TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 62, Issue II, June, 2019

STUDY OF PUMP FLOW WITH PROGRESSIVE CAVITIES

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Abstract *Progressive cavity pumps are part of the rotary motion volumetric pump type. They consist of a rotor, which is an internal stator element which forms the external stage of the pump. This article attempts to estimate the volume along the length. Under these conditions, it was observed that the volume varies depending on the position of the pump elements and knowing that the flow is directly proportional to the cylinder and the speed, it was concluded that it is also pulsating. This, however, can only be demonstrated on the basis of tests carried out on a stand that allow the cavity volume to be identified in different positions of the rotor in the stator.*
Key words: *pump with progressive cavity, cavity, volume, flow, rotor, stator.*

1. INTRODUCTION

The helical pumps and their operating principle were first presented by the French inventor René Moineau.

Currently, the vast majority of pumps are used with a single screw. Its geometric design is illustrated in Fig. 1. According to the figure, we observe that the length of the stator step (Ls) is exactly the double of the length of the rotor step (Lr).

By coupling the rotor and stator, two parallel helical cavities are formed, where the outer part of the rotor along the length of the pump, including each cavity thereof, is equal to the length of the stator step.

When the rotor revolves inside the stator, the cavities move from the lower part towards the upper part of the pump (from aspiration to discharge) to support the air and cause the fluid to flow through the pump and to rise upwards through the pipes, do actually the pumping action.

According to the above, we need to:
The suction and discharge range is continuously insulated by touching the helical surfaces of the rotor and the stator;
Pass through the gearing pole of the normal starting circles in the rotor and stator contact points.

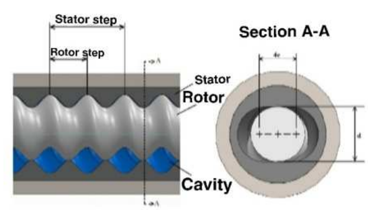


Fig. 1 Geometrical parameters of helical pumps,[3]

2. THE OPERATING PRINCIPLE OF HELICAL PUMPS

The rotor movement inside the stator is a combination of two movements: a rotation around its own axis and a rotation around the stator axis, as shown in Figure 2.

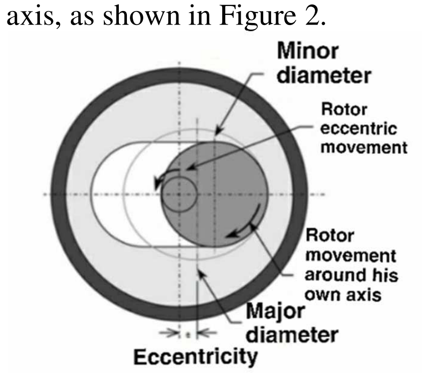


Fig. 2 Rotor movement, [3]

In a screw pump, the rotor in section (minor diameter, (d)), while the cavity together with the stator has conjugate geometry.

The most important geometric parameter is the eccentricity of the pump (e), which is equal to the distance between the axe of the major diameters (D) and minor diameters rotors. The distance between the stator axis and the rotor axis and the major diameter is also equal to the eccentricity value.

In a perpendicular section on the rotor axis the major diameter (D) of the rotor is given by the relationship:

$$D = d + 2 \cdot e \qquad (1.1)$$

where:

d – minor diameter, e - eccentricity of the pump.

A complete rotation of the rotor creates fluid flows. When she wishes to be discharged, at the same time she is shut down. (A) and the success story of the event is the turn of the rhythm:

$$A = 4 \cdot d \cdot e \qquad (1.2)$$

where:

d – rotor diameter, e - eccentricity.

Pump cylinder (V) is the volume displaced during a rotation and is given by the relationship:

$$V = A \cdot L_S = 4 \cdot d_e \cdot L_S \qquad (1.3)$$

where:

A – cross section area, Ls - the length of the stator step, d – the diameter of the rotor, e – eccentricity [2].

Table 1 attempted to identify the cavity volume according to the position for pump elements along the length of a stator step Ls in the case of a pump with the dimensions (fig. 3.). Minor diameter (d) = 35 mm, Eccentricity (e) = 4 mm, Length of the stator step (Ls) = 48 mm.

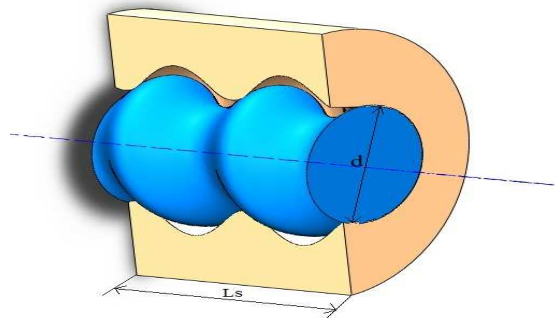
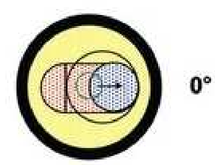
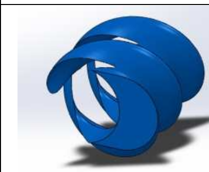
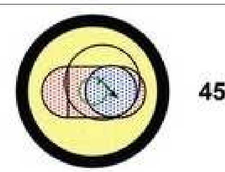
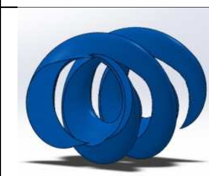
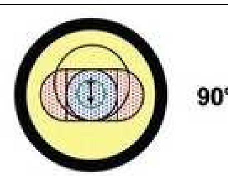
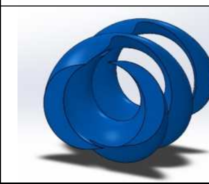
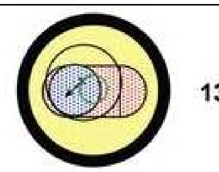
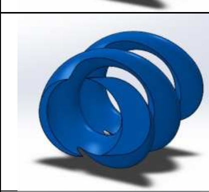
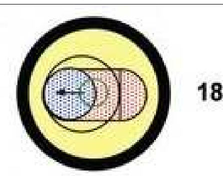
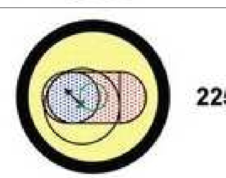
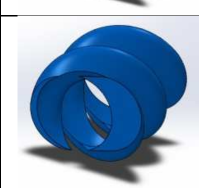
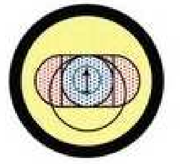
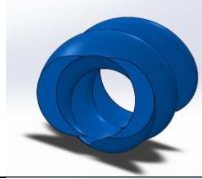
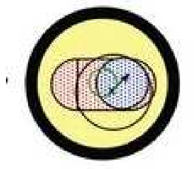
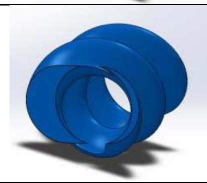


Fig. 3 Part of the studied pump

Table 1. Volume of cavity according to rotor position in stator

Position of the rotor	The resulting cavity	Estimated volume [mm^3]
		27339.59
		27018.04
		27391.48
		27513.35
		27192.44
		27071.17

 270		27225.42
 315		27322.28

3. RESULTS AND DISCUSSION

The volume of the cavities along the length of a stator step is not constant and varies according to the position of pump elements, according to Fig.4, and knowing the relationship for the flow (1.4) it can be deduced that it is pulsating only after a rigorous calculation.

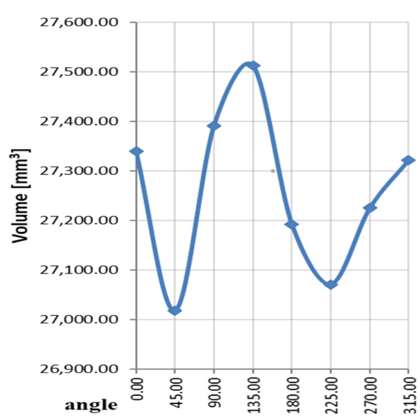


Fig. 4 Volume variation according to rotor position in stator

At zero pumping height (zero pressure) the flow rate (Q) is directly proportional to the cubic capacity and the rotor speed (n),

$$Q = V \cdot n = 4 \cdot d \cdot e \cdot L_S \cdot n \qquad (1.4)$$

where:

V - the cubic capacity of the pump (volume) d - diameter of the rotor, e - the eccentricity, Ls - the pitch length of the stator.

4. CONCLUSIONS AND PROPOSALS

In the case of NPCP pumps (pump with progressive cavities provided with a hydraulic regulator), rotor bending is practiced (Figure 5). Using this technology, the internal recirculation between the cavities allows compression in a slower manner throughout the length of the stator so that the pressure increases regularly from aspiration to discharge.

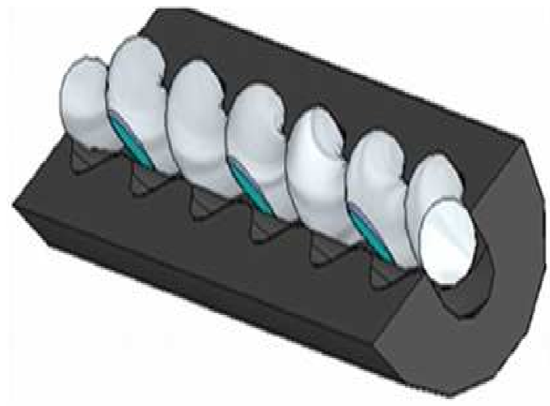


Fig. 5 Rotor chamfering

In the case of NPCP pumps (pump with progressive cavities provided with a hydraulic regulator), rotor bending is practiced (Figure 5). Using this technology, the internal recirculation between the cavities allows compression in a slower manner throughout the length of the stator so that the pressure increases regularly from aspiration to discharge.

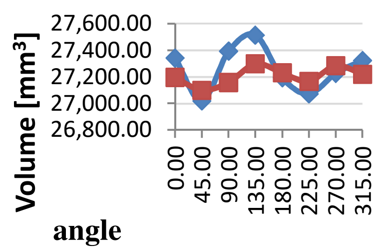


Fig. 6 Volume variation curves according to rotor position in stator

♦ - normal rotor; ■- modify rotor

Analyzing the volume variation curve in figure 3, we notice that it encounters a maximum when the rotor reaches approximately 1350 position. For these reasons, it is proposed to chop the rotor exactly where it encounters a maximum volume, which will lead to flow uniformity. This has to be tested on a bench where the results obtained in relation to the flow can be analyzed on the basis of a rigorous calculation.

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Studiul debitului pompelor cu cavități progressive

Rezumat Pompele cu cavitate progresivă fac parte din categoria pompelor volumice cu mișcare de rotație. Acestea sunt formate dintr-un rotor, care se prezintă ca element intern și dintr-un stator, care formează treapta externă a pompei. În cadrul acestui articol s-a încercat estimarea volumului cavității pe lungimea unui pas al statorului. În aceste condiții, s-a observat că volumul variază în funcție de poziția rotorului în stator, iar cunoscând că debitul este direct proporțional cu cilindreea și turația, s-a ajuns la concluzia că și acesta este pulsator. Acest lucru însă poate fi demonstrat practic numai pe baza unor teste efectuate pe un stand care să permită identificarea volumului cavtății în diferite poziții ale rotorului în stator.

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