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DETERMINATION BASED ON EXPERIMENTAL MEASUREMENTS OF THE EQUATIONS GOVERNING OPERATION OF THE NETWORK - CENTRIFUGAL PUMP IN ORDER TO SIMULATE OPERATING CONDITIONS FOUND IN PRACTICE

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Abstract: The paper aligns current global concerns regarding energy sustainability, focusing on issues of operational sustainability of water pumping system. After an overview of the current situation sectoral regulations and international, national and local issues of concern highlighted in this background is developed in an approach multidisciplinary research that integrates conceptual approaches, methodological and basic tools of the machines and networks hydraulics, energetics industrial installations in the spirit of ISO 50001 energetics management and sustainable development.

The energetics system for the installation of a pumping groundwater mining, identification and analysis of major components, energy flows and performance of this system is the core of the article.

Key words: turbo pumps, electric pumps, pump systems, hydraulic network, energy efficiency, sustainable use of water pumping systems.

1. INTRODUCTION

Methodological instruments used mainly include operational tools in sustainable water pumping systems and methods for quantifying the performance of energetics systems (energetics analysis methods/exergetic, economic and quantify the environmental impact). On these bases diagnoses the current state of the system are simulated operating conditions and establish areas of operation corresponding to a performance indicator aggregate energy cost, economic cost and the environmental cost, identifying measures/solutions to improve ahead, compatible with sustainable development [1, 6].

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2. THEORETICAL CONSIDERATION

The pumping station, pumping aggregates ensures the circulation of water in the basin volume suction consumers who are connected to the network.

Figure 1 is the general case of a pump operating in a facility. The circulation of the fluid between the suction tank R_A and the discharge R_R is provided by the pump P through the suction tube draws C_A and discharges through the discharge pipe C_R. Additional gauges of pressure were positioned in the suction nozzle (1) and the discharge (2) [2, 5].

The flow rate of the fluid that is circulated by a pump units can be expressed by: the volumetric flow rate discharged, Q_1 (m^3/s, m^3/h, l/s), the volumetric flow rate sucked Q_2 (m^3/s, m^3/h, l/s), volume flow nominal Q_n (m^3/s, m^3/h, l/s), volume flow optimally Q_{opt} (m^3/s, m^3/h, l/s), maximum flow and minimum Q_{max}, Q_{min}.

The load of pump or pumping the total height H (m) is useful mechanical work submitted by the impeller to fluid or increase energy pumped fluid passage through paragraphs (1) and (2) fig.1.

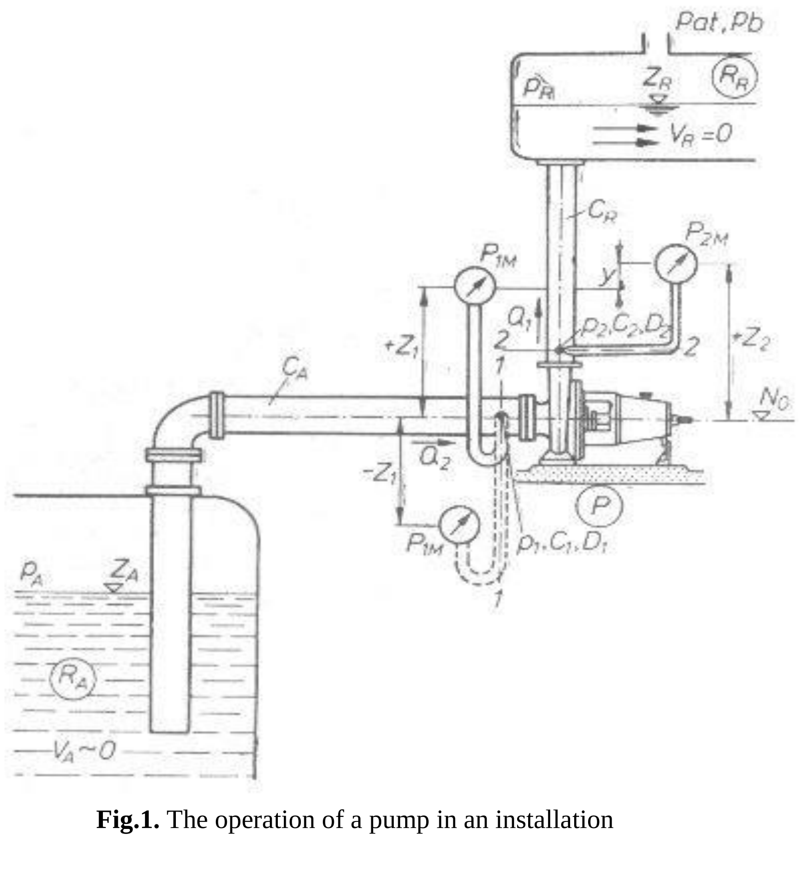

Fig.1. The operation of a pump in an installation

The unit of time, due to losses occurring in pumps ($\Delta P = \gamma \Delta Q \cdot \Delta H$) to achieve output power P_u, the pump must obtain a higher input power $P_p = \gamma \cdot Q \cdot H / \eta_p$, η_p – at the shaft - is the overall efficiency of the pump.

Speed and direction of rotation of the pumps. They are driven by electric motors in general, resulting from the relationship speed:

$$n = k \frac{60 \cdot f}{p} \quad (1)$$

where *f* is frequency of the current in the network; k - the coefficient of sliding depending on the type of the motor (synchronous motors k = 1, and asynchronous motors 1 < k); p - number of pole pairs of the motor [3].

3. EXPERIMENTAL RESULTS

Based on experimental measurements correlated with the performance specified in the leaflets pumps were established significant parameters summarized in Tables 1 and 2. I built with the utility EXCEL graphs of variation of significant parameters and I determined the equations of the curves corresponding results (Figures 2, 3 and 4) [1, 4].

Based on experimental measurements, correlated with information from literature and the available documentation, using the model previously described for analysis of electro LOTRU 100 yielded significant results regarding:

- The variation of pump parameters analzyed depending on time (fig.5);
- Operating point network movement depending on the variable speed shown in (figure 6);
- Percentage change of characteristic parameters for varying speed (fig.7);
- Percentage change in specific energy consumption depending on the method of adjustment (fig.8);

Table 1. ***Characteristics experimentally determined***

Pump flow rate - Q [m^3/h]	0	5	10	15	20	25	30	35	40
Load of pump - Hp [m]	47.5	49	47.5	45	42.5	39	35	29	22.5
Load of Network - Hr [m] speed control	10	12	14	17	21	28	35	42	
Pump efficiency- etaP [%]	0	25	42	55	61	64	62.8	60	53
Pump efficiency+motor - etaP+M [%]	0	20	37	47	52	56	55.6	52	46
Power pump - Pp [kW]	2	2.5	2.8	3.1	3.8	4.1	4.22	4.5	4.8
Motor power - Pm [kW]	2.9	3.4	3.7	4	4.7	5	5.12	5.3	5.6
Load of Network - Hr + Hv [m] adjustament tub	20.4	22.5	24.2	26.5	30.1	34.5	42.7		

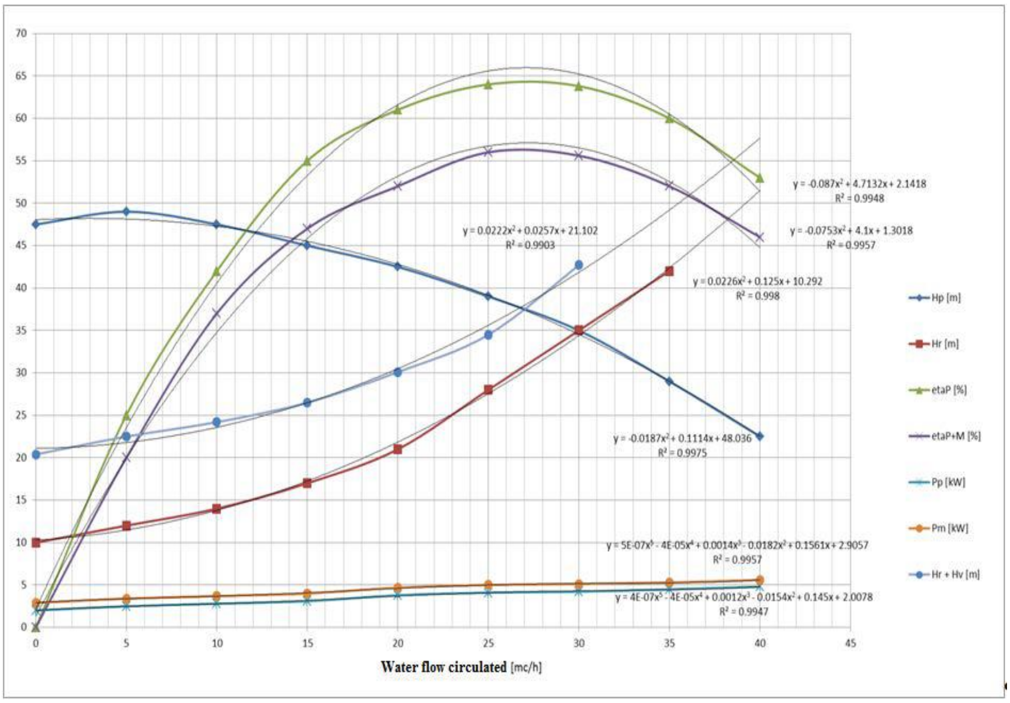

Fig.2. Trendline equation for pump and network characteristics

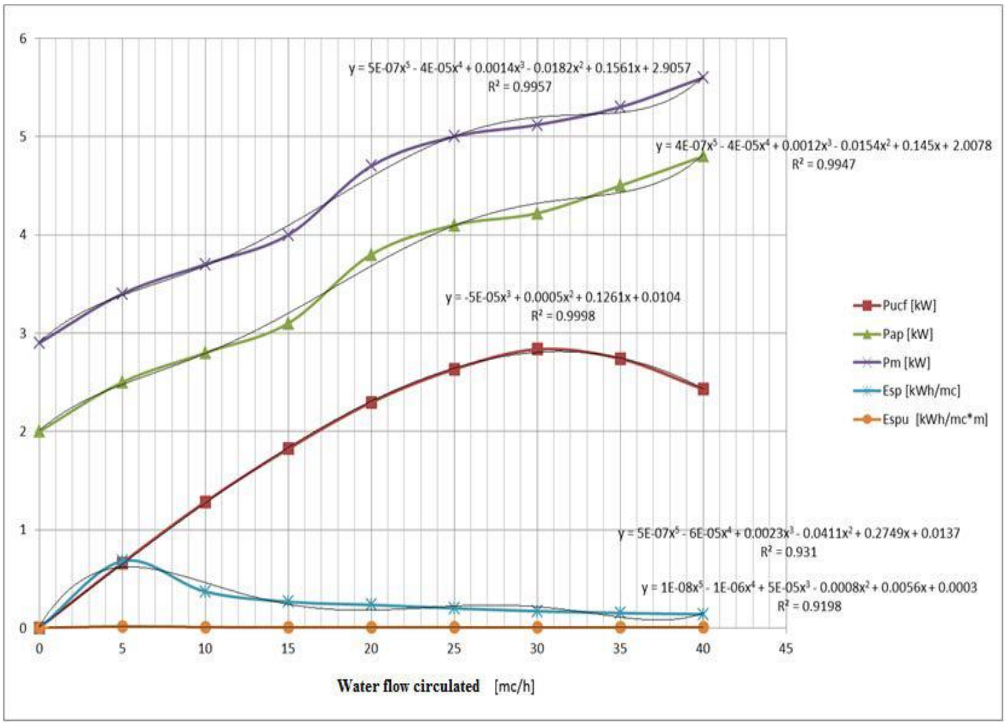

Fig.3. Trendline equations for energetics characteristics of the pump

Table 2. ***Characteristics energetics experimentally determined***

Pump flow rate - Q [m^3/h]	0	5	10	15	20	25	30	35	40
Load of Network - Hp [m]	47.5	49	47.5	45	42.5	39	35	29	22.5
The power output of stream water – Pucf [kW]	0	0.661 5	1.282	1.822	2.295	2.632	2.835	2.740	2.43
Power at the pump shaft - Pap [kW]	2	2.5	2.8	3.1	3.8	4.1	4.22	4.5	4.8
Electrical motor power - Pm [kW]	2.9	3.4	3.7	4	4.7	5	5.12	5.3	5.6
Specific energy – Esp [kWh/m^3]	0	0.68	0.37	0.266 667	0.235	0.2	0.170 667	0.151 429	0.14
Specific energy util- Espu [kWh/mc*m]	0	0.013 878	0.007 789	0.005 926	0.005 529	0.005 128	0.004 876	0.005 222	0.00 622

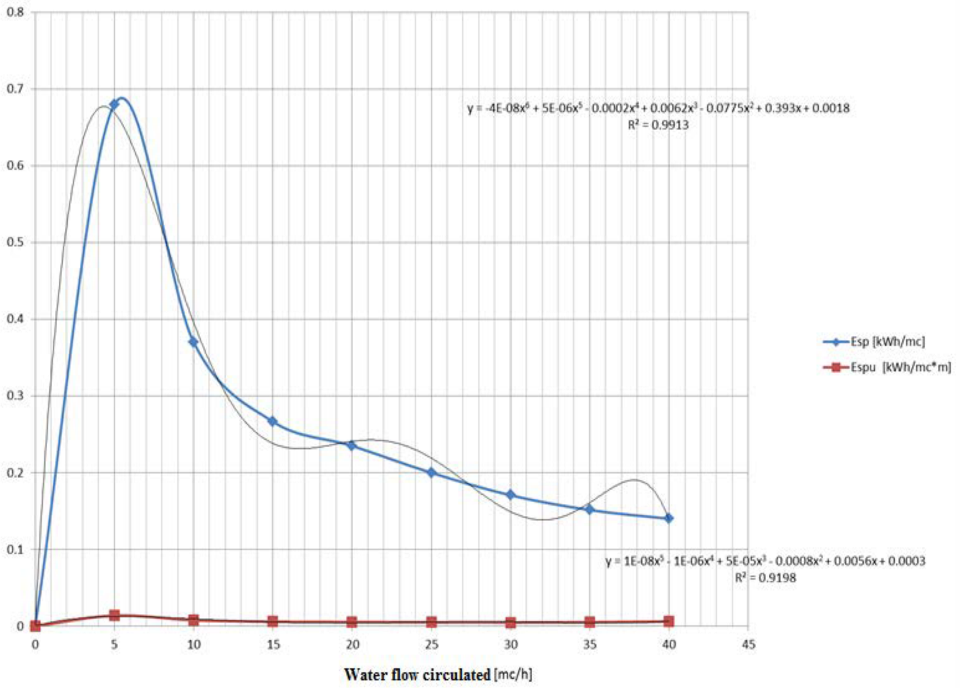

Fig.4. Trendline equations to specific energies, using a refined model regression

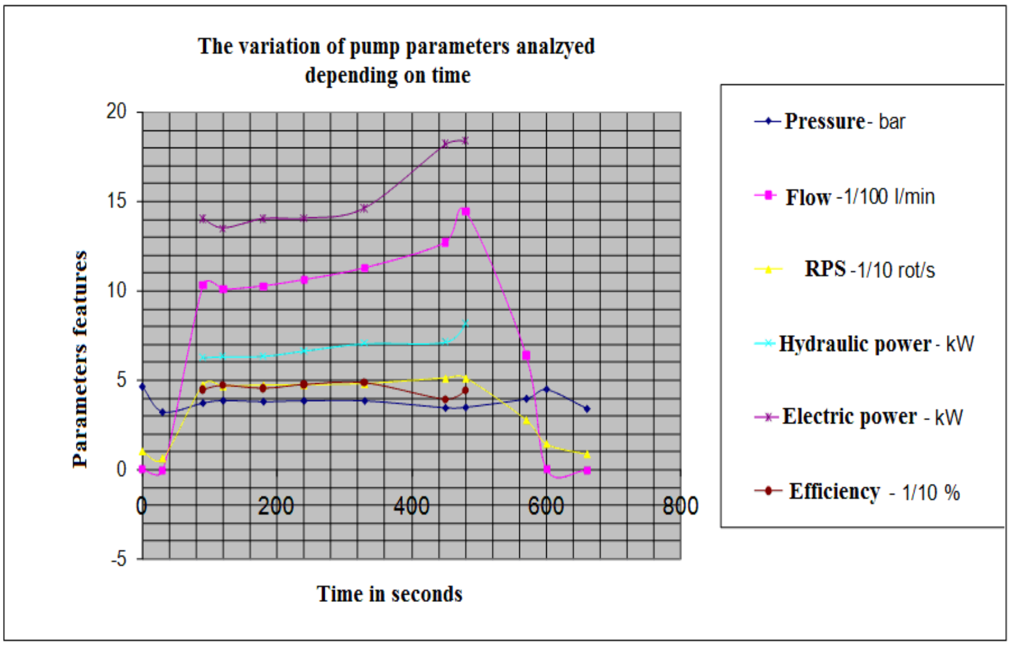

Fig.5. The variation of pump parameters analzyed depending on time

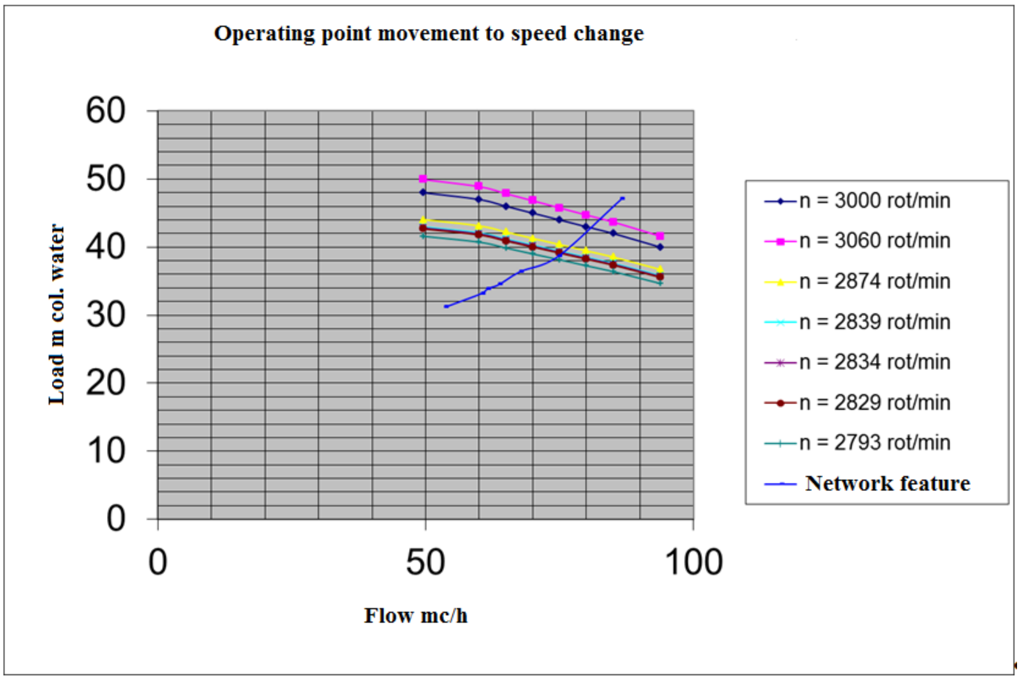

Fig.6. Operating point network movement depending on the variable speed

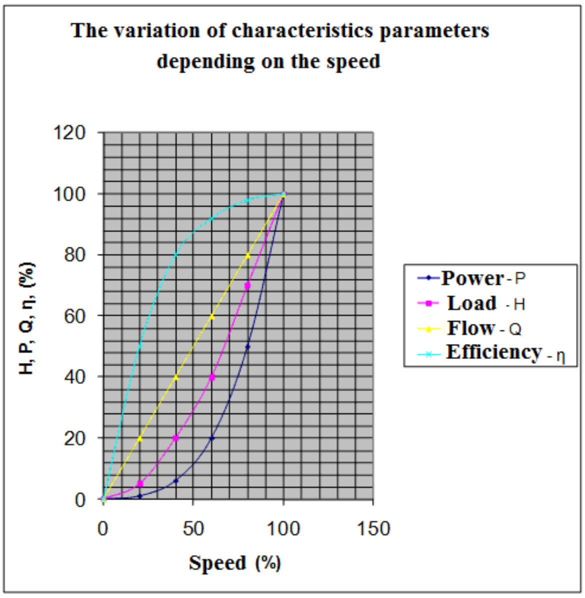

Fig.7. Percentage change of characteristic parameters for varying in specific energy consumption

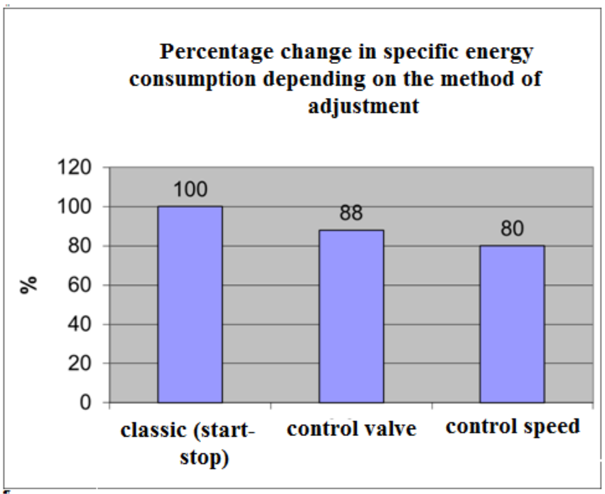

Fig.8. Percentage change speeddepending on the method of adjustment

4. CONCLUSIONS

It analyzed aggregate flow adjustment in pump systems with the following methods described in detail:

• changing pump performance curves (internal control);

• changing characteristics of installations (external adjustment);

adaptation of different working groups pumps (in series or parallel operation working pumps).

It drew charts variations versus time of characteristic parameters electropump, moving the operating point to the network for varying speed, the percentage change in the characteristic parameters for varying speed and the percentage change in specific energy consumption depending on the method of adjustment.

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