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A FEW ASPECTS CONCERNING THE COMMAND AND CONTROL OF A WASTE WATER TREATMENT PLANT

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ABSTRACT

The updating of all equipment existing in waste water treatment plants is a major priority for all Romanian public water suppliers 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.), based on a Möeller PS4 industrial PLC.

Keywords:
command, control, treatment plant , waste water

1. INTRODUCTION

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:

- 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.

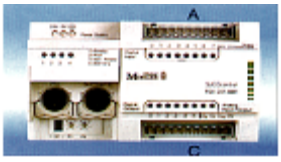

Figure 1: the PS 4-201

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.

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 IEC 1131-3, it accepts all languages compatible with:

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

2. WASTE WATER TREATMENT STATION COMPONENTS

The structure of a small wastewater treatment station is shown in Figure 2. This small installation is used for less than 100 people communities with a very high efficiency rate. It was designed by the American SPENCER Company and assembled under licence in Europe by DEUTSCHE GERATEBAU in Germany [1].

It includes [1]:

A - waste water receiving chamber;
B – primary sedimentation compartments;
C – secondary sedimentation tank;
D – biological treatment compartment;
E – aerobic mud stabilisation chamber.
Water is circulated between;
1 - waste water entrance;
2 - clean water evacuation;
3 – inside water agitator.

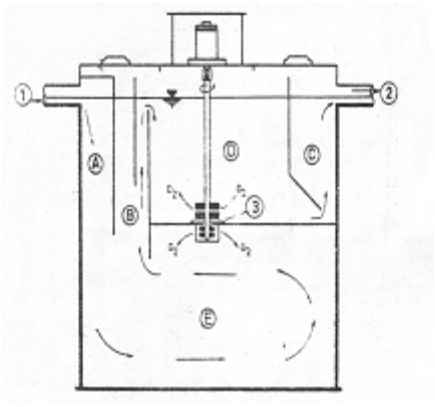

Figure 2: Low capacity waste water treatment

3. WASTE WATER TREATMENT STATION COMMAND

This technological scheme could be easily commanded by using a PS4 type PLC, which has its 8 digital outputs. No extension modules are needed for such a simple process. Only six of them are connected to some electrical contactors belonging to this waste water treatment plant:

K0 – main power contactor
K1 – contactor for pumping engine on entrance 1;
K2 – contactor for pumping engine on evacuation side 2;
K3 – contactor for circulating engine 3;
K4 – contactor for oxygen pump;
K5 – contactor for mud evacuation device.

Each contactor is placed in parallel with a control lamp located into the command panel in order to show correct functioning.

PLC's 6 inputs are not totally used. Only 4 of them are involved:

S0 – main reset power button;
S1 – main set power button;
S2 – tank maximum level sensor;
S3 – maximum oxygen concentration sensor;

All operations must be executed as follows, when plant is functioning (K0 activated by pressing S1):

First, pumping station 1 must function at a constant flow (K1 continuously connected when plant functions). Water is pumped up until tank is filled in receiving chamber A (S2 is activated). Water must remain inside primary sedimentation compartments for at least 30 minutes. After that water is again pumped up by using the number 3 engine connected through K3. Water is introduced in the secondary sedimentation tank where it remains for at least 15 minutes. After that, water is pumped again with the same number 3 engine and introduced into the biological treatment compartment. All the mud produced after sedimentation is aerobic stabilised for stabilised for at least one hour before being evacuated. Oxygen is pumped continuously until concentration overflows (S3 activated). Everything stops when S0 button is pressed (for normal and accidental stops)

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

```
ld      S1
s       K0                                          (start)
ld      K0
s       K1                                          (pumping on waste water on entrance)
ld      S2                                          (tank filled in receiving chamber)
r       K1                                          (stop pumping waste water)
st      sedimentation1
cal     sedimentare1(in:=sedimentation1,pt:=t#1800s)  (start  primary sedimentation procedure for 30 minutes)
ldn     sedimentare1.q
s       K3                                          (stard moving existing water to chamber 2)
s       K1                                          (pumping on waste water on entrance)
ld      S2                                          (tank filled in receiving chamber)
r       K1                                          (stop pumping waste water)
st      sedimentation2
cal     sedimentare1(in:=sedimentation2,pt:=t#900s)   (start  primary sedimentation procedure for 30 minutes)
ldn     sedimentare2.q
s       K3                                          (stard moving existing water to chamber 2)
s       K1                                          (pumping on waste water on entrance)
ld      S2                                          (tank filled in receiving chamber)
r       K1                                          (stop pumping waste water)
st      biologic
cal     bio1(in:=biologic,pt:=t#3600s)              (start  primary sedimentation procedure for 30 minutes)
s       K4
s       K2                                          (clean water evacuation)
ldn     bio.q
s       K5                                          (mud is evacuated)
r       K4                                          (oxygen is stopped)
ld      S3                                          (oxygen concentration overflow)
r       K4                                          (stop oxygen)
s       K3                                          (stard moving existing water to chamber 2)
s       K1                                          (pumping on waste water on entrance)
ld      S2                                          (tank filled in receiving chamber)
r       K1                                          (stop pumping waste water)
ld      S0
r       K0
r       K1
r       K2
r       K3
r       K4
r       K5                                          (stop all)
```

4. CONCLUSIONS

PLCs are fully recommended for command and control of 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, fiability of all pieces involved at a lower maintenance cost, with interchanging possibilities. 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.

References

[1] DIMA, M., *„Canalizări. Epurarea apelor uzate”*, Editura Universităţii „Gh. Asachi” din Iaşi, 1998

[2] VASILIEVICI, Al., ANDEA, P., *“Aparate şi echipamente electrice”*, Editura „Orizonturi Universitare”, Timişoara, 2002;

[3] *“Language Elements for PS- 4, SUCOSOFT S40 Software and Documentation”* Klöckner MOELLER 1997