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ADDITIVE MANUFACTURING THROUGH 3D PRINTING FDM-FUSED DEPOSIT MODELING OF LUBRICATION RING

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ABSTRACT

It presents an element of absolute novelty for industrial scientific research in Romania, the fact that the housing of the washing head and other landmarks of the washing head from the FA100 water well drilling installations. FA125, FH150 and FG40 were made by additive manufacturing by 3D printing with PETG and ABS+ filament.

KEYWORDS: washing head housing, 3D printing, Fused Deposition Modeling, water drilling installation

1. Introduction

The housing of the FG40 washing head costs 1600 lei through classic manufacturing technologies, now in the 3D printed version of PETG and ABS+, it costs only 120 lei, the labour is zero (see Figure 1), thus a major increase in work efficiency and productivity occurs.

Fig. 1. *3D printed FA100 washing head housing at the end of PETG Material, assembled together with the other 3D printed parts of the FA100 washing head*

We are now experiencing some historic moments, for the first time in 70 years of communist and security depravity, Romanian engineers finally have access to their own means of production, represented by 3D printers, now also with high resistance carbon fiber filament, and of machining centres with CNC numerical control, with the status of industrial robots with zero labour.

The manufacture of light water well drilling installations FA75-U, FA100, FA125, FH150 and FG40 represents an absolute degree of novelty for Romania, this research program aligning with the current Re-Industrialization Program of the European Union, generated by the container crisis in China, of the energy, economic and humanitarian crisis and of the crisis of raw materials and materials due to the war in Ukraine, the EU Re-Industrialization program which is carried out in 2 major Development Directions:

A. Additive manufacturing of industrial objects by 3D printing, now also 3D printing by printing high resistance parts with FDM (Fused Deposits Modeling) technology, with Carbon Fiber filament, as in racing cars, with the flow limit Sigma_C = 400

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MPa, at unbeatable prices, because 3D Printers have the status of Industrial Robots, with Zero labour; And in Romania a 3D printer has reached extremely low prices, a 3D printer now costs 1500 lei, for example Creality Ender 3 V2. One of the research institutes in the bidding consortium recently acquired a 3D printer with high strength carbon fiber filament, the MakerBot Method X CF Carbon Fiber.

B. The subtractive manufacturing of industrial objects by chipping processing in high-alloy high-strength steels on 3- and 4-axis Numerical Control CNC Machining Centers, and on 2-axis Numerical Control Lathes, at unbeatable prices, because the Centers of CNC processing has the status of industrial robots, with almost zero labour. And in Romania mini CNC machining centers with steel cutting possibilities have arrived at very low prices, for example a CNC 6090 4-axis machining center, with P = 1.5 KW motor, with steel machining possibilities, now costs only 18 000 lei.

These FA75-U, FA100, FA125, FH150 and FG40 lightweight water well rig designs align with the two EU development directions in that high strength water well rig parts can be 3D printed with fiber filament of carbon, like in racing cars [1].

2. Fabrication

Landmark "Oil Ring", No. Drawing FG40-04.05.14.0 was additively manufactured by FDM 3D printing with ABS+ filament according to the drawing in Figure 2.

Figure 3 shows the 3D modeling in the Autodesk Fusion 360 program of the "Lubrication Ring" landmark, which results in the STL format file for "slicing" before its 3D printing.

Figure 4 shows the 3D slicing modeling of the landmark, using the slicing program, Ul-timaker Cura 4.13.1

Figures 5 and 6 show the slicing settings of the top cap landmark.

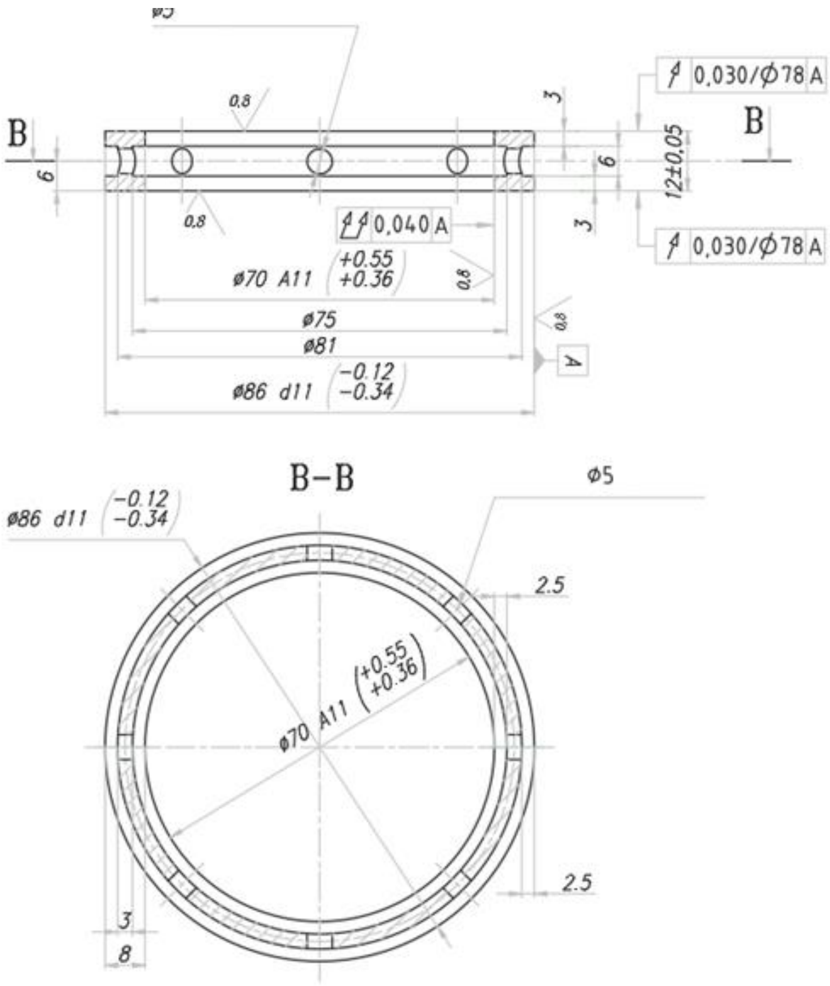

***Fig. 2.** Execution drawing – lubrication ring*

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Fig. 3. *3D modeling in the Autodesk Fusion 360 program of the oil ring landmark, resulting in the STL format file for "slicing" before its 3D printing*

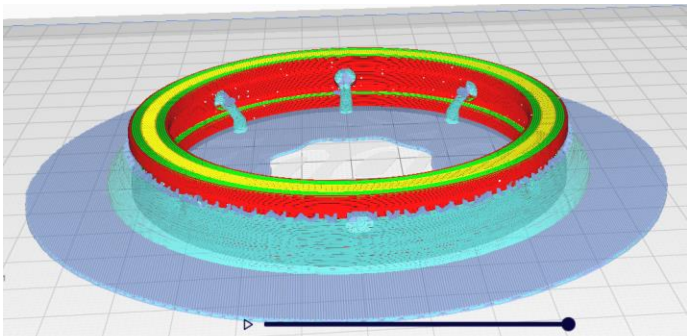

Fig. 4. *3D slicing modeling of the top cap landmark, using the slicing program, Ultimaker Cura 4.11*

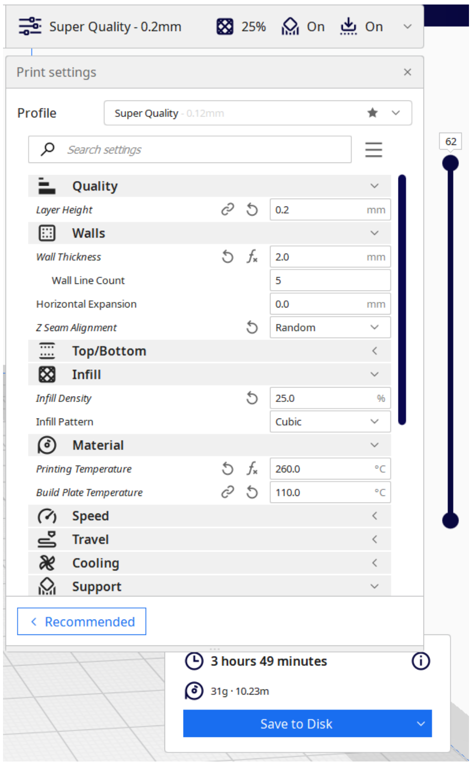

Fig. 5. *The slicing settings of the grease ring reference*

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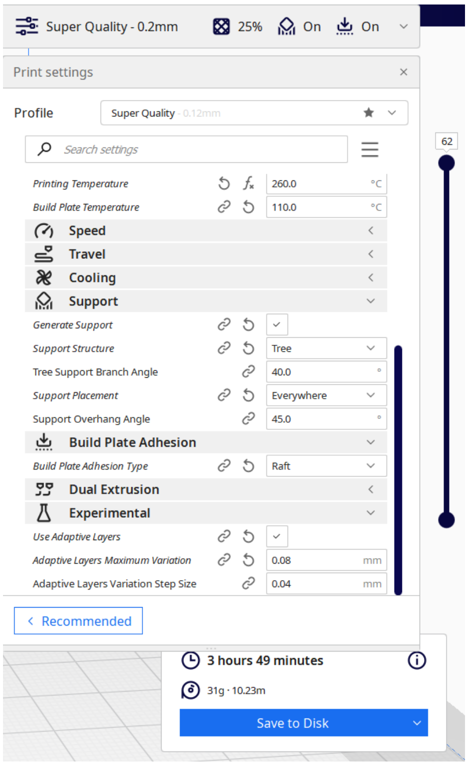

Fig. 6. *The slicing settings of the grease ring reference*

Parameters:

The main slicing settings for the "Grease Ring" feature in Cura 4.13.1 were as follows:

- Layer height = 0.2 mm;
- Wall thickness = 2 mm;
- Z-Seam Alignment = Random;
- Infill density = 25;
- Infill Pattern = Cubic.

Material = ABS+:

- Printing Temperature= 260 ºC;
- Build Plate Temperature= 110 ºC.

Generate Support = Yes:

- Support Structure = Tree;
- Tree Support Branch Angle = 40º;
- Support Placement = Everywhere;
- Support Overhang Angle = 39º;
- Build Plate Adhesion Type = Raft.

Experimental:

- Use Adaptive Layers = Yes;
- Adaptive Layers Maximum Variation = 0.08 mm;
- Adaptive Layers Variation Step Size = 0.04 mm;
- Printing the milestone "Anointing Ring" took 3 hours and 49 minutes. and consumed 31 g of ABS+ filament.

Figure 7 shows the 3D printed landmark, using ABS+ filament, on the Creality 3D printer, Ender 3 V2.

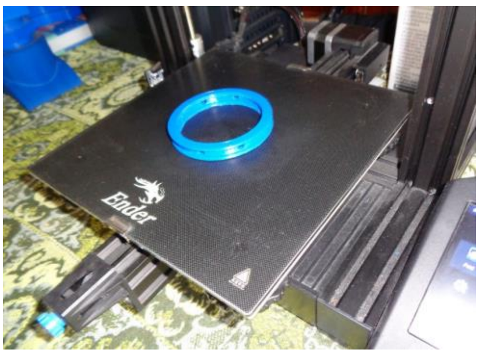

Fig. 7. *Lubrication ring landmark, 3D printed using ABS+ filament, on Creality 3D printer, Ender 3 V2*

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Conclusions

FA100 washing head housing, 3D printed from PETG material (housing body) and ABS+ (Caps, grease rings, reduction assembly Gas thread Rp2"-M60x2 thread-M60x2 Dutch nut-Dual hose DN50 mm) worked perfectly, without damage and no drilling fluid leaks, during experimental drilling of a water well with the FA125-FG40 drilling rig.

The samples for experimenting with the washing head FA100, with landmarks manufactured additively by 3D printing, were made by integrating it into the water well drilling rig with hydraulic drive FA125-FG40, by drilling with it a water well with a depth of H = 20 m and diameter D = 230 mm, by the "rotary-hydraulic drilling method with direct circulation of drilling fluid, and by maintaining a circulation of abrasive drilling fluid through the washing head FA100 and through the inside of the drill rod gasket, for a week.

The realization of the landmark "Lubrication ring" with the help of 3D printing is an experimental achievement that in 3 hours and 49 minutes can put the drilling rig back into operation by replacing the original part. Practical tests have shown that this landmark fulfils the main function of the part made of classic materials by classic technologies.

The main advantages of 3D printing for the manufacture of the "Lubrication ring" landmark are:

- Possibility of fabrication without the use of bulky machine tools that cannot move to the drilling location. This printer only needs one power source.
- The qualification of the personnel serving the printed matter. With multidisciplinary training a single operator can program the printer and make and replace the part.
- The multitude of landmarks that can be made using the same printer.
- Economy of energy and raw materials.

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