ATEE - 200

MODERN DRIVING SYSTEM FOR THE PUMPS IN WATER SUPPLY STATIONS

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Abstract *– The paper is referring to a modern driving system intended to monitor and control the pumps from the water supply public utilities. The electric drives of the motors from the pumping station have been modernized, the functional technical parameter monitoring, dispatching and control has been assured by specialized equipment. This modern driving system is a part of the centralized monitoring and control system of the pumping station and enables the optimal operation of the driving system, plant and equipment reliability and endurance increase, thus leading to the efficient use of energy and optimal administration of drinking water. The system consists in the characteristic quantities acquisition from the transducers, acquired data processing, transmission at the level of central dispatcher, station operation tracking by means of the dynamic synoptic diagrams, data transmission to the decision factor.*

1. INTRODUCTION

In the pumping stations from the water supply public utilities, the pump motors run at constant speed, the water pressure being adjusted by starting and stopping them, depending on the consumption. This is an adjustment method unsatisfactory and inefficient. The energy consumption is high, because the average pressure is unreasonably excessive, and a high pressure variation can be noticed at the consumers. Additionally, the pressure shocks cause the fast wear of the pipes.

Some local monitoring methods are used in the course of certain stages of the process of supplying with water some locality, [1], [2], [3], but there is no system including the monitoring, control and dispatching on the entire route, from basin input up to the consumers

The known methods have some disadvantages:

- the method of adjusting the pumps by starting and stopping them depending on the consumption is unsatisfactory and inefficient and energy consumption is high;
- high variation of pressure is noticed at the consumers;
- pressure shocks lead to the fast wear of the pipes;
- local control systems are not able to track continuously the water distribution, on the entire route, from its coming into the basins up to the consumers;
- the commands are lately done, after contacting the central dispatcher and being confirmed a certain situation within the water supply station;
- is not posssible to have a record of the process state changes in diaries of events;
- is very difficult to have operative reports drawing up and presentation.

2. WATER SUPPLY SYSTEM

The modern driving system is a part in a centralized monitoring and control system for the operation of the equipment from the pumping station from Simnic – Autonomous Administration of Water – CRAIOVA and has been achieved within the AMTRANS program

of the National Plan for Research, Development and Innovation. The general objective of this project has been the improvement of the distribution parameters of supplying the Craiova City with water. By implementing this project, the electric drives of the motors from the pumping station have been modernized, the functional technical parameter monitoring, dispatching and control has been assured by specialized equipment

The centralized monitoring and control system of the pumping station equipment operation enables the optimal operation of the driving system, increase of plant and equipment reliability and endurance, thus leading to the efficient use of energy and optimal administration of the drinking water [4].

One of the main objectives of this project was to propose a solution for an integrated information system type Decision Support System –SCADA, based on the technological process analysis, operative management and operation, reliability conditions and requirements. This solution leads to an optimal management of the technological process and a higher operational reliability for the drinking water distribution. Thus, a modular, configurable, system, opened to the technological process monitoring and control and for informing the decision factors is carried out, under a format specific to the responsibilies and working place.

On the whole, the unified system should assure the following functions:

- carrying out the pump control and the reduction of energy consumption;
- following permanently, in real time, the condition of technological parameters and energy consumption;
- offering information to the factors responsible for taking the optimal decision
- providing the information flux necessary to the management

The system consists in the characteristic quantities (water level in basins and pressure in distribution pipes) acquisition from the transducers, acquired data processing and displaying, transmission at the level of central dispatcher, also the tracking of station operation by means of the dynamic synoptic diagrams. Depending on the value of the signal picked up from the main water supply pipe, the system controls the motors driven by soft-starters and carries out the fine adjustment of the speed for the motor driven by the static frequency converter, with a view to keeping the monitored quantity at a constant, pre-set value. The monitoring and control system of the pumping stations controls the adduction subsystem made of water basins and supply stations for cities.

2.1. ADDUCTION AND DISTRIBUTION

The adduction subsystem is composed of the water basins and supply station for cities.

By automating and controlling the basins, it is assured the pump centralized supply, basin level tracking, surveillance of pump on/off/ fault condition, and of instantaneous and metered flow rate. The proposed solving way for automating the water supply station consists in a distributed, hierarchical, real-time system, containing the following functional blocks:

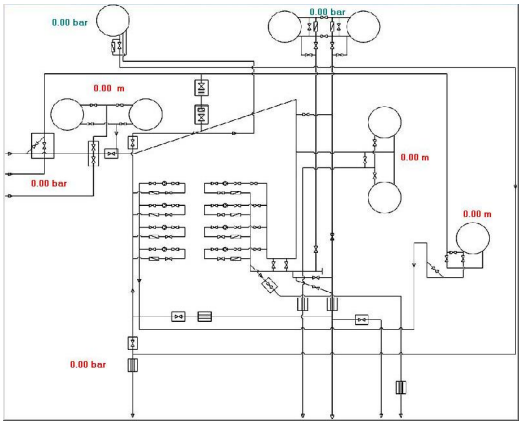

Fig.1 Diagram of the water station from Simnic

- signal matching block, made of control loop transducers, enabling to bring the process signals into the range of unified signals, able to be taken over by the computing system interfaces;
- local equipment for data processing, enabling the automatic acquisition of the parameters, primary processing, keeping within the limits, display of the local operative situation, alarms when the limits are exceeded, communication with the superior hierarchical system .
,
- central equipment, having a role in the entire system

supervision, superior data processing, system diagram display, synoptic diagram display with real-time tracking for each local dispatcher (Fig.1), issuance of the Tracking Report, operative account drawing up.

For the distribution network, a system for tracking the pressures (and flow rates) is carried out in important points of the network. The local equipment is connected with the local dispatcher by a radio station. At central level, the parameters are tracked by synoptic and graphical diagrams, setting up at the same time a database. Operative statistical accounts and data transmission to the decision factors are periodically carried out.

The static frequency converters (Fig.2) supply with variable voltage and frequency the asynchronous motors of the water pumps, thus providing the change of the speed between zero and the rated speed.

Fig. 2 Converter

3. CENTRALIZED MONITORING

The central equipment has a role in the entire system supervision, data processing, system diagram display, synoptic diagram display with real-time tracking for each local dispatcher (Fig.1), issuance of the tracking Report, operative account drawing up.

3.1. MONITORING AND CONTROL SYSTEM

This system provides:

- monitoring and controlling the technological process
- acquiring and processing the data coming from transducers
- keeping the acquired quantities within technological limits, alarming when these limits are exceeded
- controlling the pumps, the adjustment being done depending on the flow rate or pressure within the drinking water distribution network;
- carrying out the Tracking Report and specific Reports;
- presenting the database and archive content, with the possibility to complete/change it
- assuring the information support by setting up and maintaining a reliable and complete database and informing the decision factors with a view to taking the optimal required measures;
- increasing the operation safety and increasing the technological efficiency (the continuous surveillance includes the surveillance of technological conformity)
- providing the possibility to be configured and extended
- administrating and managing the system in a centralized manner

3.2. SOFTWARE SUPPORT SUBSYSTEM

The software support of the system fulfils the following major requirements:

- Assurance of an information support by creating and maintaining a reliable and complete database ;
- Coherent information flow ;
- Communication between the system components, in a manner transparent to the users

- Offering of a general view on the distributed system and protected access to its components and easy information presentation to the users ;
- Availability and operation under acceptable conditions, even when some components have failed; safety in keeping the information;

The proposed system is based on the conception of *distributed and open system*, able to be adapted and extended in successive stages and interfaced with applications, so as to fulfill the requirements of a modern system. The system should offer information to the departments having a role both in the operative management of technological process and also in decision taking.

3.3. PUMPING DRIVING - PROGRAM

The pump control of the drinking water distributed to city is done by means of inverters/soft starters, the adjustment being done depending on flow rate or pressure. The control and adjustment logic is carried out with a programmable automaton, integrated within the control loop. The converter supplies with variable voltage and frequency the asynchronous motors of a water pumps, thus providing the change of the speed between zero and rated speed. These converters are designed so as they comply with most of the general drives with asynchronous three-phase motors requiring high torques over the entire range of frequency variation. The converters are able to operate under the following working duties: manual and automatic. Under the manual working duty, the speed adjustment can be done either from a potentiometer, or by pushing one of the two keys C. UP (command for speed increase) and C.DOWN (command for speed decrease).

The following should be taken into account :

1. The motor changes its speed as long as the button is kept pushed.
2. The commands for speed change can be locally or remotely (max. 100 m) given

Under the automatic working duty, the converter operates in closed loop, the feedback signal taken over from the system (0 – 10 V or 4 – 20 mA) determining the speed adjustment so as the prescribed value for the adjusted parameter (pressure, flow rate) is kept.

The centralized monitoring and control system is presented in Figure 3.

The main element of the monitoring system is the process automaton, where the primary information taken over by the transducers from the water basins and supplying pipes are sent to the block for signal matching, which enables bringing the process signals within the range of unified signals able to be taken over by the interfaces of the computing systems.

The process automaton comprises the control unit with the equipment for data processing, where the automatic acquisition of parameters, primary processing, keeping within limits, alarms when the limits are exceeded, operative account displaying in station are done.

With the information processed in the control unit, the regulator, located within the control loop, carries out the adjustment logic of the static frequency controller; by the digital output block it is performed both the control of static frequency converter and the control of soft starters by means of which the pump motors are started.

At a pumping station with many pumps, a static frequency converter controls the speed of a single pump, the other ones working constantly and being started or stopped, as it is required, by means of the soft starters. The static frequency converter adjusts automatically the pressure at the general output of the pumping group, depending on the water flow rate variations. The adjusting method consists in varying gradually the speed of one motor, in order to keep the pressure constant.

The static frequency converter (6) supplies with variable voltage and frequency the asynchronous motors of the water pumps, thus assuring the change of the speed between zero and rated speed.

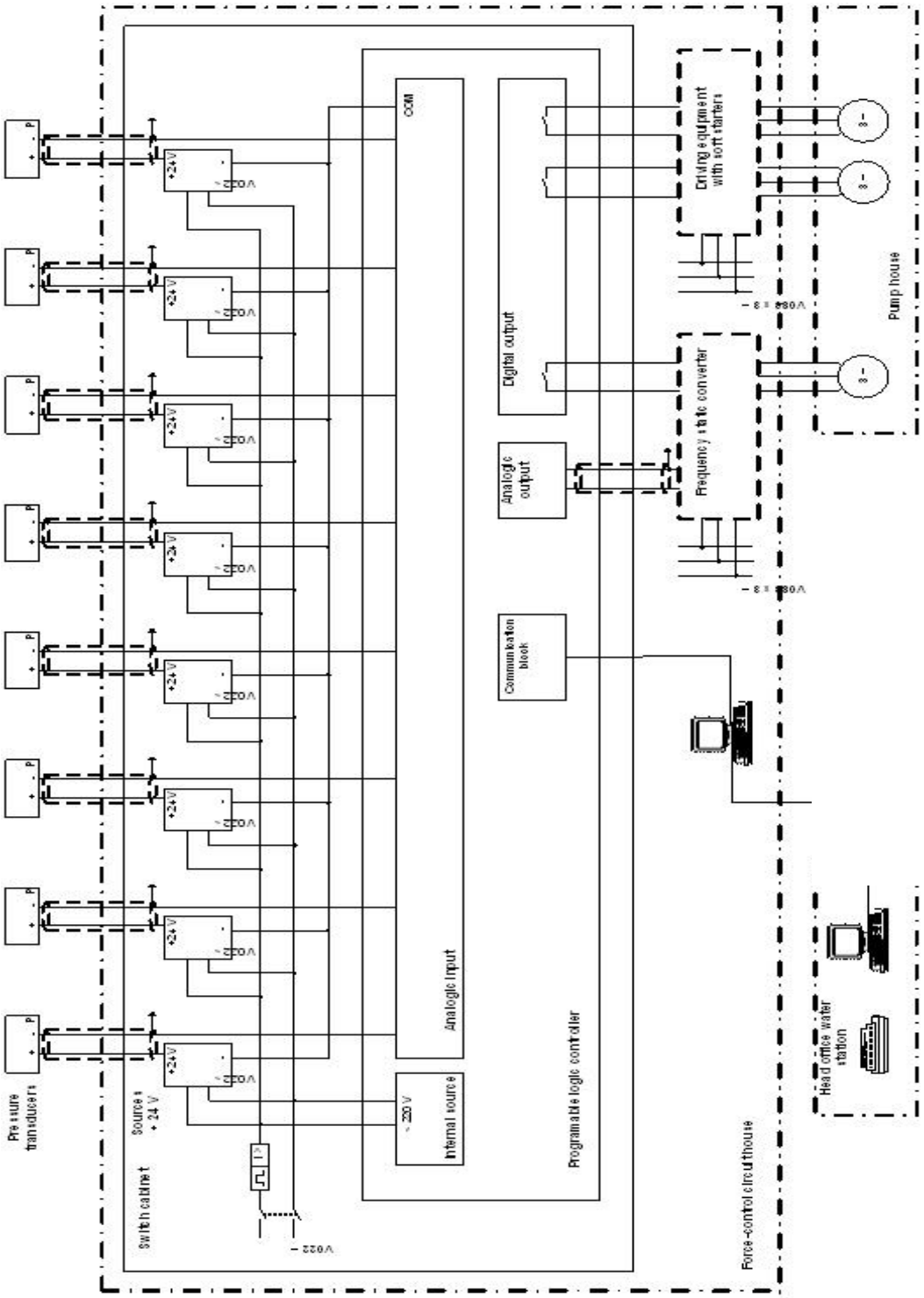

Fig. **3** The monitoring and control system of the Water Station from Simnic

At the same time with the increase of the consumption over the maximum flow rate given by only one pump, the system passes the respective motor to the network, supplying it at rated voltage, and starts the second motor, whose speed will be adjusted further on. The process is repeated for all the motors, until reaching the maximum flow rate. The sequence is inversely repeated when the demand decreases. The static frequency converter operates in closed loop, the feedback signal taken from the system determining the speed adjustment so as the value prescribed for the adjusted parameter (pressure or flow rate) is maintained. The control with

static frequency converter causes a practically shockless adjustment of pressure on an extended range of the flow rate. The costs are minimized, since the rated power of the static frequency converter is reduced as compared to the installed power of the system.

The primary data processed in the signal matching block, regulator and digital output block are transmitted to the control unit located in the engine room, and from here further on, through the communication module to the local dispatcher placed in the office of the chief of the water station.
At the local dispatcher, the local operative account from the respective water station can be displayed and the centralized supply of the pumps, tracking of basin level, tracking of pumps on/off/ failure condition, tracking of momentary flow rate and metering are provided.

4. CONCLUSION

The aim of this project implementation is to apply the modern solutions for the electrical drives of the motors from pumping stations, to modernize the existing pumps, to monitor and control the technical functional parameters by specialized equipment, thus obtaining many technical and economical advantages:
- a centralized system for monitoring and controlling the operation of the equipment from the pumping stations, enabling the optimal operation of the pumping system will be carried out;
- the reliability and endurance of equipment and plants will increase;
- the distribution parameters of supplying the citizens from the city of Craiova with drinking water will be improved, simultaneously with the price lowering;
- the period of water supplying for the residential districts Craiovita Noua, Brazda lui Novac, Calea Bucuresti, Centre will increase from 14 hours to 16 hours per day;
- the intervention time in case or failures or damages will increase;
- the professional training of the personnel from the pumping station will be improved;
- the energy efficiency of the pumps in operation will increase .

By applying the project results, a reduction of the yearly energy consumptions of about 10% .

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