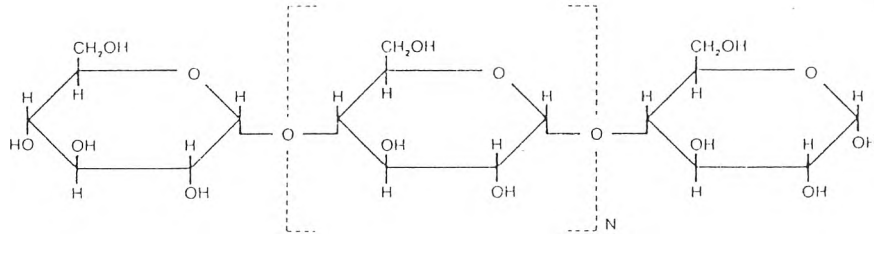

Figure 2.2 Linear-chain structure of amylose molecules.

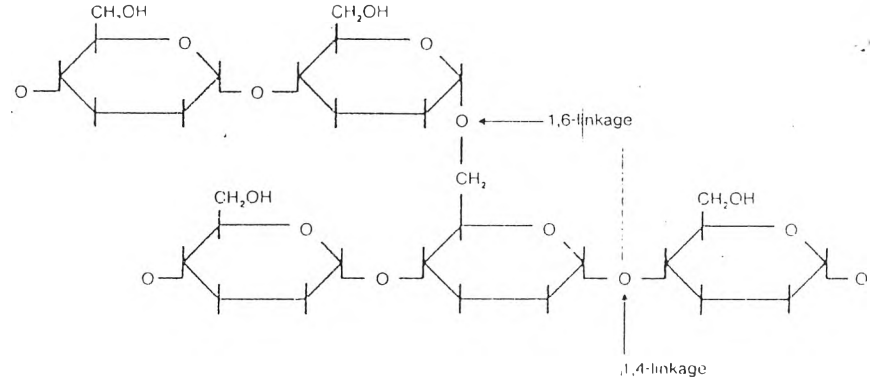

Figure 2.3 Structure of amylopectin branching points.

2.3 Processing additives

Polyethylene is non-polar while starch is polar . They can thus not be compatible very well . The compatibilizer , however , was used to improve mixing of two component .

Lubricant was used as compatibilizer that have beneficial effect on property optimization of compounds and finished articles . They acted on machine part and molds result in finished articles with smooth , glossy surfaces . The interfacial properties of certain product facilitate dispersion of fillers and pigments . At the same time the lubricating effect partially compensates for the poorer flow of filled melts . Lubricants are required which at which the lowest possible concentration to improve the flow of polymer melt without reducing resin properties (Riedel , 1990).

Jane. J. L. et al.(1994) was found that 1% of glyceryl monostearate increased the tensile strength and elongation of plastic . According to Onteniente. J. P. et al. (1996) 's investigation, they reported that 1% of epoxidized linseed oil was acted as lubricant , which gave the films better tensile strength and less brittleness as it was more plasticized . However, both researches had indicated that increasing the amount of the lubricant decreased the physical strength .

2.4 Literature Review

Ontenient J. P. et al. (1996) research on biodegradable thermoplastic starch. They obtained a suspension of three component, corn starch, lubricant and glycerol . They concluded that lubricant, epoxidized linseed oil, generated a protective film on the surface of extruded ribbon which gave the material a better tensile strength and less brittleness as it more plasticized . The experiment showed that the formulation with more than 2% epoxidized linseed oil gave rise to a segregation of phase during extrusion .

Lawton J. W. and Fanta G. F. (1994) described the equation were obtained from response surface models to show the ultimate tensile strength and percent elongation at break of solution-cast films vary with relative amounts of starch, poly (vinyl alcohol) (PVA), poly (ethylene-co-acrylic acid) (EAA) and glycerol in the formulation . In general, percent elongation increased as EAA, PVA and glycerol were increased together . However increased amount of EAA could decreased percent elongation if EAA was the only component increased . A mixture of 55.6% starch, 2.8% EAA, 28.3% PVA and 13.3% glycerol is believed to be does to the optimum formulation to obtain films having at least 100 percent elongation and ultimate tensile strength of 25 MPa.

Griffin (1977) research on polyolefin/starch blends . LLDPE are blended with starch, treated with silylylating agent such as trimethylsilyl halide, in an extruder to form a master batch that is typically 50% starch content . Silylation make the starch dried to <1% moisture content . More LLDPE is added to produce resin that contained 6-20% starch. Film made from the blends have advantages other than degradability, with increasing starch level, they felt more paper-like, and are more permeable to water vapor.

Roque L. et al . (1991) studied effect of compounding and starch modification on properties of starch-filled low density polyethylene . Linear low density polyethylene (LLDPE) cast film were prepared with native corn starch (NCS) and modified (octenyl succinate) corn starch (SOS) . The addition of either starch to LLDPE decreased the tensile strength and elongation and increased water absorption. However SOS/LLDPE cast films showed higher tensile strength and elongation value than did incorporating NCS/LLDPE cast films .

Otey F. H., Richard P. W., and Willium M. D. (1980) investigated starch-base blown films which formulation containing high level of gelatinized starch and various amount of poly (ethylene-co-acrylic acid) and LDPE . It can be readily blown into biodegradable films having general appearance of conventional plastic films . Moisture content appeared importance to achieving quality of films . The degree of transparency and flexibility decreased slightly as the level of starch was increased . They reported that all the blends were uniform and indicated that good compatibility existed between starch and EAA in the presence of ammonia . Inclusion of polyethylene in the film formulation improved the economics and rate of biodegradability of the blown films.

Gonsalves et al.(1983) conducted research on PE/starch blend . A metal catalyst and auto-oxidant were added to promote chemical degradation . The PE/starch sample were compression molded to sheet and cut into tensile bars . The tensile strength of PE/starch blend with 15% starch content decreased about 6% when placed in marine condition for 3 months .

Miss Thanida Pabungruang (1995) studied on degradation of cassava starch-filled polyethylene films . Iron stearate and epolene were used in some formula as prooxidant and dispersing agent , respectively. The oxidative degradation of the films , examined by outdoor exposure and soil burial test. LDPE films did not change significantly while the films containing prooxidant lost their properties more. The investigation of the biodegradation by using fungi indicated that at high starch content the degradation rate was high and tensile strength was very low after 6-month exposure .