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Analyze the different properties of injection molded products fabricated by injection molding of a plastics resins

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Abstract- The plastics products are encourage inventions that support to make human life better, healthier and safer life day by day. In this paper we analysis the mechanical properties of injection molding product of plastic material to increase the human comfort. The importance of plastic products are enable durable, design in home environment, buildings, as well as structure like over bridges, In automobile design, plastics materials has play important role to a assembly of innovations and security, performance and fuel proficiency, which reduces fuel consumption and decreases greenhouse gas emissions. From computers and mobile phone to TVs and microwaves, durable, lightweight as well as reasonable costs. plastics has be of assistance transform products in wide variety of power and motion transmission applications is relatively incomplete due to frail mechanical properties and different instrument of failures. Injection molding is favored where close-fitting tolerance, decent quality and high productions rate is required. This paper analyze the different properties of injection molding product of polymer material. The technique, concept, methods as well as consideration needed in designing of plastic injection mold are obtainable. Design of mold is approved nylon polyethylene, polyester, and Epoxy materials.

Keywords— Injection molding, Mechanical Property, Inspection instruments; plastic materials .

1. INTRODUCTION

SMAW, Present time, injection molding are an industrial process for production parts from together material a thermoplastic and a thermosetting plastic in production industries. The plastic injection molding method creates with resin pouring and suitable additives after the hopper to heating system of the injection molding instrument. The molten plastic is an added with a high pressure mold, . Injection molding pressure generally minimum range 70 Mpa and maximum range approx. 200 Mpa, which are different to the shape of produce product. There are some various type of plastic molding, an input molding, Injection molding, rotating molding, compression molding. Every process has his own benefits in producing some products. Once the product are made, regularly by an manufacturing engineer designer, the mold are formulate by an mold maker (or tool maker) with steel and ceramic material, generally metal or aluminum alloy, and mechanical accuracy to form the parts of desired part. Molding injection is broadly used to produce an variety of components, from the smaller component to different type of a vehicles body panels. Injecting molding are an common process of manufacturer, with some of the most common ingredients including bottle caps and outdoor furniture.

Injection molding contains a higher pressure injection of a raw material into a mold wherever it is shaped. The separable parts of that procedure is too short. The entire injection molding procedure normal lasts from 5 seconds to120 second. There are four stages in the cycle. These stages are the clamping, injection, cooling and ejection stages.

1.1 Objective:

The main objective of this study is to analyze the mechanical properties of injection molding product of a polymer material

- Prototypical study as well as, notice and fix problematical regions.
- The study of designated resources have been completed, to recognize its physical as well as mechanical properties.
- High precision and increase production rates.
- To minimize the manufacturing cost with only a relatively high initial cost for products design.
- Increases its durability.
- Identifying the critical positions in the products, and reduce.
- Compare the results from stress-strain analyses and eigen frequency analyses for the different type of raw materials.

As the purpose of this research project, when produced a plastic substance analysis materials and its mechanical properties. and molds for injecting injection ideas, the product component of the Tubular Connector, mimics and analysis are performed based research.

1.2 Scope:

The scope of this research addresses two main points, one is to design and develop injection molding mechanism for industrial plastic articles. And other one is to conduct testing for checking mechanical performance of the produced products using virtual and experimental method. And compare the different type of a mechanical properties of plastic articles.

1.3 Problem identification:

The process of designing the transformation of ideas, needs, or demands of consumers or a huge competition in market of a product that need not satisfied the expectation of customer, also not satisfies the needs of customer. The problem is identified of a design products through testing.

1.4 Limitations of the stud

While analyze the different properties of a injected molded product of polymer materials; there was limitations which is written below.

- Due to unavailability of high quality testing equipment.
- Due to lack of skilled worker to performed molding operation.
- Due to lack of budget and facility only one raw material availability.

1.5 Mold Flow analysis:

The Mold flow investigation of plastic articles supports engineers to see how their strategies will be lead to after injection molding procedure. Autodesk Mold Flow are a dominant recreation implement to study performance of changed parameters on finishing quality of the produce products. Investigational trial information is used to equate with results through Mold Flow recreation. The Injection Molding process are suggested design procedure with more than eight phases. It is declared that this process will be not the same from each assignment, but this offers idea into the expenditure and flow time of the process.

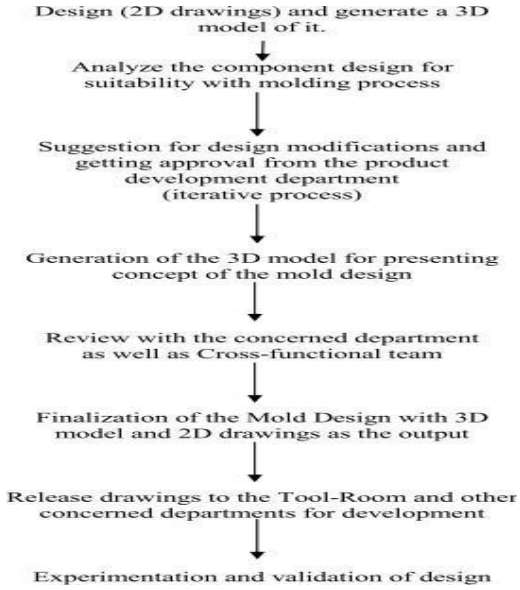

Fig 1 Mold flow diagram of analysis

1.6 Material selection:

Injection molding can be used with a variety of plastic resins. the materials was selected based on what were used in his this research work. For this experimentation, only ABS and NYLON 66 polymers have utilized in injection molding, so here was not predictable issues through these materials, so the analyze the mechanical properties of Nylon 66, for the reason that was reachable in bits for injection molding then the melting temperature was predictable and also features of intricate shapes can easily be produced.

2 LITERATURE SURVEY

2.1 Tong- Hong Wang , Wen -Bin Young

The layer elimination technique was performed to analyze the enduring stresses in a smooth thin-walled experiment illustration. Moldings below diverse conditions were examined to study the effects of the procedure conditions on the residual stresses of a thin-walled product. The mold temperature was only the feature to affect the size of the core section and residual stress on the surface coating of a thin-walled part . The filling pressure was establish to be unresponsive to the enduring stresses in the deliberate high- pressure limits. The projected stress level and tendency are close to the investigational measurement in plastic model. The layer elimination technique was as well initiate to be satisfactory for a thin-walled portion.

2.2 C. H. Lu and C. C. Tsai

This paper improves a multivariable self-tuning control technique to further develop execution of a temperature control framework for an extruder container in the plastic infusion molding procedure. Virtual experience and exploratory outcomes are represented to show the possibility and adequacy of the proposed technique.

2.3 Pankaj Shakkarwal and Lipin Yadav

In this study presumed that design with the CAD instruments and mold stream investigation is the main necessity for infusion molding parts. The review brought about decrease of consumptions and save significant worker hrs, that will be extraordinary misfortune as far as cash that happens during creation stage. Hence form stream programming is a preventive and remedial apparatus, which can assist an architect with examining the interaction to diminish the process duration and to work on nature of item.

2.4 Shaikh Mohamed, Mohamed Yusuf, Jafri Mohamed Rohani , Wan Harun Wan Hamid & Edly Ramly

This research paper has initiate that defects in injection molding procedure were mainly due to improper management of material, material flow and quality of material. They nominated appropriate working range for input and output restrictions and level for it. The investigation was made on crater location. After examination, they made a final optimal setting, and found that there were no additional defects.

2.5 Rishi Pareek, Jaiprakash Bhamniya

In this research have originate that In injection molding process of Polycarbonate, for tensile strength melt temperature is found to be the greatest important factor. The results display that, for polycarbonate the finest arrangement of processing factors in terms of tensile strength are 2600C melting temperature, 150 bar injection pressure and 7.5 seconds cooling time. The effect of all factors has been recognized and understood can be a key factor in aiding mold designers in defining optimal process circumstances injection molding bounds.

2.6 M.C. Song, Z. Liu, M.J. Wang, T.M. Yu, D.Y. Zhao

In this paper, an orthogonal method (Taguchi method) and quantitative simulation, the impact of various cycle boundaries (infusion rate, infusion pressure, softening temperature, metering size and part size) is utilized during the time spent shaping super slim plastic parts is examined. In this paper, we can say, Part thickness is an immediate boundary in the development of super slim plastic parts, the dissolving limit diminishes quickly with the decrease partially size and Metering size and infusion rate are key elements in forming an infusion in a tiny divider. Legitimate metering size is a condition expected in the plan, speed increase of infusion rate can cause huge expansion in filling rate and Melt temperature and infusion pressure are optional elements, yet higher softening temperature and infusion pressure are expected in the ultra plastic trim divider components.

3 Experimental Procedure :

The analyze different properties of injection molded design of a polymer material to obtained optimal results from plastic designed. After analysis of mechanical properties of plastic product the output results in the future can be improve. After selecting the appropriate materials, improving part and mold design, and predicting the performance of the plastic product before the real process of the part manufacturing takes place. An injection molding machine is a member of equipment contains of two basic components, the injection unit and the clamping unit. Investigate the mechanical properties of designed portions has not yet been placed to the investigation beside those from outdated methods of industrial. The subsequent experiments will equate the mechanical properties of samples that was produced result with different test.

3.1 Test:

The several different zones that related to support recognize the variance in mechanical properties as of every manufacturing technique. The designed plastics articles was examine for dimensional precision, tensile strength, water absorption, Shore hardness and microscopy. These are the several zones will be recycled investigation in the injection molded samples. The outcomes as of the injection molded portions and designed portions will support us understand and used to produced different industrial items.

3.2 Tensile strength test:

When we analyze tensile strength test is executed on polyacrylonitrile-butadiene-styrene its also known as ABS and Nylon 66 . In tensile strength test, measure the strength required to braked the plastic articles sample and the amount to which the sample elongates or stretches to that flouting point. that were used in altogether of the experimentations are calculated through the American Society for Testing and Materials (ASTM D 638). The ASTM be responsible for the disclaimers for the sampling, and the technique used for testing the sampling for tensile strength. The testing instrument are prepared with a 10 kN weight chamber. In this test the upper clamp is linked to the 10 kN weight chamber and jerks the sample uphill, positioning stress on the sample. Every substantial was verified in open environment at an temperature is approx. 250C.This sampling is considered to test the tensile strength of dissimilar plastics parts.

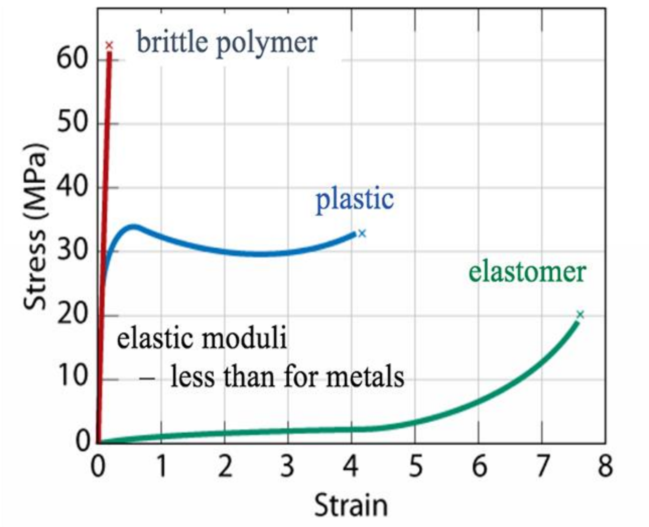

Fig 2 Stress -Strain graph of polymer materials

3.3 Water absorption

In this test are done to detect variances in how much water are absorbed during produced in industrialized technique; injection molding of a plastics articles. In this experiment, the samples are underwater were located in a flexible bag and after that left in an free environment and well-ordered atmosphere for 7 days, or 170 hours. This helped drop error by make definite every single part was detained in similar ecofriendly environments.

WATER ABSORPTION PERCENTAGE = $(weight\ after$ 24 hr Submersion (g)$-initial\ weight\ (g))\ \ initial\ weight\ (g)$ 100.

3.4 Shore hardness test

In this test done to know the inflexibility of a polymer. The D scale are utilize for stiffer and additional rigid polymers like Nylon 66 and ABS, a are considered hard plastics. To measure the Shore hardness Type D Durometer. The durometer have a sharp indenter that are hard-pressed obsessed by a plastic, and analyzes the hardness constructed on how ample potency it takings to pierce the plastic. For this investigation take two different trial sample of both material are used. This test was established at three places on every single side of every test sampling and after that result was note down at every position after that we take average value and also calculate standard deviation of each results for each material To support decrease inaccuracy.

3.5 Shrinkage

Shrinkage test done to checked the dimensional accuracy of each and every plastics sample, the dimensional precision is greatly additional skillful in injection molding, the shrinkage of every single material will be related to the dimensional precision. Every polymer material has an individual shrinkage rate, which means the type of material that is presence recycled essential be measured when generating a mold. The measurements was noted and after that used to compute the average and standard deviation of every single point. a Moticam 10 arithmetical camera, and Motic Pictures Plus 2.0 software. An image of one sampling from every injection molded material was take out after that related to the images of the enterprise plastic portions.

3.6 Microscopy

Microscopy test was done to find Post tensile test, images of the fractured test sample were occupied to note the inner arrangement. The rigorous apparatus that was used MEIJI Techno EMZ-5TR stereo microscope. An spitting image of one sample as of every single injection molded material was taken out then equated to the imaginings of plastic portions. This experimentation is meant to support discover the isotropic nature of injection molding against the anisotropic nature shaped products.

3.7 Temperature effects

Plastic materials is Compared to metals, the mechanical properties of polymer composites are extremely dependent of temperatures. Thermoplastics mixtures are much more sensitive to high temperatures than thermosetting composites. The temperature effects on mechanical properties are strongly affected by the polymer matrix and the fiber content. Increased fiber content will enhance the temperature resistance.

All polymer composites have decreased strength and stiffness and increased strain at elevated temperatures. The temperature effects on mechanical properties are powerfully affected by the polymer matrix and the fiber content. Increased fiber content will enhance the temperature resistance. All polymer composites have decreased strength and stiffness and increased strain at elevated temperatures. This behavior is illustrated in Fig. 11

3.8 Fatigue test

The plastics products are subjected to loads of vibrations during their lifetime and hence, fatigue can be a gamble factor. During cyclic loading, disappointment might happen at altogether lower loads than under static stacking conditions. polymer composites have lower fatigue strength than other material 107 cycles, Due to lower fatigue strength in the polymer composites, fatigue behavior must be investigated in order to secure that the fatigue strength is high enough. For checking fatigue behavior of molded products we use S N curve. For polymers and polymer composites, the fatigue strength is decreased at mold lines. For polymers, the load level, load frequency, and the test temperature strongly affect the mechanical behavior due to the facts that polymers have low heat conductivity and high damping. During cyclic loading, energy will be absorbed by the material and dampen the vibrations. Due to the low heating conductivity and the high damping of polymer materials, the temperature is increased to high levels without reaching an equilibrium plateau before fracture. This fracture mechanism is called thermal fracture.

3.9 Creep

When a polymer material is uncovered to a stress, the strain will rise gradually but not constant over time, which is called creep. The reason for this phenomenon is due to molecular movement in the polymer. When the stress is removed the strain go back since the molecular want to return to their initial position, due to the materials viscoelastic behavior. The creep goes through different stages, First, an initial elastic strain occurs when the constant load is applied which thereafter are followed by the three stages; primary creep, secondary creep, and tertiary creep. The primary stage has a decreasing rate which indicates that the strain rate is decreasing until the strain rate is constant and that's when the second stage begins. The second stage is called the steady state stage due to the constant strain rate. In the third and last stage, the strain rate is increasing very rapidly and rupture will occur. Due to the high strain rate, necking or another failure will take place in the material. The necking will result in very high local stresses giving an even faster increase of strain rate.

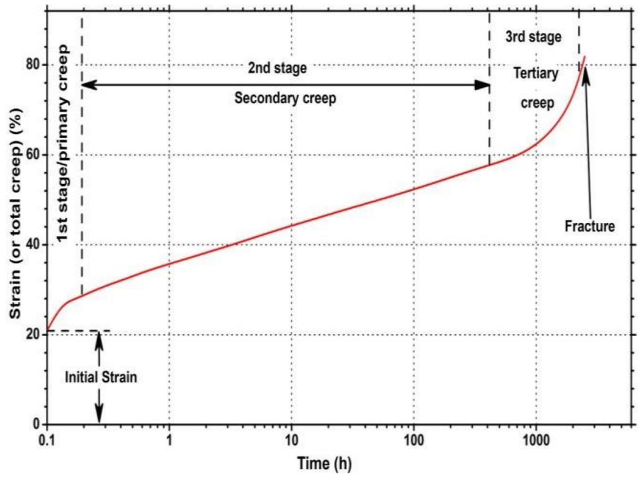

Fig 3 Typical creep behavior for a plastic material for a constant load.

4 Results and discussion

1. In section 3.2 done different experiment sample, of every single material, was shaped through injection molding products then there prototype model are utilize in that experimentation. The Nylon 66. And ABS are used as polymer materials, The effects of the injection molded ABS experiment samples and prototype and Nylon 66 and there prototype The middling tensile strength of the injection shaped test specimen are 45MPa and 39MPa , for nylon 66 is 54.75MPa. 50.8MPa and elongation of each for ABS are 4% 3.9% and for Nylon 66 is 270% and 7.74%. purpose of that experimentation are to define which developed technique created the durable part.

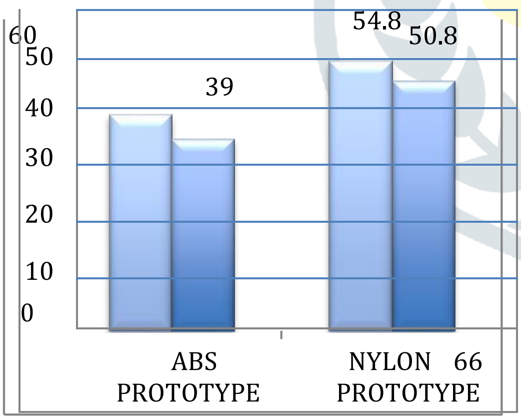

Fig. 4 Average Tensile Strength ABS, Nylon 66 there prototype model

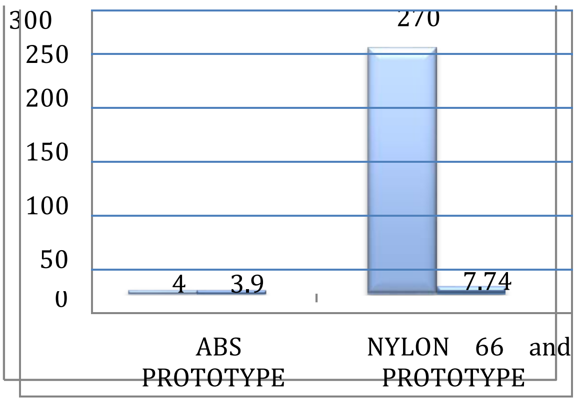

Fig. 5 - Summary of Average Elongation

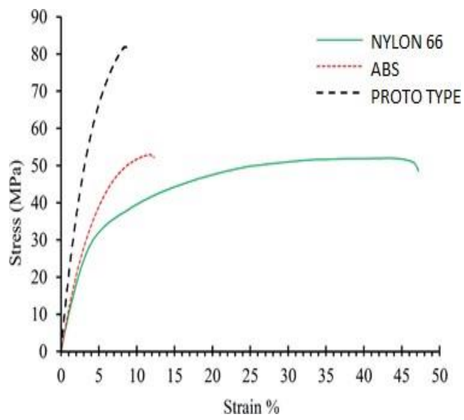

Fig. 6 Stress-strain curves under tensile test for NYLON 66 ,ABS and Prototype Model.

The summary of every tensile test effects can achieved. This experimentation checks that the injection formed experiment sample has a upper tensile strength, a greater elongation, and extra elongation to break than the rapid prototyped sample.

2. In section 3.3 done different experiment sample, ―the growth in weightiness, dimensional dissimilarities So The weight of ABS experiment sample improved by an usual of 0.40% and around prototyped experiment sample improved through an middling of 11.60%. and in case of nylon 66 experiment sample improved through usual of 0.23% as well as the prototyped experiment sample greater than before through an usual of 1.51%. In this experiment illustrations the consequence of a isotropic arrangement of an injection molding versus the anisotropic arrangement of a rapid prototyped portions and There prototyped portions will be absorb additional water because voids amongst the covers of a constituent.

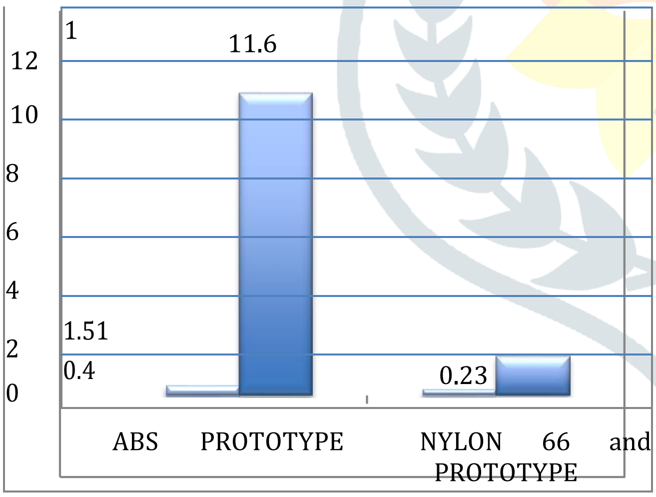

Fig. 7 Summary of Average Water Absorption

3. As described in 3.4, we analyze the Shore Hardness. The results are be around of the ABS experiment sample is 76 for injection molded also 78.70 for prototype model. The Nylon 66 trial sample have an usual of 71.17 designed for injection molded design and 78.17 for prototype design. The prototype technique makes a harder manufactured goods for both ABS also Nylon 66 material**s.**

4. From section 3.5 The shrinkage are measure as a % change in dimension, comparing the dimensions of the mold to the dimensions of the finishing item. After investigation we can say that the injection formed parts achieved improved as compared to prototype portions in dimensional precision. Although certain type of prototype portions has a low middling fault as compared to the injection molded portions, and also the standard deviation of a injection molded portions are lesser value as compared to their prototype model specimen. With the outdated technique of injection molding shall deliver a additional accurate invention and design might be familiar to deliver a additional precise fragment.

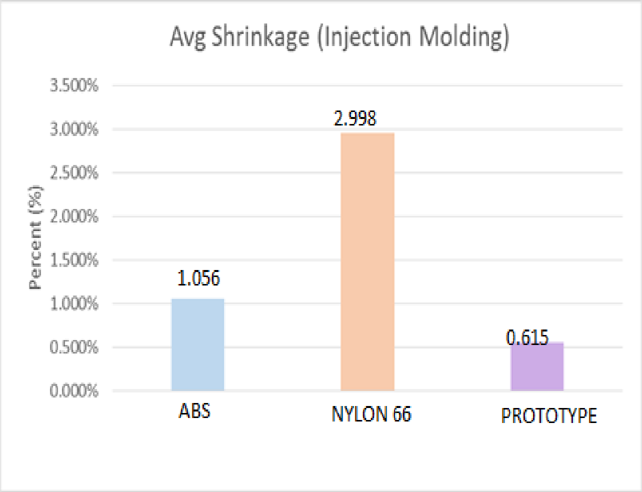

Fig 8 summary of Average shrinkage

5. From section 3.6 we are analyze In 10x enlarged pictures of an injection molded products. In this Test sample on their flouting point afterward tensile test. These imageries display the isotropic arrangement of portions formed by injection molded products. The isotropic configuration means that there portion is one solid part. So these are imageries of the verified portions, the inner breakdowns can be understood. Equating the enlarged imageries of an injection molded portions to the prototype portions. The ABS experiment sample displays a lot additional inner stress then cracking throughout the experiment, Nylon66 sample are comparatively smooth. Considerate the inner arrangement of these portions are significant if prototype technique are trying to develop a ordinary manufacturing technique.

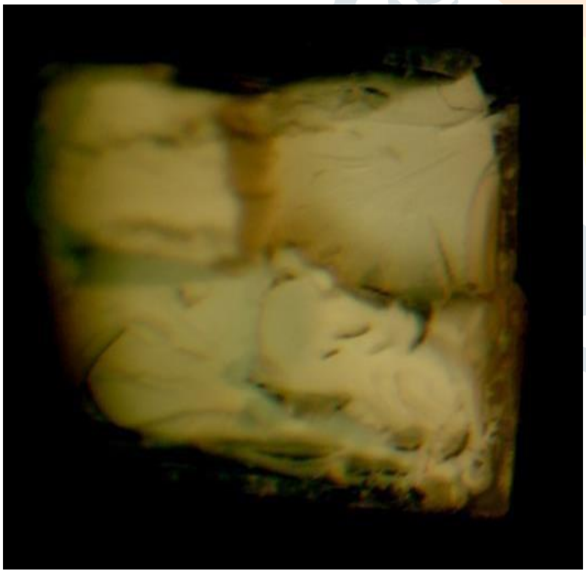

Fig 9 ABS at break point 10x magnification

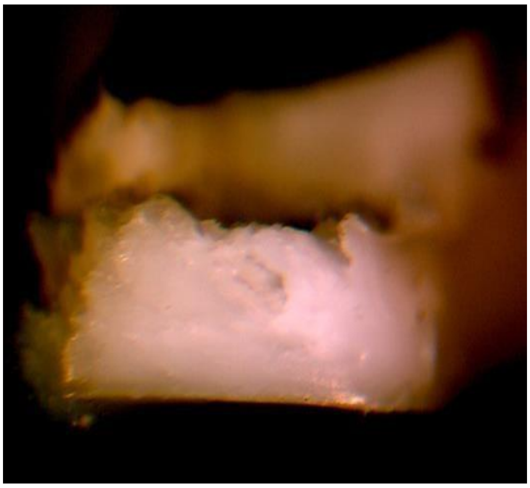

Fig 10 Nylon 12 at break point 10x magnification

6. When analysis the temperature effects of polymer, than found the results All polymer composites have decreased strength and stiffness and increased strain at elevated temperatures. The maximum service temperature is the highest temperature the material can withstand for an extended period of time without causing significant problems due to e.g. chemical change, loss of strength, oxidation, excessive creep, or other properties that are primary in applications. The maximum service temperature for ABS is 170-200◦C and for Nylon 66 is the temperature is between 90-130◦C.

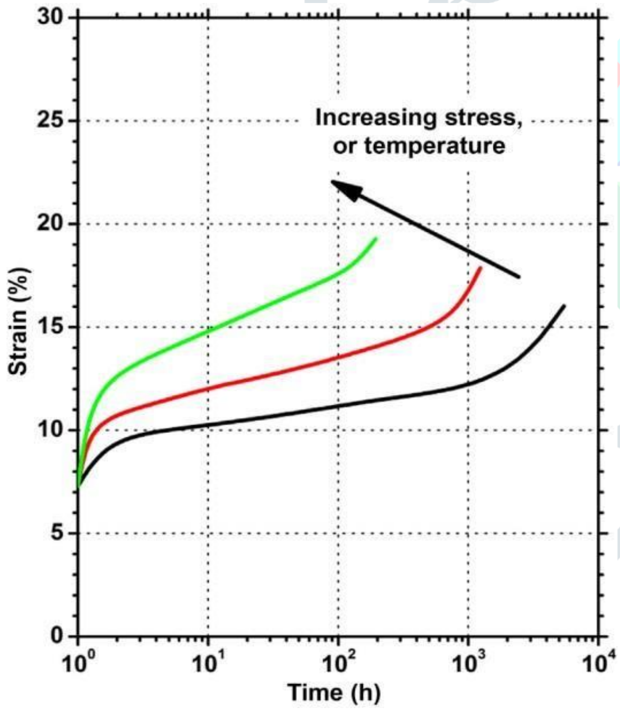

Fig 11 Temperature and load effects for creep behavior.

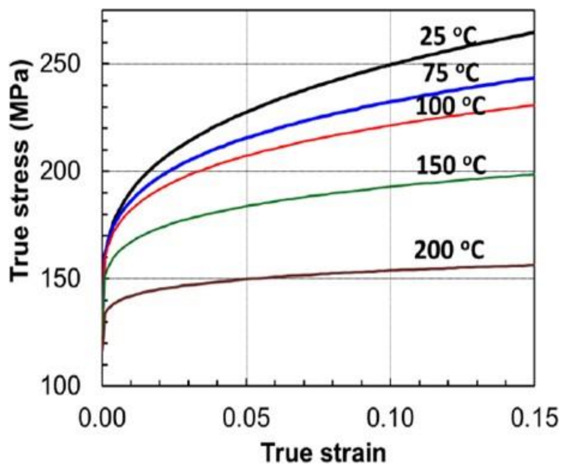

Fig. 12 The Effect of a temperature Stress-Strain behavior of a plastics material.

7. In section 3.9 Creep is the function of time, temperature, functional load, and measurable properties. In analysis when Increased load and increased temperature have the same effect on creep and as illustrated in Figure 3.

The creep experiment have main aim to accurately gauging the rate which secondary creep happens. When Increasing their stress or else a temperature have the result of growing the gradient of the link it means the quantity of distortion in a assumed time increases. The effects has obtainable as the quantity of strain (deformation), normally stated as a percentage, produced through spread over a definite weight designed for a definite time and temperature e.g. 13% strain in 100,00hrs at 34MPaand 475°C.

8. In section 3.8 According to material data obtained from CES Edu Pack polymer composites have lower fatigue strength than EN AC-44310 at 107 cycles, see Table 1. Due to lower fatigue strength in the polymer composites material abs and nylon, fatigue behavior must be investigated in order to secure that the fatigue strength is high enough.

Table 1: Fatigue strength at 107 cycles for different material

Material	Fatigue Strength (MPa)
ABS	57-64.3
NYLON 66	66.1-75.1

The design and material affect the fatigue strength. For polymers and polymer composites, the fatigue strength is decreased at weld lines, by fiber agglomerations or by the presence of notches. For polymers, the load level, load frequency, and the test temperature strongly affect the mechanical behavior due to the facts that high damping. During cyclic loading, energy will be absorbed by the material and dampen the vibrations. Due to the low heating conductivity and the high damping of polymer materials, the temperature is increased to high levels without reaching an equilibrium table before fracture. This fracture mechanism is called thermal fracture. investigated the fatigue behavior of NYLON 66 and by applying different strains at two different frequencies, 2 Hz and 10 Hz. At the lower frequency, the matrix remains in the smooth state and the fracture is only mechanical. When the frequency is increased to 12 Hz, both thermal and mechanical breakage occurs since the temperature is elevated to 160◦C on the surface of the sample. For 10 Hz the conditions is in the chewy state and the fracture is ductile. While thermal fracture is common during cyclic loading of polymers, mechanical fracture mechanism will occur for metals, even at upper frequencies. Further for polymers, already at room temperature creep and stress relaxation must be taken into account which is not required for metals.

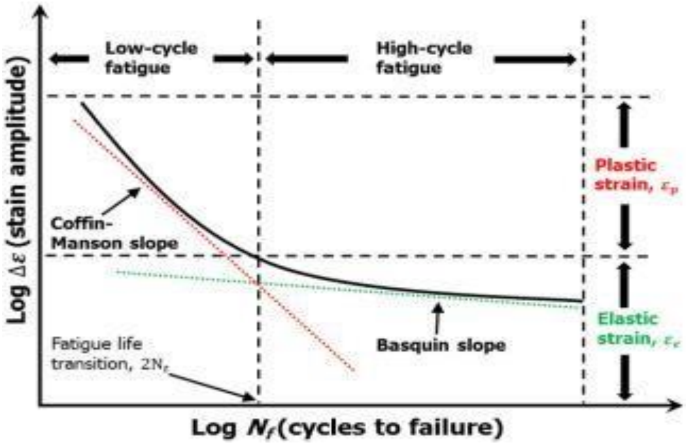

Fig. 13. S N curve of plastic materials at normal condition **.**

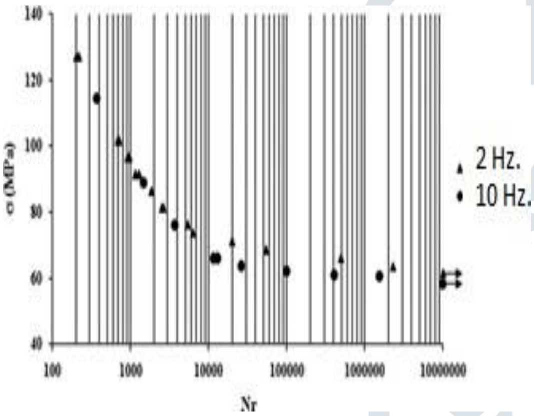

Fig. 14 Wohler curves in f a t i g u e tests for the frequencies of 2 and 10Hz, of plastic material.

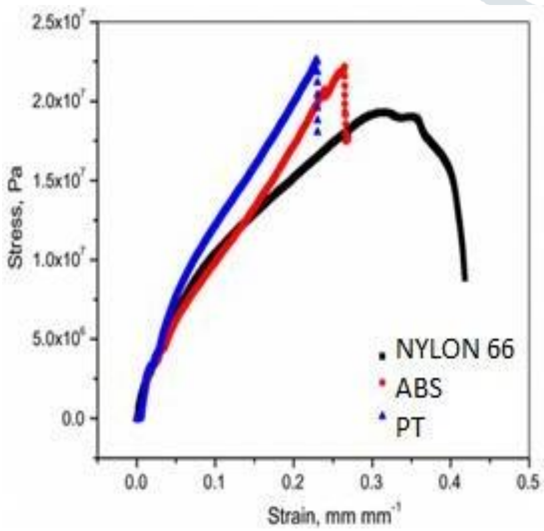

Fig. 15. Stress Strain curve of ABS, NYLON 66 and PROTOTYPE sample of polymer material during fatigue strength teste.

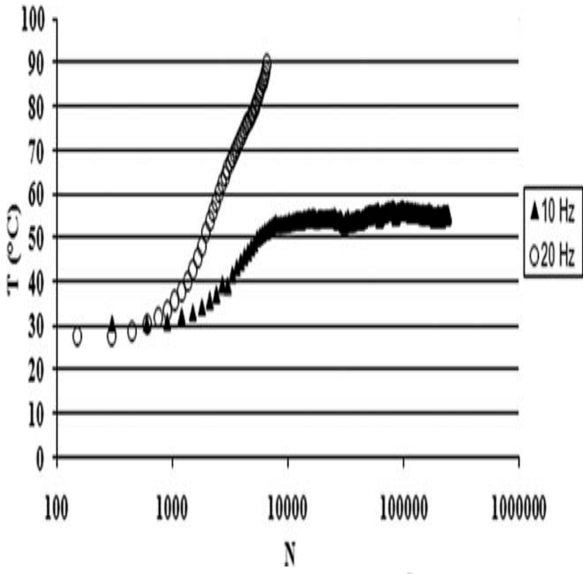

Fig. 16 Surface temperature of a NYLON 66 and ABS sample tested at 10 and 20 Hz, and 66 MPa against the number of cycles.

Effects are exposed in Figs. 15 and 16. We can visibly understand that self-heating are additional marked for 20 than 10 Hz for two kinds of experiments. For nylon 66 sample experiment, the temperature increases from room temperature up to 558 C if the frequency are 10 Hz but when the latter is 20 Hz, it growths up to 908C before breakage. For ABS experiment, we can understand the similar inclination, throughout this type of experiment, self- heating is not noticeable when the frequency is 2 Hz. The temperature growth is only equivalent to 108 0C before the rupture. Earlier involvement has exposed that when the polymer materials is uncoated, the temperature increase is significantly upper even at a frequency is 10hz.

5. Conclusion

The analysis of many influences have been recognized and understood can be a important factor in serving to produce greatest feature and less production cost in injection molded designed products from a polymer materials. Injection molding process of ABS and NYLON 66 materials, dissolve temperature and injection pressure is originate to be the furthermost important feature which contributes. In this paper displays that through evaluate the temperature and strength can reduce defects of products as of construction unit. This research will increase the performance of injection molded products and reducing the production cost. By performing research, investigations the greatest arrangement of procedure restrictions was originate that would deliver the lowermost materials faults of samples prepared from ABS and NYLON 66 material. On this basis, it was initiate that temperature strength, creep, fatigue strength of materials and injection pressure is the best important procedure parameters affecting the procedure. Additional parameter of this procedure is still under research and necessity additional participation of multidisciplinary science and equipment to attain development. in this paper contains results from experiments containing the succeeding: shrinkage/dimensional precision, tensile strength, elongation and elongation, water absorption, and Shore hardness. All of the experiments was achieved more than two different plastic portions that was created using injection molding. Two of these plastics are ABS and Nylon 66, are the same materials used in prototype.

6. Acknowledgement

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