ANALELE UNIVERSITĂŢII
"EFTIMIE MURGU" REŞIŢA
ANUL XII, NR. 1, 2005, ISSN 1453-7394

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Technical Solutions Concerning the Updating of Reşiţa's Waste Water Plant

The updating of all equipment existing in waste water treatment plants is a major priority for all Romanian public water suppliers (including those of Reşiţa) which have to insure a low level of environmental pollution. In order to obtain a higher quality level for the resulting cleaned water and to insure the performances and the safety required by those strategic industrial objectives, new flexible and reliable command strategies have to be applied both to existing electric equipment already involved and new electric equipment which could be introduced in the future. This paper presents an original technical solution concerning that type of command used for all electrical equipment inside the plant (pumps, valves, etc.).

1. Introduction

One of the most important trends in today industry is to use electronic state of the art equipment in order to command and to control existing electric equipment, machines or tools. This effort leads to important financial advantages (cheaper than buying new modern tools and machines), to a better quality of the final product and a higher safety for the operating personnel, together with more environmental friendly technologies [1].

During the last few years we assist to an increased number of command equipments based on PLC's. PLC's (Programmable Logic Controllers) are today the most common technical solution applied to such equipments due to some obvious advantages [2]:

- the electrical scheme of the whole equipment could be easily modified by changing only some program instructions;
- increased flexibility;
- safety in exploitation;

- improved liability;
- reduced volume;
- it not requires special and periodical maintenance;
- it could be easily programmed by any electrical engineer or technician;
- any command sequence could be virtually verified without any costs or risks.

When the price of all classic electrical equipment replaced is higher than PLC's price, this piece of equipment becomes even economically justified, being cheaper than the old parts changed [2].

In fact, a PLC is a small industrial computer specialised in simultaneously treatment of both combinational and sequential logic instructions. It is equipment which allows connections between a large number of inputs and another large number of outputs.

It simulates the classical wire structure by using logical ports disposed in a flexible and complex structure.

Figure 1 shows us such a PLC, type PS4-201 MM1 produced by the German manufacturer Klöckner MOELLER, belonging to the Low Voltage Equipment Laboratory of the POLITEHNICA University of Timisoara.

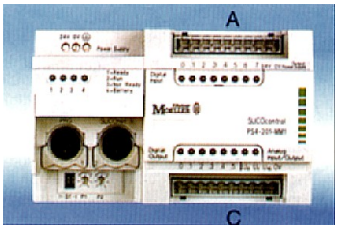

Figure1. The PS 4-201
PLC basic type.

This piece of equipment has 6 digital inputs (marked with an A) and 8 digital outputs (marked with a C). All digital inputs and outputs are 24 V DC and maximum current of 100 mA. This current allows enough power to command a semiconductor device, relay or micro-contactor connected to that output [2], [3].

It also disposes of two analogical inputs and one analogical output all offering an array of 0 - 12 V DC at maximum 100 mA. This PLC disposes of a serial RS 232 communication port which allows program downloading from an external program source (PC or panel). It also has a RS 485 serial communication connector used for PLC connections and an extension module connector for multiplying all the inputs and outputs needed. According to the IEC 1131-3 standard, it accepts all languages compatible with [2]:

- **IL** (Instruction list);
- **LD** (Ladder Diagram);
- **FBL** (Function Block Language).

This paper proposes a technical solution, based on such a PLC, which could be easily applied to equipment operating at Reşiţa's waste water treatment plant.

2. Waste water decanting tank

Reşiţa has an old waste water treatment plant, made during 1960 and 1970. A modern and efficient waste water plant is under construction, located in the same area, near the Bârzava River, between Câlnic and Moniom [1].

One of the most important equipment inside a waste water treatment plant is the decanting tank. Here, water rests until all big and heavy particles are coming down, at the base of that tank. All references will be made according to this new project, which is partially finalized. The new plant will have 3 big decanting tanks. One of those tanks is shown in Figure 2 [1].

Figure2. Main decanting tanks located near Reşiţa.

All technical solutions applied will be useful even for dirty water, coming from heavy industries. The treatment is completed with a mechanical separation part, a biological fermentation part, a fat flotation part and sand evacuation equipment [3].
This paper presents an example of such an equipment (built with cheaper components) which could be used for a small set of commands, reducing the human exposure to chemical and biological pollution, and insuring a safer and better treatment process, with energy efficiency and low costs.

The principle of such a primary radial decanting tank is shown in Figure 3:

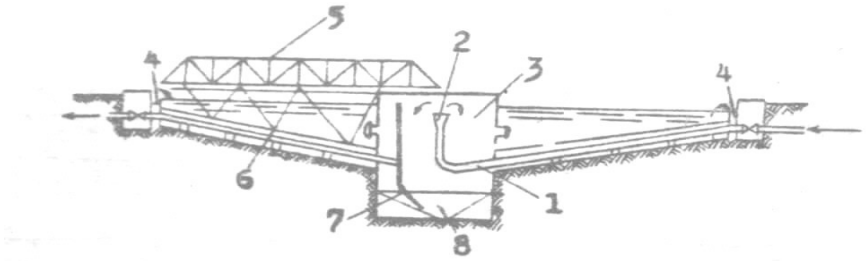

Figure 3. Radial decanting tank.

It

1) Untreated water admission pipe;
2) Central distribution pipe;
3) Deflector;
4) Ring canal;
5) Mobile bridge;
6) Cutting device;
7) Treated water evacuation pipe;
8) Mud tank.

The decanting tank is made of reinforced concrete, located underground, having 25 m in diameter and 2 m of water height inside, with an effective volume of 982 m^3, and a 49 m^2 area. The mobile bridge has a slow speed of two rotations/hour, driven by an electric engine, having a cutting device mounted on it, in order to insure a better mud cleaning.

Untreated water is pumped through water admission pipe (2) located 20-30 cm under water level. Treated water is pumped out through pipe (7). When the mud level is higher, a mud evacuation pump starts running.

3. Main tank controls

This technological scheme could be easily commanded by using a PS4 type PLC . It has its 6 digital outputs connected to some electrical contactors belonging to this treatment plant:

K0 – main power contactor;
K1 – untreated water admission valve contactor;
K2 – empty tank valve contactor;
K3 – treated water exit valve contactor;
K4 – mud evacuation pump contactor;

K5 – bridge engine.

Each contactor is placed in parallel with a control lamp located into the command panel in order to show correct functioning.
PLC's 5 inputs are:

S0 – main reset power button;
S1 – main set power button;
S2 – water maximum level sensor (inside tank);
S3 – mud maximum level sensor;
S4 – mud minimum level sensor;
S5 – empty procedure button.

All operations must be executed as follows, when filter is functioning (K0 activated by pressing S1): First, untreated water pumping station must function at a constant flow (K1 continuously connected when filter functions). In such a normal state, K3 must be connected too, in order to evacuate all treated water. K2 must be disconnected. K5 is permanently connected when in normal state (engine running). When mud level increases (S3 active), K4 is activated in order to pump out the mud deposed, until S4 is active (all mud evacuated). When water level increases (S2 active), empty procedures are running automatically (only K1 is disconnected). The empty procedure is finished by a reset (S0 pressed). A desired empty procedure is made in the same way by pressing S5. When S0 is pressed, everything stops.

The necessary programming sequence made by using the SUCOSOFT S40 dedicated language is shown in the next paragraph [3].

4. Main command program

All details concerning this program are shown between brackets.

```
ld    S1        (pressing the on button)
s     K0        (start)
ld    K0        (when everything works)
s     K1        (untreated water pumping on)
s     K3        (treated water evacuation on)
r     K2        (empty valve disconnected)
s     K5        (bridge engine on)

ld    K0        (when everything works)
and   S2        (when water level is critical)
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or      S4      (desired empty procedure)
r       K1      (untreated water pumping off)
s       K2      (empty valve connected)

ld      K0      (when everything works)
and     S3      (when mud level is critical)
s       K4      (mud evacuation)
ld      K0      (when everything works)
and     S4      (when mud level is low)
r       K4      (mud evacuation)

ld      S0      (emergency button pressed)
r       K0
r       K1
r       K2
r       K3
r       K4
r       K5      (everything stops)
```

5. Conclusions

Inside this paper, we used a small example (based on Reşiţa's water decanting tanks) to demonstrate that PLCs are fully recommended for command and control of all waste water treatment plants. A small program sequence introduced to a PLC could replace many electrical apparatus involved in a classic scheme. It could increase safety, liability of all pieces involved at a lower maintenance cost, with interchanging possibilities and a high environment protection. No major changes have to be made in the command scheme in order to apply this technical solution. The program sequence could be easily verified virtually, before being applied at the plant.

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