

## Impact and Thermal Properties of Tin slag /Polyester Composite

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### Abstract

The properties of the tin slag/polyester have been assessed experimentally by using DSC (Differential Scanning Calorimetry) and Impact method. The amount of the Tin slag mixed with the Polyester is varies in wt% which are 5wt%, 10wt%, and 15wt%. MEKP was added to the mixture as a hardener with a small amount to ensure the tin slag and the polyester is mix. The amount of the MEKP added to the tin slag/polyester mixture is 1%. The mixture is tested by using Impact Strength Test and DSC. The DSC experiment reveals the thermal properties of the tin slag/polyester. The results of the experiment are different from the sample ratios. The reason of this is due to the amount of tin slag being introduced to the polyester. Another reason is that the dispersion of the tin slag in the tin slag/polyester mixture when preparing the sample. The Impact experiment shows that different ratios of the tin slag/polyester mixture indicates different impact resistance. The impact resistance indicates the amount of the energy can be absorbed by the sample when the impact experiment was conducted. The experiment of Impact resistance was conducted with all the ratios of the mixture of the tin slag and the polyester including pure polyester to see the difference of the impact resistance of each of the tin slag/polyester mixture.

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### 1. Introduction

Most people did not realize the existence of tin slag. Tin slag had been around for a quite long time but then this waste never been used. People did not know the values of tin slag, so they just simply decomposed the tin slag. Tin slag was used as filler in making new polymer. The properties have shown that tin slag contain small amount of chromium. This will be one of the things that can affect the environment. Amount of tin slag would follow the exposure limit so that it would not harm the environment, humans, animals and plants. Tin slag is produced from the special process that has high temperature incineration which being solidified.

In a way to reduce the harmful effect to the environment and reducing the percentage of the radioactive substance, tin slag has to be combined with polyester resin. The combination made will form a new property which is more environmentally friendly. Polyesters can be formed from the reaction of a diacid or acid anhydride and a diol with the elimination of water, or by ring-opening polymerization of cyclic (di-) esters. According to the composition of their main chain, polyesters are classified as aliphatic, semi aromatic and aromatic. Aromatic reactants improve the hardness, rigidity, and heat resistance, whereas aliphatic acids and diols increase the flexibility, lower the melting or softening point and improve the process ability (Zhang, 2015). During the past research people recently used the paddy's husk to replace trees in producing papers. (Kumar, Sangwan, V, & Bidra, 2013). Process of this substituted had been taken as the example and helped in make the research on going.

The research made a comparison for the properties of polyester resin and tin slag powder. Composites that have been mixed with different formulations would be the main subject of this research. It also includes the study of the composites formed when the mixture was being mixed with different formulations. The original mixture of polyester resin and tin slag will be compared with the three others formulation. Component of original includes the 95% of resin and 5wt% of tin slag. There are two testing that have been done in this research which is Differential Scanning Calorimetry (DSC) and IZOD impact strength.

Thermal testing will be one of the methods used to compare the composition of polyester resin. The objective of this research was to investigate the possibility of percent used of tin slag and resins to produce a very ex polymer. Next objective was to reduce the amount of pollution in our country yet producing the good polymer that can be very dominant in one fine day. Besides that, in this research is to compare the melting temperature needed of the pure polyester and the polyester/tin slag. For the IZOD impact strength research is to identify whether by adding tin slag the impact will be decrease or increase. Furthermore, by adding tin slag can the amount of the polyester in the plastic production.

## Methodology

### 1 Materials

There are three main material that has been used in this experiment which are tin slag, polyester and the Methyl Ethyl Ketone Peroxide (MEKP). All the materials are been provided by the University of Technology Malaysia (UTM). The form of the tin slag are in powder which is the around 500 $\mu$ m to 550 $\mu$ m.

#### 2.1.1 Sample preparation

First, the tin slag that has been provided needed to be blend by using the blender. To get the sizes of tin slag in powder condition it needed to sieve in the siever that was been provide by the Faculty of Chemical Engineer. Next, dry the tin slag in the microwave about 10 minutes at 60°C. It is due to prevent the tin slag in moist condition.

Table 1: The ratio of the polyester and the tin slag

Tin Slag (wt%)	Polyester (wt%)	Methyl Ethyl Ketone Peroxide (Ml)
0	100	3.0
5	95	3.0
	90	3.0
15	85	3.0

1% (wt%) of The Methyl Ethyl Ketone Peroxide (MEKP) was added about 12 drops. Then poured the mixture of polyester and the tin slag in the mold that been provide. The polyester resin was mixed with tin slag to form a solid. Thus, it took time for the process of hardening to happen. The catalyst which named Methyl Ethyl Ketone Peroxide (MEKP) was added 1% to the mixture of tin slag. In this research the ratio range for catalyst to resin is 1 to 2 percent harder to the total volume resin to be used.

## *2 Thermal testing*

DSC test was carried out. The sample was taken about 5-10mg and been sealed in the hermetic aluminium pans. The flow rate of the nitrogen gas are 50 mL/min. There are two steps for the heating which are from 50 to 350°C. There is an intermediate cooling process due to eliminating the heat history of the sample. This step will repeat until the last data. The data of the sample will be recorded from the cooling step.

### *2.3 IZOD impact strength*

This testing are carried out by using the IZOD TOYOSEIKI Tokyo on the sample with weight of pendulum is 3190 N at 150° of angle in raised position of the pendulum. The distance required from the center of rotating axis to the center of gravity is at 0.1842m.

### 3. Results and Discussion

#### 3.1. IZOD impact strength

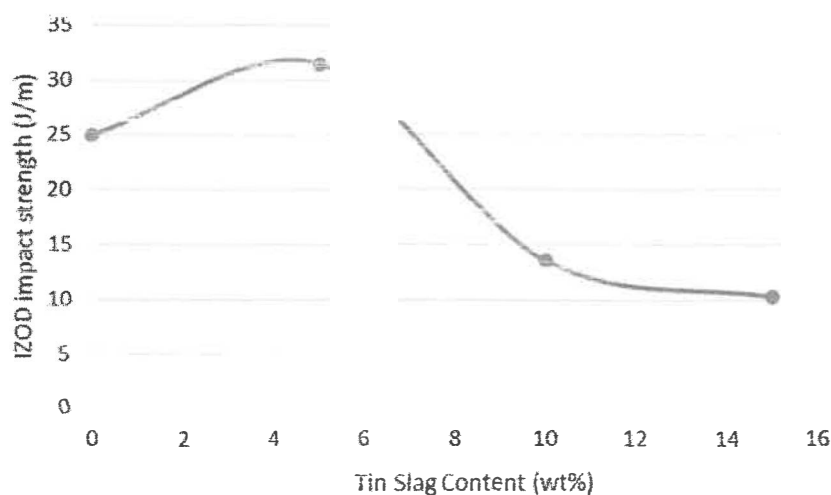


Figure 1 IZOD Impact Strength (J/M) Vs Tin Slag Content

Based on the graph above, the average impact strength of the tin slag-polyester composites with 0 wt% of tin slag is 25.00 J/m. By adding 5% of tin slag to the polymer, the value increases respectively from 25.00 to 31.51 J/m. The difference is about 6.51 J/m. However, by adding 10 wt% and 15 wt% of the tin slag to polyester, the value of IZOD impact strength drastically drops. This shows that the good value to reduce the amount of polyester is by adding only 5% or above.

There are some researches that could support the above statement. Based on the research of glass reinforced polyester hybrid composite, the value of the IZOD impact strength was increased about 87% just by adding 8.6% of the glass fiber, and if the value of the glass fiber is more than 8.6% there is no significant increase in impact strength.

However, a reduction in the impact strength is observed when the tin slag added is greater than the optimum loading. The possibility of this happening because of the tin slag interaction that caused agglomeration, which leads to a poor interaction between the tin slag and the polymer. These undesirable polymer interactions and the existence of weak interface region in the polymer matrix may attribute to the reduction in the resistance against the crack propagation of the system. Therefore, the ability of the composite to absorb external applied force reduces due to the presence of stress concentrators. So, lower impact strength is obtained for those composites filled with high tin slag. There is a research about silica that it can cause the stress concentrator polymer matrix will decrease by adding more silica content in the polymer. (Rafael Auras, 2010)

#### 4. Conclusion

The conclusion from the Graph 1, we can conclude the 5wt% is the maximum value needed to increase the impact strength of the polymer and it also helps to reduce the amount of the polyester. If the amount of the tin slag is more than 5wt% the impact strength of the polymer will increase. There are some factor that can increase the impact of the polymer are by adding some filler with the polyester so the structure of the polymer is increase. For the thermal testing, polyester does not have its own the melting point however it have temperature glass. The range of the temperature glass is about 60-140 °C. Now the temperature will continue to increase until the polymer reaches its melting point. When this happens, the temperature will hold steady for a while, even though the heat is added to the polymer. It will hold steady until the polymer has completely melted. Then the temperature of the polymer will begin to increase once again. The temperature rising stops because melting requires energy. All the energy you add to a crystalline polymer at its melting point goes into melting, and none of it goes into raising the temperature.

#### 5. Acknowledgements

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