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SOME CONSIDERATIONS REGARDING THE EXPLOITATION OF HYDRO-URBAN NETWORKS IN POPULATED CENTRES AT LOW WATER CONSUMPTION

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Abstract - The paper highlights the effects of low water consumption on the exploitation of hydro-urban networks within populated centers, as well as the measures that are required to combat self-pollution processes, to the prolonged stagnation of water, in the distribution networks, as well as those produced by the anaerobic fermentation of organic matter from the deposits retained on the existing sewerage collectors, with emanations of toxic or explosive gases.

Keywords: water consumption, exploitation of water supply networks, clogging, deposits, water quality deterioration

1. GENERAL CONSIDERATIONS

The hydro-urban systems in the localities of our country were sized for a population growth perspective of 25-30 years, for the wide-perspective works, considering a population growth of 1.40% and of 10-15 years for the phased ones, the increase being 1.15%.

For the design of the water supply systems, the following relationships were used: [3], [4], [5], [8], [12], [20], [24]:

$$Q_{zi.\,max} = k_p \cdot k_s \cdot \Sigma N_i.q_i/1000 \quad (mc/day) \quad (1)$$

$$Q_{zi.\,max} = k_p \cdot k_s \cdot k_{zi} \cdot \Sigma N_i.q_i/1000 \quad (mc/day) \quad (2)$$

$$Q_{o.\,max} = k_p \cdot k_s \cdot k_{zi} \cdot k_o \cdot \Sigma N_i.q_i/1000 \quad (mc/day) \quad (3)$$

$$N_i = N_o (1 + 0.01p)^n \quad (inhabitants) \quad (4)$$

$$Q_l = Q_{zi.\,max} + Q_{r.i} \quad (mc/day) \quad (5)$$

$$Q_i^{'} = 24\, Q_i/T \quad (mc/day) \quad (6)$$

$$Q_e = Q_{o.max} + Q_n \quad (mc/day) \quad (7)$$

Where:

k_p is the increase coefficient for water losses;

k_S - the increase coefficient for the technological needs of the water supply system;

k_{zi} - the coefficient of unevenness of daily consumption;

k_o - the coefficient of non-uniformity of hourly consumption;

N_o - the number of inhabitants in the existing situation;

N_i - the number of inhabitants for the final stage;

q_i - specific consumption norm, in l/man.day;

p - the percentage of population growth, established based on statistical data;

n - the number of years for which the calculation is made (25-30 years for the final stage);

q_i - specific consumption norm, in l/man.day;

Q_l - the calculation flow rate for buildings and installations from the catchment to the reservoir (T = 24 hours);

$Q_i^{'}$ - the calculation flow rate for constructions and installations from the catchment to the reservoir (T< 24 hours);

$Q_{r.i}$ - the flow rate for replenishing the fire reserve;

T - the intermittent operating time of the installations, in hours/day (T= 24);

Q_e - the calculation flow rate for the distribution network with indoor hydrants (Q_{ii}), in l/s;

The socio-economic changes after 1989 were strongly reflected in the demographic decline in Romania, caused by international migration, family planning (births) but also by the high mortality after 1992, with percentages ranging from 11.4% in 1992 to 11.7% in 2015.

According to data provided by the National Institute of Statistics (INS), the population of our country registered, between 1990 and 2024, a decrease of 4.2 million, from 23.2 million to 19.0 million inhabitants. During this period, the migration of Romanians to the EU states was 2.5 – 2.7 million [18].

By the transition from the centralized economy to the market economy, important changes have occurred in all spheres of activity, including that of communal water and wastewater management services, with important implications on the functioning and exploitation of the existing hydro-urban systems in the populated centers, reflected by the significant decrease in the flows conveyed with flow rates well below the allowed ones (v = 0.30 m/s).

The reduction of drinking water consumption in Romania, after 1989, was mainly determined by: the significant decrease in the birth rate; closure of activities on the platforms of industrial units; changing the production profile of economic agents; international migration; the introduction of water metering at the level of each consumer and especially the increase in tariffs for consumed water. These aspects have led to a decrease in water consumption by about 40-45% compared to the estimates considered in the design, water consumption being conveyed through oversized systems, with negative effects on the quality of water conveyed through existing buildings and installations.

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The significant decrease in water consumption on the hearth of populated centers, compared to those considered when designing the hydro-urban systems, is reflected in the way they operate and operate, with significant effects on both the drinking water distribution networks and those for the collection and transport of domestic wastewater.

The operation of water and wastewater supply systems at flows much lower than those considered in the design is very difficult, which is why it is necessary to revise the Water Safety Plans to the specifics of the newly created situations.

2. THE PROBLEMS OF OPERATING THE DISTRIBUTION NETWORKS IN POPULATED CENTERS, IN CASE OF LOW WATER CONSUMPTION

The substantial reduction of water consumption conveyed through the existing distribution networks in populated centers was felt both in the mode of operation and in the maintenance mode by: the qualitative depreciation of drinking water, but also by the significant increase in the prices of consumed water, correlated with the advanced state of degradation of some pipes within the current distribution systems, led to the substantial reduction of transport speeds well below the allowed limit (0.3 m/s), thus favoring the deposits and creating the conditions for the qualitative depreciation of drinking water intended for human consumption [2], [3], [7], [9], [12], [15], [17].

The prolonged stagnation of water in the distribution pipes and connections, above the permissible limit of 7 days, can cause the formation of organic and inorganic sediments that can favor the qualitative depreciation of drinking water, which must be clear/unsuspended, tasteless and healthy/healthy [1], [6], [10], [11], [12], [23], [24].

The significant reduction of flows and flow rates (Q,v) in the distribution networks, with long stagnations, on some sectors longer than 7 days, can determine: sedimentation of organic and inorganic suspensions in the transported water, degradation/depreciation of drinking water quality parameters, but also by the increase of chlorine doses to combat the proliferation of bacterial biofilms, in view of ensuring the state of health in human communities [11], [16], [18].

The self-pollution of drinking water in distribution networks is determined by the probability of emergence and formation of biological ecosystems, when water drains on certain sections, at very low speeds, resulting in a reduction of residual chlorine well below the allowed limit [8], [11].

In order to maintain in good working order all buildings and equipment of the distribution networks, ensuring the consumption flows, the service pressures, the minimum water flow speeds through the pipes, as well as the permissible doses for residual chlorine, the following measures are required: washing, cleaning of deposits and periodic disinfection of pipes for which self-cleaning speeds and minimum doses of residual chlorine are not ensured; weekly opening of the fire hydrants related to pipe sections where water stagnates or flows at very low speeds; arrangement of public cisterns with continuous or intermittent drainage; supervision of the operation and condition of pipes, connecting parts, fittings, accessory constructions, measuring and control devices, etc.; detecting and combating water losses and pressure drops; replacement of old and degraded pipe sections; control and completion of residual chlorine on pipe sections with values below the limits allowed by the technical norms; execution of new connections and revision of existing ones [14], [18], [19], [21], [25].

The disinfection of the pipes that transport drinking water will be done with water containing 20-30 mg

chlorine/l for 24 hours, after which the clean cup is washed. If only a part of the network is disinfected, the solution is introduced into a hydrant by pressure injection, leaving the flow free through other hydrants and service taps related to the network portion, after which the pipes are washed with clean water [11].

The operation of water supply systems and especially those for water distribution in populated centers must be adapted to water consumption much lower than estimated, which is why it is necessary to develop the Water Safety Plan (SAP) to the specifics of the situations created, so as to eliminate the risks that may arise due to the circulation of flows much lower than those expected, so that the water supplied to consumers is of good quality [18], [25].

The Drinking Water Safety Plan is the framework for hazard identification and risk assessment, to provide safe water for human consumption [22], [23].

The technical maintenance of the distribution networks involves ensuring the following operations: preventive inspection and revision; planned current repairs; cleaning and washing operations; preparation for the operation of the distribution system during winter [4], [14], [16].

3. PROBLEMS OF OPERATING SEWERAGE NETWORKS IN POPULATED CENTERS AT LOW FLOW RATES

Sewerage networks collect and transport runoff water from the hearth of populated centers and send it to wastewater treatment plants, or directly into natural outlets, in order to ensure environmental protection, public health and hygiene, to prevent flooding of basements from apartment blocks and traffic arteries within populated centers [4], [13].

The fundamental requirements can be satisfied, only if the prescriptions and regulations in force regarding the design, execution, operation, and maintenance of these installations are complied with.

If significant changes occur, such as those regarding the reduction of the flows taken and transported through the sewerage networks, it is necessary to develop plans to the specifics of the situation, to avoid the impact on the personnel working in this environment.

Accidents can be caused mainly by: poisoning or asphyxiation with toxic gases emanated (carbon oxide, carbon dioxide, methane gas, hydrogen sulfide); explosions due to flammable gases; electric shocks due to electrical cables not properly insulated from the

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electrical network. To prevent undesirable events, the operation and maintenance personnel must be trained.

Workers are obliged to wear appropriate protective equipment (boots, overalls, and gloves. The control and work teams must be equipped with Davis type miner's lamps, gas masks and seat belts, detectors of toxic gases (carbon oxide, ammonia, hydrogen sulfide) or flammable (methane). Before entering the manholes or the sewer, it is necessary to open three covers upstream and downstream in order to achieve a 2–3-hour ventilation, after which the presence of gases will be checked with the help of the miner's lamp. If the lamps go out, artificial ventilation will be used, and the entrance to the dormitory will be made only with gas masks and seat belts, the worker entering the dormitory will be tied with a rope held by a worker located outside. In some cases, there is a danger of explosions also due to the gases that are released from wastewater, or because of fermentation processes that can occur in the sewer collectors [24], [25].

4. CONCLUSIONS

The paper highlights the effects of low water consumption on the operation of hydro-urban networks within populated centers, as well as the measures that are required to combat self-pollution processes, prolonged stagnation of water, in distribution networks, as well as those produced by anaerobic fermentation of organic matter from deposits retained on existing sewerage collectors. with emanations of toxic or explosive gases.

These shortcomings are caused by the demographic decline in population centers, the exodus of people who go abroad in search of jobs, as well as the excessive water consumption for the household needs of people with low and very low incomes.

Within this general context, the hydraulics of the existing water supply and sewerage systems in our country are strongly affected, being reflected by the qualitative depreciation of drinking water from the distribution networks, as well as by the excessive clogging of the sewerage collectors, due to the low drain speeds, well below the allowed amounts.

To combat these shortcomings, it is necessary to update the Water Safety Plan (PSA) for all those localities where water consumption has been significantly reduced.

The work is a practical guide for Water Operators in populated centers.

REFERENCES

1. *E., Barsan*, Water Supply. Performantica Publishing House, Iasi, 2005.
2. *E., Barsan, Gh., Nichita, I., Mirel, A., Anton, M., Ceauşescu,* Simulation programs for the modification of water quality in distribution networks. International Conference: Drinking Water Quality in Water and Wastewater Disinfection Networks – National Report – Romania. Proceedings of the IWA Congress 15-19 Oct. 2001, Berlin.
3. *C., Berevoianu, M., Sandu, A., Anton,* Influence on discontinuities in the continuous supply of drinking water on the comfort and health of the population, Hidrotehnica, Bucharest no. 2-3 /2001.
4. *M., Giurconiu, I., Mirel, A., Retezan, I., Sarbu*, Hydraulics of Constructions and Hydro-Urban Installations. Facla Publishing House, Timisoara, 1989.
5. *M., Giurconiu, I., Mirel, A., Carabet, D., Chivereanu, C., Florescu, C., Staniloiu,* Constructions and h installations. West Publishing House, Timisoara, 2002.
6. *A., Manescu, M., Cucu, L., Diaconescu,* Environmental Sanitary Chemistry. Medical Publishing House, Bucharest, 1994.
7. *I., Mirel, C., Florescu, .C., Panfil, C., Breb*, Some considerations regarding the design and optimized operation of sewerage networks within populated centers
8. *I., Mirel, I., Vlaicu, A., Carabet, I., Sisu, A., Girbaciu*, Considerations on the Pressure and Residual Chlorine Balancing in Water Distributions Networks of Populated Centers. Proc ARA Int. Conf. On Safety of Water Supply Systems and Sewerage, Juni 22-23, Bucharest, Romania, 2006.
9. *I., Mirel*, Good quality water, source of health. AGIR Bulletin, no. 1-2, 2006.
10. *I., Mirel, R., Retezan*, Some considerations on the use of small diameter PVC pipes for drainage on populated health centers. Scientific Bulletin of Politehnica University Timisoara, Transactions on Hidrotehnics. Tom 56(69), Fasc. 1-2, 2010.
11. *I., Mirel, A., Carabet, M., Patrick, C., Florescu*, Self Degradation of Water Quality in Distribution Networks. Scientific Bulletin of Politehnica University Timisoara, Transactions on Hidrotehnics, Tom 56(70), Fasc.1, 2011.
12. *I., Mirel, C., Florescu, C., Panfil, C., Breb*, Some considerations regarding the design and optimized operation of sewerage networks within populated centers. International Conference "Everything for Clean Water" Ed. III, 17 – 18 May 2012 Pitești.
13. *M., Negulescu*, Sewerage, E.D.P. Bucharest, 1978.
14. *I., Pislarasu, N., Rotaru, M., Teodorescu*, Water Supplies, Ed.3, E. T., Bucharest, 1981,
15. *M., Sandu*, Water Quality Correlation – Distribution Network Complex. EXPO APA 2000, Bucharest 5-7 Sept. 2000.
16. *G., Zarnea*, Treatise on General Microbiology, R.S.R. Academy Publishing House, Bucharest 1964.
17. *P., Trofin*, Water supply. Didactic and Pedagogical Publishing House, Bucharest, 1972.
18. Statistical Yearbook of Romania (INS), 2024.
19. Water disinfection to ensure consumer protection.– CNPDAR Scientific Seminar – UTCB, October 28, 1998.
20. STAS 1343-1 2006. Determination of the quantities of drinking water for urban and rural localities.
21. STAS 1478-1990. Plumbing, Water Supply to Civil and Industrial Constructions.
22. Law 458-2002 on the quality of drinking water
23. Law 311-2004 on the quality of drinking water
24. NTPA 133-2013, Normative regarding the design, execution and operation of water supply and sewerage systems of localities. Vol.1-2, MATRIX ROM, 2013.
25. Ordinance No. 2552/2721/2727/2022 on the Water Safety Plan (PSA)

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