UNIVERSITY **POLITEHNICA** OF BUCHAREST

Faculty of Mechanical Engineering and Mechatronics

Department of Thermodynamics, Engines, Thermal and Refrigerating Equipment's

PhD THESIS ABSTRACT

Operation equations for a rotating working machine that transport fluids

Ecuații de funcționare pentru o mașină de lucru rotativă care vehiculează fluide

Author: Eng. Almaslamani Ammar Fadhil Shnawa

Coordinator: Prof. emeritus dr. eng. Nicolae Băran

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The present doctoral thesis continues the theoretical and experimental researches in the field of rotating machines with profiled rotors. A constructive solution for fluid transport is presented which can be used as a "reversible machine" as follows:

I. If the pressure of the fluid entering the machine (p_1) is lower than the pressure at the discharge (p_2) then the machine can be used as a working machine i.e.: as a pump, fan or low pressure compressor.

II. If p_1 is greater than p_2, the machine can be used as a force machine, namely: steam engine, combustion engine, pneumatic engine, hydrostatic engine.

The constructive solution developed, designed and built in the laboratories of the Department of Thermotechnics, Engines, Thermal and Refrigeration Equipment's of the University Politechnica of Bucharest.

The thesis is written on 122 pages and contains 100 bibliographical references as well as the list of 10 papers published by the author of the thesis.

Chapter 1. Current state of researches regarding the construction solutions for rotating machines for liquids transport.

This chapter presents a classification of rotating machines, sets out the main types of rotating pumps: vane pumps, gear pumps, screw pumps, lobe pumps. At the end of the chapter, the constructive solution of a new type of a rotating pump with profiled rotors is presented and the objectives of the doctoral thesis are listed.

Chapter 2. Establishing the architecture of profiled rotors.

The mathematical calculation relations are established for determining the coordinates of the points located on the contour of the rotor profile. Three calculation programs have been developed regarding the rotor cavity, the circular portion of the rotor and one side of the rotating piston; because the rotor is executed on a C.N.C the calculation accuracy is high, to five decimal places.

Chapter 3. Operating modes of the rotating volumetric machine.

Calculation relationships are established for the flow rate of the machine and for the theoretical driving power of the machine; the variation of the electric motor speed driving the machine is indicated and for certain speeds, the functions: $\dot{V} = f(n_r)$ and $P = f(n_r)$ are drawn.

Chapter 4. The influence of geometric and functional parameters on the performance of the rotating volumetric machine.

The influence of two categories of parameters (I + II) is analyzed:

I) Geometric:

- Influence of rotor length and radius;

- The influence of the rotating piston height;

II) Functional:

- The influence of machine speed;

- The influence of the pressure increase on the flow rate and driving power of the rotating volumetric machine;

Chapter 5. Operating equations for the rotating machine.

The operating equations of the machine are defined and analyzed, the characteristic parameters of the machine are specified.

The connection relations between:

- the rotor radius and the rotating piston height;

- the driving power of the machine and the rotating piston height.

Chapter 6. Characteristic curves of the rotating volumetric machine with profiled rotors.

The hidrostatic load, power, and efficiency characteristics are generally presented; subsequently the three characteristics are theoretically drawn. These are be compared with the characteristics experimentally determined in Chapter 9.

Chapter 7. Pumping installations.

For a pump, the operating point is specified; subsequently, pumping installations with positive and negative suction are presented.

Chapter 8. Conception, design and construction of the installation for experimental researches.

This chapter presents the installation diagram and the operating principle, the measuring devices used to perform the measurements, an overview of the installation.

The installation is open circuit and was built in the laboratory of the Department of Thermotechnics, Engines, Thermal and Refrigeration Equipments from the University Politechnica of Bucharest, room CG131.

The rotating volumetric pump (10) draws water from the tank (3); at the outlet of the pump the water pressure is measured with the manometer (16). Subsequently, the flow rate discharged by the pump is measured with the electromagnetic flow meter (17) and the water reaches the tank (20) through the pipe Ø 50x2; from figure 8.1 it is observed that Hg = 4 [m].

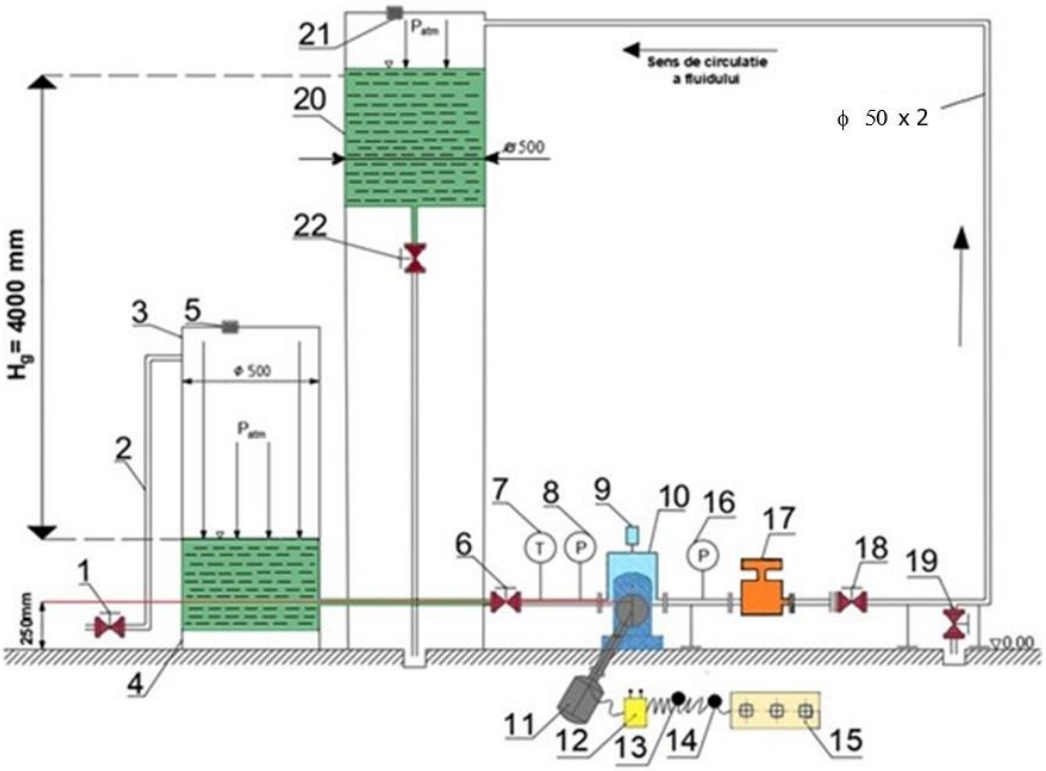

Fig.8.1. Sketch of the experimental installation

1- valve; 2 - pipe; 3 - water tank; 4 - water tank support; 5 - plug for ventilation; 6 - valve Dn 60 Pn 2 bar; 7 - thermometer; 8 - manometer at the suction of the pump; 9 - differential manometer; 10 - volumetric pump; 11- electric motor; 12 - frequency converter; 13 - ammeter; 14 - multimeter; 15 - 380 V alternating current source; 16 - manometer at pump discharge; 17 - electromagnetic flow meter; 18 - flow control valve; 19 - circuit drain valve; 20 - water tank; 21- plug for ventilation; 22 - water tank drain valve.

Chapter 9. Experimental researches and processing of experimental obtained data.

The purpose and the researches methodology are set out.

The results of experimental researches are presented which validate the results of theoretical researches on:

- the operating equations of the rotating machine;
- the characteristic curves of the rotating machine.

The conclusions chapter is presented successively: general conclusions, original contributions and perspectives for further researches development.

The paper comprises 122 pages and 100 bibliographic titles are presented. The list of published papers by the author of the doctoral thesis, in journals listed ISI, BDI or in the volumes of international conferences are presented at the end of the thesis.

In the thesis, the term working machine refers to a rotating volumetric pump with two profiled rotors.

The pump has two specially profiled rotors; each rotor is provided with two triangular-shaped rotating pistons.

Through its content, the thesis aims to present a new type of rotating machine with profiled rotors that can be practically performed in several versions [1][2]:

- as a working machine (pump, fan, blower); in this case, the pressure of the fluid at discharge (p_2) is higher than at suction (p_1).

- as a power machine (steam or flue gas engine, hydrostatic engine); in this case $p_1 > p_2$.

Researches in the field of rotating machines is expanding in the sense that these machines transform one form of energy into another form of energy with minimal losses; in these machines there is no reciprocating rectilinear motion, no valves [3][4].

The paper is an example that includes both elements of originality regarding both the constructive solution and the calculation relations regarding its operation.

The paper reveals new theoretical aspects regarding the circulation of fluids with a new type of rotating machine with profiled rotors, its performances being validated through experimental researches.

C.1. General conclusions

The advantages of rotating working machines, some constructive solutions being "reversible", ie the same constructive solution can be used as a pump or hydrostatic motor are revealed. The analyzed constructive solution was developed, designed and built in the laboratories of the Department of Thermotechnics, Engines, Thermal and Refrigeration Equipment sfrom the University Politehnica of Bucharest.

From the class of rotating working machines, a new type of rotating volumetric pump that can transport any fluid substance was previously presented in the thesis:

- Pure liquids (clean);
- Liquids with suspensions:
- Biphasic fluids (water + sand, water + ash);
- Rheological fluids;
- Fluids in the food industry: water, wine, oil.

The constructive solution does not contain elements to perform alternative rectilinear movements; it has a safe operation and easy maintenance.

Increased accuracy is required in its construction due to the fact that if there are large clearances between the rotor and the case, the volumetric efficiency of the pump will decrease.

C.2. Original contributions

In accordance with the proposed objectives, as well as analyzing the obtained results during the elaboration of the doctoral thesis, one can highlight a series of original contributions, of which the most representative are:

● ***Theoretical contributions:***

1) The developement of a constructive solution that presents originality elements and scientific creation in the field of rotating machines with profiled rotors that serve to transport of fluids.

2) Establishing mathematical relations between the constructive elements of the machine such as:

- The connection between the rotor radius and the rotating piston height, an original relation;

- Correlation between case radius + rotating piston height, an original relation.

3) Elaboration of the calculations regarding the design and realization of the volumetric working machine, more precisely of the volumetric pump with profiled rotors.

4) Establishing the operating equations of the rotating machine and at the same time deducing relations between:

- Rotor radius and piston height.

- Piston height and driving power of the rotating machine.

5) Theoretical construction of the characteristic curves of the rotating volumetric machine.

● **Numerical contributions:**

The construction of the rotating machine required as accurate data as possible because it was built on a numerical calculation program that can be adopted at a numerically controlled computing center (C.N.C.).

For certain chosen dimensions for the rotor and the rotating piston, several calculation programs have been developed which result in specifying the $x_i y_i$ coordinates of the contour of the profiled rotor.

For a constructive solution of the rotating machine specified by l, z, R_r, the equations established in this thesis relate the functional parameters (n_r, H) to the quantities ($\dot{V}$, P) that energetically characterize a rotating machine for fluid transport.

● ***Experimental contributions:***

The experimental researches aimed at:

- Validation of the operating equations set out in Chapter 5.

- Also in Chapter 9, which contains experimental researches, the characteristic curves of the rotating machine, theoretically deduced in Chapter 6, were validated.

C.3. Perspectives for further development of researches

This rotating working machine can carry dirty water with solid particles, so it can be used in agriculture for irrigation.

Selective references

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