# „WASHING HEAD HOUSING" 3D PRINTING FROM FA 100 DRILLING INSTALLATION, USING PETG FILAMENT

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**Abstract:** *In this work, we proposed 3D printing additive manufacturing, using Fused Deposition Modeling technology for the washing head housing, which is common for water drilling installations FA100, FA125, FH150 and FG40. Due to the common use of this washing head for the water drilling installations FA100, FA125, FH150 and FG40, we use the generic name "FA100 Washing Head". We use 3D printing technology because, on the one hand, it is technically possible to make the part and on the other hand, for economic reasons. It is approximately ten times cheaper to make the part through 3D printing than through conventional technologies*

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

## 1. Introduction

Due to the common use of the washing head in light water well drilling rigs FA100, FA125, FH150 and FG40, its generic name will be "FA100 Washing head" [1].

Until now, no washing head has been made in Romania that has the casing and the drilling fluid supply fittings, 3D printed from PET filament.

The washing head is the most important sub-assembly in a water well drilling installation, and ensures the operation of the installation on the principle of "hydraulic rotary drilling with direct fluid circulation", whereby, inside the rotating drill rod assembly, is injected, through the washing head, drilling fluid from the mud pump discharge, which is fed from a pit dug below ground level.

The 3D printed FA100 washing head housing prototype will be additively manufactured by 3D printing from PETG filament on Creality Ender 3 V2 3D printer, Shenzen China [2], [3]. The housing from the FH100 washing head in the initial version costs a lot, being made of steel, with low labor productivity and using outdated manufacturing technologies. In the 3D printed PETG version, the part costs only 120 lei, the labor being almost zero. This issue represents a spectacular leap in work efficiency and productivity.

## 2. Fabrication

The 3D-Fused Deposition Modeling printing technology consists in the deposition of fusible material layer by layer in the XoY plane with the thickness of the 3D printed layer between 0.12÷0.24 mm, the printing resolution being r=0.1mm, while the head printhead advances vertically on the Z axis.

For the PETG 3D printing filaments, the Shenzen China Creality Ender 3 V2 3D printer will be used.

Figure 1 shows the printer used by us in the manufacture of the washing head casing landmark for the FA 100 drilling rig.

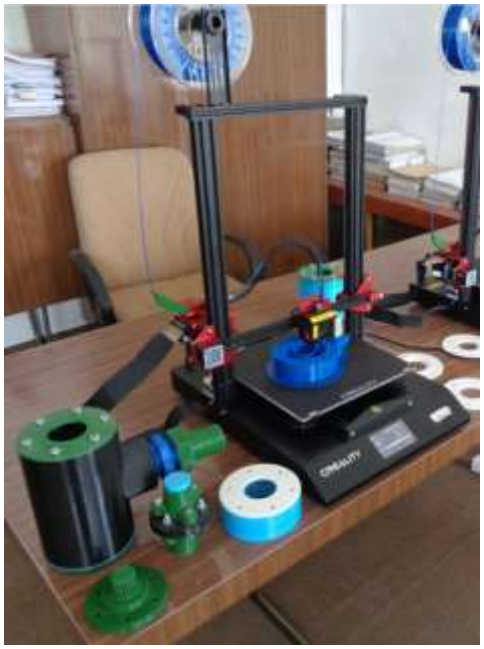

**Figure 1.** 3D Printer Creality Ender 3 V2

Some technical specifications of the 3D printer used are presented below.

-3D printing technology: FDM- Fused Deposition Modeling

- Extruder type: Bowden

-Minimum number of extruders: 1

-Maximum number of extruders: 1

-Compatible filament: PLA; PETG; TPU ABS+; PLA+

-Print support material: Glass

- Frame type: open

-Maximum layer height: 0.4 mm

-Minimum layer height: 0.1 mm

-Fill [%]: 0%-100%

- Inner filling model: Fast honeycomb Full honeycomb Wiggle Triungular Grid - Rectalinear

-Outer filling model: Rectilinear Concentric

-Maximum temperature [℃]: 260

-Maximum print speed [mm³/s]: 180

-Minimum print speed [mm³/s]: 10

-Maximum layer resolution [mm]: 0.4

-Minimum layer resolution [mm]: 0.1

-Software included: Cura

-Filament diameter [mm]: 1.75

-Nozzle diameter [mm]: 0.4 mm
-Length [mm]: 475 mm
-Width [mm]: 470 mm
-Height [mm]: 620
Some characteristics of the PETG filament used in printing are presented below.
-Type of filament material: PETG
-Print head nozzle temperature [℃]: 250
-Printer bed temperature [℃]: 75
-Tensile strength [MPa]: 49
- Elongation [%]: 225
-Flexural strength [MPa]: 68
-Flexural modulus [MPa]: 1800
-Strength [MPa]: 7.6

It starts from the sketch of the longitudinal section of the FA100 washing head housing, necessary for the generation of Solid 3D by revolutionizing the 3D model, within the Autodesk Fusion 360 program [4]. Figure 2 shows the 3D modeling in the Autodesk Fusion 360 program of the landmark "FA100 washing head housing", which results in the STL format file for "slicing" before its 3D printing.

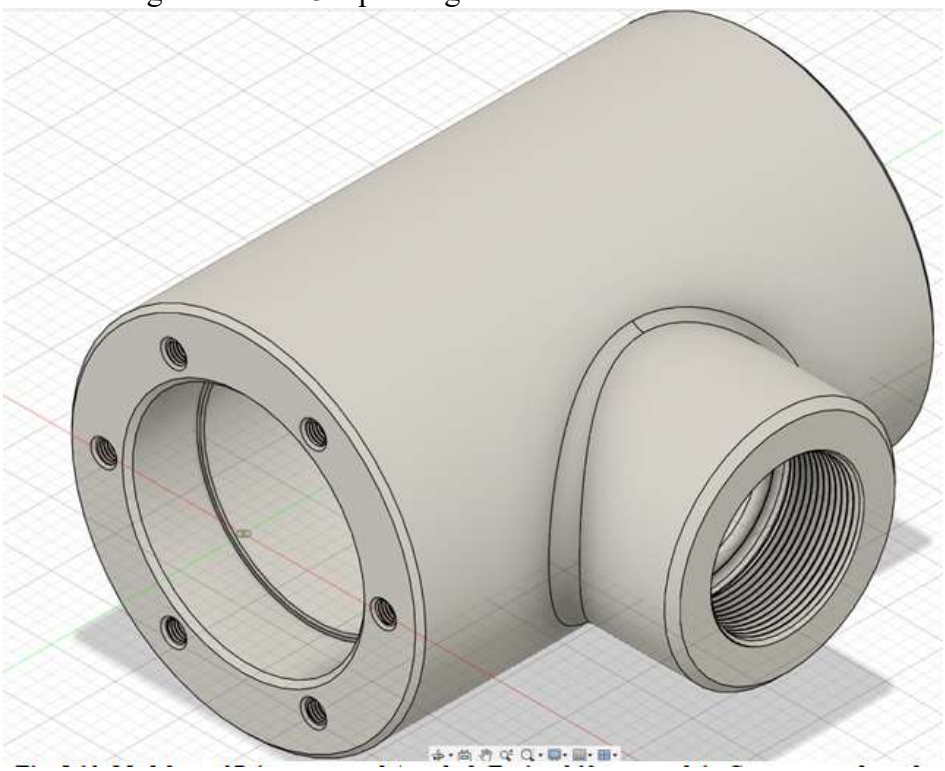

**Figure 2.** 3D modeling in Autodesk Fusion 360 for FA 100 washing head housing

The STL format file of the 3D model of the washer head housing is processed for slicing before the FA100 washer head housing is 3D printed with the Ultimaker Cura 4.13.1 program.

Figure 3 shows the 3D STL model before slicing in the Ultimaker Cura 4.13.1 program.

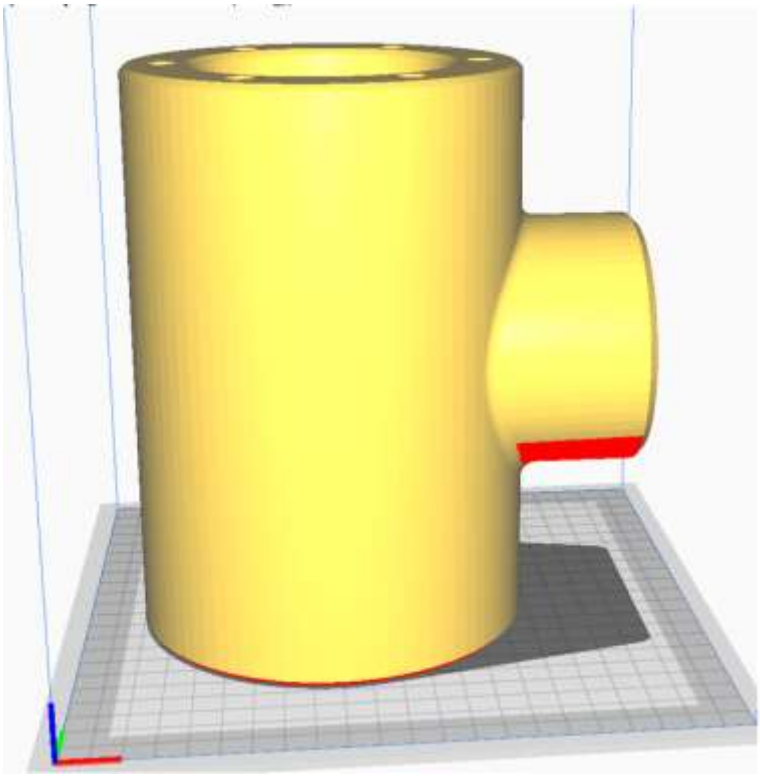

**Figure 3.** FA 100 washing head housing model before slicing in the Ultimaker Cura 3.13.1 program

Figure 4 shows some of the slicing settings for the FA 100 washing head housing.

After slicing in the Ultimaker Cura 4.11 program, a G-code file results, which is loaded from the computer onto a 9 Gb Mini SD Card, which is inserted into the Mini SD slot of the 3D printer and printing can begin.

3D printing the FA 100 washer head housing took 4 days, 6 hours and 2 minutes, continuously, and consumed 859g of PETG filament.

The main slicing settings for the FA100 wash head housing, in Cura 4.13.1., were as follows:

-Layer height= 0,24 mm;
-Wall thickness= 3 mm;
-Z-Seam Alignment= Random;
-Infill density= 10;
-Infill Pattern= Cubic;
-Material= PETG
-Printing Temperature= 250ºC;
-Build Plate Temperature= 75ºC;
-Generate Support= Yes;
-Support Structure= Tree;

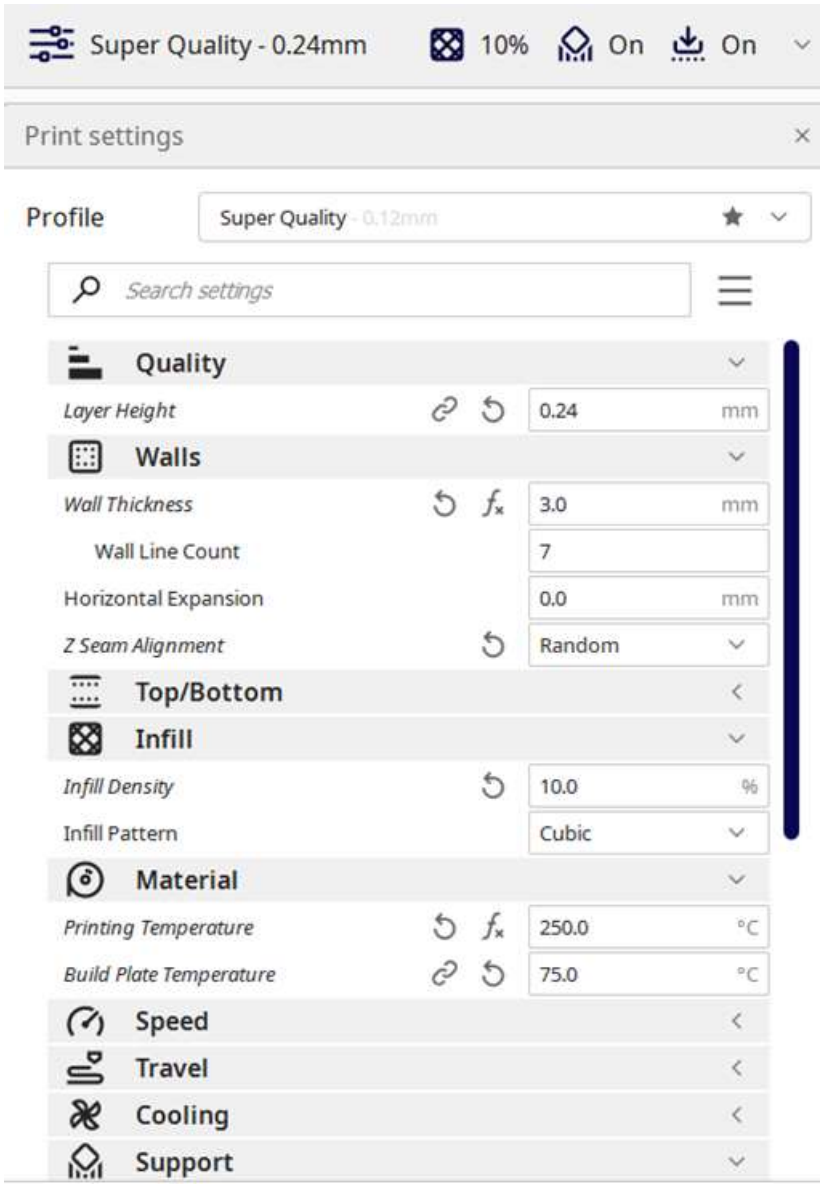


**Figure 4.** licing settings for FA 100 wash head housing

-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;
The Slice command is given.

Figure 5 shows the 3D printing of the FA100 washing head housing, using PETG filament, on the Creality 3D printer, Ender 3 V2.

**Figure 5.** 3D printing of the FA 100 washing head housing

The housing of the FA100 washing head 3D printed at the end of PETG Material, assembled together with the other 3D printed parts of the washing head is shown in figure 6.


**Figure 6.** 3D printed washing head housing

## 3. Experimental results

The samples for the experimentation of the washing head FA100, with parts additively fabricated by 3D printing, were made by integrating it into the water well drilling rig with hydraulic drive FA125-FG40, when drilling with it a water well with a depth of H=20m and diameter D=230mm.

The "rotary-hydraulic drilling with direct fluid circulation" method was used, maintaining the circulation of abrasive fluid through the FA100 washing head and through the inside of the drill rod assembly, for one week.The integration of 3D printed parts in the FA 125-FG 40 drilling rig is shown in figure 7. The results were excellent and the drilling rig worked properly.

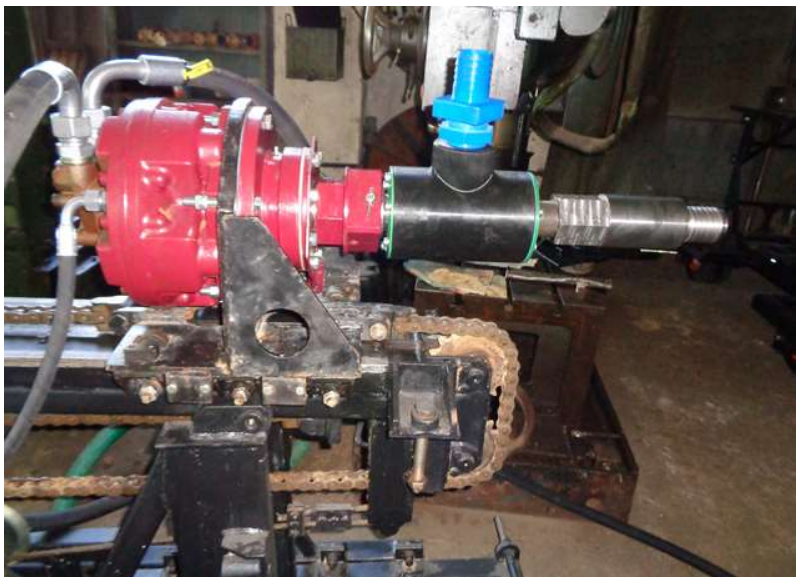

**Figure 7.** Integration of 3D printed landmarks to the FA 125-FG 40 drilling rig

## 4. Conclusions

The manufacturing of the FA100 washing head prototype through 3D printing represented the optimal solution from a technical and economic point of view. In the conventional manufacturing version, a high manufacturing cost results and the labor productivity was low. In the 3D printed PETG version, the part costs approximately 10 times less, the labor being almost zero. This issue represents a spectacular leap in work efficiency and productivity. The integration of the 3D printed landmarks in the drilling rig FA 125-FG 40 was done successfully, obtaining excellent results in operation.

## References


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