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OPTIMIZATION TEMPERATURE AND FRICTION STENT PRODUCTION PROCESS BY EXTRUSION METHOD

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Abstract: The stent is manufactured by traditional machining methods. This study has been carried out to improve the mechanical properties of stents produced by removing swarf. Production methods have been examined and extruded to produce a seamless cylindrical section pipe. The Mg-Zn-XX alloy used in stent production was used in this study. Extrusion mold design is made to produce stent with Mg-Zn-XX alloy. These parameters are optimized because temperature and friction values from the Extrusion parameters affect the shaping parameters of the generated stent. During optimization, the Simufact finite elements program was used. The optimization has shown that the Mg-Zn-XX alloy has the best styling results of friction of 300 °C de Coulumb 0.4.

Key words: Stent manufacturing, Ekstrusion, Ekstrusion temperature, FEM

1. INTRODUCTION

From the past to the present, people have fought many different kinds of diseases, from birth to death. It is therefore very important that the research for disease and the remedy for these diseases is very important. One of these diseases is cardiovascular disease [1]. The coronary artery artery occlusion is removed by the insertion of small bio-compatible metal parts which called stents into the vessel. The work will be based on the production of stents installed for coronary artery occlusion patients who are still in progress today. During stent surgeries, the stent to be transported into the vessel enters the vessel without opening/inflating during surgery. As for the closed part, the stent is inflated using a balloon, and the blocked section of the vessel opens, posing as a stent bridge, allowing blood flow to occur. When the stent is inflated and acts as a bridge, it must meet the loads to come. These loads are due to blood pressure, vessel resistance and the accumulated materials which in vessel. Increasing the strength of the stent by increasing the mechanical properties of the stent will extend the life of the stent used, but also the patient’s comfort. The solution method for coronary artery venous blockage is only carried out by positioning the stent which producing with high mechanical properties that are bio-compatible [1]. It is extremely difficult to provide the technical and quality requirements of the stent tube. Stent production is usually produced as a seamless pipe. Then, the stent is cut off in the desired form CNC, lathe or milling, machined with laser machine and tempered, electro-polishing, etc. actions are applied [2]. Limited materials and manufacturing techniques are available in stent production. In the design phase of stent production, the geometric shape is generally designed as a ring. In stent production, wire erosion, laser cutting, photo chemical wear and knit manufacturing methods are used. The extrusion method is a method of manufacturing with plastic deformation that allows you to bypass the above-mentioned steps and focus on direct stent production. By extrude, the temperature can be checked after casting in manufacturing to create a smaller and equal axial structure. The method of plastic deformation, extrusion, causes to close the fabrication casting gaps, distributing the circations and making the chemical composition more homogeneous. It will also extend in the direction of deformation, causing some solid to form a fibrous, mechanical anisotropy. This shows the superiority of the extrusion method [3] [4]. Not only is the stent tube produced, but also processing it requires high precision, such as jewellery [5]. One of the biggest problems with stent designers is high quality. Producing high-quality stent pipes makes easier workmanship and improves patient comfort after stent surgery [6]. New type of stent production will be performed to complement the body’s biocompatible, superior mechanical properties, precise size and tolerances, with the alloys contained in the stent such as Zn – Mg deficiency in the body [7]. The materials used in stent manufacturing are usually iron-based alloys. In recent years, other than

316LVM stainless steel, cobalt and some Ti alloys have also been started to use. In research, Mg and Zn can also be as biocompatible materials. For this reason, Mg and Zn will be used with as alloy (Zn-3Cu-1Mg). Mg, Zn alloy (Zn-3Cu-1Mg) mechanical characteristics of new type stent production are preferred because it is well-suited to the body, resistant to wear, corrosion and fatigue [7-8]. In addition, Mg, Zn alloys are very useful bio-material, as they will cover the shortage of Mg and Zn over time for the human body. Fully biodecompatible within the body when used as a stent. it has high abrasion and corrosion resistance. high fatigue resistance is preferred as a convenience for inflatable and cudable designs. The method of production of stent with extrude is modeled by the Finite Elements Method and theoretically worked by us. In the studies, theoretical mechanical characteristics have been improved, dimensional sensitivity and internal external diameter tolerances have been observed, while the homogenization of grain size has been ensured by controlled grain size. Optimizing the controlled reduction of grain size is shown in many extrusion and ECAP studies in the literature [9]. The grains will be aligned, resulting in an isotropic material and no pre-laser cut pick-up will be required. Therefore, the equity material will be produced by extrusion. This will produce a stent before laser cutting with small mechanical properties of grain dimensions [10]. The material is a biocompatible alloy (Zn-3Cu-1Mg). we have used Mg-Zn-XX alloy. Optimization criterias are temperature, friction and force. Not only that criterias validate in plastic deformation processes but also speed, plastic deformation coefficient, mold temperature, ambiance tempreture etc. In this paper, optimisation of temperature, friction studied. Temperature, friction must be optimized during the production of stent with extrusion. It is necessary to know which temperature and friction value results in an optimal shape change of stent. We have researched shape tolerans and strain rate of the product during extrusion process. Therefore, the temperature and friction optimization of the Mg-Zn-XX is done with the simufact program in this article.

2. MATERIALS AND METHODS

2.1Finite Element Analysis

Mg-Zn-XX alloy material is used in material selection. Tensile strength 234 MPa, yield strength 152 MPA, slip module (Shear modulus) 17 MPA, elasticity module (Elastic modulus) 45 GPA, poisson ratio 0.35. stent production by extrusion will be made warm and hot. The model is drawn exactly in experimental dimensions as a solid model in the CAD program (Figure 1).

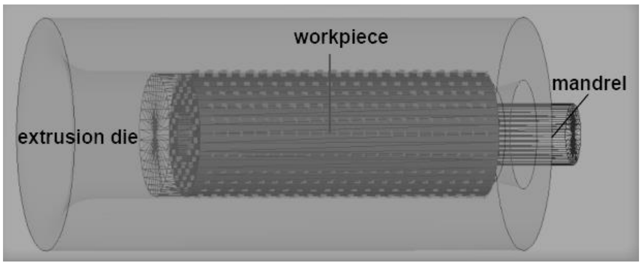


Fig. 1. Die, mandrel and workpiece

The required model for the mandrel has been created and assembled (Fig. 1). In the model ([12], [13]), the workpiece is meshed and nodes are placed to measure the shape size parameters (Fig. 2). These nodes are created to show shape changes that occur in the event of friction and temperature change, which are our optimization parameters. The lower mold material is also designated as Ti alloy material. In the first step, the temperatures values have been determined for dies 25ºC and 500ºC for material. The lower extrude mold is of great importance to the part to be produced. Their dimensions and required rounds are carefully modeled. Hydrolic press speed is cosntant 40 mm/s. The mesh is failed and must be re-mesh when the material is deforming plastic. This is why the reconstruction/remeshing (mesh refresh and adaptation) is being performed. If the program is run and does not provide the desired values, the design and/or external parameters can be modified and analyzed. In the event that optimal force shape tolerances are met, the analysis, which is successfully resolved, results such as temperature, normal strain, slip strain are obtained. The resulting models and true-to-life modeling analyzes were done in the simufact program and the final product was successfully achieved (Fig. 3).

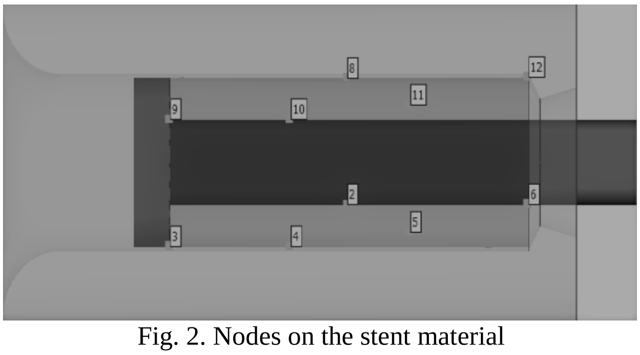


Fig. 2. Nodes on the stent material

In the optimization, the maximum strain values were obtained at 0.4 friction at 300 and 500 C when node numbers 6 and 12 were examined. For 300 ºC and the 500 ºC values 2.55 and 2.75 and 300 ºC have been found to be suitable for stent shaping (Fig. 4, Table 1).

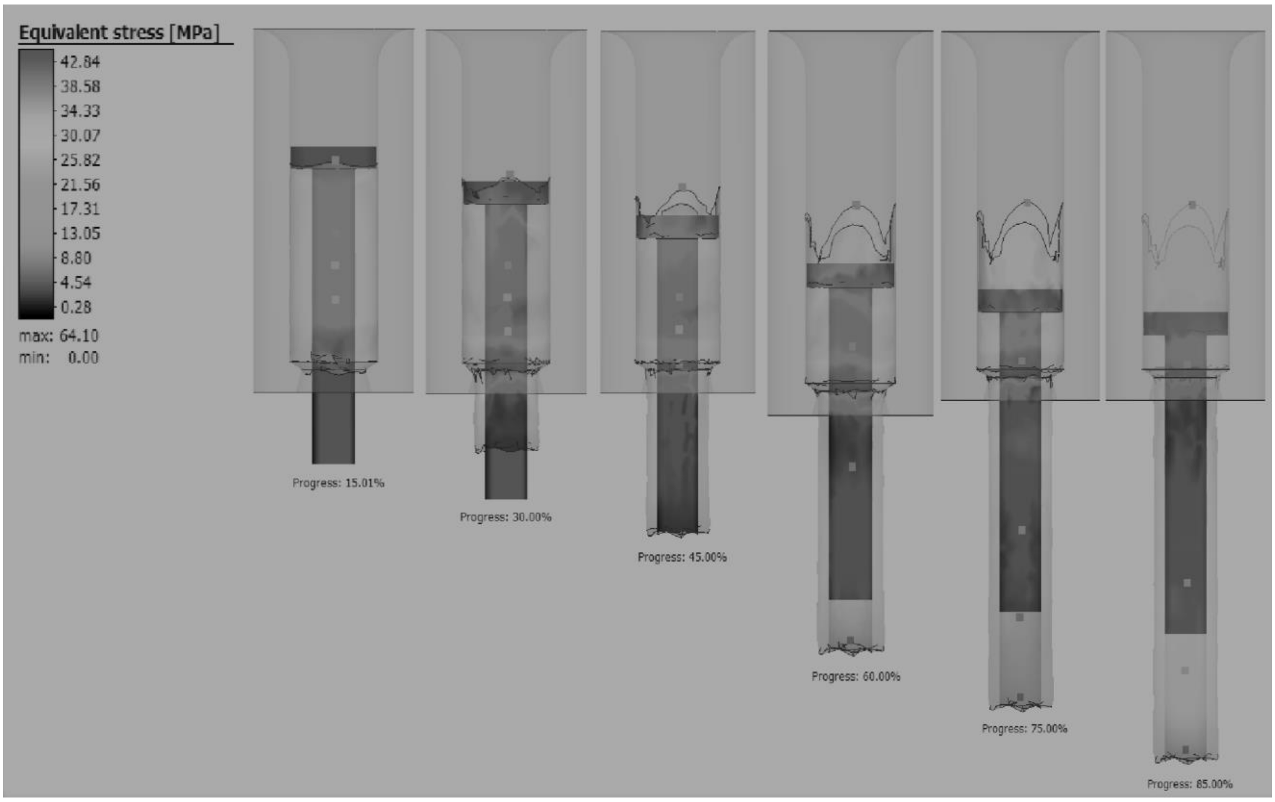
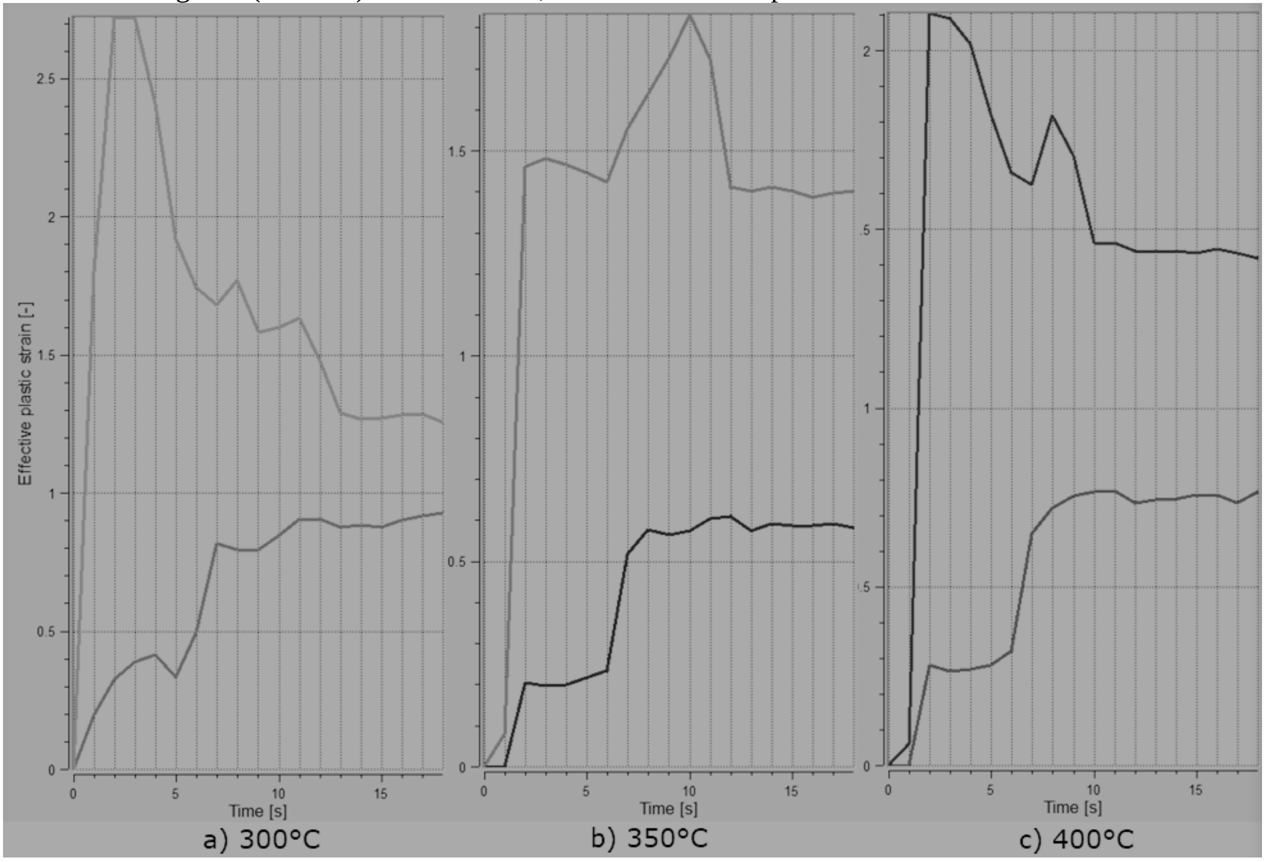


Fig. 3. Extrusion Analysis of Deformations rates: 15.01%, 30%, 45%, 60%, 75% vs 85%

For 0.7 friction values, the optimum values obtained at 300 ºC and 500 ºC are obtained (Fig. 5, table 2). Strain values are found in 2.75 and 2.55. The evaluation determined that extrusion at 300 ºC for the optimum intervals at 0.4 friction should be carried out. When the figures (4 and 5) are examined, it is observed that the friction forces have no significant effect. The friction change only causes the applied force to change. As the temperature value increases, changes in the effective strains in the shape change are observed. So, it is observed that the graphs of the same temperature values are the same.



a) 300°C b) 350°C c) 400°C

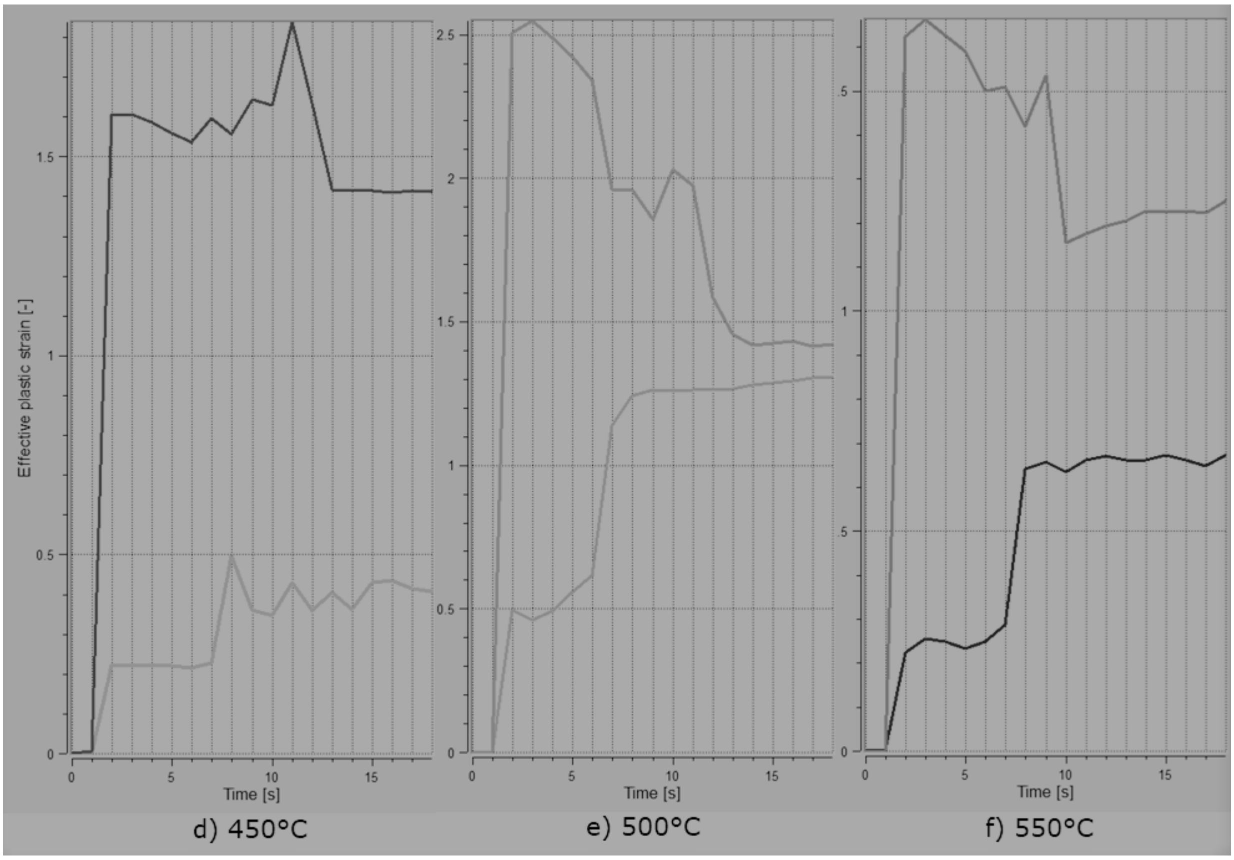
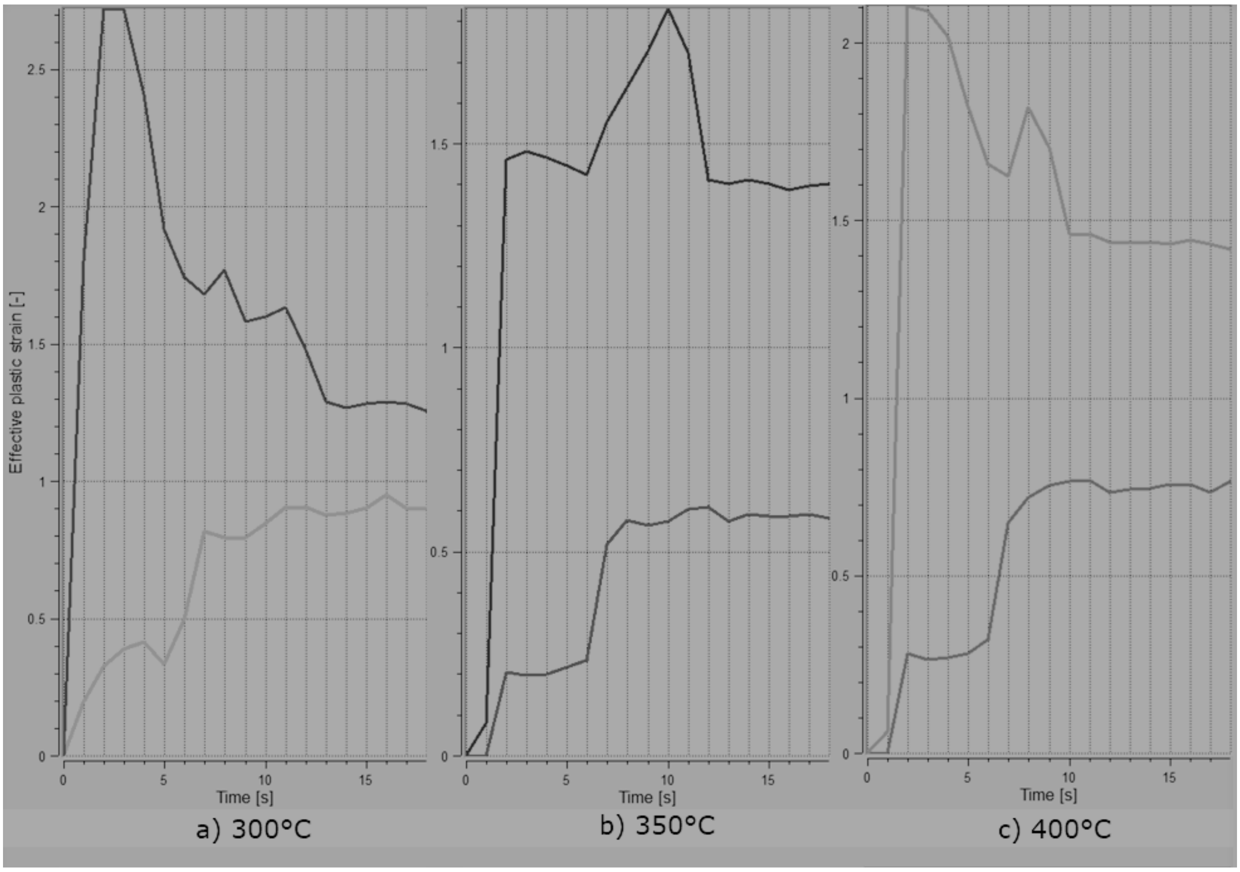
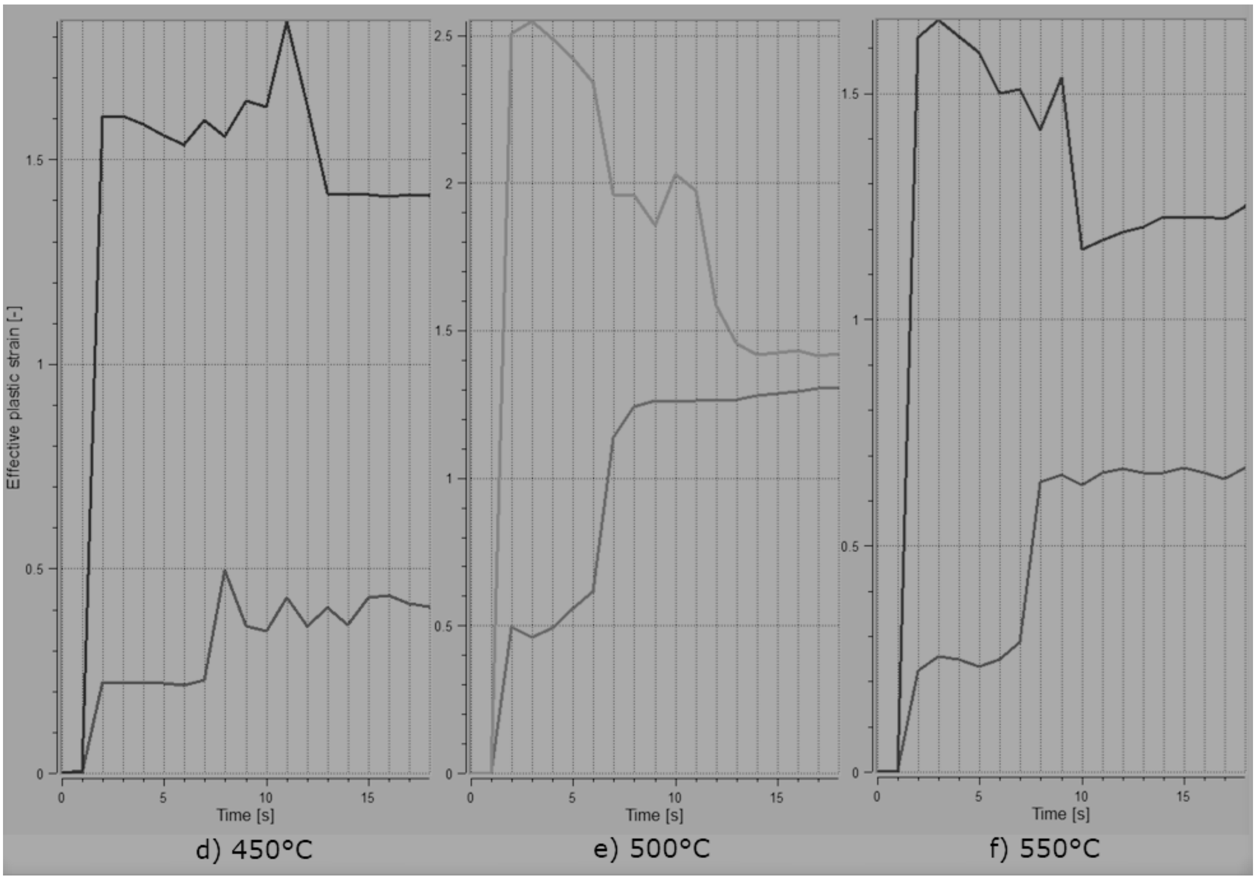


Fig. 4. Time-dependent effective strain Plots at 0.4 friction





d) 450°C e) 500°C f) 550°C

Fig. 5. Time-dependent effective strain Plots at 0.7 friction

Table 1. Strain rates of materials at 0.4 friction (coulomb)

Temperature, [°C]	Strain rate of 6th node	Strain rate of 12th node
300	2.75	0.95
350	1.85	0.65
400	2.1	0.75
450	1.85	0.5
500	2.55	1.3
550	1.65	0.7

Table 2. Strain rates of materials at 0.7 friction (coulomb)

Temperature,	Strain rate of 6th node	Strain rate of 12th node
300°C	2.75	0.95
350	1.85	0.65
400	2.1	0.75
450	1.85	0.5
500	2.55	1.3
550	1.65	0.7

When these values are looked at, the strain values are highest in 300 °C and 500 °C (Table 1, 2). Given the friction values, it has no effect on the shaping values. However, friction is also examined in the force section, another optimization parameter (Table 1, 2). Therefore, the effect of friction on shaping is not discussed in this article as an optimization parameter.

3.CONCLUSION

Extrusion and mould is designed and printed the parts that were extruded and assembled in the analysis program. Temperature and friction is optimized our analysis by increasing the friction force of 50°C and 0.1. The data from the graph was presented in the tables, and according to the data, it was determined that there were the highest effective strain rates at temperatures of 300°C and 500°C. The ideal temperature is set to 300°C as achieve stent by using low energy when compared to these results. Analysis outputs have results such as temperature and normal strain. These values also allow us to reduce the number of experiments and prototypes of products. Stent which planing will be produced in fine grain by extrude method. This means that the mechanical properties are getting higher. On the other hand, our shorthand is that the mg alloy material that we have prepared as a result of our research is being released on drugs, which in time performs its duties in the body and is beneficial to the mg and Zn that the body needs. The other stents remain in the same area where they were placed after being placed in the body.

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