

## CHAPTER II

### BACKGROUND KNOWLEDGE

To design the hotmelt adhesive, the raw material need to be in the preferred form; it has to have the right mechanical properties to enable it to be handled in, rope or powder form. The bond will lack of heat resistance if the melting point is too low. And the melting point cannot too high, so the glue is difficult to apply to the joint surfaces. The adhesive has to be transfer to the joint. Viscosity and molecular weight is importance for adhesion. The lower viscosity the better adhesion can permeate right through a porous substrate. If too high a viscosity , the problem of stringing form the work will arise. Then the hotmelt adhesive has to labile long enough for the adhesive lamination to be made. Thus 'open time' again is connected with temperature and rate of cooling, speed of crystallisation and struction of the polymer.

When the joint is form then we can remove the work by releasing pressure, the time for this step call 'set up' time. It is also connected with differential temperature , crystallisation and viscosity. Finally, the bond is made , however strength, durability and adhesion again depending on molecular weigth viscosity and specific adhesion. Also we consider the cost.

In this experiment we choose ELVAX 260 , ethylene vinylacetate copolymer as a thermoplastic polymer (for flexibility, strength and adhesion), HERCOTACK 1149 as tackifiers or wetting agent to improve bond strength, SASOL wax to reduce viscosity, dibutyl phthalate as plasticizer to improve flexibility and adhesion, butyl hydroxy toluene as stabilizer to retard oxidation.

## 2.1 POLYMER

Earlier the general popular polymer used as adhesive for packaging, paper and wood are homopolymer of polyvinyl acetate. It is a hard brittle resin which always used in emulsion form ( 1940 ) because of fast set up time, good strength and adhesion. If added some plasticizer to improve soft flexibility, the adhesive is better adhere to hardly adhered substrates. When plasticizer diffuse to the surface of the substrates , the polymer become brittle at the joint. When the plasticizer is used to plastic film, it may diffuse to that film surface. To reduce this problem, copolymer of polyvinylacetate is developed. First it was used as paint binder in the year 1940-1950. This polymer has the same property as adding some plasticizer into internal chemical structure of resin. This polymer has good flexibility but better durable than add the plasticizer later.

Ethylene vinyl acetate ( EVA ) copolymer is specially design to used as adhesive in the year 1966. The production reactor must be high pressure type because this reactor is the gas phase ethylene is used as monomer.

Ethylene vinylacetate is available in arrange of monomer ratio of 18 to 50 percentage vinyl acetate (figure 2.1) and with various molecular weigth. The polymer used in formulating hotmelt adhesive are chosen from the 18 to 40 percentage range having melt index from 2 to 200. The materials are random copolymers and essentially amorphous. In the range 18 to 30 percentage vinyl - acetate, they are compatible with parafin and other waxes . Copolymer of higher vinyl acetate content become progressively less compatible with wax.

The soften melting temperature, although of course a function of the vinyl acetate content is more closely linked, in commercially available compounds, to the molecular weight and therefore to the melt index. Thus there are available EVA with a ring and ball softening temperature of about  $96^{\circ}\text{C}$  with either 18 or 40 percentage vinyl acetate content and both with MFI of less than 1.0. Similar materials with a vinyl acetate content of 28 percentage but with softening points of  $80^{\circ}\text{C}$  and  $150^{\circ}\text{C}$  and corresponding melt flow index (MFI) of above 150 and 3 are available.

ELVAX 260 is a polyvinyl acetate produced by DUPONT, containing 28 percentage vinyl acetate and MFI of 6 dg/min.

## 2.2 WETTING AGENT

The traditional tackifiers were based on natural resins . The conjugated unsaturation suggests that, under condition of use the molecule may be polymerised to some small degree unless it has been fully or partially

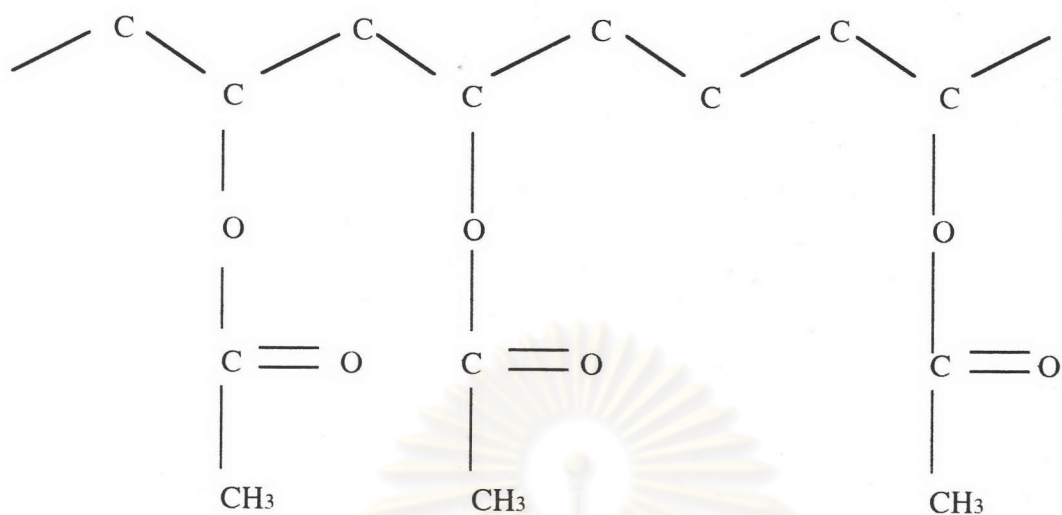


Figure 2.1 Chemical structure of EVA (25% mole of ethylene)

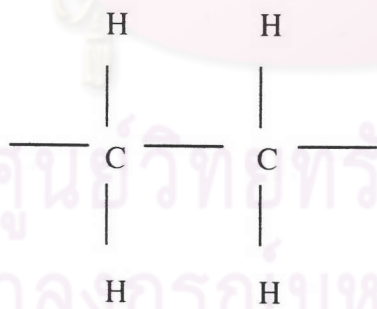


Figure 2.2 Chemical structure of polyethylene wax



hydrogenated. If unsaturated remains during use there is almost bound to be some hydroperoxide formed and these material are known occasionally to act as pro-oxidant towards susceptible polymers. There have been suggestions made that hydroperoxidation is a feature in system possessing high tack.

Hydrocarbon polymers are best plasticised with pinine based plasticisers though the increasing shortage of the natural product and its consequent high cost has led to the use of petroleum based substitutes. These long chain residues from hydrocarbon cracking plants have a part to play in the industry as also do the polymerised olefin. These polymers contain side chain of 6-10 carbon atoms but in the opinion of many technologists are not equivalent of a good pinene resin.

HERCOTAC 1149 is a moderate softening , aromatic modified C5 hydrocarbon resin. It is produced from petroleum feedstock by polymerization followed by hydrogenation. Production of the resin with the desired softening point is obtained by controlling the polymerizing process. These hydrocarbon resin are essentially fully saturated. As a result, they have good colour, heat stability, and ageing properties that can carry through the final product in which they are used.

### 2.3 WAX

Waxes are low molecular weight polyolefin resin (figure 2.2) which are by-product from the reaction of polyolefin polymerization. It is useful as viscosity reducer.

## 2.4 PLASTICIZER

High polymers exist in different physical property at different temperature. If the sequence of states is enumerated as a function of rising temperature, start from the amorphous glass or crystalline mass at the lower temperature. As the temperature rises the polymer becomes rather leathery or dead in its elastic properties and then passes through the stage of a rubber showing relatively high extension and energy return after deformation. Further rise of temperature reduce viscosity until chemical instability destroys the polymer. But not all polymer exhibited all stage, Polyethylene, for example, shows no rubbery stage. Crosslink resins behave with a limited response at all temperatures and decompose instead of melting.

The temperatures at which linear polymers exhibit rubbery properties can be modified by mixing them with plasticisers. Plasticisers are solvents for the polymers and by being incorporated separated the polymer chains and enable deformation to be more easily accomplished. They may be not real solvent but their interaction are chosen as substances of very low vapour pressure so that they do not evaporate, or do slow evaporate, from the polymer surface. Plasticisers serve to move the position of polymers on the temperature / frequency scales of any of the properties sensitive to those variables. As tack is a viscoelastic property, therefore, plasticisers can modify it.

The primary pole of a plasticiser is to reduce the rigidity (stiffness) of a polymer, that is, to render it more flexibility. But sometimes low cost plasticiser

added mainly to reduce the cost of compounds when the level of stiffness is not important, so they referred to as extenders. Plasticisers are normally relatively small molecules that are sufficiently compatible with the polymer molecules to penetrate them. They form nonchemical attractions with polymeric molecules of varying strength or performance, often associated with polarity.

Plasticisers often play a so-called lubricating role in the processing of thermoplastics, may be referred to as internal lubricants. There are a large number of commercial plasticisers but plasticisers suppliers is advisable to choose the best result at optimum cost.

Esters are the large class and are of the aliphatic (alkyl) or aromatic (aryl) types. Phthalates are esters of difunctional phthalic acid; examples include dioctyl phthalate (DOP), dibutyl phthalate (DBP) (figure 2.3), butyl benzyl phthalate (BBP), and di phenyl phthalate (DPP), as well as DINP, DIDP, DIOP, DUP, DTDP, DCHP, DMP, DMEP, DOTP, etc. Phosphates are esters of trifunctional phosphoric acid and generally also play a flame retardant role ; they include tributoxy ethylphosphate, tricresyl phosphate (TCP) , triphenyl phosphate (TPP) and isodecyl diphenyl phosphate. Adipates are esters of adipic acid and are generally suitable for food contact; they include dioctyl adipate (DOA), as well as DIOA, DIBA, DBEA, DBEEA, DIDA, and NODA. Trimellitates include trioctyl trimellitate (TOTM). Isobutyrate include TXIB. Other esters include azelates (Z), citrates, glutarates, oleates, ricinoleates, salicylates, sebacates (S), and stearates.

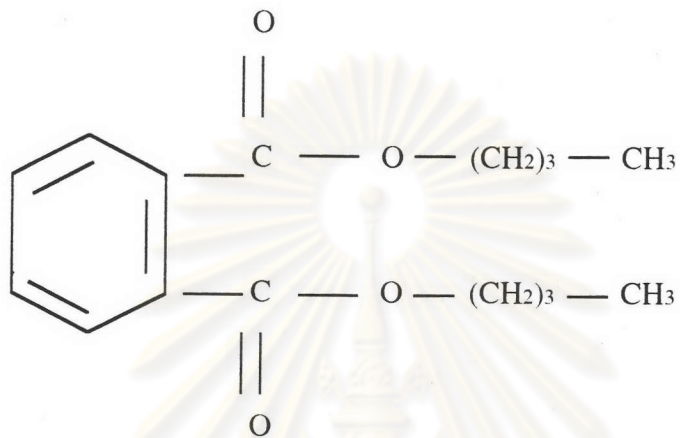


Figure 2.3 Chemical structure of DBP

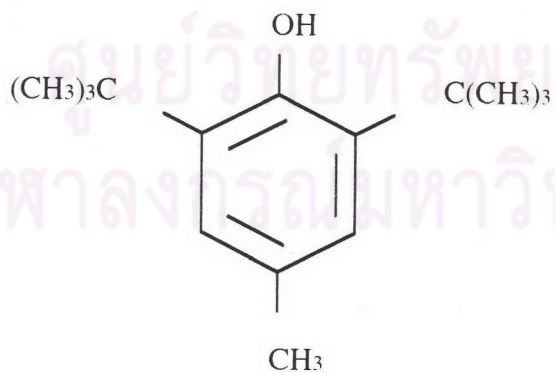


Figure 2.4 Chemical structure of BHT



## 2.5 Antioxidant

Many polymer are susceptible to oxidation , which causes either a reduction in chain length and molecular weight ( chain scission ), for example , in polyethylene , leading to a loss of stiffness and strength in the first case and embrittlement in the second case. Oxidation can be slow at moderate processing temperatures and its effects are then associated with aging , or quite fast at high processing temperatures, and its effects are then associated with thermal stability. Radiations or impurities such as metal traces can also initiate or catalyze oxidation ( photooxidation, metal activation ). Antioxidants are additive that can contribute to the control of oxidation in polymer.

Primary antioxidants that can be used alone are subdivided into two classes. “Hindered” phenolics of low or higher molecular weight operate through reactive OH groups and include butylated hydroxy tolyene ( BHT ) (figure 2.4) and tetrakis [methylene 3-(3',5',di-t-butyl 4' hydroxyphenyl) propionate] methane. “Hindered” secondary aryl amines operate through reactive NH groups and include substituted para phenylene diamines and diphenyl amines.

Secondary antioxidants engage in synergistic (mutually reinforcing) action with primary antioxidants but would not have a strong role alone. Phosphorus (P)-containing types include organophosphites. Sulfur (S)-containing types include thioesters, such as thiopropionate.