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WATER SUPPLY SYSTEM IN MIĘDZYCHÓD COMMUNE

Ewa OGIOŁDA[1*], Ireneusz NOWOGOŃSKI[1], Beata LESZCZYŃSKA
[1]University of Zielona Góra, Faculty of Civil and Environmental Engineering,
Institute of Environmental Engineering
Szafrana st 15, 65-516 Zielona Góra, Poland
FMT "Christianapol" Ltd. Łowyń

The properly designed and exploited water supply system is very important both for consumers and management in commune. Work conditions of such systems are changing so it is necessary to know its current parameters. Now we have different modern programs which make possible to calculate parameters and carry out simulation of designed changes which could improve reliability coefficients. Evaluation of exploited water supply system in Międzychód and designed its connection with subsystem in Radgoszcz were presented in this paper.

Keywords: water supply system, hydraulic calculations, numerical simulation

1. INTRODUCTION

Water supply systems are expensive while requirements for technical systems are higher and higher, so they are designed assuming their longlasting exploitation. One should create more durable and reliable systems. In properly designed system there should be realized distribution of required amount of good quality water under adequate pressure at the right time for consumers.

With passage of exploitation time work parameters are changing. There are software such as Epanet which makes possible to carry out calculations of existing systems or simulation calculations which let to estimate results of designed sytem changes.

[*] Corresponding author. E-mail: e.ogiolda@iis.uz.zgora.pl

2. CHARACTERISTIC OF WATER SUPPLY SYSTEM IN MIĘDZYCHÓD

City and commune Międzychód are localised on the Warta River, near the west boundary of Wielkopolskie Provence. There live about 6 thousand people in the city and about 12 thousand in commune Międzychód. There are great forest area and more than 50 lakes in the commune so during the summer there arrive many tourists – as a consequence water comsumption is very different, especially during a year [Studium uwarunkowań, 2005].

Fig. 1. Map of Międzychód commune [www.miedzychod.pl]

Most consumers in Międzychód commune has access to water distribution system, 17 from 26 villages are equipped with water pipe network. Technical condition of pipe system in a part of villages is poor [Plan zagospodarowania, 2007].

Tab. 1. Specification of water supply subsystems [ZGKiM Międzychód, 2009]

Lp.	Subsystem	Villages	Number of consumers
1	Międzychód	Międzychód, Bielsko, Dzięcielin, Wielowieś, Zatom Stary, Kolno, Muchocin, Gorzycko Stare, Gorzyń	14.776

2	Radgoszcz	Radgoszcz, Mierzyn, Przedlesie, Kaplin, Zwierzyniec, Mokrzec, Zatom Nowy, Puszcza	1.165
3	Kamionna	Kamionna, Mocberk – Folwark	516
4	Głażewo	Głażewo, Skrzydlewo, Gralewo, Dormowo, Mnichy, Mniszki, Tuczępy	1.196
5	Lewice	Lewice	219
6	Łowyń	Łowyń	716

3. CALCULATION METHOD

Hydraulic calculations were computed with EPANET 2 prepared by The National Risk Management Research Laboratory. This program is applied in water ditribution system analysis, makes possible analysis of water flow, pressure values in particular nodes, water level in tanks and reservoirs and concentration of chemical compounds in pipes. Obtained results are presented in different forms – tables, graphs, contour plots, profiles what allows to evaluate changes designed in water network [Rossman, 2000].

Input data necessary in hydraulic model of water network are:

- grahical presentation of pipe network,
- lengths, diameters and roughness coefficients of pipes,
- water demands in nodes,
- localisation of reservoirs, tanks and pump stations.

The hydraulic headloss by water flowing in a pipe can be computed using one of three different methods:

- Hazen-Williams formula,
- Darcy-Weisbach formula,
- Chezy-Manning formula.

In carried calculation Darcy – Weisbach formula was chosen [Rossman, 2000]:

$$\Delta h_L = Aq^B$$

where: Δh_L - headloss, m,
q - flow rate, m^3s^{-1}
B - flow exponent, B = 2,

A - resistance coefficient,

$$A = 0.0252\ f(\varepsilon,d,q)\ d^{-5}L$$

ε – Darcy – Weisbach roughness coefficient, mm,
d – pipe diameter, m,
L – pipe length, m.

4. CALCULATIONS OF EXPLOITED PIPE NETWORK

Existing pipe network consists of 9 loops and pipes of total length 88 km. Elevations on Międzychód commune area are significantly differentiated - about 32,5 m so this is necessary to apply a few pump stations. Diameters of pipes ranges from 90 to 250 mm. Graphical representation of water pipe network in Międzychód is shown in figure 2.

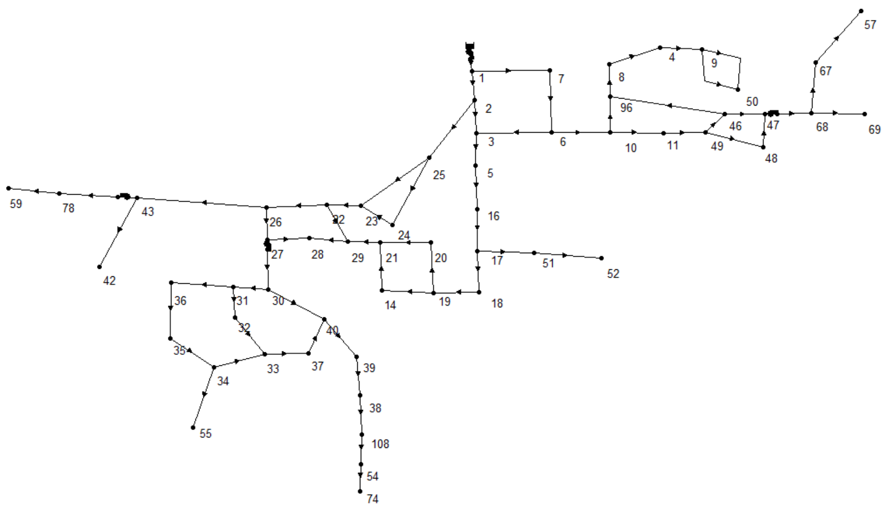

Fig. 2. Graphical representation of water pipe network in Międzychód

Calculations were realized in terms of real consumption - water demand was evaluated for number of consumers established as it is shown in tab. 1. Maximum singular coefficient of water consumption was accepted as an average value from 2006 – 2008 – it means $q = 90\ dm^3 \cdot M^{-1} \cdot d^{-1}$.

The results of carried out calculations make possible to evaluate work conditions in exploited water distribution system. As the results one obtaine values of pressure and flow velocity (tab.2).

Tab. 2. Zakresy prędkości przepływu i ciśnienia w systemie Międzychód

Parameter	Minimum value	Maximum value
Water pressure [m]	23,77	61,77
Flow velocity [mps]	0,11	0,73

Results were shown on contour plot – ranges of pressure in particular nodes (fig. 3).

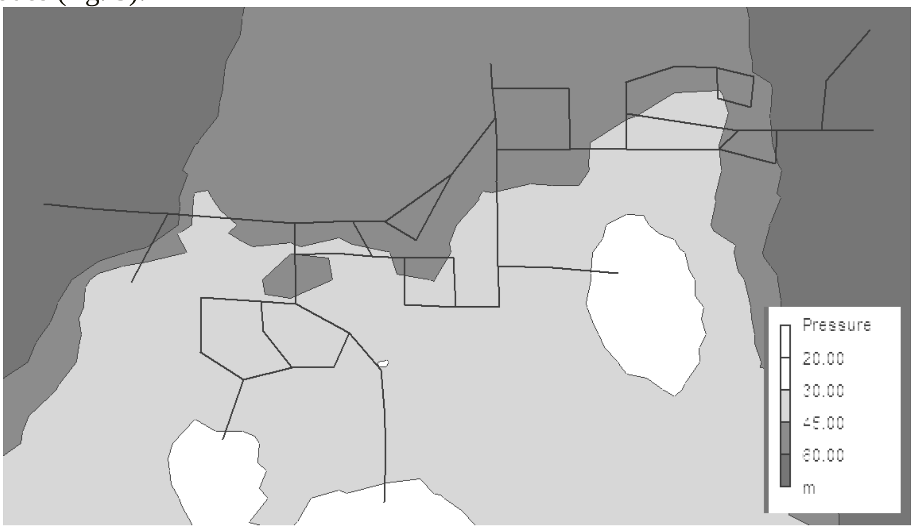

Fig. 3. Contour plot of pressure in system of Miedzychod commune

Results show that pipe network is exploited under too high pressure, not adjusted to real needs, however maximum pressure exceeds allowed 60 m only outside of supply area. Flow velocity values in many pipes are too low - minimum value 0,5 $m \cdot s^{-1}$ was achieved only in 20% of pipes length.

Parameters differ from those which should be guaranteed during correct explotation what is the result of water demand decrease.

5. NUMERICAL SIMULATION OF CONNECTED WATER SUBSYSTEMS

To improve reliability connection of two subsystems Międzychód and Radgoszcz was considered. Elevation in both cases are similar and in case of breakdown of one water treatment station there is a possibility to distribute water from other. Capacity of water intake in Międzychód equals to 175 $m^3 \cdot h^{-1}$, so it is sufficient to meet water demand for Międzychód and Radgoszcz. On the other hand intake capacity in Radgoszcz is 35 $m^3 \cdot h^{-1}$, so it could ensure only about 20% of water requirements for Międzychód. Connection was designed in node 22 and simulation was carried out for pipe of diameter Ø300 under conditions of maximum demand of water.

Graphical representation of connected subsystems Międzychód and Radgoszcz is shown in fig. 4.

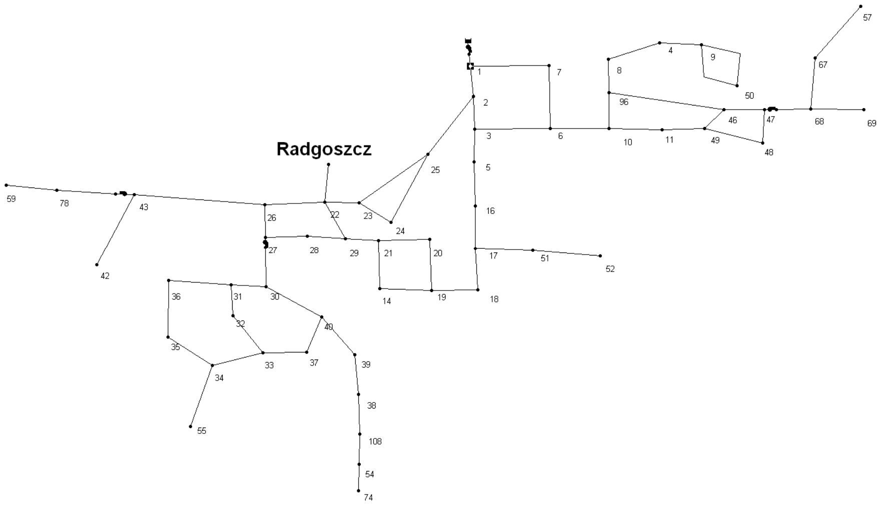

Fig.4. Graphical representation of connected subsysterms Międzychód and Ragdgoszcz

Tab. 3. Velocity and pressure ranges in connected subsystems

Parameter	Minimum value	Maximum value
Water pressure [m]	15,66	50,66
Flow velocity [mps]	0,01	1,00

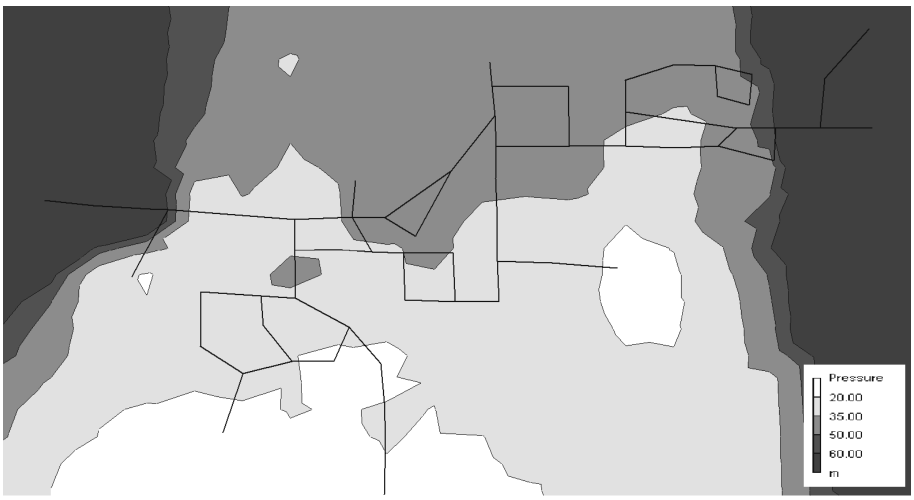

Fig. 5. Contour plot of pressure in connected subsystems Międzychód and Radgoszcz

Obtained simulation results show that it is possible to connect water system supplied from water treatment station in Radgoszcz to subsystem in

Międzychód. Pressure range is sufficient for low buildings which are typical of village area, but flow velocity values are lower than 0,5 $m \cdot s^{-1}$, so it is necessary to rinse pipe network.

6. CONCLUSIONS

Evaluation of exploited system should be the base of taking decisions concerning the best solutions choise in respect of the technical, economical and reliability point of view at a stage of design, realization and exploitation.

Results of carried calculations make possible to evaluate existing water supply system in Międzychód. Analysis confirms by low values of flow velocity that pipes diameters are too large. It could result in deterioration of physical, chemical and bacteriological water quality. System supply under exscessive pressure could cause breakdowns and increased water losses.

Results show correctness of reliability improvement by application of subsystems additional connection. Carried out simulation of connected subsystems Międzychód and Radgoszcz proves that it ensures better reliability of water deliverying to consumers both during standard exploitation and in case of increased demands (e.g. extinguishing fire).

Water supply system in Międzychód should be modernized, especially in regards pipe diameters and extension pipe network by connection with other subsystems. Prepared hydraulic model makes possible to simulate and evaluate introduced in future changes.

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SYSTEM ZAOPATRZENIA W WODĘ W GMINIE MIĘDZYCHÓD

S t r e s z c z e n i e

Systemy zaopatrzenia w wodę są kosztownymi inwestycjami – isotne jest zatem z punktu widzenia użytkowników projektowanie i eksploatowanie ich w taki sposób, aby pracowały niezawodnie przez długi czas. Warunki pracy omawianych systemów zmieniają się w czasie ich użytkowania – istotna jest zatem znajomość aktualnych wartości poszczególnych parametrów eksploatacyjnych. Cennymi narzędziami są programy komputerowe, które umożliwiają zarówno ustalenie wartości poszczególnych parametrów, jak i przeprowadzenie obliczeń symulacyjnych dla projektowanych w systemie zmian mających przyczynić się do poprawy jego niezawodności. Przy użyciu programu EPANET obliczono i poddano analizie parametry pracy istniejącego systemu zaopatrzenia w wodę w Międzychodzie. Zaproponowano połączenie systemu z podsystemem Radgoszcz, a uzasadnieniem prawidłowości takiego rozwiązania są wyniki przeprowadzonych obliczeń symulacyjnych.