STRATEGIC MODELING OF WATER DISTRIBUTION NETWORK IN BUCHAREST

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Abstract

The paper presents aspects of designing The Strategic Model of the Water Distribution Network of Bucharest.
The mathematical model, created in SynerGee software, represents the peak of rehabilitation and modernization for the water supply network: The GIS foundation for the distribution network, the partition and division of the distribution network by installing flow-meters, clients consumption data base, the rehabilitation of water pump station with automated parameter monitoring installations, implementation of a SCADA software for the water supply network.

Stages of the model consisted of: importing GIS base distribution network, and designing and correction distribution network, the location of the valves and the regulating district. Modeling pumping stations must take into account the type of pump hydraulic parameters and the speeds measured for each pump. The calibration model was developed following measurements in the network and the pumping stations. Elements of originality consisted in the determination and allocation of water loss in each district based in part on water balances in place, and the large amount of measurements made.

For large distribution systems errors may be important, at any time of measurement can appeared discontinuity elements, damage, non-permanent flow of water in the system.
The model developed can not fully answer the question of chlorine in the system dynamics due to process complexity. In this case it is recommended to analyze the dynamics of chlorine in water supply systems in smaller districts, uniform characteristics as material, diameter and age of water in the system
The results presented in this paper allowed a decrease of exploitation costs, by adopting a relative constant pressure values in the system, by manipulation of valves, investment reduction by dimension of specific sections of arteries being in rehabilitation, high quality of the water delivered to the consumer, measures needed for reduction of the impact caused by damaged pipes and there rehabilitation.

Keywords: water distribution network, rehabilitation, consumer

1. INTRODUCTION

Water supply to communities is achieved through complex systems in which components are intercommunicate between him, the environment and beneficiaries. In this context explains the dynamics of functional systems for water and the need to establish relationships that allow safe operation with minimum resources. Diversity issues, in these systems specialists require a separate approach to each element of the system and establish the functional element upstream.
The water network of Bucharest is composed from:
- 3 water treatment plants:
*Rosu: Qmax=500.000 mc/d, suction-coagulation (Advanced) - flocculation-settling-filtration-disinfection with chlorine gas, source Arges River
*Arcuda: Qmax=600.000 mc/zi, coagulation – filtration - disinfection with chlorine, the source of the Dambovita River
*Crivina: Qmax= 240 000 mc/day); Pump-treatment with ozone-coagulation (Advanced) - flocculation-sedimantations - filtration-disinfection with chlorine, the source of the Arges River
- Transport system/ water network: 270 km
- Storage system: 300 000 mc
-Municipal pumping stations related to two separate distribution networks: Drumul Taberei-Precizia- Uverturii and Nord- Grozavesti- Sud-Grivita.

This work presents the implementation and results obtained for the mathematical modeling of transport carrying network pumping stations North-Grozavesti-Grivita -South, which represents about 80% of the total distribution network.

From this distribution network are supplied household, industrial and pumping stations (about 32 stations) and boosters (about 140 stations) that provide consumers of buildings higher than 4 levels.
Modeling was carried out with SynerGee program.

2. OBJECTIVES MODELING

- Knowledge of network distribution
- Optimizing the pumping stations in concordance with the distribution network
- The values of velocity and pressure in water network
- Evolution of water quality parameters, “water age”
- Analysis of network expansion and resizing
- “Scenarios” of events
- Detect areas with loss or abnormal water consumption.

3. STAGES OF MODEL

- Import network of GIS: network, network characteristics, consumption in nodes; about 17 000 nodes; 19000 sections of pipes, 1600 km network
- Designing network D minimum 250 mm, 340 km network.

Fig. 1 Water distribution network in Bucharest (import GIS)

- Registration rates for geodetic network nodes
- Modeling pumping stations: technological schemes (pumps, pressure regulators) pumps operating curve (4 types),
- Set point is the distribution chain: pumping stations, pressure measurement points, flow and chlorine residual
- Positioning valves sector and setting
- Measures flow rates and pressures: two-stage: about 60 points for pressure measurements, over 250 points for flow (pumping stations, distribution chain);
- Determination of water loss trough measurements on site
- Registration measured dates in model
- Model calibration

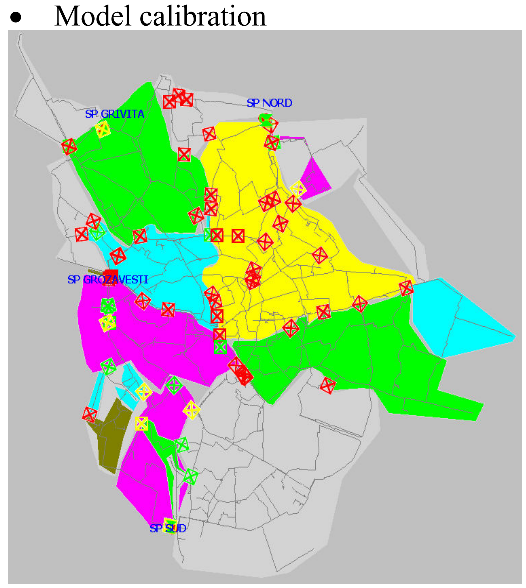

Fig. 2 Designing and zonal division of the distribution network

Calibration pressure simulator was provided because of very low speeds and large diameters analyzed network.
Zonal division of the distribution network and balance calibration flow allowed the determination of water loss on each area separately.
If water quality analysis was performed on the data "quality" with values of key parameters and particularly residual chlorine, determined to treatment plants, pumping stations and about 40 points in the network
Calibration in terms of the indicator "chlorine residual" was not made due to the following aspects:

- The model is made for network system with Dn>250 mm, while most measurements are in network Dn<250 mm.
- Water distributed has variable quality due to transport in aqueducts and storage
- Raw water quality and differentiated treatment schemes involve drinking water results with specific characteristics

Data available about chlorine were processed and interpreted; determined pipeline influence on residual chlorine [3].

$$C = C_0 \cdot e^{-K \cdot t} \qquad (1)$$

C- chlorine concentration at t moment;
C0- initial concentration;
K- reaction rate factor;

$$K = k_b + \frac{k_w \cdot k_f}{R_H \cdot (k_w + k_f)} \qquad (2)$$

K_b- reaction factor (0,85- 1,00)
R_H- pipe hydraulics radius;
Kw- pipe's wall reaction coefficient;
K_f- mass transfer coefficient;

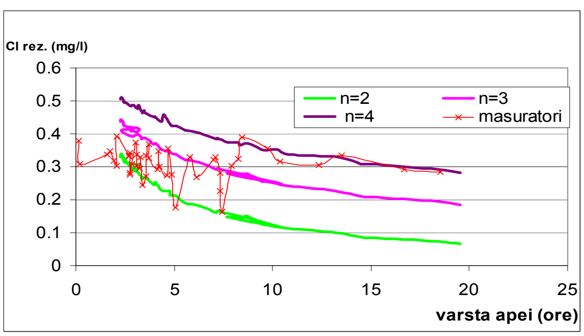

Fig.3 Measured values (in network) and calculated (model) depending on the age of residual chlorine water (kb = 1, n-order reaction)

The analysis of the relationship (2) that in case of network analysis pipeline diameter coefficient K does not significantly influence the reaction of chlorine with water so because of the influence of the pipeline wall is not significant.
Values measured in the distribution network and plotted Fig. 5 showed the influence of diameters and reaction dynamics of chlorine with water elements. Hence it is necessary to analyze water quality in the system to achieve the regional patterns of distribution network.

4. RESULTS AND DISCUTIONS

Running the model developed allowed the diagnosis distribution network and determining measures needed to increase functional reliability and quality of water delivered.
Diagnosed as negative aspects of distribution system:

- The rage of presure in the network relatively variable pressure mainly due to differences in geodetic and small miscarriages.
- "age" of water in the system variable depending on time (due to volumes stored in the network comparable to the daily volume pumped)

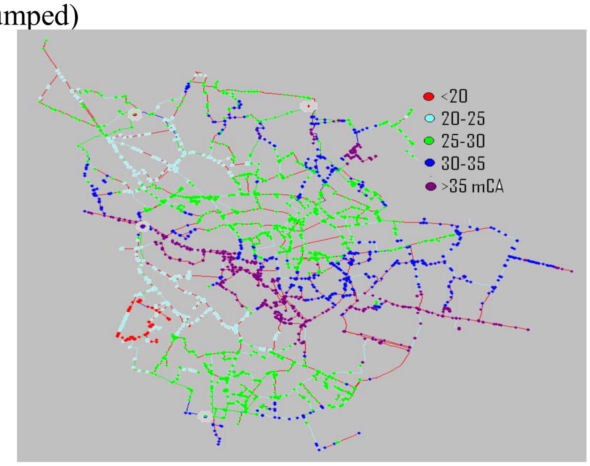

Fig.4 Pressure distribution in network system(at 6.00 AM)

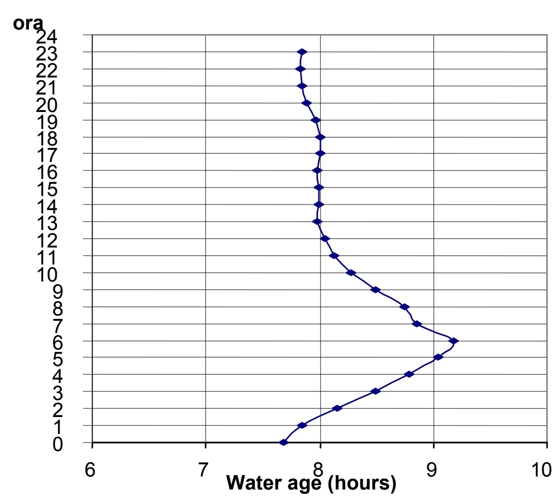

Fig. 5. Average water age in distribution network Dn >250 mm

- low water beach gear with increasing age implications of water in the system
- poor inter-network areas supplied from North and Grivita pumping stations (those located in high geodetic rates)
- have identified areas supplied from two pumping stations (located at rates different geodetic ΔHg> 6-7 m) mixing zones, with implications in decreasing the energy efficiency of pumping stations.

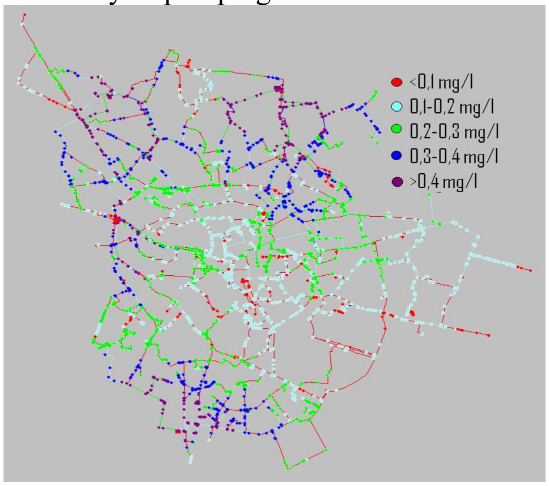

Fig. 6 Dynamics of residual chlorine in distribution network

The values measured and calculated using the model for residual chlorine in water supplied registered variable values. It requires the development of scenarios to establish additional points of chlorine dosing.

5. RULES SET AFTER THE DISTRIBUTION MODEL HAS BEEN MADE CONCLUSIONS

Setting the mathematical model, allowed us to see the functional system of the distribution network and setting the additional parameters for optimal performance. All the tests where made on an existing model:
- tap adjustments in order to standardize pressure, which in fact , were tests regarding the position energy 's control of the pumping station set at great geodesic values;
- setting the interconnection mode of the specific zones belonging to the pumping stations and ensuring the water in case of damage at the pumping stations;
- setting the pressure raising mode in high areas;
- setting the additional dosing points of residual chlorine;
- sizing the pipe sections planed to be replaced;

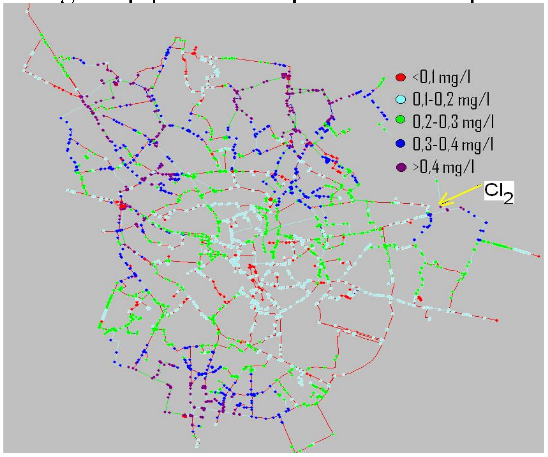

Fig. 7. Residual chlorine dynamics after additional injections.

6. CONCLUSIONS

Distribution networks modeling ensure the knowing of it's functionality, improving the transportation and power efficiency.
For the distribution systems that have monitored the flows and pressures, real-time insurance is set with the accidental losses model, the transportation and power gravel, water losses at the distance network unit.
For modeling the quality of the water that is delivered it's needed to take in consideration the system proportions and the admittance points; solving this problem must be done on uniform segments.
Done models, are perfectible and must respond the dynamic character of the distribution systems.

7. REFERENCES

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