International Journal Science and Technology
IJST Vol 1 No. 2 July 2022 | P-ISSN: 2828-7045 E-ISSN: 2828-7045, Page 1-7

ANALYSIS OF FLAME RETARDANT POLYPROPYLENE FOR PLASTIC INJECTION MOLDING USING BROMINATED AROMATIC COMPOUND

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ABSTRACT

Flame Retardant (FR) is a type of thermoplastic material that is resistant to fire. Application of FR on various types of plastic resins such as polypropylene (PP), Acrylonitrile butadiene styrene (ABS), and other types of plastic resins. This study discusses the analysis of Brominated Aromatic Compound as a mixture of Polypropylene to produce PP-FR types for plastic injection molding with the material formulation method to perform a flame retardant test on the results of the specimens that have been made. This study shows that PP material and Acrylonitrile butadiene styrene can bind scanning microscopes with ×15,000 and ×30,000 zoom. The extrusion process results did not experience cracks after going through a chamber test of -5◦C to 70◦C for 120 hours on the specimen. In addition, the results of the flame retardant test fire can die in under 2 seconds

Keywords*:* Brominated, Flame-Retardant, Injection Molding, Polypropylene.

1. INTRODUCTION

Flame Retardant (FR) is a chemical compound that is generally used for a mixture of plastic materials to prevent the spread of fire when a fire occurs in an injection part. The research of chemical technology can make a mixture of plastic resin material additives with flame retardant additives as a plastic injection material. Defects that occur in plastic materials are the lack of resistance to hot temperatures such as burning, the effect caused is the expansion of the fire area on the injection part, this is due to the absence of anti-fire properties in plastic injection materials as fire protection. Previous research Flame Retardant Polypropylene Composites with Low Densities where Aluminum trihydroxide (AHT) is used as a mixture of plastic materials as a fire resistance with low density [1]. Synergistic Flame Retardant Effect of Organic Boron Flame Retardant and Aluminum Hydroxide on Polyethylene, the result showed that organic/inorganic synergistic flame retardant for efficient fire resistance in plastic materials. The analysis was carried out by a composite mechanism by scanning electron microscopy (SEM) in the gaseous and condensed phases [2]. Synergistic Effect of Diatomite and Instrument Flame Retardant on Flame Retardant Properties Rubber Composites This research combines melamine (MEL) and diatom (DM) materials and is applied to silicon rubber (RTV) composites, the result show that the combustion test has better results on silicon rubber [3]. The Charring Effect and Flame Retardant Properties of Thermoplastic Elastomer Composites Applied for Cable the result shows that improving the quality of fire resistance in cable material with thermoplastic elastomers (TPEs) [4]. Flame Retardant Effect of Cross-Linked Phosphazene Derivatives and Pentaeryhritol Derivatives on Polypropylene this research is flame retardant was synthesized using material hexachlorocyclotriphosphazene and also N-aminoethylpiperazine to increase the fire resistance of polypropylene materials [5].

The purpose of the research is to analyze the effect of brominated aromatic compounds on polypropylene (PP) material as a fire protection for plastic injection parts and as electronic part protection that is not easily scattered in case of a short circuit triggers the spread of fire.

2. LITERATURE REVIEW

Plastic injection molding is a method for the mass production of product with material thermoplastic (resin). Injection molding is a method to obtain molded products by injecting plastic materials molten by heat into a mold, and then cooling and solidifying them.

Figure 1. Plastic Injection Product

2.2 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 [6]

Table 1. Grade List [6]

Grade	Appearance	Melting Point	5% weight Loss Tempertaure *1 °C	Bromine Content	Specific Gravity	Solubility			
						Water	Methanol	Acetone	Benzene
FG-7000	White Powder	230-250	444	52.8	1.9	X	X	O	O
FG-7500	White Powder	208-228	442	52.1	1.9	X	X	O	O
FG-8500	White Powder	205-225	446	58	2.1	X	X	O	O

3. RESEARCH METHOD

The research method is mixing polypropylene material with brominated aromatic compounds with a composition of 5% ~ 8% to make a specimen with a thickness of 1.2mm. 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 timing required for brominated aromatic compounds to stop the spread of fire to the injection part.

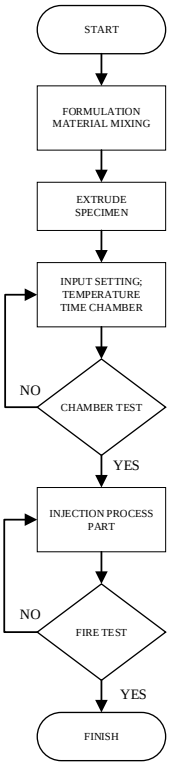


Figure 3. Research Methods

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	Brominated Aromatic Compound	52434-90-9	5~8%
4	Antimony Trioxide	1309-64-4	3%

Figure 4. Resin PP and Brominated Aromatic Compound

3.2 Extrude Specimen

The process of making specimens is carried out from the results of a mixture of polypropylene material with an aromatic compound. Specimens were made with a size of 100 mm × 100 mm with a thickness of 1.2 mm. Specimens will be subjected to a chamber test process for 120 hours. The results will be analyzed for crack potential that will occur after the process of mixing PP resin material with Brominated Aromatic Compound.

Figure 5. Specimen Chamber Test

3.3 Chamber and Flame Retardant Test

Chamber test process is carried out at a temperature of -5 ◦C to 70 ◦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. RESULT AND DISCUSSION

The testing in research is done by SEM test, Chamber test, spot test and Flame retardant Tes

4.1 Testing

Results of a scanning microscope with a ×15,000 and ×30,000 zoom on a chemical resin polypropylene material with a brominated aromatic compound showed that the material binds to each other. At ×15,000zoom you can see all the materials are bonded together but at ×30,000 zoom there are some materials that have not been fused but 90% of the material has fused as shown in figure 7.

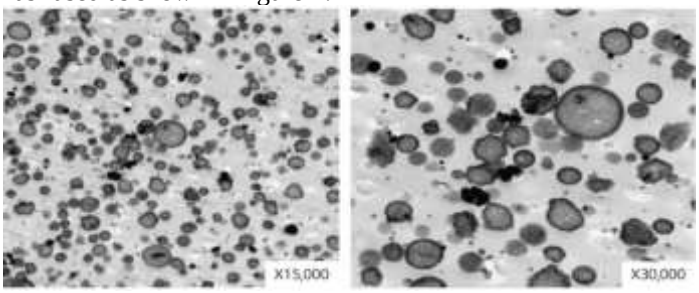


Figure 7. Scanning Microscope Material

The results of the chamber process showed no physical changes in the specimen, all specimens had the same shape as before the chamber process was carried out for 120 hours. Figure 6 shows the results of the chamber from 24 hours to 120 hours, the extruded polypropylene resin material with brominated aromatic compounds did not experience any physical structural changes.

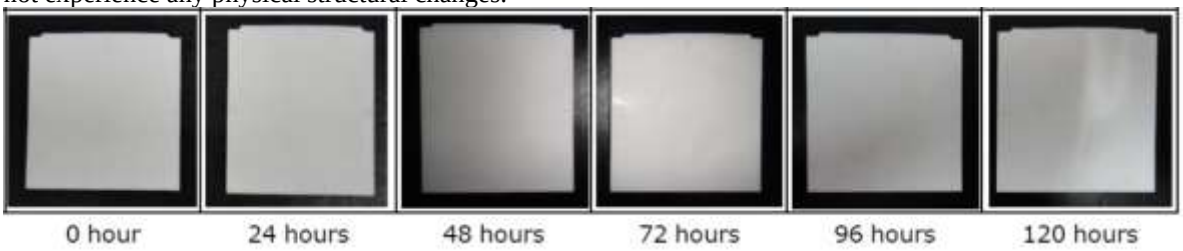


Figure 8. Chamber Test Result

Figure 9 shows results of checking the material visually with a scanning microscope, it is known that the results of the extrusion process on the specimen do not experience cracks and the material can be continued with a fire test.

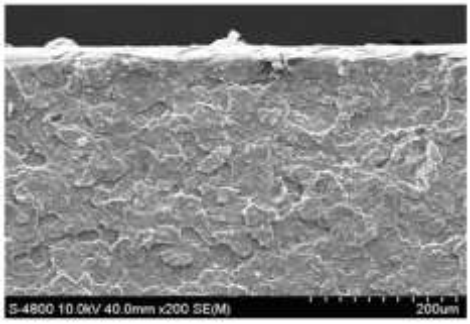


Figure 9. Physical Crack

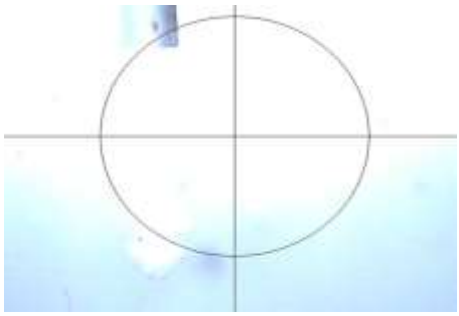
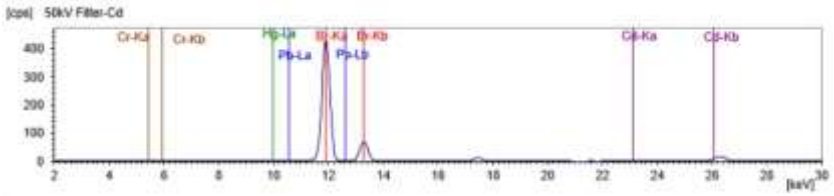


Figure 10. Spot Test Result

Figure 10 show result of the specimen using spot test method due analyze compound material being tested. The result show that specimen doesn't have any broken structure, and also the figure 11 show the Br have 100cps with 11.5keV, for Pb 0.6cps with 11keV, Cd has 0.3 cps with 23keV, and Hg 0.8 cps with 11.5 keV.



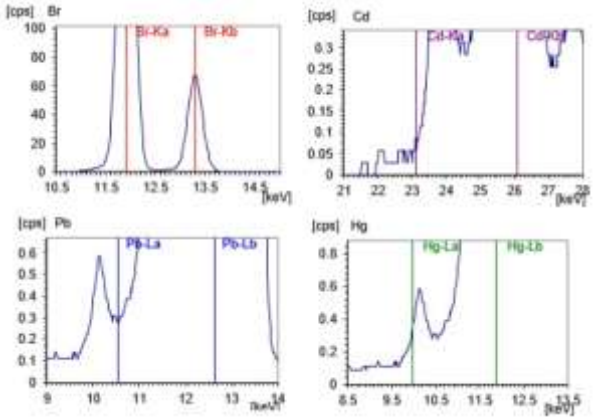


Figure 11. Spot Test Result

Figure 12 shows that the results of the flame retardant test process are carried out by conducting a combustion test on the specimen. The results of this test are the function of the brominated aromatic compound (Compound FR), which has functioned as a protective polypropylene material so that the spread of fire can be stopped quickly. The time required for this specimen is 1.9 seconds.

Figure 12. Flame Retardant Test

4.1 Comparison of Specimen

Figure 13 shows that in comparison to specimen A without additive flame retardant, the fire will be made total broken on the part and B using Brominated Aromatic Compound, the fire will drop due FR additive protect part, the fire will drop fast same like polymer protection. The result of fire test for 10 specimens is average drop time for FR better than without FR due protection of polymer resin.

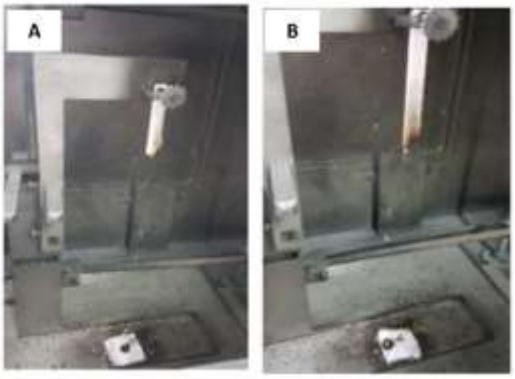


Figure 13. Flame Retardant Test

Table 3. Comparation Drop Time Fire Test

No	Data	Drop Time Fire (s)	
		Without FR	Using FR Additive
1	Specimen 1	15,5	1,3
2	Specimen 2	16,2	1,2
3	Specimen 3	15,6	0,95
4	Specimen 4	15,9	1,1
5	Specimen 5	15,8	1,1
6	Specimen 6	16,4	1,2
7	Specimen 7	16,9	0,8
8	Specimen 8	17,2	1,2
9	Specimen 9	17,5	1,3
10	Specimen 10	15,4	1,2
Average		**16,24**	**1,14**

5. Conclusion

The results showed that brominated aromatic compounds can be used as a mixture of flame retardants for polypropylene. In addition, the results of the scanning microscope showed that the results of the injection did not change physically after the 120-hour chamber process and there was no crack on the specimen. The results of the flame retardant test show that the fire cannot spread to the specimen, and the fire will die in under 2 seconds. The results of this study are still possible to improvise a mixture of flame retardants using benzene on polypropylene material or recycle polypropylene.

REFERENCES

[1] Nerea Perez, Xiao Lin, Shibin Nie, Pablo Acuna and De Yi Wang,"Flame Reterdant Polypropylene Composites with Low Densities", Journal of Material, Vol. 1, 5 Jan, Hal 152-163, 2019

[2] Lianghui Ai, Shanshan Chen, Liu Yang, dan Ping Liu, "Synergistic Flame Retardant Effect of Organic Boron Flame Retardant and Aluminum Hydroxide on Polyethylene" Journal of Fiber and Polymers, Vol. 22, 19 Jan. Hal 354-365, 2021.

[3] Weijin Song, Yunrui Lan, dan Jincheng Wang" Synergistic Effect of Diatomite and Instrument Flame Retardant on Flame Retardant Properties of Silicone Rubber Composites", Journal of Rubber Reaserch, Vol 24, 22 Jul. Hal 489-499, 2021

[4] Li-Chun, Qing Sun dan Chen Chen Zhang,"The Carring Effect and Flame Reterdant Properties of Thermoplastic Elastomers Composites Applied for Cable, Journal of Fiber and Polymer Vol. 22, 17 Dec, Hal 2599-2606, 2020.

[5] Kailun Zhang, Hongjuan Wu, Tian Wang, Meng Yao, Jixing Xie dan Yunhong Jiao, "Flame Reterdant Effect of Cross Linked Phosphazene Deterivatives and Pentaerythritol on Polypropylene, Journal of Thermal Analysis and Calorimetry Vol. 145, 17 Jun. Hal 3067-3075, 2020.

[6] https://www.teijin-resin.com/products/resin/fg accessed on 2 June 2022

[7] Chureerat Prahsarn, Najaporn Roungpaisan, and Sirda Pade "Thermal and Flame Retardant Properties of Shaped Polypropyle Fibers Containing Modified Thai Bentonite", AUTEX Reaserch Journal Vol 1, Jan, Hal 13-19, 2017.