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ADDITIVE MANUFACTURING BY 3D PRINTING OF THE LANDMARK GAS REDUCTION R2-M60X2, USING ABS+ FILAMENT

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ABSTRACT

This work deals with the additive manufacturing by 3D printing of the Gas Reduction R2-M60x2 landmark which is part of the Gas Reduction R2-Hose DN 2 in subassembly. This sub-assembly is a component part of the washing head of the light water well drilling installations FA 100, FA 125, FH 150 and FG 40. The generic name of the washing head will be FA 100. 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: Gas reduction, 3D printing, Fused Deposition Modeling, water drilling installation

1. Introduction

Due to the common use of the washhead on light water well drilling rigs FA100, FA125, FH150 and FG40, its generic name will be "FA100 Washhead" [1-3].

The aim is to obtain the components of the washing head at water well drilling installations, through 3D printing additive manufacturing, both for technical and economic reasons [4-6]. From an economic point of view, it is approximately ten times cheaper to manufacture the parts of the washing head through 3D printing additive manufacturing than to manufacture them using conventional technologies. This issue represents a spectacular leap in work efficiency and productivity.

This paper deals with the additive manufacturing by 3D printing of the Gas Reduction R2-M60x2, a component part of the washing head of water well drilling installations, generically called FA 100.

The Gas Reduction R2-M2x60 subassembly whose additive manufacturing by 3D printing is to be described is part of the Gas Reducer R2-Hose DN 2 in subassembly, whose component elements are shown in Table 1.

The drawing of the Gas Reduction R2-Hose DN 2 subassembly is presented in Figure 1.

Tabel 1. *Component elements of the R2 Gas Reduction-Hose DN 2 subassembly*

Item	Name	Drawing no. or STAS	Buc.	Material	Remarks	Weight kg
1	Gas ReductionR2-M60x2	FG40-04.05.20.1	1	C45 imb.		0.621
2	Dutch nut M60x2	FG40-04.05.20.2	1	part		0.711
3	Hose pipe DN50 mm	FG40-04.05.20.3	1	S235JR		0.316
4	Flat gasket Ø 58	FG40-04.05.20.4	2	rubber PN70A	Ø58Ø40x2	0.02

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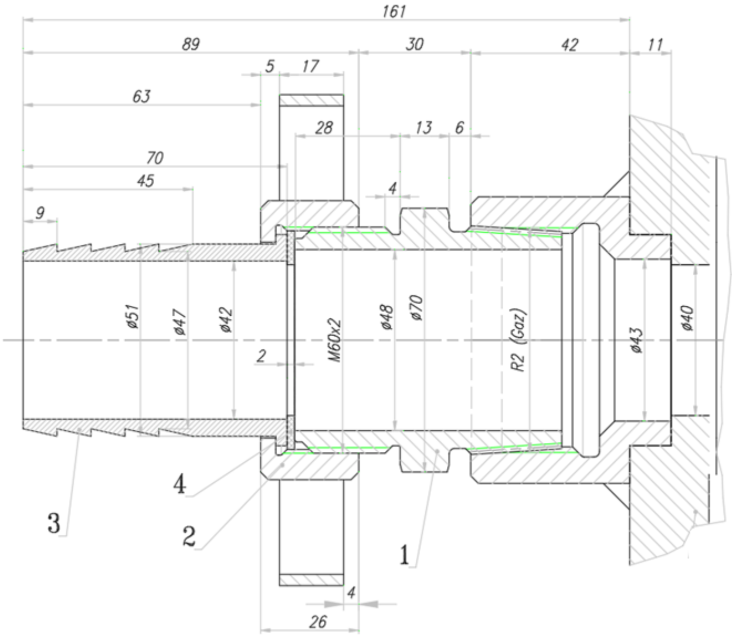

Fig. 1. *Drawing of the R2 Gas Reduction-Hose DN 2 in. subassembly*

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 = 0.1 mm, while the head printhead advances vertically on the Z axis.

For ABS+ type 3D printing filaments, Shenzen China Creality Ender 3 V2 type 3D printer will be used. Figure 2 shows the printer we used to manufacture the Gas Reduction R2-M2x60 benchmark.

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%- Interior filling model: Fast honeycomb Full honeycomb Wiggle Triangular Grid – Rectilinear;
- Outer filling model: Rectilinear Concentric;
- Maximum temperature [°C]: 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.

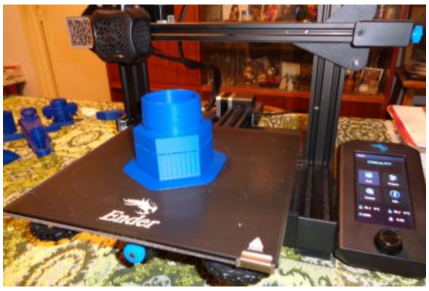

Fig. 2. *3D Printer Creality Ender 3 V2 used in the manufacture of the R2 Gas Reducer-Hose DN 2 in*

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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.

The R2-M60x2 Gas Reduction landmark is additively manufactured by 3D FDM printing with ABS+ filament whose characteristics are presented in Table 2.

The R2-M60x2 Gas Reduction landmark made by 3D printing must be in accordance with the execution drawing in Figure 3.

Figure 4 shows the 3D modeling in the Autodesk Fusion 360 program of the "Gas Reduction R2-M60x2" landmark, which results in the STL format file for "slicing" before its 3D printing.

Table 2. *Features ABS+ filament*

No	**Type of filament material for FDM 3D printing**	**Temp. Nozzle 3D Print Head °C**	**Temperature bed printer °C**	**Tensile Strength [MPa]**	**Elongation at Break [%]**	**Flexural Strength [MPa]**	**Flexural Modulus [MPa]**	**Strength [MPa]**
1	ABS+	260	110	40	30	68	2443	42

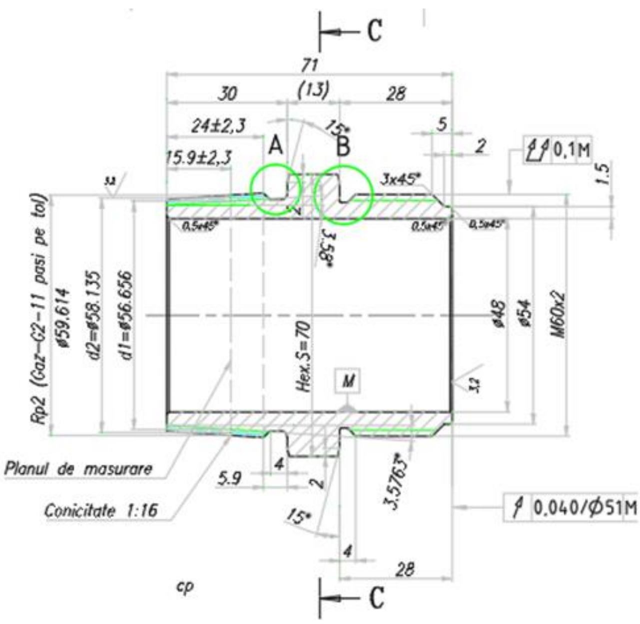

Fig. 3. *Execution drawing for the R2-M60x Gas Reduction benchmark 2*

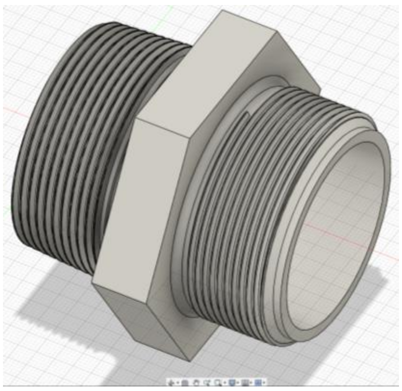

Fig. 4. *3D Modeling in the Autodesk Fusion 360 program of the landmark "Gas Reduction R2-M60x2*

Figure 5 shows the slicing of the Gas Reducer R2-M60x2 benchmark, with the help of the slicing program, Ultimaker Cura 4.13.1.

Figure 6 shows some of the settings for slicing the Gas Reduction R2-M60x2 benchmark.

Other settings made for slicing the Gas Reduction R2-M60x2 benchmark are shown in Figure 7.

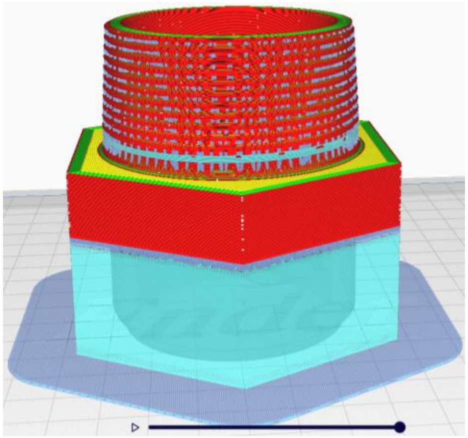

Fig. 5. *Slicing the landmark "Gas reduction R2-M60x2, using the Ultimaker Cura 4.13.1 program*

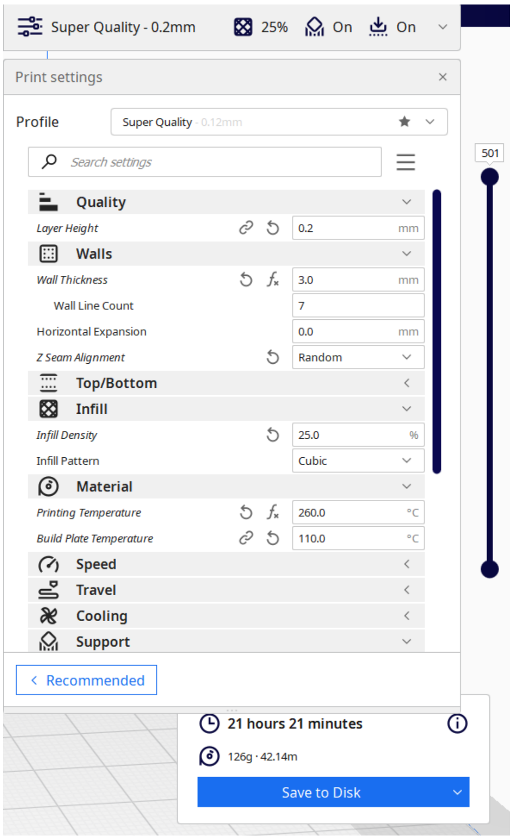

Fig. 6. *The first part of the settings for slicing the "Gas Reduction R2-M60x2" landmark, using the Ultimaker Cura 4.13.1 program*

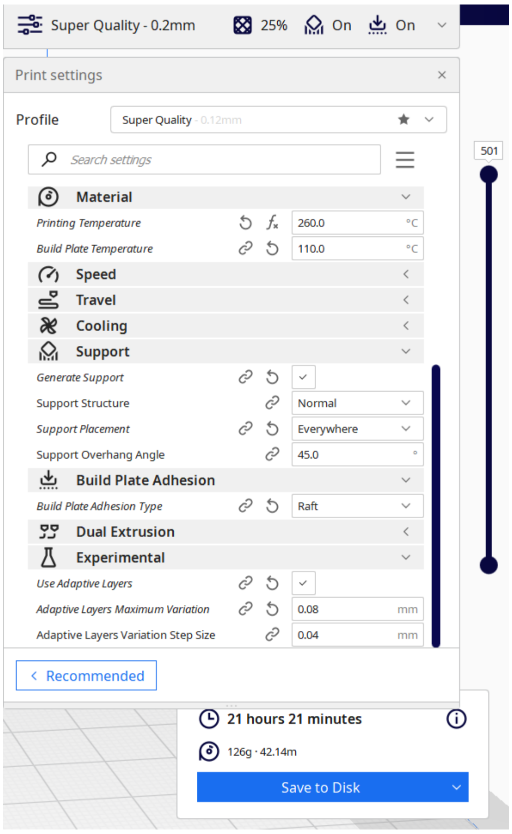

***Fig. 7.** The second part of the settings for slicing the landmark "Gas reduction R2-M60x2, using the Ultimaker Cura 4.13.1 program*

The main slicing settings for the R2-M60x2 Gas Reduction benchmark, in the Cura 4.13.1 program, were as follows: Layer height = 0.2 mm; Wall thickness = 4 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; Use Adaptive Layers = Yes; Adaptive Layers Maximum Variation = 0.08 mm; Adaptive Layers Variation Step Size = 0.04 mm.

The benchmark "Gas Reduction R2-M60x2" took 21 hours and 21 minutes to print. and consumed 126 g of ABS+ filament. The Slice command is given.

The Gas Reduction landmark R2-M60x2 manufactured by 3D additive printing on the Creality Ender 3 V2 3D printer, using ABS+ filament is presented in Figure 8.

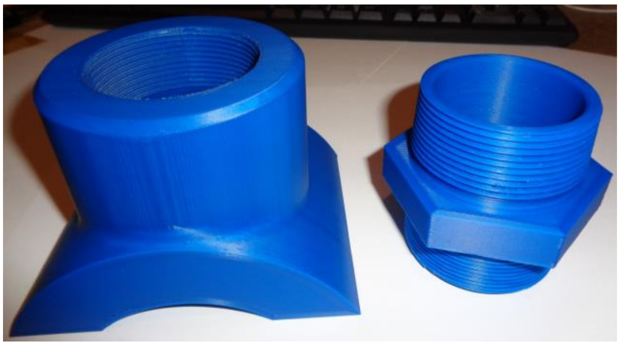

***Fig. 8.** The landmark Gas Reduction R2-M60x2 manufactured by additive 3D printing on the Creality Ender 3 V2 3D printer*

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Conclusions

The manufacture of the benchmark Gas Reduction R2-M60x2, 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 labour productivity was low. In the 3D printed version made of ABS+ filament, the part costs approximately 10 times less, the labour being almost zero. This issue represents a spectacular leap in work efficiency and productivity.

This landmark is an integral part of the washing head from light water well drilling installations, type FA 100, FA 125, FH 150 and FG 40. The additive manufacturing by 3D printing of this landmark aims to reduce the manufacturing cost of light drilling installations water wells thus falling into the category of green projects and projects for the realization of industrial parts through additive methods.

The partial realization through additive manufacturing through 3D printing of some land-marks of light water well drilling installations has several advantages. On the one hand, from an economic point of view, the reduction of the manufacturing cost is obtained, and on the other hand, a modern, fast and relatively easy to implement technical solution is used.

Another objective pursued by the manufacture of light installations for drilling water wells at low costs and using modern technical solutions such as additive manufacturing through 3D printing, is the relaunch of irrigation in Romania. This is a requirement of the European commissioners in the National Recovery and Resilience Plan of Romania PNRR. The proposed solution is to make water wells with drilling installations, or a water well with a depth of 80 meters, on two hectares of land agricultural.

Taking into account the fact that Romania's agricultural area is 13.8 million hectares, and that there is the ability to irrigate 2 hectares of agricultural land, by drilling a water well with a depth of H = 80 m, it is expected that in the coming years the need to drill approximately 6 mil-lion water wells with H = 80 m. For this, it is expected to carry out in series production a number of 60 thousand light FA100 water well drilling installations, for hydrogeological drilling in favourable plain areas, without particular geological problems, for example in the Mostiștea aquifer, with a depth of H = 80 m, below Bucharest-Ilfov and neighbouring counties, and the realization in series production of a number of 10 thousand hydrogeological drilling rigs FH150, modular, with hydraulic drive, on monoaxle trailer, for drilling water wells in difficult geological areas, hilly with hard geological layers (limestone, sandstone, shale, conglomerate, gravel and boulder, etc.).

In this sense, the approach of manufacturing the components of light water well drilling installations, at the level of Romania, through additive methods such as 3D printing, is a perfectly justified technical-economic solution.

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