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*Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird*
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# THE EXONERATION OF THE HYDRAULIC SYSTEMS

**ALEXANDRESCU, A[urora] & MILOS, T[eodor]**

***Abstract:*** *This paper presents the technical solutions for upgrading the pumping station in Iasi CUG. The aim of the study is to optimize the functional parameters of pumping station and improve the quality of drinking water supplied to consumers. The exoneration of pumping station was done by the projection and installation of performance monitoring systems and drinking water, necessary to adjust the pumping station operation at variable operating regimes of hydraulic system. It is calculated the electric power saving achieved by the application of rehabilitation measures and was estimated the recovery time of the investment in pumping and water distribution network.*
***Key words:*** *active consumers, adduction, conductivity, pipe network, tank*

## 1. INTRODUCTION

A good methodology for optimizing the reinforcement of water networks based on the analytical study of the links between the parameters that characterize its operation, the geometric and structural parameters and the investment's and operation's costs in the new conditions, are elements that dictate the approach for elaborating the solution, decreases the necessary working time and guarantees the selection of the optimal ways to abate the detected shortcomings, [1].

The paper shows a determination method about the pumping installation's average global output in the adjustment situation through hydro – pneumatic loads. It is presented an analyze method about power and economical efficiency of the pumping installations equipped with only one type of pumps.

Many systems for which a centrifugal pump is otherwise suitable may, however, have a variable demand in which case, a certain loss of efficiency may have to be accepted from part of the head or part of the capacity used for control purposes, using either discharge throttling or bypass control. Both methods will inevitably result in power loss, so if economic regulation is of primary importance, discharge regulation by speed control should be investigated first since this is less wasteful of power and there is usually a considerably smaller loss of pump efficiency. Speed control is now a particularly attractive proposition with the increasing availability of variable frequency power units. The adaptation to variable regimes is done by the hydrophore's usage, [2, 3].

Profitability of water distribution activity depends largely on the relationships between operational capability and service costs, related to supplier's performance, volume of distributed water and effective operating costs. The main variables that influence the total selling price are required investment value, specific consumption of electrical energy for pumping power, unit price of the electrical energy and total volume of monthly consumed water billed. The selection of rehabilitation and modernization measures must rely on market studies results that appropriately establish the quantities of water that may be distributed and billed, [5]. Present and future water requirements will be determined based on the analysis of actual operation data and on estimation of future trends in water consumption on national and international levels, [4, 6].

## 2. PROBLEM DEFINITION

The objective function of the optimization problem is the economic function $Z$; it depend on economic function for the investment in pumping station $Z_i$ and the investment in water transport pipes $Z_e$:

$$Z = Z_i + Z_e \text{ , [RON]}. \tag{1}$$

The economic function for the investment in pumping station $Z_i$ has the following mathematical term:

$$Z_i = \frac{a_{SP} \,.\, i_p \,.\, K_N \,.\, m \,.\, Q_M^{1+\gamma} \,.\, L_R \,.\, 1{,}1}{\eta_{SP} \,.\, n^{\gamma} \,.\, D^{\beta}} + \\ + a_{SP} \,.\, I_p + a_R \,.\, L_R \,.\, i_o \,.\, n + a_R . a \,.\, n \,.\, L_R . D^{\alpha}. \tag{2}$$

The investment in the water transport pipes $Z_e$ can be calculated used the following mathematical form:

$$Z_e = \frac{K_N \,.\, m \,.\, L_R . Q_M^{\gamma} . F . W_o . p_e \,.\, 1{,}1}{3600 \,.\, \eta_{SP} \,.\, n^{\gamma} . D^{\beta}} \,. \tag{3}$$

The energy economy $\Delta E$ it is expressed depending on the unitary specific. The reduction of the electric power $\Delta e$ is calculated depending on electric power specific consumption planted $e$ and electric power specific consumption present $e_a$ with the following mathematical term:

$$\Delta E = \frac{W_o \cdot e_a}{100} \,.\, \Delta e = W_o . \left(e_a - e\right) \text{ , [MWh/year]}. \tag{4}$$

The recuperation time of minimum investment $T_{RI\ min}$ and maximum investment $T_{RI\ max}$ can be calculated depending on total investment $I$, the reduction of the electric power $\Delta e$ and electric energy unit cost $p_e$ likeness:

$$T_{RI\ min} = \frac{I_{min}}{\Delta E_{max} \cdot p_{e\ max}};\ T_{RI\ max} = \frac{I_{max}}{\Delta E_{min} \cdot p_{e\ min}} \text{ , [years]}. \tag{5}$$

## 3. EXPERIMENTAL RESULTS

The optimization method is applied in the CUG Iasi pumping station for drinkable water. The pumping station is equipped with two 8NDS pumps and rotational speed of $n$ = 1450 rpm. Using several original mathematical algorithms, author developed a computer program for analysis and graphics that calculates the functional parameters of the pumping station as well as the available consumer parameters. It is selected also the best pump for the water supply of consumers.

The computer program has analysed eight pumps variants fot the replacement of 8NDS pumps: Wilo - IL 250-160/4; Wilo IL 250-200/4; KSB CPK/HPK 300-500-504; NB, NK 150-500/489, ISO 9906 Annex A, Grundfos; NBG/NKG 150-125-250/248, 2 poli, ISO 9906 Annex A, Grundfos; NB, NK 150-125-250/248, 2 poli, Grundfos; CPK, CPKN, HPK 200-500/460, KSB; CPK, CPKN, HPK 200-500/480, KSB.

The annual average total expenses *Z* is calculated for the following coefficients: $m$ = 1,6 . $10^{-3}$; $\beta$ = 5,09; $\gamma$ = 1,97; $i_o$ = 1,9 . $10^6$; $a$ = 4,5 . $10^6$; $K_N$ = 9,81; $\eta_{SP}$ = 0,75%; $\alpha$ =2,75; $a_R$ = 0,0355; $i_p$ = 2,2 . $10^6$; $a_{SP}$ = 0,058. Daily average time of water pumping "of basis" head turn $t_p$ is estimated at (10 ÷ 15) hours. Daily average time of water pumping "of top" head turn $t_{vp}$ is estimated at (2 ÷ 6) hours. The hydraulic system has the parameters with values: $Q_M$ = 0,2 $m^3/s$; $W_o$ = 2,04.$10^6$ $m^3$/year; $F$ = 0,82; $L_R$ = 700 m.

It is calculated the electric power economy $\Delta E$ depending on electric power specific consumption planed *e*; it is allowanced water volume values pumping minimum, average and maximum, (*fig. 1)*. The investment's recuperation time $T_{RI}$ is calculated for the minimum $W_{omin}$ = 1,8. $10^6$ $m^3$/year and maximum volume $W_{omax}$ = 2,7. $10^6$ $m^3$/year values of water transported. *Figure 2* represents the variation of the investment's recuperation time $T_{RI}$ for the minimum $I_{min}$ and maximum investment values $I_{max}$ depending on total investment *I*, electric power economy $\Delta E_{med}$ and electric energy unit cost $p_e$.

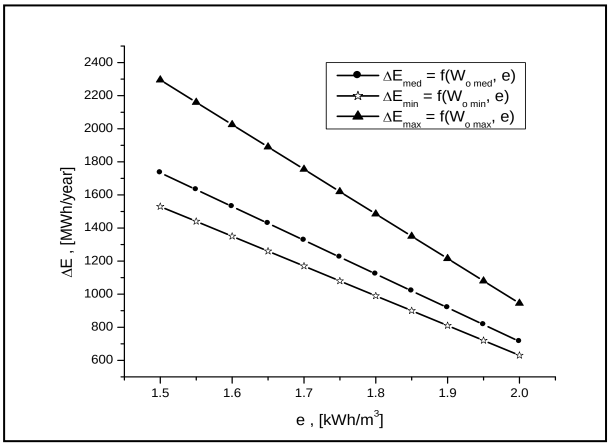


Fig. 1. Electric power economy $\Delta E$ depending on electric power specific consumption planed *e*.

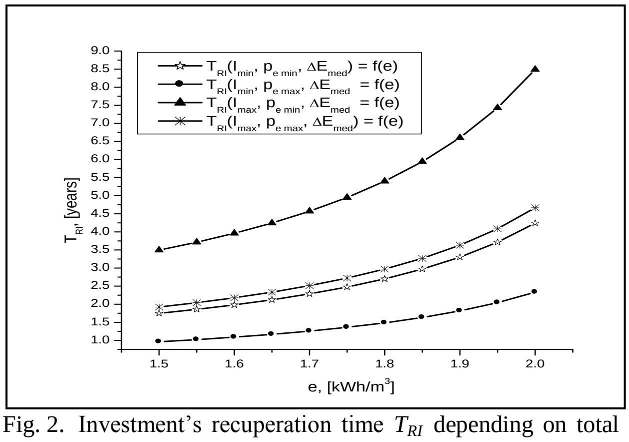


Fig. 2. Investment's recuperation time $T_{RI}$ depending on total investment *I*, electric power economy $\Delta E_{med}$ and electric energy unit cost $p_e$.

## 4. CONCLUSION

The replacement of the existent equipment, that is obsolete from physical and technological point of view, must be done with new equipments with performances that will meet the requirements of an optimum operation from both energetic and economic perspectives. The water transport and distribution network must have the capability to meet the requirements of the consumers. It is recommended the avoidance of the pumps work outside of (0,11 ÷ 0,14) $m^3/s$ flows and maintain the outturn between (80 ÷ 82) % values.

The computer programs created by authors permit the selection of the best pumps for the water supply of hydraulic system. The following variants are available: Grundfos/NBG, NKG 150-125-250/248/2; Grundfos/NB, NK 150-125-250/248; KSB/CPK, CPKN, HPK 200-500/480. The beneficiary of project S. C. APAVITAL S. A. Iasi will choose a variant depending on the price acquisition, the speed, the outturn of the pumps; the cost price of the investment in avatars that will be made in the pumping station CUG Iasi are very important.

The investment's recuperation time is advised to be (1 ÷ 8,5) years. The research results are used for design optimization of the water supply installation for areas with various relief forms. The proposed method for the optimization allows a reduction with 10 ÷ 15 % of the energy consumption required to operate the pumping station – network – consumers ensemble.

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