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Polymer Sealing and Bonding Resistance to the Tensile Strength of Flexible Food Packaging

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Abstract:- Polymer is a very important material when used as packaging, such as flexible food packaging which is engaged in the industrial world. The packaging process is carried out using a rotogravure printing machine with the procedure stage. To test the feasibility of the polymer material used, several samples will be taken to be tested at the Quality Control Laboratory, one of the parameters is Sealing and Bonding. Sealing and Bonding are types of tensile testing with the aim of measuring the tensile strength of seals or bonds of an object, while the function of testing in companies engaged in the packaging sector is to find out whether the polymer material being processed is in accordance with packaging company standards or in accordance with consumer demand. In this study, the seal strength temperature used was in accordance with packaging standards (150℃) with a speed of 280 mm/min, while for bonding strength using a speed of 250 mm/min with a withdrawal distance of 50 mm (5 cm), the thickness of the specimen tested approximately 70µmm.

Keywords:- *Packaging, Polymer, seal strength, bonding strength.*

I. INTRODUCTION

The growth of the Indonesia's economy at a macro level, bringing good impact on the purchasing power of purchasing power of consumers. One of the sectors that growing is the food industry industry, both small and large with wide variety and derivation of products to answer the needs of consumers. A good product is products that are maintained in quality from the time it is made until it reaches consumers. [1]

Packaging is a container that occupies an item so that it is safe, attractive, has the allure of someone who wants to buy a product. In the beginning, the function of packaging was limited to protecting goods and making it easier to transport them so they would not be damaged to their destination. In this era of globalization, packaging has begun to experience additional functional values and the role of packaging in marketing has begun to be recognized as a major force in market competition, for example its aesthetic value in terms of color, shape, features and durability of the packaging. One of the most concrete examples of the role of packaging in this era is as food product packaging (food packaging). The trend of food packaging has been carried out more than half a century ago, namely in the 1960-1980 period by considering functions and issues in accordance with the times which include the efficiency of packaging materials.[2

Polymers are giant molecules (macromolecules) that are formed from rearrangements of hundreds or even thousands of simple molecules called monomers. Polymers have many relatively very large molecular masses. In general, polymers are organic chemical compounds based on carbon, hydrogen, and non-ferrous elements. Polymers are widely used in everyday life, for example clothing, drinking bottles, plastic folders and bags, tires, pipes, paper, and others.[2] One of the most common examples of polymers is plastic. Plastics are polymeric compounds with a rigid structure formed from the polymerization of hydrocarbon monomers that form long chains. Plastics have different boiling and melting points.[3]Types of plastics are divided into two main classifications based on economic considerations and their uses, namely commodity plastics and engineering plastics.[4]

In the industrial sector, generally plastic materials used as food packaging will be included in the extrusion/melting process by adding plastic pellets. Plastic pellets are a material that is generally in the form of clear white granules which are the main ingredients for making plastic-based products, both household products, electronic products, automotive products and other products. Plastic pellets are basically derived from a chemical called styrin monomer. The main ingredient is then mixed with other chemicals and goes through a heating process which is finally shaped like a liquid elongated cylinder which is then made hard to be cut into the desired size.[5] The types of plastic pellets that are often used in the extrusion process are Polyprophylene (PP) which has physical properties that are flexible, hard, and resistant to grease[6], Low Density Polyethylene (LDPE) which functions as a seal layer and sandwich layer in the extrusion process[7], Masterbatch resin which is a PP resin which gives color to the laminated film[8], Cast Polyprophylene (CPP) which is a synthetic polymer with the aim of improving product clarity and hardness and has excellent rigidity and odor resistance [9], and Polyethylene (PE) is a polymer material that has a varying melting point and is resistant to chemicals [10].

The purpose of this research was to determine the sealing and bonding characteristics of polymer materials used as packaging for food products, as well as to determine the maximum tensile force values for different polymeric materials when a tensile test was carried out using a tensile test equipment available at PT. Suryakemasindo Sejati so as to be able to minimize the cost of food packaging production in the industrial sector.

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II. RESEARCH METHODOLOGY

Fig. 1: Flowchart

The research started with preparing different plastic material specimens which were tested for their tensile strength using a tensile testing machine. The specimen enters the sealing machine at a given temperature until a change is given. After the seal continues to check its strength through the bonding process, where per layer of the specimen is pulled 90° at a specified speed and later given a change. The two processes were analyzed by testing data. Sealing and bonding tests used a Twing-Albert EJA Series tensile testing machine owned by PT. True Suryakemasindo. In the tensile test, seal strength depends on the adhesion of the innermost packaging layer [11], while bonding strength determines how strong the chemical bond strength is between two or more materials [12].

The specimens which are used in this research is a sample of polymer/plastic material that has undergone a rotogravure printing process with OPP (Oriented Polyprophylene), PET (Polyethylene Terephthalate), and Nylon, which are used as the main layers because these materials are the most common materials with customer requests as flexible (food) packaging materials. The plastic layers that were added during the extrusion or dry laminating process are CPP (Cast Polypropylene), Aluminum, PP (Polyprophylene), and LDPE (Low Density Polyethylene).

The equipment of this research is a Twing-Albert tensile testing machine owned by PT. Suryakemasindo Sejati. The machine is capable of performing the process of determining seal strength and bonding strength.

Fig. 2: EJA Series Twing-Albert Tensile Testing Machine

Fig. 3: Sealing Process

III. RESULT AND DISCUSSION

A. Result and Discussion of Seal Strength

The results of the type of tensile test for seal strength will be carried out 3 times with one type of material with the same temperature. The speed of the test was carried out at 280 mm/min at a pressure of 2.5 kgf. The tensile force value to be taken is based on the highest tensile strength value in each experiment. As for the sealing strength test, it is also carried out by changing the temperature to three types (150 ℃, 145 ℃ and 140 ℃) with the hope that the value of the tensile force is higher or lower.

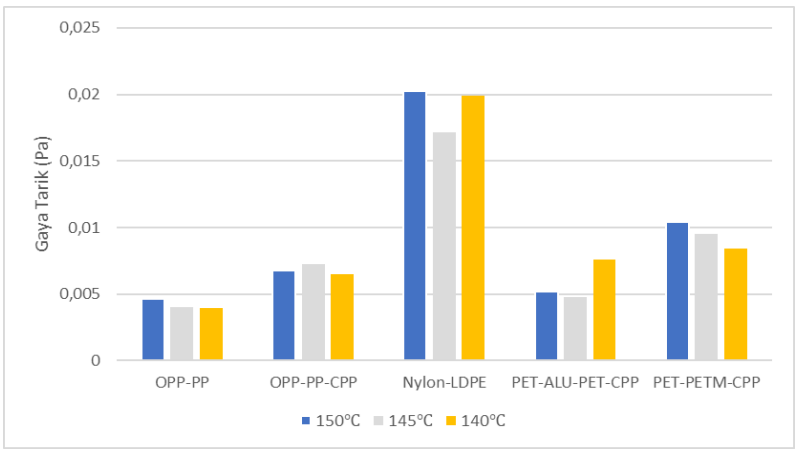

Fig. 4: Graph of Temperature Variation of Seal Strength Against the Average Tensile Value

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Fig 4. is a graphical image of the results of the average tensile force value with the seal strength testing method against different temperature variations. From the graph above it can be said that the highest average tensile strength value is found in the polymer film material Nylon combined with LDPE, where the tensile strength value at each temperature variation is much higher compared to other material specimens, namely 0,002028 Pa for a seal temperature of 150°C, 0,001713 Pa for a seal temperature of 145°C, and 0,001991 at a seal temperature of 140°C, This is because nylon itself has light, strong, and high levels of elasticity. On the other hand, the OPP film material specimen combined with PP plastic pellets as a whole becomes the material with the lowest average tensile strength value, namely with a tensile strength value of 0,000445 Pa for a seal temperature of 150°C, 0,000481 Pa fo a seal temperature of 145°C, and 0,000467 Pa for a seal temperature of 140°C. Based on a fig 4. above, it can be seen that temperature variations do not affect the value of the tensile force, but rather the pressure exerted on the tensile testing machine, as well as when holding the specimen when it is pulled 90° upwards.

B. Result and Discussion of Bonding Strength

The results of this type of Bonding Strength tensile test will be carried out 3 times on one type of material with a test speed of 250 mm/min, the distance of this material bonding test lasts up to 5 cm (50 mm) The value of the tensile force to be taken is based on the value of the tensile force highest in each experiment, unless during the testing process the material being tested is interrupted, then the highest tensile strength value will still be taken in that experiment.

Table 1: Tensile Strength Value of Bonding Strength Test Results

Material	Force (Pa)						
	OPP-PP	OPP-PP-CPP	*Nylon*-LDPE	PET-ALU-PET-SPE		PET-PETM-CPP	
				BS-1	BS-2	BS-1	BS-2
Average	0,281	0,466	2,347	1,099	1,585	0,597	1,579

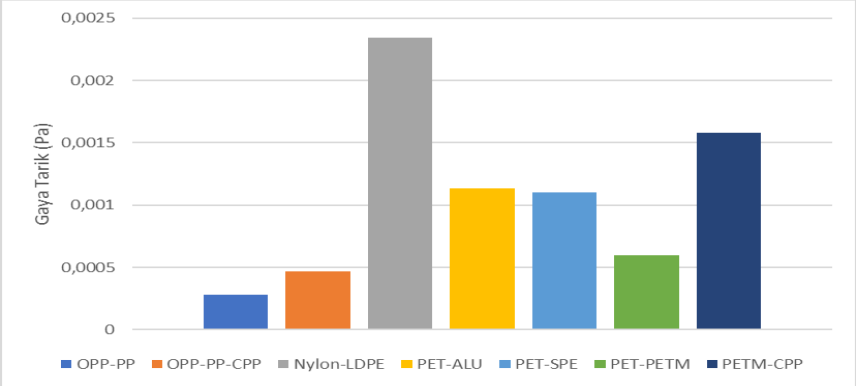

Fig. 5: Graph of Average Tensile Value of Bonding Strength Test Results

Fig 5. is a graph of the tensile force value with the bonding strength test method. On the combined film material specimens between PET-ALU-PET-SPE and PET-PET-CPP, 2 types of testing processes were carried out, namely the material bond test between PET-ALU and PET-PETM as bonding strength 1, and the material bond test between PET-SPE as bonding strength 2. It can be seen that in experiments 1, 2 and 3, the tensile strength produced was the highest with the first experiment 0,003010 Pa, the second experiment 0,002286 Pa, and the third experiment with 0,001746 Pa. In the other hand, the two materials with the lowest tensile strength are all OPP materials which are the main film layers as food packaging materials, both OPP combined with PP and OPP combined with PP and CPP. However, OPP-PP material is the lowest force with the first experiment was 0,000293 Pa, the second experiment 0,000295 Pa, and the third experiment 0,000256 Pa (the average value of tensile force is 0,000281 Pa). Based on Table 1. and Fig 5. above, it is known that nylon material as the main film layer has the best bonding material in testing bonds between other materials, followed by PET materials, and OPP being the third best.

IV. CONCLUSION AND SUGGESTION

The conclusion that can be drawn from this study is Temperature variations in seal strength testing do not affect the value of the tensile force produced. This can be seen in the table and graphical representation of the seal strength test results, where not all 150°C temperatures have high tensile force values, nor does the seal temperature of 140°C reduce the tensile force itself. Nylon material combined with LDPE is the food packaging material with the highest tensile force value, both in the seal strength and bonding

strength test methods. In seal strength, the average tensile force value is 0.002028 Pa at a seal temperature of 150°C, 0.001713 Pa at a seal temperature of 145°C, and 0.0019.91 Pa at a seal temperature of 140°C. Meanwhile, the average bonding strength value is 0.000234 Pa. Based on the results of the seal strength and bonding strength tests, nylon material as the main layer film material in food packaging is the best material because the tensile force value produced is much greater than the OPP or PET material as the main layer. When conducting the test, several human errors occurred, causing some of the data that has been presented to be not so close in results compared to the other 2 experiments. Therefore, the author suggests that the production team working in QC PT. Suryakemasindo Sejati be more thorough in conducting tensile testing both with the seal strength and bonding strength methods. The author would also like to add input to try varying the pressure on the tensile testing machine or conducting a withdrawal with 0° or 45° in the hope of being able to provide a more optimal tensile force value in making plastic packaging as food packaging.

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