

Mechanical Properties Studies of Components Formulation for Mixing Process Contain of Polypropylene, Polyethylene, and Aluminium Powder

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Abstract. Certain powder and others components can induce toxic reactions if not properly handled in the mixing stage. During handling, the small particles can become airborne and be trapped in the lungs, another concern is inhomogeneities in the mixing process. Uniform quantities of the particles of the components are needed in all portions of the mixture. This paper reports the results of mechanical properties studies of mixing three components formulation for mixing process. Contain of Polyethylene (PE), Polypropylene (PP) and Aluminium Powder. Powder mixer, Autodesk mold flow and computer based on excell method was carried out to study the influence of each formulation component on the flow %, PE 20% and Aluminium powder 2%. Macroscopic optic and macro photo was carried out to identify the homogeneity of mixing, tensile test for identify the strength of component after mixing. Finally the optimal tensile test with composition PP 785, PE 20% and Aluminium powder 2% at speed 52 rpm, temperature 1500C, the tensile strength 20,92 N/mm². At temperature 1600C, speed 100 rpm the optimum tensile strength 17,91 N/mm². The result of simulation autodesk mold flow adviser the filling time 6 seconds. Otherwise on manual hot hydraulic press the time of filling 10 seconds.

1. Introduction

After selecting the powder and ingredients, next concern is to mix these ingredients. Mixing is the first step in the preparation of the feedstock for molding [1,2]. The quality of the feedstock is crucial, since deficiencies can not be corrected by subsequent encountered with powder injection molding mixtures and considers how mixing can be assessed [3,4].

Another concern is inhomogeneities in the PIM mixture, uniform quantities of the particle and binder are needed in all portions of the mixture. Because of the particle size, this can be a difficult goal to attain. Intensive mixing is needed to ensure that each interstice between the particles contains aluminium powder, polypropylene and polyethylene. as representative combination of the components [6].

Temperature in mixing are needed in all portions of the mixture. Because melting point of each are different. Ingredients system selection for very fine powder is important to achieve low viscosity of the feedstock [9]. It is desired to complete filling during injection stages. The components system in injection molding consists of major binder, minor binder and various processing aids such as polypropylene and polyethylene. The selection of binder system for aluminium powder was observed in this work.



2. Experimental Procedure

Varying of Aluminium powder 2% up to 10% was used for the present work. The particles are spherical in shape as is shown in Figure 1 as follow



Figure 1. Aluminium Powder

Two different thermosetting polymers have been used are A commercial polyethylene and polypropylene. Figure 2 shows a several scheme of the process.

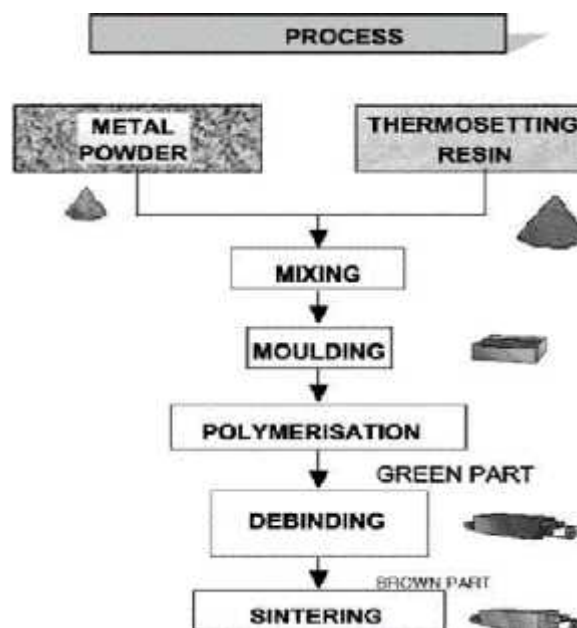


Figure 2. General scheme of process

2.1. Mixing

Mixing of aluminium powder and liquid resin was carried out as shown in Figure 2. at temperatur 160°C, 170°C and 180°C. Immediately after mixing, the tensile test and cylindrical shape specimens were by pouring the polyethylene into mold. In order to permit polymerisation of the commercial resin, the mixture was heated to 160°C, 170°C and 180°C. Different amount of components based on varying percentage of weight allow for varying speeds and temperatures.

The quantity of aluminium powder was optimised, and the final weight percentage was 2%, at temperature 160°C , speed 52 rpm.,

Nominal composition 78%, PP, 20% PE and Aluminium powder 2% speed 52 rpm was chosen for investigation because of its extensive application relative to other aluminium in production, while the additive considered in the study. polyethylene (PE), polypropylene (PP). Appreciably at temperature above its melting point under atmospheric and speed.

The mixing bowl was then cooled to the point at which the feedstock began to gradually solidify. Under continued shearing in the mixer, the material was milled into the coarse and solid. The samples were tested using the American Society for Testing and Materials Standard (ASTM.E8-9), as shown in Figure 3 below.

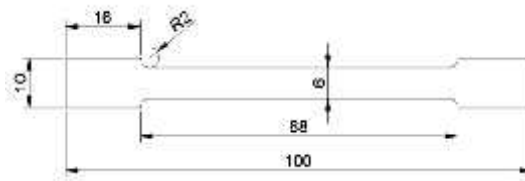


Figure 3. Dimension of the sample for tensile strength of PP, PE and ALP

3. Results and Discussion

Three series of feedstock batches were prepared in order to identify the combination of aluminium powder, polyethylene and polypropylene. In synthesizing the feedstock batches, it was noted in all cases that both the PP and PE dissolved completely in the molten to adding aluminium powder, yielding a transparent solution after a few minutes of heating 160°C . The torque required to keep the mixing blades rotating at a constant speed of 52, 100 and 144 rpm was recorded along with the internal temperature of the feedstock throughout the entire mixing process. A typical example is shown in Fig.2 for a feedstock containing formulation.1 (PP.70%, PE.20% and ALP.10%), the tensile strength $18,7 \text{ N/mm}^2$, formulation.2 (PP.72%, PE.20% and ALP.8%). the tensile strength $14,8 \text{ N/mm}^2$. formulation.3 (PP.74%, PE.20% and ALP.6%). the tensile strength $12,88 \text{ N/mm}^2$. formulation.4 (PP.76%, PE.20% and ALP.4%). the tensile strength $18,98 \text{ N/mm}^2$. formulation.5 (PP.78%, PE.20% and ALP.2%). the tensile strength is $20,92 \text{ N/mm}^2$. These values are in the range of values reported by other authors [3,4]. The tensile strength and elongation of the mixing is shown in Figure 4 as below.

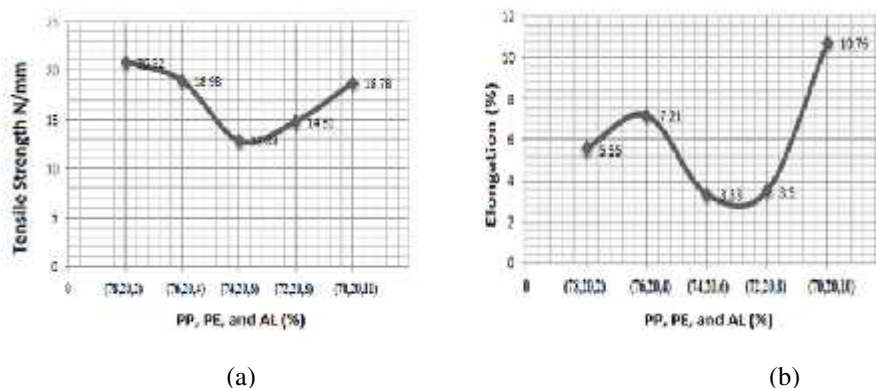


Figure 4. (a,b) Tensile strength and elongation of mixing Component. PP, PE, ALP

3.1. Image Analysis System

Image Analysis system was used to identify the distribution of PP, PE and ALP at formulation.5 (PP.78%, PE.20%, ALP.2%), as shown in Figure 5 (a).

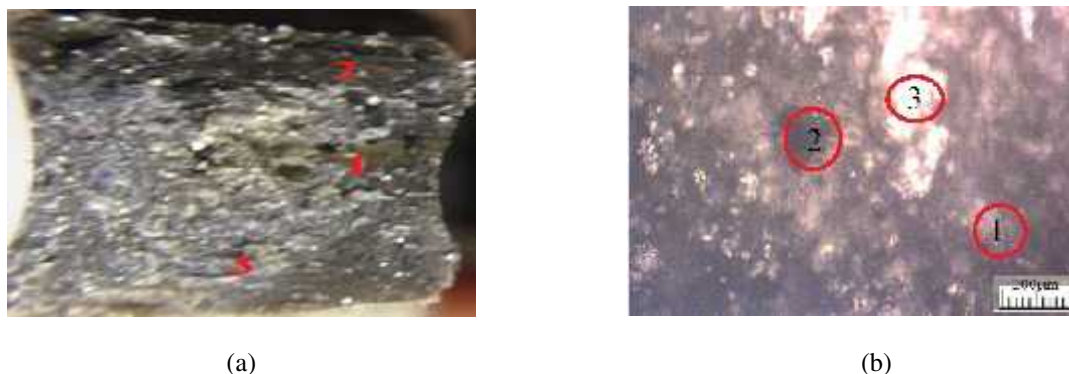


Figure 5. (a,b) Image Analysis system of (PP.78%,PE.20%,ALP.2%)

Figure 5 (a) shows the varying composition cause the material change in properties ,such as PP (no.1) the colour become brown up to temperature 160°C . PE (no.2) up to 160°C getting black, otherwise aluminium powder (no.3) getting bright white up to 160°C . Figure 4 (b) shows the appereance of mixing aluminium powder no.3. the appereance more bright. The substitution of Al.P to increase the strenght of component PP and PE. The Image Analysis of micro shows the increased of temperature causes the surface more dark. PP looks more bright at no.1. the varying composition influence the tensile strenght, and the optimum is $20,92 \text{ N/mm}^2$. A higher porosity and the irreguller shape of the pores in P/M parts leads to worse mechanical properties in the case of MIM parts [6].

3.2. Tensile test varying speed at temperature 160°C

Varying speed and optimum temperature at formulation.1 at 160°C ,the composition are PP.78%,PE.20% and ALP.2%, as shown in Fig.6 as follow

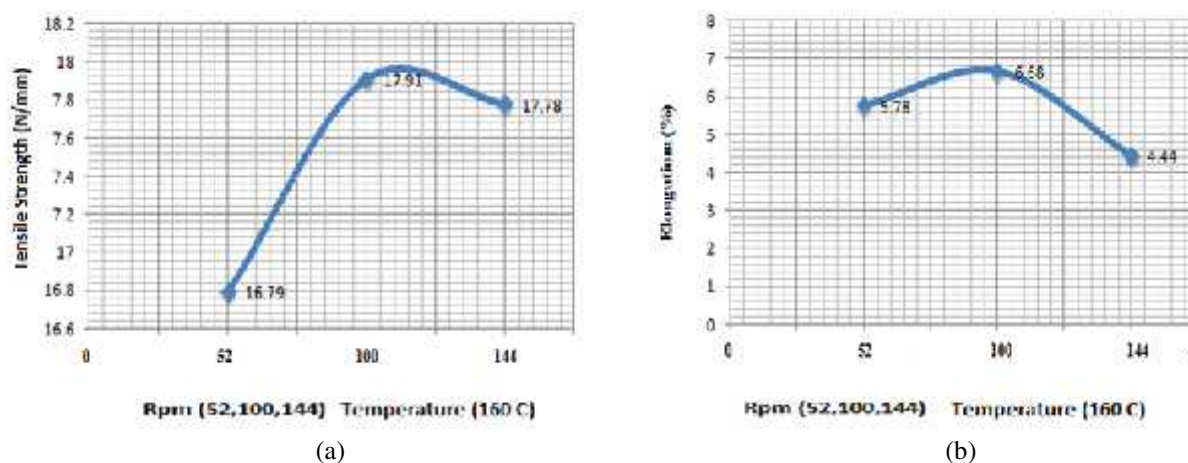


Figure 6. (a)Tensile test at temperature 160°C ,52 rpm,100 rpm,144 rpm. (b) Elongation varying speed 52 rpm, 100 rpm, and 144 rpm at 160°C

Figure 6 (a) shows the tensile test for PP.78%,PE.20%,ALP.2% at 160°C at 52 rpm,the tensile strenght is $16,79 \text{ N/mm}^2$. At 100 rpm the optimum tensile is $17,91 \text{ N/mm}^2$. The different of speed influence the tensile strenght of material mixing, and the elongation.[9]. shows in Fig.6 (b). Fig.6 (b) shows at speed 52 rpm,elongation 5,78%. At speed 100 rpm elongation is optimum 6,68%.at speed 144 rpm elongation 4,4 %.

3.3. Image Analysis system at temperature 160°C

Image Analysis used to identify the distribution of PP, PE and ALP after mixing as shown in Fig.7 below.

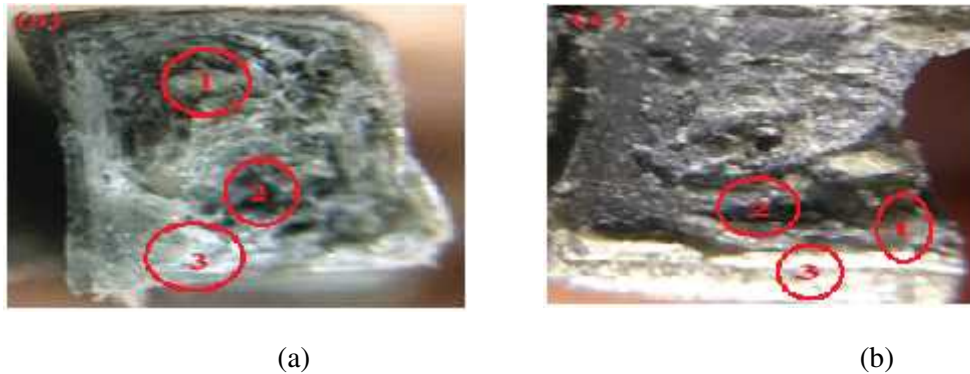


Figure.7 (a,b) Image Analysis at varying speed 52,100 and 144 rpm, at 160°C.

Figure 7 shows the varying speed at 52,100 and 144 rpm at 160°C, has effect to the mixing components. Fig.7 (a,b) PP no.1 at temperature 1600C the colour gets brown.. Componen PP no.2 after getting heat the colour get black. Component ALP.no.3 the colour bright white.

Image Analysis used to check the surface of sample varying speed 52,100 and 144 rpm at temperature 1600C, and here the optimal results as shown in Fig.7. Fig.8 (a,b,c) below shows the surface of mixing,that PP (1) was influenced by varying speed.[11]. cause the surface of mixing more dark, because component (2) has the lowest melting point consequently get burn. Varying speed and temperature give effect to tensile strenght and the optimal is 17,91 N/mm² at 100 rpm.



Figure 8. (a,b,c) The optimal Image Analysis at varying speed 52,100 and 144 rpm, at 160°C.

3.4. Tensile strenght of Poliprophylene varying speed and temperature

The result of poliprophylene test has carried our by former reseacher, and the results as shown in Fig.9 below.

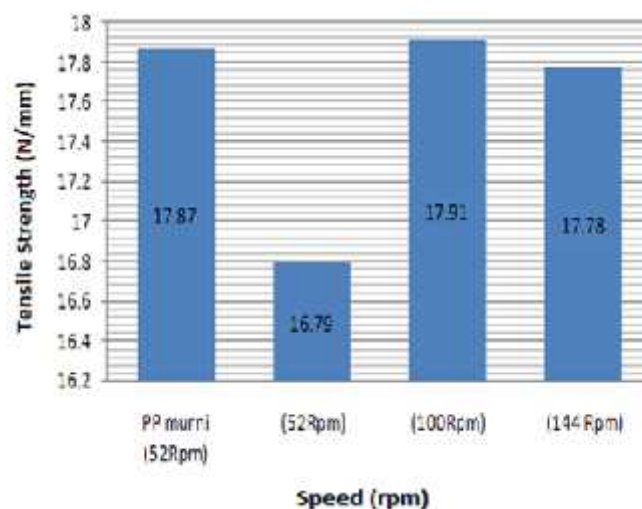


Figure 9. The tensile strength of PP varying speed and temperature.

Figure 9 shows the result of mixing PP, PE and ALP, varying speed at 52 rpm. The tensile strength 16,79 N/mm², at 100 rpm the optimal tensile strength is 17,91 N/mm². At speed 144 rpm is 17,78 N/mm², otherwise the tensile strength of PP only 17,87 N/mm² at speed 52 rpm.

4. Conclusion

Varying composition of mixing influences tensile strength the composition, formulation.5 PP.78%,PE.20% and ALP.2%,the tensile strength 20,92 N/mm². The optimal tensile strength is formulation.1. at speed 100 rpm,temperature 1600C is 17,91 N/mm². The optimal elongation is formulation.1. PP.70%,PE.20% and ALP.10%. at speed 100 rpm,temperature 1600C, the elongation 6,68%. Image Analysis shows the mixing of PP,PE and ALP has the surface of sample inhomogenities.

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