International Journal Science and Technology
IJST Vol 1 No. 1 March 2022 | P-ISSN: 2828-7045 E-ISSN: 2828-7045, Page 47-54

ANALYSIS OF FLAME RETARDANT FOR COVER ELECTRICAL PLASTIC INJECTION USING MATERIAL POLYPROPYLENE

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ABSTRACT

Injection is manufacturing process for make a product using thermoplastic material, critical part for electric normally should be self-protecting from fire. Flame Retardant (FR) is a type of thermoplastic material that is resistant to fire and can to mixed additive between resin plastic. Application of FR on various types of plastic resins such as polypropylene (PP). This study discusses the analysis of flame retardant for cover electrical using material polypropylene and benzene additive compound. This study shows that PP and benzene can mixed for create FR grade for application injection plastic. In the physical structure this material has a crack after scanning ×10,000. that elongation of material has a different in some temperature, for 30 ◦C elongation of material is 50%, for 60 ◦C elongation material is 60% and for 90◦C elongation about 90%. Heat capacity of material average in 2700J/kg◦C. average of drop time fire in cover electric average is 1,12 second.

Keywords*:* Benzene, Injection Molding, Polypropylene, Flame Retardant.

1. INTRODUCTION

Injection plastic is a thermoplastic process for a make a product by injection molding processing. Normally material of injection is thermoplastic without flame retardant additive for providing part by fire. The risk is assembly components in the electrical part are potential to make heat transfer for base housing using material thermoplastic. The problem is when base part for assembling electrical part without additive protection (FR) when the electrical malfunction or shortcut will be making a fire to be broken a part or component. Previous research Improvement in fire-retardant properties of polypropylene filled with instrument flame retardants, using flower-like nickel cobaltate as synergist The result of cone calorimetry test also reveals that $NiCo_2O_4$ plays an excellent synergistic role in with IFR, resulting in a significant improvement in the flame retardancy of the PP composite [1]. Influence of surface flame retardant layer containing ammonium polyphosphate and expandable graphite on the performance of jute/polypropylene composites, the results showed that the jute/PP composites with APP/EG-retardant layer were less flammable with higher LOI value, longer time to ignition, lower value of the peak heat release rate, total heat release, effective heat combustion, total smoke production, and became self-extinguished in HBR test [2]. New Composites from Waste Polypropylene/Eggshell Characterized by High Flame Retardant and Mechanical Properties, the results indicated that the 10 phr of the WCES enhanced the tensile strength and flexural strength of WPP/WCES composites by 15 and 8 % compared to the neat WPP composite, respectively [3]. Effect of hollow glass microsphere on the flame retardancy and combustion behavior of intumescent flame retardant polypropylene composites, the result of the LOI can be as high as 36.5% with only 1 WT% HGM and 24 WT% IFR addition. Scanning electron microscope–energy-dispersive spectrometer (SEM-EDS) and CCT results illustrated that during the combustion, HGM would migrate onto the surface of the sample to form a compact char layer and prevent further combustion of the material.

The purpose of the research is to analyze the flame effect of injection of a plastic part using material polypropylene (PP) with compound benzene. Focus analyzes for effect additive material to part after injection processing process and compares between specimen.

2. LITERATURE STUDY

Plastic injection molding (PIM) is a manufacturing process for making a product. Process of making product using melting and injecting process to molding and forming follow molding model. Method for processing plastic product normally using natural resin or adding masterbatch for coloring of the part, and also

resin polypropylene have many grades for the mass production of product. Key of perfect of injection product is good composition material, cooling time, machine condition and health of molding.

Figure 1. Plastic Injection Product

2.1 Flame Retardant

Flame retardants are compounds added to manufacturing materials, such as thermoplastics, and as surface polishers and coatings that can inhibit, suppress, or delay the formation of flames to prevent the spread of fire. The articles can be mixed with the base material (additive flame retardant) or the chemical to which the object is bonded (reactive flame retardant). Mineral flame retardants are usually additive while organ halogens and organophosphorus compounds can be reactive or additive.

Figure 2. Flame Retardant Additive

Table 1. Grade List [6]

Grade	Appearance	Melting Point	5% weight Loss Temperature *1 °C	Bromine Content	Specific Gravity	Solubility			
						Water	Methanol	Acetone	Benzene
FR-15	White Powder	210-260	434	51.8	1.7	X	X	O	O
FR-25	White Powder	218-238	421	53.1	1.8	X	X	O	O
FR-30	White Powder	201-215	445	55.7	2.7	X	X	O	O

3. RESEARCH METHOD

The research method is using material polypropylene and mixing with benzene compounds with a composition of 5% ~ 8% to make a specimen and trial with injection molding with part with a thickness of 1.2mm for the specimen. The analysis uses a chamber test machine with a temperature of -5°C to 70°C. Chamber test duration is 48 and 120 hours to analyze the structure of specimen. and also conduct a fire test to analyze effect of mixing virgin material using a compound to stop the spread of fire to the injection part.

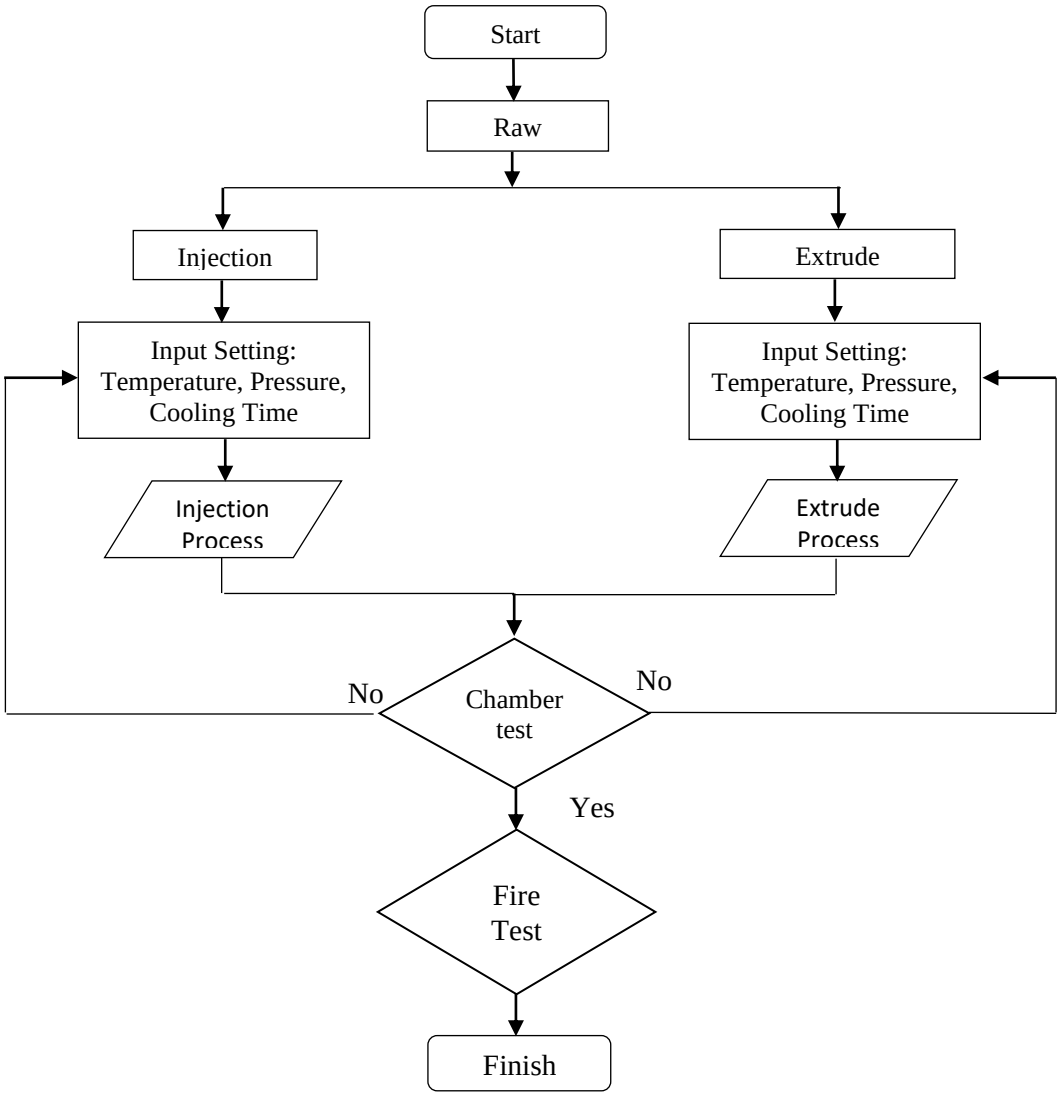

Figure 3. Research Methods

3.1 Material Formulation

At this research stage, the material formulation is making a mixture of main chemical polypropylene with brominated aromatic compounds with brominated levels of 5% ~ 8%. In addition, the material will be added with 3% antimony trioxide, then the material will be mixed and a specimen with a thickness of 1.2 mm will be made to carry out the test chamber and fire test processes.

Table 2. Material Composition

No	Composition	CAS Number	Percentage
1	Polypropylene Homo Polymer	9003-07-1	81~83%
2	Polypropylene Block Copolymer	9010-79-1	9~11%
3	Benzene	21850-44-2	5~8%
4	Antimony Trioxide	1309-64-4	3%

Figure 4. Resin PP and Benzene Compound

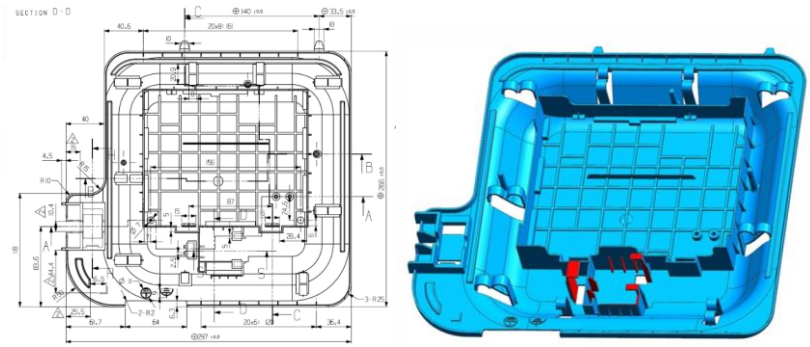

Figure 5. Cover Electric dimension scale 1:10

3.2 Setting Injection Machine

This trial for injection part using injection machine capacity 500 MT and 2 cavities for product. Processing injection cover electrical with capacity 43.4 kW and screw torque 7322 Nm, molding using material resin polypropylene and benzene compound, need analyze variable of temperature and cooling time for good result of product. In the first analyze should be pressure hydraulic pressure. (Ps) Pressure screw/injection pressure is 2380 bar. (As) is wide of screw 75mm^2 and (Ah) is wide of hydraulic is 150 mm^2. Result of calculation of Pressure hydraulic is 1190 Bar / 119 Mpa.

$$Ph = \frac{Ps\ x\ As}{Ah}$$

Description :
Ph : Pressure Hydraulic
Ps : Pressure Screw
As : Wide Screw

Table 3. Injection Machine Specification

No	Description	Unit	Injection Unit
1	Manufacture		SX XIN II
2	Model		A45000XF
3	Clamping Force	kN	8500/9500
4	Injection Pressure	Mpa	238
5	Pump Flow	L/Min	379
6	Motor	kW	43.4
7	Screw Torque	Nm	7322

$$S = \frac{-t^2}{2\,\pi\,a}\,x\,\ln\left[\frac{\pi}{4}\;x\;\frac{Tr - Tm}{Tc - Tm}\right]$$

t : Thickness of part
Tr : Ejection Temperature
Tm : Molding Temperature

The second analyze after finding pressure hydraulics is cooling time calculation for setting injection machine. (t) is thickness of part injection being 2 mm, with thermal diffusy resin is 0.094 mm2/s. (Tr) Ejection temperature 80 ˚C, Molding temperature (Tm) 40 ˚C and Cylinder temperature is 135˚C.

$$S = \frac{-2^2}{2\,x\,\pi\,x\,0.094}\,ln\left[\frac{\pi}{4} \times \frac{(80-40)}{(135-40)}\right] = 7 \text{ Second}$$

3.4 Chamber and Flame Retardant Test

Chamber test process is carried out at a temperature of cold temperature -5 ˚C to hot temperature 90 ˚C for 120 hours. This process aims to determine the change in the specimen from the influence of temperature on the crack problem. From the observations, it will be continued with a fire test on the specimen to determine the function of the flame retardant to work to stop the fire under 10 seconds.

Figure 6. Chamber and Fire Test

4.1 RESULT AND DISCUSSION

The results obtained using a scanning microscope. This is to find out cracks in the base material. Result of scanning microscope show that resin and additive have a small crack in the base material. It will be impact to be injection result if setting of injection machine in figure 7.

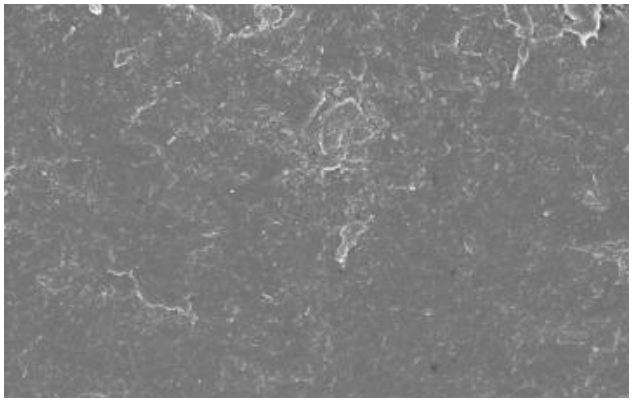

Figure 7. Scanning Microscope Material

Figure 8 show that elongation of material has a different in some temperature, for 30˚C elongation of material is 50%, for 60˚C elongation material is 60% and for 90˚C elongation about 90%. Heat capacity of material average in 2700J/kg˚C.

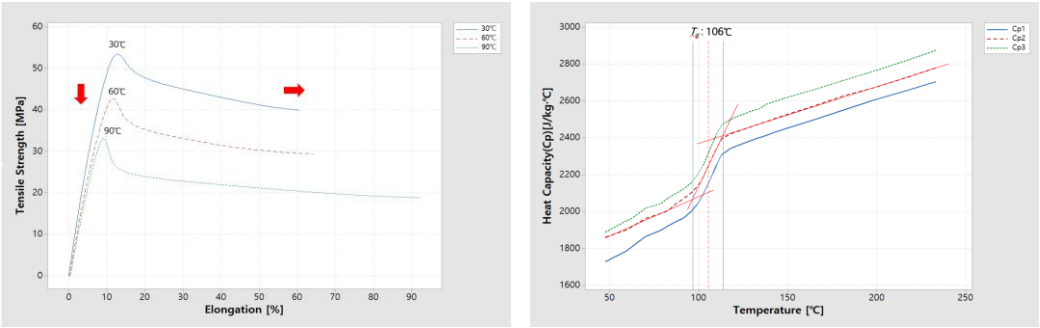

Figure 8. Elongation and Heat Capacity

The results of injection cover electric no any defect finding in cavity 1 and cavity 2, injection process use 10 shoot using cooling time 7 second after calculation spec material and injection machine. In side area no any flashing and short mold area part shown in figure 9.

Figure 9. Injection and Chamber result

Result of chamber test show that in figure 9, using temperature of -5◦C to 70◦C for 120 hours. process aims to determine the change in the specimen from the influence of temperature on the crack problem. Fire test applied after chamber test finished and all sample have fire test and result, fire off below 2 second.

Figure 10. Flame Retardant Test

On fire test, all part injections for ten samples of cover electric will test fire. This item checked for analyze effectivity of additive benzene for protecting part. As below table showed that average of drop time fire in cover electric average is 1,12 second.

Table 4. Fire test part result

No	Data	Drop Time
1	Cover Electric 1	0,92
2	Cover Electric 2	1,03
3	Cover Electric 3	1,25
4	Cover Electric 4	1,11
5	Cover Electric 5	1,21
6	Cover Electric 6	1,12
7	Cover Electric 7	0,85
8	Cover Electric 8	1,32
9	Cover Electric 9	1,43
10	Cover Electric 10	0,97
Average		**1,12**

5. CONCLUSION

The results showed that benzene aditive will protect thermoplastic material from fire as drop time 1,12 second. Cooling time in this material is 7 second per cycle shoot product and result show that no any defect like short molding or flashing in part. Based on chamber test cover electric no any change physical visual part but based on scaning microscope based material have a small crack in the physical structure, in this case possible to improve material for research in the future.

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