TECHNICAL SOLUTIONS REGARDING THE REHABILITATION OF THE IRRIGATION SYSTEM UNDER THE OUAI ”AQUA” NORTH SOLONEŢ BIVOLARI

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Abstract
The pumping and pressurization SPP 1.b, situated on the Tabăra - Trifești – Sculeni (Iasy County) arrangment of irrigation has been put into operation in 1983 and it serves an area of 1428 ha. Being nearly 30 years old, the hydro mechanical installations and the related electrical installations have accumulated a high degree of wear.The technical rehabilitation and modernization of the structural and functional elements of the hydrotechnical works performed for water pumping aims to reduce them to the initial operating parameters, but also to modernize them, according to the current location requirements, modern technology in the field of execution technologies currently used. It was necessary to redesign some basic parameters for the hydromechanical technological lines, but also for the auxiliary technological lines. Thus, it was decided to replace the electric pumps, with some new generation, with higher efficiencies, the introduction on each pumping stage of 1-2 pumps with variable speed, to reduce energy consumption and modernize the pumping process. The fittings (water tapss, valves) have been replaced with modern variants, facilitating the optimal operation with a high hydraulic efficiency. The pipes on the internal network have been replaced, the measuring and control equipment has been rehabilitated. A monitoring and automation system has been introduced to monitor the operating process.

Key words: rehabilitation, irrrigation systems, E.U. funds

The Organization of Water Users for Irrigation "AQUA" Soloneț-North-Bivolari was established in 2004, submitted a project in 2012, in order to access European funds through the National Program for Rehabilitation of the Main Irrigation Infrastructure in Romania Measure 125 a1, in order to obtain the fund for the rehabilitation of the Pumping and Pressurization Station SPP 1.b.

The paper aims to present the technical solutions for the rehabilitation of the components of the entire irrigation station, their operating characteristics, as well as the differences in operation observed after rehabilitation.

MATERIALS AND METHODS

The study and research material is represented by irrigation systems within OUAI „AQUA” North Soloneţ-Bivolari, which operate on a surface of 1428 hectares, in Iași county. Pumping station serving these lands - Pumping and pressurization station SPP 1.b. - is part of the Tabăra-Trifești-Sculeni Irrigation Development. (*figure 1*) The irrigation system is supplied with water taken from the Prut river and pumped with the SPA Soloneţ supply station through the CR 1.b pipe to the SRP1 pumping station.

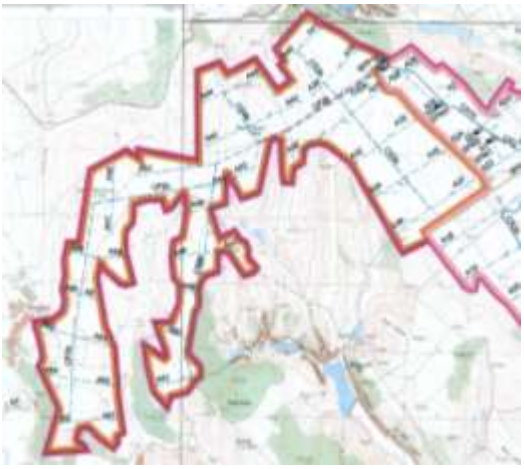

Figure 1 ***OUAI „AQUA” North Soloneţ-Bivolari***

From here the water is pumped back through the discharge pipe CR 2.b then transported through the open supply channel with trapezoidal section Ca 1.b to the pumping and pressurizing station SPP 1.b. The entire arrangement is located in the Prut meadow.

It was put into operation in 1983 and is made in the wet chamber type, without superstructure.

For this reason, the electrical equipment (electrical installations, cells and switchboards) are mounted in an adjoining building, located in the same fenced enclosure.

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The current paper presents the results of research conducted within the project Modernization and refurbishment of pumping stations for irrigation of "AQUA North Soloneț-Bivolari, Iași County.

The research method is the one used to carry out the technical expertise for the objectives of rehabilitation of irrigation systems with water distribution at the pumping stations using a network of canals.

The data processing followed the methodology used in the technical and scientific analyzes developed for irrigation systems with canal and pipe networks.

RESULTS AND DISCUSSIONS

The industrialization of agriculture determined a remarkable development of the irrigation systems, after 1965, to which the development of hydraulic systems also contributed.

In the organization of irrigation systems, the irrigation plots were the basic unit of the system. Each plot had a structure for capturing, transporting and supplying water. (Cazacu E. and contributors, 1982; Blidaru V. and contributors, 1982).

After the 1989 Revolution, more precisely after the application of the Land Fund Law, the small landowners did not have the financial power to maintain and operate the irrigation systems, so most of them were taken out of operation, deteriorating over time. (Grumeza N., Klepș C., 2005).

This scenario was found in most areas of the country, implicitly in the area of Moldova.

Some private operators have tried to develop the irrigation structure themselves, but have not had the financial strength to support a project of this magnitude. (Cismaru C., 2004)

With the emergence of the Organization of Irrigation Water Users, where a group of entrepreneurs have joined forces, funding projects have been submitted from European funds.

The National Program for the Rehabilitation of the Main Irrigation Infrastructure in Romania meets some measures from the irrigation sector within the National Rural Development Program (PNDR).

Within the SPP 1.b pumping and pressurization station, the irrigation system is supplied with water taken from the Prut river and pumped with the SPA Soloneț supply station through the CR 1.b pipe to the SRP1 pumping station. From here the water is pumped back through the discharge pipe CR 2.b (characteristics: PREMO 1000 mm, L = 630 m) then transported through the open supply channel with trapezoidal section Ca 1.b (L = 2305 m, slope pier 1: 1, 5) to the pumping and pressurizing station SPP 1.b. (Documentation 2012).

Technical condition of the installation, before rehabilitation:

The connection between the Ca 1.b channel and the pump station advance was provided by a suction basin at the end of the channel. The anteroom had a common body with the tank of the pumping station, and the platform of the station located at an altitude of 141.5 mMB. The dimensions of the tank are width = 2.88m, Length = 6.44m, and the depth of 3.8m.

Because SPP station 1.b had no superstructure, the electrical equipment (electrical installations, cells and electrical panels) were mounted in an adjoining building, located in the same fenced enclosure.

The water was discharged in the buried collectors CP2.b (inner Ø = 800mm) and Cs2.b (inner Ø = 400mm) from which sprinkler irrigation was performed with pivot type installations and reel machine purchased in 2006-2010 .

Basic hydromechanical installations:

Initially, the station was designed to operate on two basic technological lines, with the role of putting pressure on the pipeline networks:

The technological line for the pumping stage I:

- flow rate: Q = 800 l / s
- pumping height: Hp = 84 mCa
- power of the installation: P = 1150kW

The line was equipped with 7 electric pumps, out of which 2 were MA 200x8 type and 5 were MV 253x4 type.

Their characteristics are presented in table 1.

The 7 pumps discharge in CP2.b which, through the network of secondary pipes and the respective antennas, ensures the irrigation of the surface of 907 ha.

Technological line for pumping stage II:

- flow rate: Q = 190 l / s
- pumping height: Hp = 42 mCa
- power of the installation: P = 165kW

The line was equipped with 3 MA 200x8 electric pumps, the characteristics are described in *table 1*.

Auxiliary hydromechanical installations:

- *Tank depletion system*
- *Drainage system for the common discharge pipe*
- Hydrophore system for protection against ram blows

Sieve lifting installation

Electrical installations:

To ensure the supply of electricity in the immediate vicinity of the pumping station, a 1600 KVA - 20/0.4 kv CIPIA ASO-M-20 S transformer

station was provided for servicing the pumps and a 63 KVA-20 / transformer station 0.4 kv for domestic services.

The construction of the pumping station, the main installations, as well as the secondary ones were in operation for about 30 years, intermittently in the period 1989-2012, so that the degree of wear and aging was differentiated on the structural components.

The pumping technology line had a degree of physical and moral wear, operating with low efficiency and very high energy consumption.

The network of internal pipes showed a very high degree of wear, after 30 years of operation. The network of buried pipes allowed large water losses due to chemical corrosion of the metal and obsolete service life.

The auxiliary technological power supply line, presented the risk of some damages.

Being operated for a very long period the electric motors driving the pumps had a high degree of physical and moral wear, operating at low efficiencies.

The connecting pipes of the pumping station to the network of the irrigation plot had an exceeded service life.

Considering the advanced state of wear of the structural and functional state of the components of the pumping station, of the pipe networks in the connection area it is necessary to apply measures to rehabilitate the buildings, modernize the technological lines, in order to increase efficiency, reduce water losses and reduce electricity costs.

In the analysis of the risk of the rehabilitation works of the SPP 1.b station, the following factors were identified: (Chirica Ştefania, Luca M., 2017 Luca M., 2016, 2020)

- The quality and the way in which the various studies were elaborated: geodetic, topographic, seismological etc

- Technical quality of the project, in the implementation stage: feasibility study, technical project, some specifications, etc.

- Natural risk factors, as well as anthropogenic ones: geophysical damage, calculation of parameters, choice of materials, etc.

- The professional quality of the work team.

Proposals for rehabilitation:

Following the feasibility studies, the following rehabilitation measures were adopted:

a) Rehabilitation of hydro mechanical technological lines, by:

- Replacement of electric pumps with new generation ones with higher efficiencies;

- Modernization of the pumping process, by replacing on each stage 1-2 pumps with variable speed, thus reducing energy consumption;

- Rehabilitation and modernization of fittings, obtaining a high hydraulic efficiency;

- Rehabilitation of the equipment for measuring and controlling the functional parameters of the pumps, the network of internal and external pipes;

- Introduction of a system for monitoring and automation of the operation process of the station

b) rehabilitation and modernization of the auxiliary electrical technological line, by:

- changing the electric motors of drive the pumps with some with high efficiency and the level of current technology

- rehabilitation and modernization of the pump supply system (electrical panels, cables)

- introduction of a monitoring and automation system

- rehabilitation of the construction which includes: cells, transformers, power supply and distribution panels;

c) Rehabilitation and modernization of the auxiliary technological line for ram protection, by:

-rehabilitation and modernization of the hydrophore installation on structural components: tank, piping, fittings, valve, compressor;

-modernization of ventilation aeration-deaeration devices.

d) Rehabilitation and modernization of constructions on the technological line of aspiration, by:

- rehabilitation of the pumping station tank, through restoration works of the concrete structure, the waterproofing plaster and the external protection one;

- rehabilitation of the grill installation;

-rehabilitation of the access area to the station tank and connection to the CA1b channel, by restoring the waterproofing and unclogging system.

e) Rehabilitation and modernization of the connection area of the pumping station with the irrigation plot network:

- rehabilitation of connection constructions, at constructive and functional level (manholes with bypass and adjustment fittings)

-rehabilitation of pipes, in order to avoid water losses;

- installation of a water meter at each pumping stage, for a more correct management of the water consumption

The duration of the investment was 12 months.

Actions during the project implementation phase:

A. The following equipment, installations and systems were ***purchased***:

1. Vertical centrifugal pumps with stainless steel rotor and diffuser, with isolation valves, check valve, pressure gauge and pressure sensor, with height-adjustable vibration dampers, including command and control panel, accessories: electric head, one-way valve, etc., as bellow:
- 2 pcs. vertical centrifugal pump, having Q = 180 m3 / h, H = 84 m3A
- 5 pcs. vertical centrifugal pump with Q = 180 m3 / h, H = 84 mca
- 3 pieces of vertical centrifugal pump, having Q = 300 m3 / h, H = 65 m3
2. Hydrophore container V = 30 m3, Pn 12 - with rubber membrane pre-loaded with nitrogen, all accessories;
3. Burglar and fire detection, alarm and event recording system, Electronic video surveillance and image recording system via CCTV
4. SCADA system for process administration and supervision.

By monitoring the sectors, a series of data are obtained that establish the investigation areas to identify possible defects that may occur in the network of channels and pipelines. (Chirica Ștefania et al., 2018)

5. Modern watering equipment, which completely covers the irrigation of 1428 ha.

B. The following ***rehabilitation works were carried out on the critical section of the CP2b pipe***, with a total length of 2415 m of helically welded steel pipe, Dn 800 mm

Earthworks embankment:
- Land clearing
- Mechanical and manual excavations,
- Mechanical and manual fillings;
- Removal of excess embankments;
- Leveling the land surface after finishing the works

Construction works:
- Making pipes
- Installation of PVC signaling grid
- Compacted ballast layer for road restoration of exploitation roads
- Reinforced concrete chimneys for connections
- Massive anchors
- Removal of PREMO and AZBO pipes for restoration of connections
- Dismantling pipes and metal fittings
- Metal fabrications and fittings
- Sequential pressure tests
- General pressure test

C. Rehabilitation works of the station:

Construction works: earthworks, constructions, insulation, according to the project.

Installation works of electrical installations, heating, ventilation, air conditioning installations, provided in the project.

D. Modernization works in the rehabilitated spaces:
- computerization / dispatching of the station
- installation of the electronic security system of the station

As for modern watering equipment, it includes:
- Central pivots,
- Frontal watering systems,
- Reel machine

The technical characteristics of the installations within "Aqua" Soloneț - Nord Bivolari are shown in *tables 2, 3*.

They are especially effective on soils and crops that require frequent and low watering;

The uniformity of watering on sloping lands is ensured by the devices for controlling the pressure and flow of sprinklers;

The range is 400 m, but the area served, if operating in one position is 50-60 ha.

Irrigation system with reel machine IITF MIDI 100x320:
- Hose diameter: 100 m
- Hose length: 320 m
- Irrigation ramp width: 44 m
- Irrigated width: 52 m
- Folding ramp on the reel machine.

Table 1

The characteristics of the electric pumps before the rehabilitation of the station

Technological line stage I		Technological line stage II
Characteristics of electric pumps, MA 200x8 type	Characteristics of electric pumps, MV253x4 type	Characteristics of electric pumps, MA 200x8 type
L= 3315 mm	L= 3450 mm	L= 3610 mm
Q=50 l/s	Q=140 l/s	Q=64 l/s
Hp=84 mCa	Hp=84 mCa	Hp=42 mCa
N=1500 rot/min	N=1500 rot/min	N=1500 rot/min
Electromotive AS 280 s VI-4 type	Electromotive MIB-V-S85 F 600-4 type	Electromotive ASI 280 M- VI-4 type
N=75 kW	Nr=200 kW	N=55 kW
U= 380/660 V	U= 380/660 V	U= 380 V

Table 2

The characteristics of the irrigation installation Pivot Mobil de 400 m and 350 m type installed after station rehabilitation

Characteristics	Irrigation installation Pivot Mobil 400 m:	Irrigation installation Pivot Mobil 350 m
Length of the installation	399 m	348m
Irrigated length	429 m	378m
Pipe diameter	6 5/8”	6 5/8”
Beam length	54,57 m	54,57 m
Console length	20,12 m	20,12 m
Maximum slope	12%	12%
Control pannel	Field Basic	Field Basic
Total flow	195 mc/h	156 mc/h
Pivot inlet pressure	2,5 bar	2,2 bar
Pluviometric	8mm/24 h	8 mm/24h
Voltage required	380V/13 kVA	380V/13 kVA
Power required	6,05 KW	5,5 KW

Table 3

The characteristics of the irrigation installation system with cu ramps and pivot RP Mobil 400 m and 300 m type II
Installed after station rehabilitation

Characteristics	Irrigation installation system with ramps and pivot RP Mobil 400 m type II	Irrigation installation system with ramps and pivot RP Mobil 300 m type II
Maximum irrigation radius	430,4 m	316,26 m
End cannon watering radius KOMET	30,2 m	33 m
Installation length	395,2 m	286,06 m
7 beam with length of	54,57 m/buc	54,57 m/buc
Irrigated surface in one position	56,8 ha	31,4 ha
Number of pivot positions	2	2
Total irrigated surface	113,6 ha	62,8 ha
Coverage report	88,75%	87,22%
Debit required	142 mc/h	78,5 mc/h
Working pressure	3,5 bar	3,31 bar
Cannon working presure	2,5 bar	2,5 bar
Irrigated surface / hour	3,6	2,79
Rainfall	6 mm/24 h	6 mm/24 h
Electric generator	12,5 KVA	10 KVA
Rotators	Nelsson R 3000 (aspersor)	Nelsson R 3000 (aspersor)
Pressure regulator	yes	yes
Extention cords for rotators	2 pieces	2 pieces

CONCLUSIONS

1. The technical rehabilitation and modernization of the structural and functional elements of the hydro technical works performed for water pumping aims to reduce them to the initial operating parameters, but also to modernize them, according to current location requirements, modern technology in the field of execution technologies currently used.

2. There is a need to rehabilitate the system because its operation was done with high losses of energy and water, mainly due to physical and moral wear of the electrical installation and hydro mechanical equipment in the pressure station SPP1.b.

3. The rehabilitation project was carried out in two stages:

In the preliminary stage, the approval documentation for the intervention works was prepared, with the related field studies and obtaining the necessary approvals. This was followed by the preparation of the necessary documentation to obtain the financing of the project. Procurement procedures and project preparation were organized.

The second stage of the project consisted in the execution of the works provided in the project, as well as the preliminary and final reception of the works.

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