School of Materials and Mineral Resources Engineering

Engineering Campus,

Universiti Sains Malaysia

PLASTICS LABORATORY (EBP418/2)

Academic Session 2021/2022
Semester 1

Group No.	Experiment No.
F	6a

GROUP MEMBERS :

Name	Matrix Number
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School of Materials and Mineral Resources Engineering		
Rubric Form	**Academic Session : Semester 1 2021/2022** **Revision : 03/2020**	

RUBRIC FOR GROUP PROPOSAL

(Will be applied for Open Ended Lab Proposal)

	Beginning (1-2)	Developing (3-5)	Accomplished (6-7)	Exemplary (8-10)	Weightage	Score	Marks (%)
INTRODUCTION AND BACKGROUND Engineering Knowledge	Provides background into the topic but does not describe the problem to be solved	Provides background into topic and describe the problem to be solved.	Provides background and have a good understanding of the topic and describe the problem to be solved.	Provides background and have a complete understanding of the topic and describe the problem to be solved	30		
EXPERIMENTAL AND RESULTS Problem Analysis	Presents the experimental procedures and expected results but not in detail and some are missing	Presents the experimental procedures and expected results but not in detail	Presents most of the experimental procedures and expected results	Presents complete experimental procedures and expected results	30		
TEAMWORK Teamwork and leadership	Showed poor teamwork (no task delegation, no communication among team members, understanding dictated by only one member)	Showed fair teamwork (chaotic task delegation, poor communication among team members, understanding limited to half of team members)	Showed good teamwork (fair task delegation, fair communication among team members almost uniform understanding)	Showed excellent teamwork (task delegation, communication among team members, uniform understanding)	20		
LIFELONG LEARNING Lifelong Learning	Poor independency, lack of initiative and requires major supervision.	Partly independent, mild initiative to learn and requires good amount of supervision.	Sufficiently show independency, good initiative but still requires fair amount of supervision.	Highly independent, excellent initiative to learn with minimal supervision.	20		
					Total Marks (%)		

Group	:	F	**Lecturer:**
Name	:	Tang Zi Jie	Dr. Mohamad Danial Shafiq
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		Nurul Athira Binti Idrus	

1.0 Introduction

According to American Society for Quality Control (1987), quality control (QC) is an operational techniques and activities that are used to fulfil requirements for quality. These techniques are used to assure that a product or service meets requirements. QC is carried out by the operating forces and its job is to do the work and meet the product or service goals. Generally, QC refer to the act of taking measurements, testing, and inspecting a process or product to assure that it meets specification. It also includes actions by those performing the work to control the quality of the work. QC also refers to the process of witnessing or attesting to and documenting such actions.

A major aspect of quality control is the establishment of well-defined controls. These controls help the standardization of both production and reactions to quality issues. Limiting room for error by specifying which production activities are to be completed by which personnel reduces the chance that employees will be involve in tasks for which they do not have enough training. Quality control involves testing of units and determining if they are within the specifications for the final product. Any defect or the product does not meet the specifications a corrective action will be taken in the manufacturing process to helps companies meet consumer demands for better products.

In this experiment, quality control will be performed on the commercial plastic product, which is a plastic strainer as shown in Figure 1. It a device that is used to strained liquids away from other ingredients but also to occasionally sift fine ingredients away from larger ingredients. There are three types of testing will be done to the plastic strainer to assure the product quality which are visual inspection, thermal analysis testing by using Differential Scanning Calorimetry and chemical resistance testing.

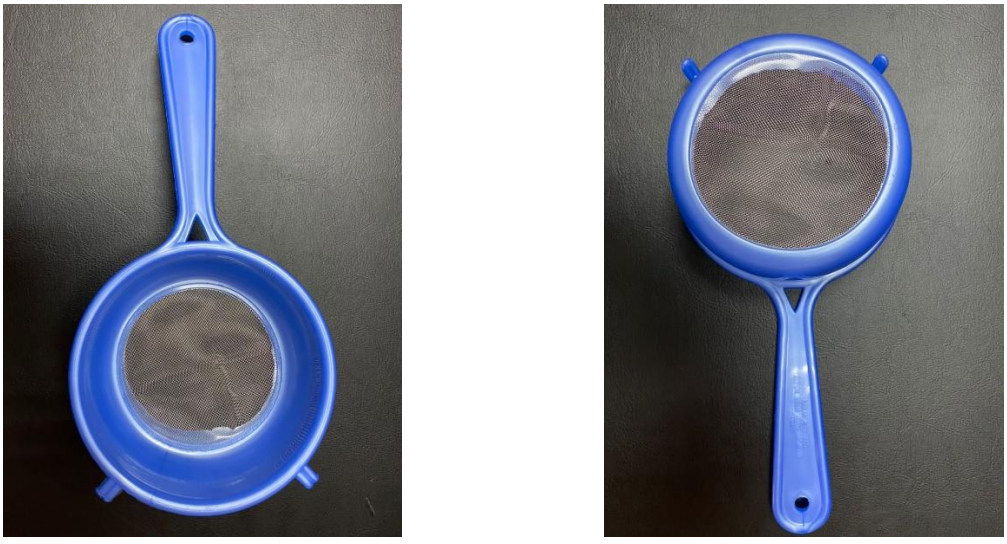

Figure 1 : Plastic strainer

The first testing method for the quality control is visual inspection. This is the simplest test to conduct, and it does not require any tools. It also can be said that this test is a cost convenient which only involve inspection by naked eyes, if there is any defect observed, the product will be automatically sent to undergo specific testing base on the defect observed.

The second test will involve thermal analysis testing using differential scanning calorimeter (DSC) according to ASTM D 3418. This is a fundamental tool in thermal analysis which measure the difference in the amount of heat required to increase the temperature of a sample and reference are measured as function of temperature. Throughout the experiment, the temperature of the sample and reference are maintained closely to one another. By performing DSC testing for quality controlling on the product, the glass transition temperature (T_g) and melting temperature (T_m) of the product can be identified.

The last test that will be performed is chemical resistance test using different chemical reagents. According to ASTM D 543, this test covers the evaluation of plastic materials for resistance to chemical reagents, simulating performance in potential end use environments. Chemical reagents can include lubricants, cleaning agents, inks, foods, or anything else that the test material may be expected to encounter. The test includes provisions for reporting changes in weight, dimensions, appearance, and strength properties. Provisions are made for various exposure times, strain conditions and elevated temperatures.

2.0 Objectives

1. To study and apply the quality control methods for commercial products.
2. To perform quality control on plastic strainer.
3. To ensure the product meet standard requirements and specifications.

3.0 Experimental

3.1 Materials and Equipment

Plastic strainer, distilled water, differential scanning calorimetry (DSC), pan and lid, electronic balance, vernier caliper, containers for submerging specimens in chemical reagents, 10% hydrochloric acid (HCl), 10% sodium hydroxide (NaOH) solution.

3.2 Procedure

3.2.1 Physical Properties (Visual Inspection)

Perform visual examination on plastic strainer using naked eye to observe and detect the possible shape or structure defects. Check on the overall appearance of the strainer, including weld line, cracking, voids and flaws on the strainer.

3.2.2 Thermal Properties (ASTM D 3418)

The thermal properties of the strainer will be determined by differential scanning calorimetry (DSC) according to ASTM D 3418 to measure the glass transition temperature, T_g, of the specimens.

Weigh $5\,mg \pm 10\,\mu g$ of specimens using electronic balance. Heat the specimens from 25 to 200°C at a heating rate of 10°C min^{-1} under nitrogen atmosphere and holding for 5 min at 200°C. Then, cooled to 25°C and reheating to 280°C at 10°C min^{-1} to obtain the T_g. Record the heating curve of T_g.

3.2.3 Chemical Properties (ASTM D 543)

The chemical resistance of the specimens to different chemical reagents will be evaluated according to ASTM D 543 to observe the behavior of strainer in contact with hydrochloric acid and sodium hydroxide solution.

Before immersion, measure the weight, dimensions and appearance of the specimens. Weigh the specimens using an electronic balance as well as measure thickness, length and width using vernier caliper before immersion. Then, immerse the specimens in hydrochloric acid with concentration of 10% at $23 \pm 2\,°C$ for 24 hours. Also, immerse these specimens in sodium hydroxide with concentrations of 10% at $23 \pm 2\,°C$ for 24 hours. After 24 hours, remove the specimens from the solutions. Wash the specimens with distilled water to remove the acid and alkali and wipe them with tissue. Immediately measure the weight and dimensions after immersion. Also, observe the appearance of the specimens after exposure to chemical reagent. Record the appearance on the basic of examination for evidence of loss of gloss, discoloration, decomposition, swelling, tackiness, cracking and solubility.

4.0 Expected Outcomes

4.1 Physical Properties by Visual Inspection

In visual inspection test, there will be a shape, colour and manufacturing structure damage inspection in the plastic strainer sample by the naked eyes. For colour inspection, there will be a slightly different colour compared to the good sample around the defect area while the shape will maintain same with the good sample if it does not have short mould defect. For the structure inspection, the production defect has been visually checked. The defect that also been distinguished as one of the defects other than voids and flaw that might affect the esthetical value of the product produced is weld line. Weld-lines or knit-lines are formed during the mould filling process when the split melt flow fronts meet at the same downstream location and look like cracks on the appearance of plastic products and can be seen by the naked eyes. In the visual inspection, it is expected that no weld line, no cracking, no voids and no flaws on the strainer. The plastic strainers are expected to have no defects through visual inspection.

4.2 Thermal Properties by DCS

Differential Scanning Calorimetry (DSC) is a thermal analysis technique that uses to measure the amount of energy absorbed or released by a sample when it is heated or cooled, providing quantitative and qualitative data on endothermic and exothermic processes.

The main melting peak of PP is around 169°C. The product is expected to exhibit a number of melting transitions due to processing and thermal history factors. The equilibrium melting temperature (T_m^o) is an important thermodynamic parameter for determining the degree of undercooling, which signifies the kinetic driving force for crystallization of a crystallizable polymer. It is simply said that no crystallization can occur at temperatures greater than the T_m^o.

The crystallization behavior can be a factor affecting the quality of the final product. As a result, there will be a significant difference in the crystallization behavior if there are defect in the product. The samples with higher crystallinity will undergo stress cracking failures at lower stresses than their less crystalline counterpart. The crystallization that leads to a high degree of order in polymer crystals and thus a reduction in entropy, S that is more than offset by the large reduction in enthalpy that

occurs during crystallization. If the magnitude of the enthalpy change ΔH_m (latent heat) is greater than that of the product of the melting temperature and the entropy change crystallization will be favored thermodynamically since lower value of G will result.

The glass transition point is the temperature at which an amorphous material undergoes a transition from a brittle or hard state to a rubber-like viscous state and this transition is reversible. The glass transition is manifested as a step change in specific heat capacity. The peak of T_g will show an abrupt and linear rise in signal before quickly leveling out in the thermograph. It is expected that steady heat flow is achieved in the thermograph.

4.3 Chemical Properties

Solution	Resistance Rating
Dilute Acid	Very Good
Dilute Alkalis	Very Good

Table 1: the chemical resistance of the plastic strainer

Diluted bases and acids do not react readily with polypropylene as polypropylene have outstanding resistance to water and other inorganic environments. Polypropylene is extremely stable chemically due to its structural properties as a hydrocarbon construction which the chemical resistance to dilute acid and alkali are good as shown in Table 1. Thus, it is expected that the weight, dimension and appearance of the sample after the immersion will be same as the initial measurement before immersion as there are no chemical reaction between the sample and the solution.

5.0 Conclusion

As conclusion, in the appearance values point of view, there are studies on silver streak, weld line, surface quality and sink mark as these defects can be seen by naked eyes. Then, DSC is an analysis tool for quality control if concerned about how temperatures will affect product stability. For materials that crystallize more easily (higher onset), or crystallize faster (steeper slope), the product will break more easily. As for chemical properties, there are no significant difference of the weight, dimensions as well as appearance sample before and after the immersion as the material has good chemical resistance to acid and alkali solution.

6.0 References

ASTM D 3418-12, Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry, 2012.

ASTM D 543-06, Standard Practice for Evaluating the Resistance of Plastics to Chemical Reagents, 2006.

B. Wunderlich, Thermal Analysis, Academic Press, 1990, pp. 417-431.

Esmizadeh, E., Tzoganakis, C., & Mekonnen, T. H. (2020). Degradation Behavior of Polypropylene during Reprocessing and Its Biocomposites: Thermal and Oxidative Degradation Kinetics. *Polymers*, *12*(8), 1627.

Quality Management and Quality Assurance Standards -- Guidelines for Selection and Use," ANSI/ASQC Standard Q90-1987, American Society for Quality Control, Milwaukee, WI, 1987.

https://www.creativemechanisms.com/blog/all-about-polypropylene-pp-plastic

https://www.perkinelmer.com/CMSResources/Images/46-141235APP_010032_01_Measurement_of_Tg_of_Polypropylene_Using_the_Double_Furnace_DSC.pdf