ON THE DURABILITY OF PROGRESSIVE CAVITIES PUMPS

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Abstract *Within this project, it has been demonstrated that the progressive cavities pump flow rate varies depending on the position of the rotor in the stator. These variations, even if they take quite low values, are extremely important because they cause stator heating to record the highest temperatures at 1/3 of the thickness of the elastomer and consequently to stiffen the pump or even damage the pump. Using the hydraulic controller technology, however, by changing its position according to the maximum volume recorded on the length of a stator step, it has been demonstrated that the flow can be uniformized by reducing the range of pulse propagation values.*

Keywords: progressive cavities pump

1. Equipment of the pump system

The progressive cavity pump derives its name from volumetric pumps whose concept was developed for the first time in 1932 by René Moineau, based on the Archimedean screw.

According to the literature, these pumps are also known as PompeMoineau, Moyno, screw, with progressive cavities or econolift. Initially, they were widely used as fluid transfer pumps in a wide range of industrial and production applications, with some attempts made to use them for the transfer of surface oil fluids.

Over the years, the use of extraction systems to match the functional parameters of the oil extraction process required the use of progressive cavity pumps (PCP).

The key features that differentiate the screw pump system from other artificial pumping forms are the deep pump and the associated surface drive systems.

Among the extraction systems, deep pumping is the most common. Currently, about 85% of all wells in production of Romania is exploited through deep pumping.

Depending on the operating conditions, it is estimated that about 46% of the total pumping wells, the working media in wells are abrasive and corrosive, at 32% are semi-brasive and corrosive, and 22% are normal .

The percentage of impurities in the extracted fluid has steadily increased from 59% in 1963 to 83% in 1980. In these situations, the main reason for decommissioning of deep pumps is abrasive wear with corrosion phenomena of couples of parts shirt-piston and seat-belt.

A pumping plant, as depicted in Figure 1.1., contains deep equipment and surface equipment. The depth equipment comprises a progressive cavity pump (PCP), extraction pipes and pumping rods, while the surface equipment consists of the pump rotor and pump rotor, the coupling between the drive and the thrust head, the drive head and support system for all bottom equipment.

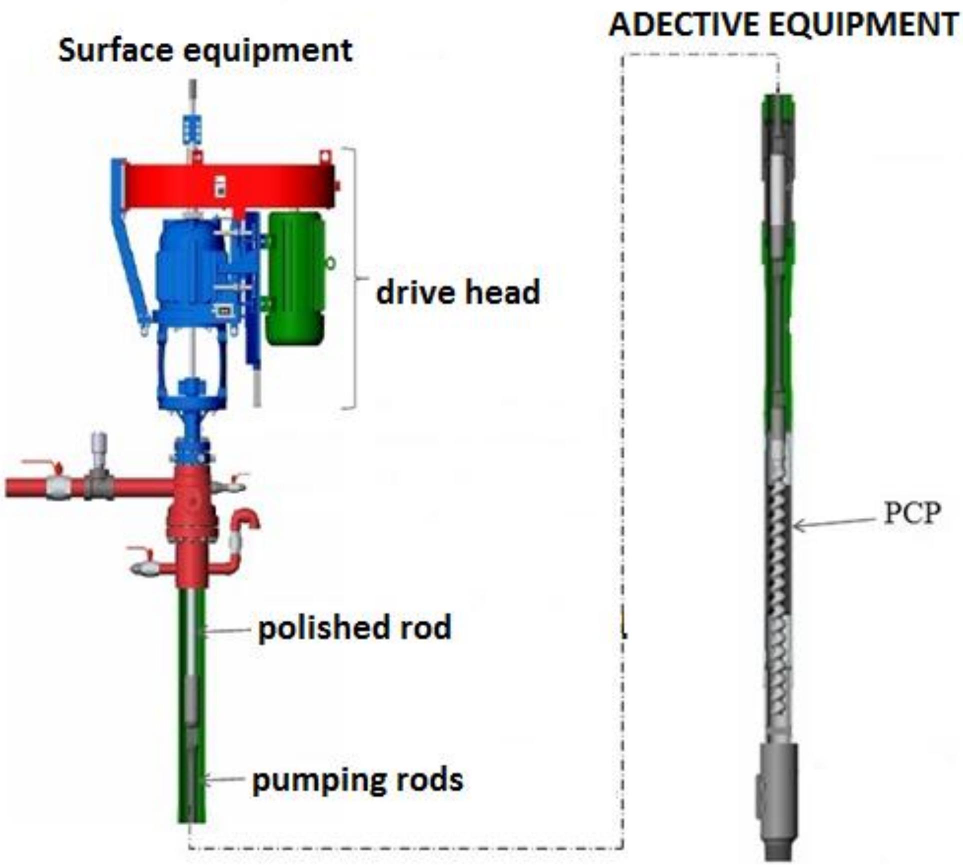

Fig.1.1: Echipamentul specific pompelor cu cavitate progresivă

https://www.spe-qld.org/useruploads/files/pcpspeaustraliafinalv1.pdf

2. Geometric modeling of progressive cavity pump

For the geometric modeling of the pump, the SolidWorks software was used to design the pieces and make the assemblies.

Stages of rotor modeling (fig.2.1):

- Designing the minor and major diameter of the rotor (fig.2.1 (a)),
- The design of the "spire" along the rotor and the determination of its pitch and the number of windings (fig.2.1 (b)),
- Extrusion of the minor diameter along the spindle using the Sweep command (Figure 2.1 (c)) and obtaining the model (Fig.2.1 (d)).

For modeling the stator it is necessary to know the following dimensions:

Steps of stator modeling (Figure 2.2):

- Making a circle of the outer diameter and the stator length extrusion (Figure 2.2 (a)),
- Create a sketch on one of the straight faces of the stator, on which the stator profile will be projected, using the Straight Slot command with the dimensions shown in Figure 2.2. (B)
- The design of the "spire" along the stator and the determination of its pitch and the number of windings (Figure 2.2 (c)),
- Cut the previously drawn sketch along the spindle using the Sweep Cut command and get the model (Figure 2.2 (d)).

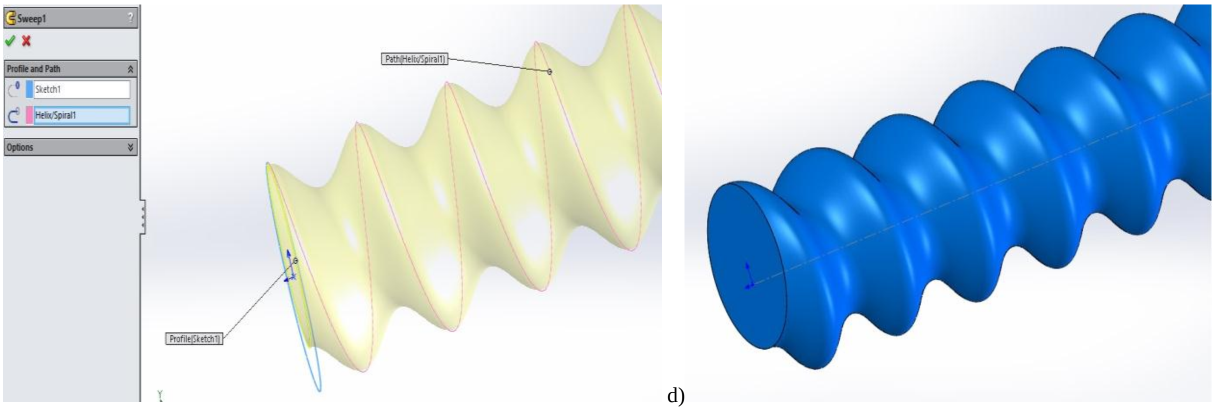

Fig. 2.1 Design of the rotor: a) design of the spiral; b) extrusion; the rotor obtained. [1]

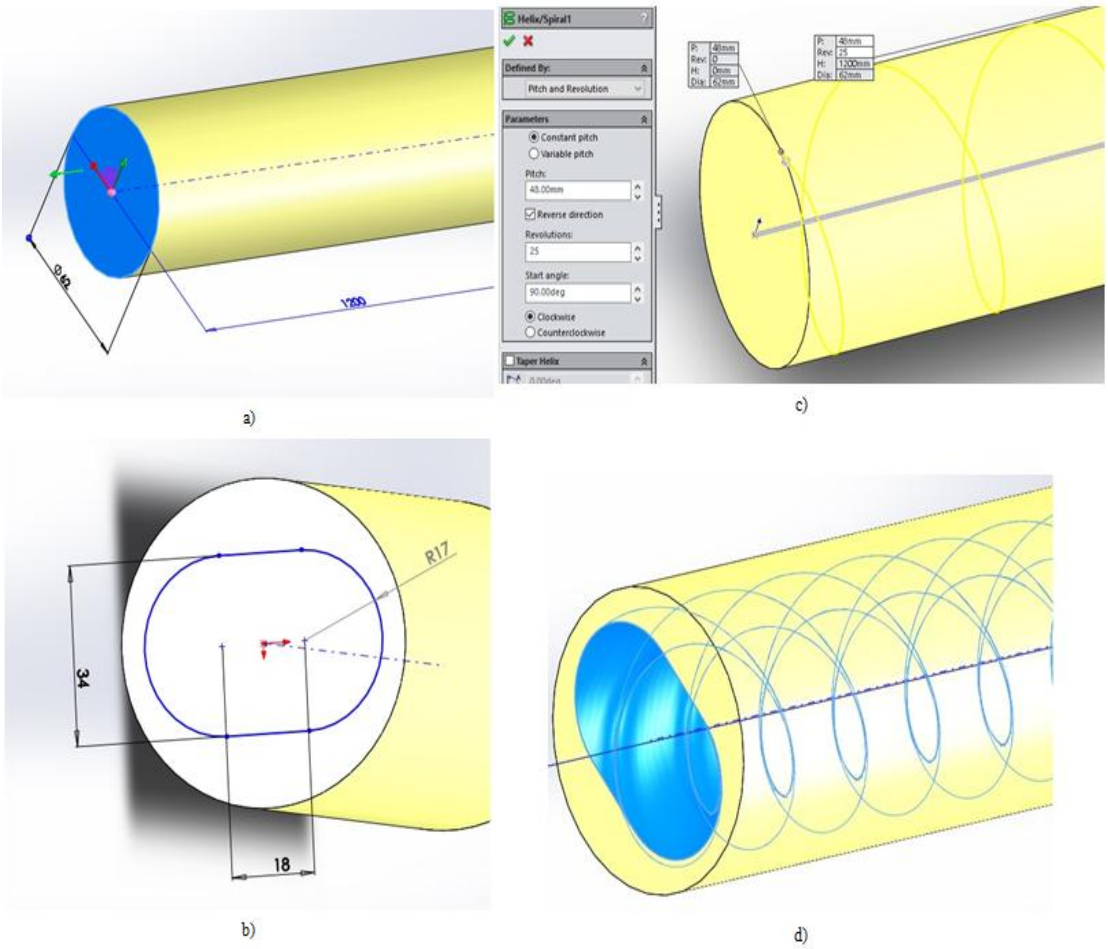

Fig. 2.2. Stator modeling: a) extrusion; b) stator profile; c) design of the spire; d) the stator ,[1]

3. Model of study of pump durability with progressive cavity

3.1. Analysis of demand distribution between rotor and stator

A static analysis will be performed to track the distribution of strains between the rotor and the stator in the maximum interference area.
Only 9 mm long to isolate the study and minimize the time to obtain the results will be isolated from the model.

In the case of the rotor, choose 42CrMo4 material, and in the case of the stator it is necessary to define a new material that has the characteristics corresponding to the elastomer. Characteristics of stator and rotor material are presented in Table 3.1.

Tabelul 3.1. Characteristics of the materials used

The material	The modulus of elasticity		Poisson's constantm	densityρ, kg/m^3	Tensile breaking strength s_r, MPa	Specific breaking strength s_r/ρ, $\frac{MPa}{kg/m3}$
	longitudinal E, MPa	transversal G, MPa				
42CrMo4	$2{,}1 \bullet 10^5$	$7{,}9 \bullet 10^4$	0,28	7800	1100	$14{,}1 \bullet 10^{-2}$
Cauciuc	2	-	0,49	900	13,79	$1{,}52 \bullet 10^{-2}$

In this study, a "shrink fit" contact type is used between the rotor and the stator, which allows for the calculation of the stresses for the tightening assemblies. Because of the normal forces developing at the interface, the inner object (the rotor) tends to contract while the outer object (stator) is expanding. For these reasons, it is necessary to introduce the abutments, which prevent the outer dilation of the stator and the rotor movement (fig.3.1).

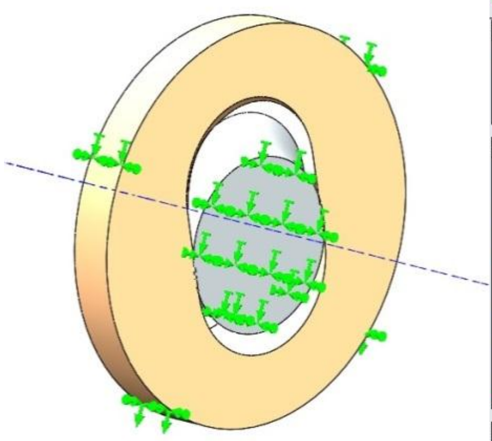

Fig. 3.1 Fixing of the stator and rotor bends

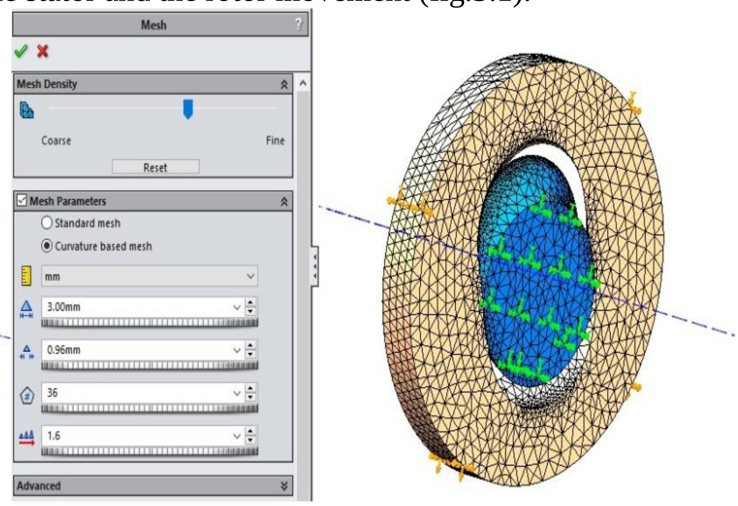

Fig. 3.2 Meshing

After the study, the results are shown in the figure 3.3.

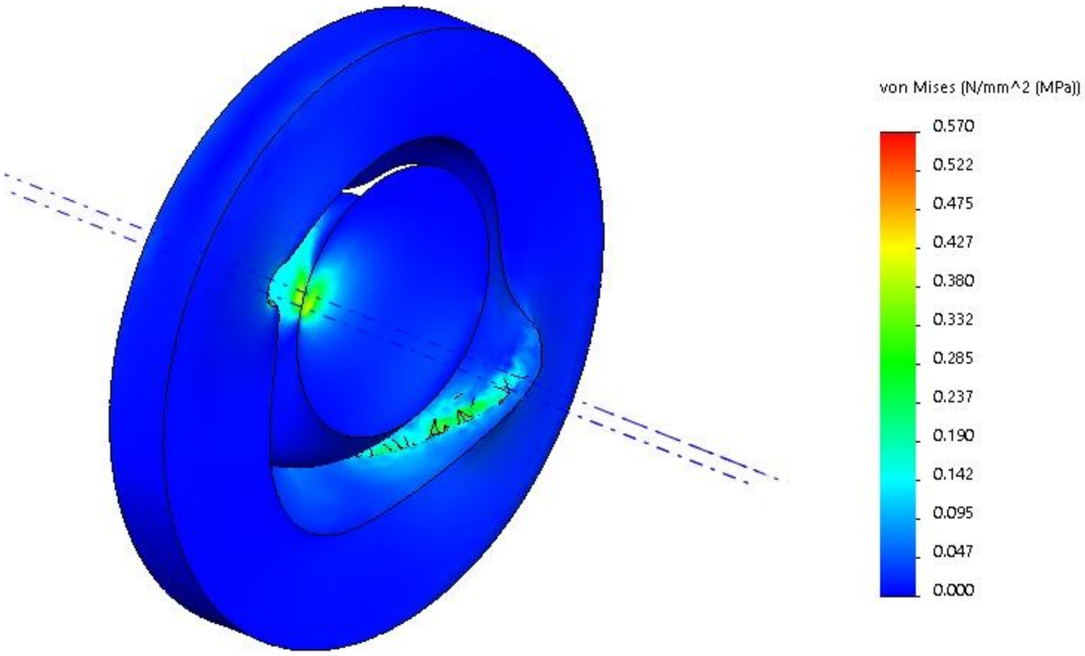

Fig. 3.3 Effort distribution

It can be seen from the figure that the stresses distributed in the maximum interference area take up to 0.57 MPa. In order to verify the correctness of the obtained results it is necessary to elaborate a new nonlinear study, which allows the use of stress-strain diagram of the stator used for the stator. This can only be done on the basis of the following assumptions:

-I consider the rotor and the stator as being in contact.

-It will introduce the material characteristics for both components as for the static study

-The two components will be positioned so that they simulate the interference area of the magnitude of the rotor and stator (0.5 mm) during the movement.

Conclusions

The PCP pumps have been developed and used in recent years, that is, they have been used more and more frequently in the oil industry, due to the evolution they have experienced over time and the benefits they have. Of these, the most important are:

- calls for small investments;

-For increased reliability due to its construction; all moving parts being safe, thus lowering the risk of injuries.

-the ability to pump crude oil with a high percentage of water and gas;

-not have valves, oscillating elements or gas stops;

- there is no danger of gas blockage (no valves to block gas), which is why they are ideal for removing water from the natural gas extraction wells;

- are capable of producing at high concentrations of sand or other solid products;

- good resistance to abrasion;

Relatively low energy costs as well as continuous energy demand;

-montage and relatively simple use;

-high maintenance;

Low noise level;

- low surface equipment;

Apart from the advantages, the Moineau pumps also have some limitations and special considerations:

- limited production capacity (up to 900 m3 / day);

- Limited lifting capacity (pump depths up to 3000 m)

- limited temperature capability (60 - 1200 ° C for solids-free fluids and 40-90 ° C for solid impurities);

- Vibration may occur in high speed applications (in this case, it is necessary to use anchors to stabilize the pumping gasket).

Many of these limitations continue to change or be mitigated over time with the development of new products and improvements to design materials and equipment. If properly configured, the progressive cavity pumps can provide an extremely efficient and economical way. At the same time, I'm asking for small investments, the cost price being lower compared to the one with centrifugal or classic pumping.

The surface system has a small gauge, being easy to handle, transported and mounted, and by its construction, it has all moving parts secured. For this reason, there were no accidents. The pumping system and its construction guarantee a long service life of about two, three years.

In the case of helical pumps, energy is needed only for the lifting of the fluid and not for the pumping rods, as the gasket of the pumping rods only performs a rotation motion, the pumping rods and the pipe being not subject to cyclic variable stresses, as in the case of the classic pumping , with poles.

It should be noted that the chromium-plated alloy steel rotor, hard on the outside, has a lower cost price and offers a fairly good wear resistance. The rotor can be easy and inexpensive, decorted and reclaimed if the coating metal has been damaged.

References

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