THE ANNALS OF “DUNAREA DE JOS” UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
Nº. 2 - 2023, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2023.2.04

CONSTRUCTION OF THE FH 150 HYDRO-GEOLOGICAL DRILLING FACILITY WITH ADDITIVE MANUFACTURED MARKERS THROUGH 3D PRINTING

Sorin Alexandru FICĂ[1], Andrei DIMITRESCU[2], Claudiu BABIȘ[2]
[1]IPCUP Ploiesti, Romania
[2]Politehnica University from Bucharest, Romania
e-mail: fica_sorin@yahoo.com, andrei_dimitrescu@yahoo.com, claudiubab8@gmail.com

ABSTRACT

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 circulation of drilling fluid", whereby, inside the rotating drill rod assembly is injected, through the washhead, drilling fluid from the discharge of the drilling mud pump, which is fed from a pit (pit) dug below ground level.

KEYWORDS: 3D printing, Fused Deposition Modeling, water drilling installation, FH 150

1. Introduction

The purpose of the work is the realization and testing of the FH 150 water well drilling installation, with hydraulic drive, on a monoaxle trailer, in a modern, flexible modular design, for the efficiency, flexibility and reduction of the energy costs of the drilling, being developed 3 innovative modules, namely, the Head Module drilling rig with mechanical drive, the Drilling Head Module with hydraulic drive and the Hydraulic Drive Installation Module, integrated into the monoaxle trailer chassis, which will contain innovative products of the Scientific and Technological Revolution consisting of resistance machine parts and other milestones made through additive manufacturing digitized, namely by 3D FDM printing, Fused Deposition Modeling - Modeling by depositing carbon fiber fusible filament, layer by layer, by hot extrusion, and by digitized subtractive manufacturing, by CNC processing [1].

At this moment, a real industrial, scientific and technological revolution is being discussed worldwide, consisting in the development of Additive Manufacturing AM technologies through the use of 3D printing [2].

In order to modernize the manufacturing program of the FH150 water well drilling rig and to relaunch the research activity, the project proposes the 3D printing of some representative landmarks of the FH150 drilling rig using one of the following technologies:

- FDM (Fused Deposition Modeling) technology, layer by layer in the XoY plane (the thickness of the 3D printed layer is g = 0.1-0.24 mm, the resolution of 3D printing is r = 0.1 mm while the print head advances vertically on the Z axis, layer by layer);
- SLA technology (StereoLitogrAphy – Stereolithography, a laser beam melts and solidifies a special photosensitive resin, layer by layer, in the XoY plane, the thickness of the 3D printed layer g = 0.12-0.24 mm, the resolution of 3D printing is r = 0.05 mm, while the print head advances vertically on the Z axis, layer by layer);
- SLS Technology - Sensitive Laser Sintering, in which a laser beam sweeps and solidifies layer by layer a vat with sinterable powders (including sinterable metal powders).

SLA-StereoLitogrAphy-photosensitive resin bath 3D printing technology, first developed for desktop 3D printers by the American company Formlabs, is used especially for high-resolution 3D printing with special materials, such as HIGH TEMP resin, which it withstands 240 °C and can be used for 3D printing of moulds for casting rubber articles, or for 3D printing with biomedical resins, or for 3D printing for elastic products [4].

The SLS - Sensitive Laser Sintering printing technology, first developed for desktop 3D printers also by the American company Formlabs, in which a laser beam sweeps and solidifies layer by layer a vat of sinterable powders (including sinterable metal

THE ANNALS OF “DUNAREA DE JOS” UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 2 - 2023, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2023.2.04

powders), is still immature and the costs of 3D printing with sinterable powders are still very high [5].

It is estimated that the most feasible and with the best price / quality ratio 3D printing technology is FDM (Fused Deposition Modeling) 3D printing technology, first developed for desktop 3D printers by to the American company Maker Bot, which use PLA+, ABS+ or PETG filament. These filaments have a maximum yield strength of Sigma_C = 60 MPa, which is a big disadvantage when 3D printing high-strength parts such as shafts, axes, gears, chain wheels, couplings, etc.

2. Fabrication

For the 3D printing of high-strength parts, the FDM Method X CF 3D printing technology was developed, Modeling by Depositing Fusible Carbon Fiber Filament (CF-Carbon Fiber), filament with the expected yield strength at Sigma_C = 110 MPa, developed technology by the American company Maker Bot Stratasys and also used in the benchmarks of racing cars.

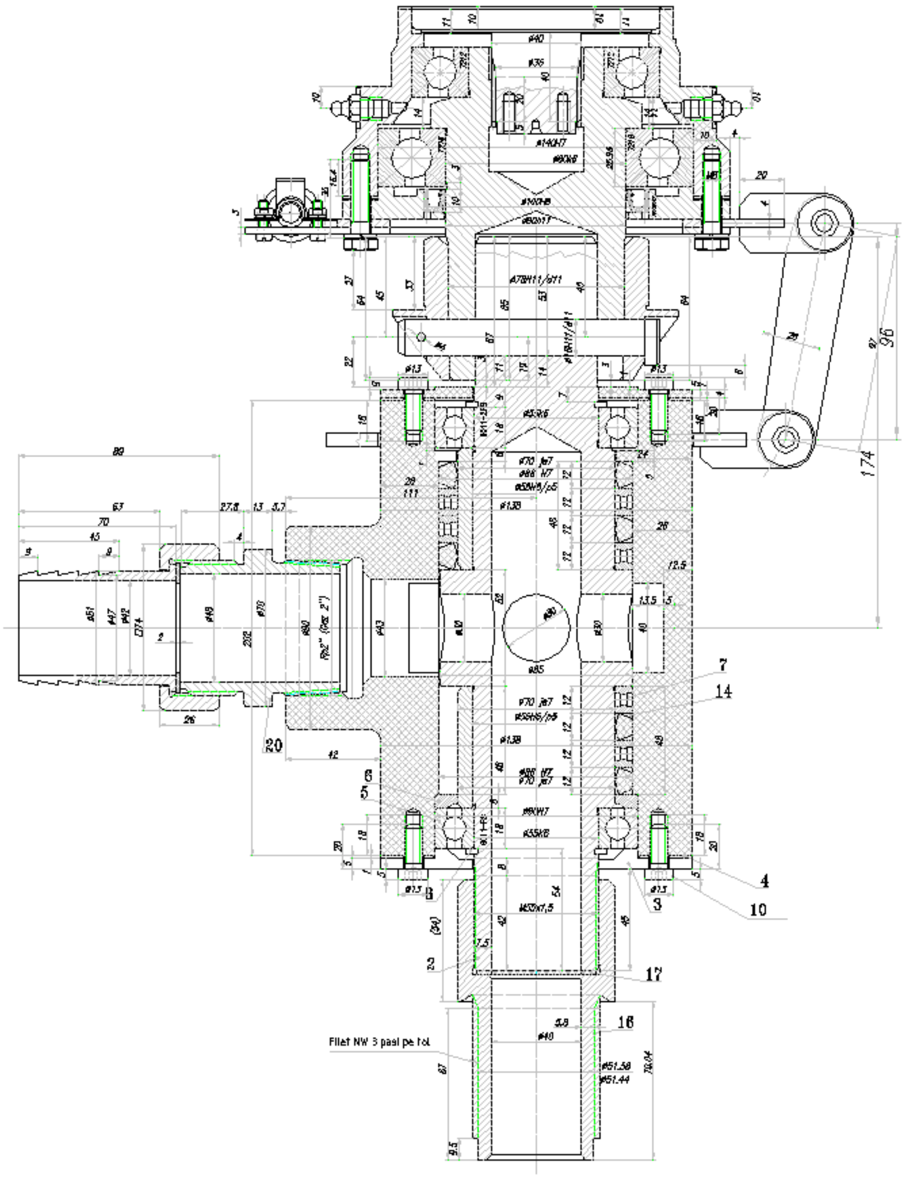

Fig. 1. *The overall drawing of the FA100 washing head, with some landmarks additively manufactured by 3D printing with FDM (Fused Deposition Modeling) technology. The housing of the FA100 washing head has been 3D printed with PETG filament and has therefore been redesigned with thickened walls for increased mechanical strength*

THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N°. 2 - 2023, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2023.2.04

The FA100 washing head shown in Figures 1-4 with the casing and the drilling fluid sup-ply fittings, manufactured additively by 3D printing from PETG and ABS+ filament, will be patented with an Industrial Model Patent. The composition table of the "FA100 washing head" assembly drawing is presented in Table 1.

The samples for experimenting with the FA100 washing head, with 3D-printed additively manufactured landmarks, will be 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 assembly, for one week.

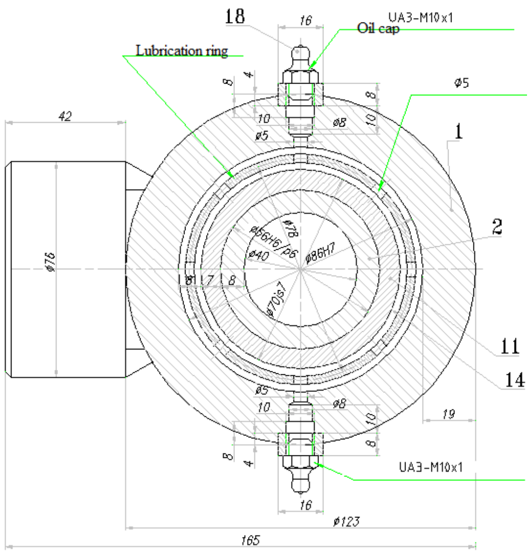

***Fig. 2.** Drawing "FA100 washing head", cross section through greasers*

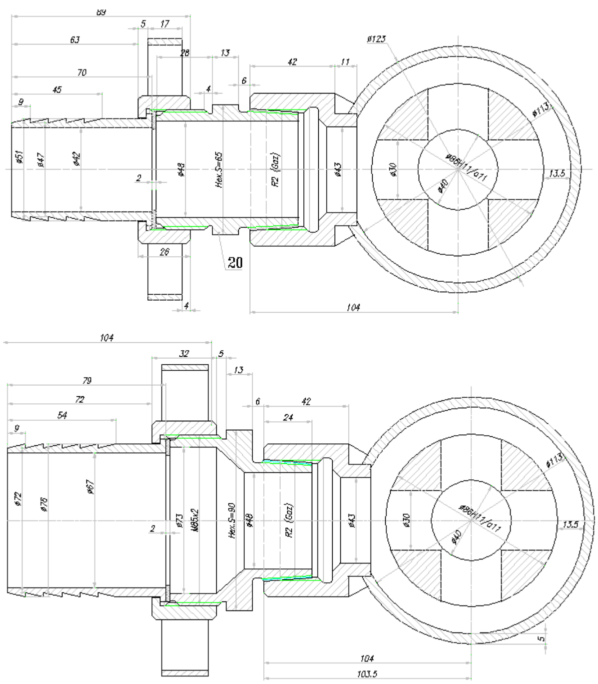

***Fig. 3.** Drawing "Washing head FA100", cross section through "R2 Gas Reduction-Hose DN 2in" and through "R2 Gas Reduction-Hose DN 3in*

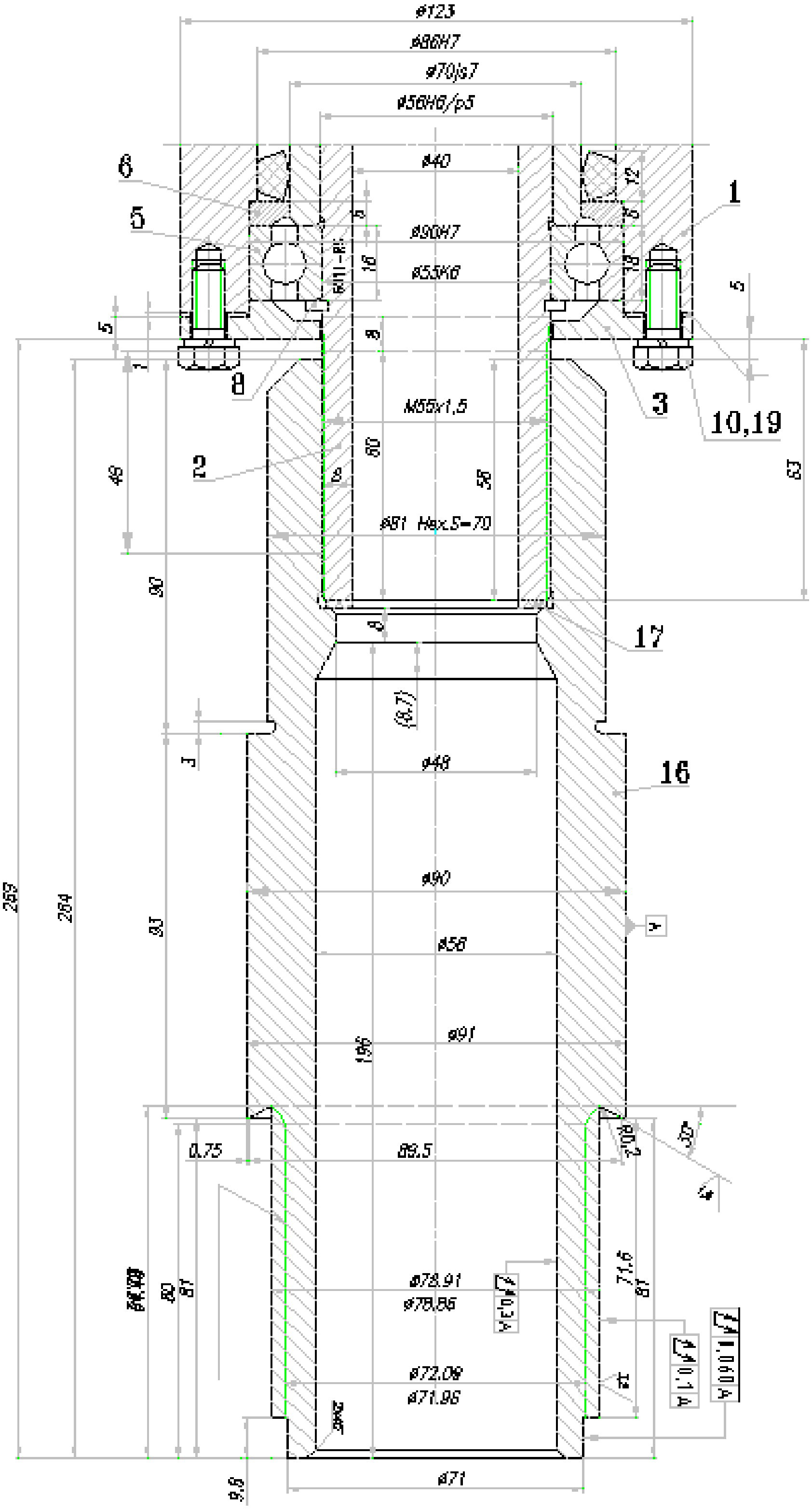

***Fig. 4.** Drawing "Washing head FA100", Assembly detail with reduction M55x1.5-Thread HW 3 steps per inch*

N°. 2 - 2023, ISSN 2668-4748; e-ISSN 2668-4756
Article DOI: https://doi.org/10.35219/mms.2023.2.04

***Tab. 1.** The composition table of the "FA100 washing head" drawing, drawing no. FG40-04.05.00.0*

Poz	Name	Drawing no. or STAS	No.	Materials	Remarks	kg
1	Washing head housing	FG40-04.05.01.0	1	subans.		7.535
2	Washer Head Spindle-M55x1.5	FG40-04.05.02.0	1	42CrMo4	imb. la 310 HB	3.703
3	Lower cover	FG40-04.05.03.0	1	S355J2		0.383
4	Lower gasket	FG40-04.05.04.0	1	Marsit		0.01
5	Radial bearing 8011-RS	SR 3041:1993	2		Ø55xØ90x18	0.21
6	Press bushing	FG40-04.05.06.0	1	CuSn12		0.137
7	Sealing gasket	FG40-04.05.07.0	4	PN70A	Ø70xØ86x12	0.04
8	Shaft elastic ring Ø55	STAS 5848/2-88	2	51Si17A	Ring Ø50,8x2	0.004
9	Top cover	FG40-04.05.09.0	1	S235J2	Gros.4	0.264
10	Screw M8x20	SR ISO 4017:1994	6	gr.8.8		0.01
11	Bush wear	FG40-01.06.11.0	2	42CrMo4	imb.310HB	7.535
12	Screw M6x16	SR ISO 4017:1994	4	gr.8.8		0.004
13	Washer Grower N6	SR 7666-4:94	4	51Si17A		0.01
14	Lubrication ring	FG40-04.05.14.0	4	Cu Sn12	Ø60xØ76x12	0.068
15	Upper gasket	FG40-04.05.15.0	1	Marsit		0.02
16	Reduction M55x1.5-thread HW	FG40-04.05.16.0	1	42CrMo4	imb. la 310 HB	1.051
17	Reduction gasket	FG40-04.05.17.0	1	Marsit	Gros.2	0.01
18	Lubricant UA3	STAS 1116-88	4		M10x1	0.005
19	Washer Grower N8	SR 7666-4:94	6	51Si17A		0.001
20	Adapter Gas R2-Hose DN 2in	FG40-04.05.20.0	1	subans.		1

Conclusions

3D printed FA100 washing head housing prototype, will be additively manufactured by 3D printing and PETG filament on Creality Ender 3 V2 3D printer, Shenzen China. The housing of the FH150 washing head has a value of 1600 lei made of metal materials and classic technologies, having a very low work productivity. In the 3D printed version of PETG and ABS+, it costs only 120 lei, the labour is almost Zero, it is a spectacular leap in work efficiency and productivity.

The theoretical and experimental research that underlies this work is mainly aimed at demonstrating that modern 3D printing technologies can be successfully introduced into the drilling industry.

Thus, the originality of the manufacturing of important milestones for the FH 150 drilling rig was highlighted at the national level. At this moment, we can consider that Romania has taken another important step in the development of Additive Manufacturing AM technologies through the use of 3D printing.

The main challenge after making the landmarks was to demonstrate that they have a strength in operation similar to the original landmarks made of classic materials and technologies.

Acknowledgement

This work was carried out through the Nucleu Program within the National Research Development and Innovation Plan 2022-2027, implemented with the support of MCID, contract no. 42N/2023, project no. PN23140101.

We also thank the external collaborators from the Politehnica University of Bucharest.

References

[1]. Fica Sorin Alexandru, *Realizarea unei instalații inovative de foraj hidrogeologic cu acționare hidraulică a sistemului de manevră si acționare mecanică a capului de foraj de tip FA125*, Programul cercetare NUCLEU, 2017.

[2]. Aamer Nazir, *et al.*, *Multi-material additive manufacturing: A systematic review of design, properties, applications, challenges, and 3D printing of materials and cellular metamaterials*, Elsevier Ltd., vol. 226, 2023.

[3]. Bandyopadhyay A., *Nature-inspired materials and structures using 3D Printing*, Elsevier Ltd., vol. 145, 2021.

[4]. Jiang J., *Machine learning integrated design for additive manufacturing*, Springer, vol. 33, 2022.

[5]. David Rosen, *Design and Manufacturing Implications of Additive Manufacturing*, Journal of Materials Engineering and Performance, vol. 30, 2021.