

CHAPTER V

CONCLUSIONS

5.1 Conclusions

This experiment is designed study the effect of type and ratio of plasticizer blends between DOP and chlorinated paraffin on the migration and mechanical properties of six flexible PVC cable compound formulations.

These flexible PVC cable compounds has the same base formulation: PVC resin 100 phr, stabilizer 3 phr, and filler 30 phr Formulation 1, which has hardness 80A, contains 50 phr of DOP as plasticizer. Formulation 2 to 5 which also has hardness 80A, contain various ratios of plasticizer blends (DOP:Chlorinated paraffin); 45:5, 43:10, 40:15 and 35:20 respectively and Formulation 6 which has hardness 90A contains 50 phr. of chlorinated paraffin as plasticizer.

There are many parameters which effect on the plasticizer migration, i.e., type of plasticizers, oil mediums, time and temperature of oil ageing test. A compatibility of plasticizers and PVC compound in term of PVC and plasticizer interaction can be observed as time and torque at the fusion peak in a Brabender Torque Rheometer .

It was observed that:

- 1) Migration of plasticizers is increased with increasing oil ageing time and temperature.
- 2) Faster migration can be seen in the earlier step of oil ageing time.
- 3) Chlorinated paraffin can be migrated into oil medium easier than DOP.
- 4) The descend-order tendency of plasticizer migration in six PVC compound formulations is Formulation 6, 2, 1, 3, 4 and 5 respectively.

- 5) Migration of plasticizers causes PVC compound to be hard, shrunken and degrading.
- 6) Comparing DOP and chlorinated paraffin, it is found that DOP has higher compatibility to PVC than. While among the plasticizer blends, Formulation 2 has higher compatibility than the others.
- 7) Comparing DOP and chlorinated paraffin, it is found that PVC compound containing chlorinated paraffin has higher oxygen index (flame retardant) than PVC compound containing DOP as plasticizer.
- 8) DOP is a flammable plasticizer while chlorinated paraffin is a flame-retardant plasticizer.
- 9) Formulation 1, which has only DOP as plasticizer, has the highest percentage retention of tensile strength at break, modulus and tensile strength at one hundred percentages of elongation than the others. Formulation 2 has higher percentages of retention of tensile strength at break, modulus, and tensile strength at one hundred percentages of elongation than the other formulations, which used plasticizer blends.
- 10) Migration of plasticizer blends in low viscosity silicone oil is higher than in high viscosity silicone oil since its low viscosity property. While, migration of plasticizer blends in high viscosity motor oil is higher than in low viscosity motor oil since it has more active aromatic hydrocarbon than low viscosity one.

Finally, the reduction migration of plasticizer is satisfactory at the Formulation 2 (hardness 80A) which containing the ratio of DOP and chlorinated paraffin at 45:5 phr with improving other properties for example, increasing flame retardant a little bit, processing ease and cost effectiveness.

The limitation of using plasticizer blends between chlorinated paraffin and DOP can be compromised by flame retardant property and plasticizer efficiency. The blending of plasticizers in PVC compound gives the desired product properties.

5.2 Further Suggestion

There exist important industrial applications dealing with closely combining plasticized and rigid poly(vinyl chloride). Hence, migration of plasticizer causes severe variation of the mechanical performance of the end products. It is interesting to study plasticized blends migration from plasticized into unplasticized PVC and varied condition test as followed:

1. Type of plasticizer blends: DOP and CP or DINP and Trimellitic
2. Amount or ratio of plasticizer blends
3. Temperature test

In addition, it should be tested until equilibrium is reached. This migration process is monitored by weight changes. It can be used the Fick's equation to determine the migration kinetics as followed:

$$M_t / M_\alpha = 2(Dt/\pi l^2)^{1/2}$$

where: M_α is the amount migrated at equilibrium

M_t is the amount migrated at time t

D is plasticizer diffusion coefficient

l is thickness of PVC compound specimen

Plots of M_t / M_α versus square root of time, this great effort can use mathematical model to describe plasticizer migration.