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MODELLING–MEASUREMENT–IDENTIFICATION AND THEIR IMPORTANCE IN CONTROLLING WATER SUPPLY SYSTEMS

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Abstract

In case of the revision of a settlement's water distribution system, different models of the whole system must be developed. In course of modelling we certainly make some approximations, thus there are certain differences between model and reality. Consequently, it must be determined, to what degree the model conforms to reality. To prove the conformity of the model to reality, measurements and calculations of the hydraulic parameters must be done for some operation conditions, and the results must be compared. We have made measurements and identifications in Bratislava and in several regions of Hungary, one of them, the basic zone of Miskolc city is presented. On the basis of comparison of the calculated and measured values , the identification can be considered as completed (*Fig. 4.*), the values entirely conform to each other.

Keywords: water supply, modelling, identification.

Introduction

In case of the revision of a settlement's water distribution system, different models of the whole system must be developed (models of the network, pumps, reservoirs and consumption). In the course of modelling, that forms of the basis of hydraulic investigations, the elements of the system

- consumption,
- network,
- reservoirs,
- pumping stations,
- fittings, etc.

are usually modelled separately (ÖLLŐS, 1987).

During the development of the model certainly, we made some approximations, thus there are certain differences between 'model' and 'reality'. However, these differences are not significant in the respect of operating conditions.

Consequently it must be determined, to what degree the model conforms to reality. This can be done by measurements.

The identification of the model is essential because the measurements reveal the errors of modelling which unavoidably happen in case of a complicated water supply system, having several feedings and reservoirs. The measurements are not only necessary for model development and verification but also for further works, e.g. hydraulic investigations, operation planning, etc. The knowledge of real parameters is required which are characteristic for the applied operation order or condition.

To prove the conformity of the model to reality, the measurement and calculation of the hydraulic parameters must be done for some operation conditions, and the results must be compared to each other (DELI-BÓDI, 1991).

In most cases, the greatest problem is the determination of the consumption because its direct measurement is usually not possible.

The development and actualization of the network model, though it seems to be much simpler than the previous one, can cause hard problems because it is very difficult to be up-to-date in all elements of the operation (e.g. opening and closing of slide-valves) in a complicated system. The determination of the absolute roughness coefficient (k) of the pipe can raise further problems, too.

1. Determination of the Consumption of a Pressure Zone

The real consumption of a zone can be determined indirectly (if the measurement at the consumers is not possible). It means that we stop the intakes of the zone, measure the pumping discharge to higher zones and the level-changing of the reservoir. The result of the balance equation based on these data will be the consumption:

$$\sum Q_{\mathrm{in}} + \sum Q_T = \sum Q_{\mathrm{consumption}}$$

where Q_T - discharge in the reservoirs, Q_{in} - input discharge.

Certainly, the measurement of the instantaneous input discharge and consumption values are rather problematical. Therefore it is more practical to use the average of the integrated measurement data.

1.1. Determination of the Discharge of Reservoirs

With the knowledge of the volume-level function of the reservoir, the actual discharge can be calculated from the changing of the level within a certain time.

The following data must be known:

- volume of the reservoir,
- volume-level function (reservoir curve),
- actual level,
- absolute value of a characteristic level (e.g. overflow level).

1.2. Determination of the Input Discharge Values

Determination of the input discharge values can be done in two different ways:

- by measuring the real discharge values,
- by using the characteristic curves of pumps.

Certainly, if both discharge values and reliable characteristic curves are available, we can follow both ways, so we have the possibility for controlling.

2. Series of Measurements for the Purpose of Identification

We have been dealing with this topic for several years at the Technical University, Department of Water Supply and Sewerage. The first measurements were carried out in Bratislava in the seventies, their prior aim was to determine the roughness coefficient. We made measurements and identifications in several cities and regions of Hungary (DELI–DARABOS–BÓDI–GÖCZE, 1989,1990), one of them, the basic zone of Miskolc city is shown. (*Fig. 4*).

The systems contain several feedings, elevated tanks, and also contain several pumping stations, working for higher zones.

In the process of investigation discharge (m^3/h) and pressure-side pressure (bar) values were measured at the feeding and pumping points. There were also measurements of pressure values on three further points of the water supply network.

3. Results of Identification

For the determination of hourly consumption, results of two measurement series were used.

- Values of the measured hourly consumption of the whole lower zone can be seen in *Fig. 1*. (To have a better comparison we also give the values advised by the standard.)
- For controlling the hourly consumption, measurements on consumption of a house-block and 10 flats were carried out *(Fig. 2)*. Through

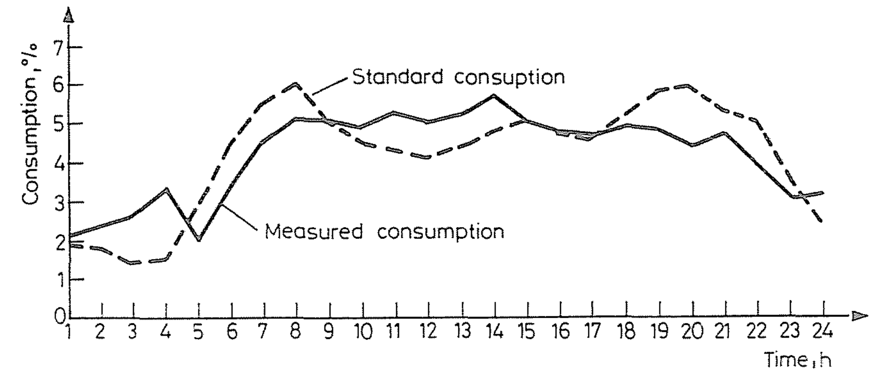

Fig. 1. Comparison of measured and consumption of Miskolc
———— smeasured consumption - - - - - standard consumption

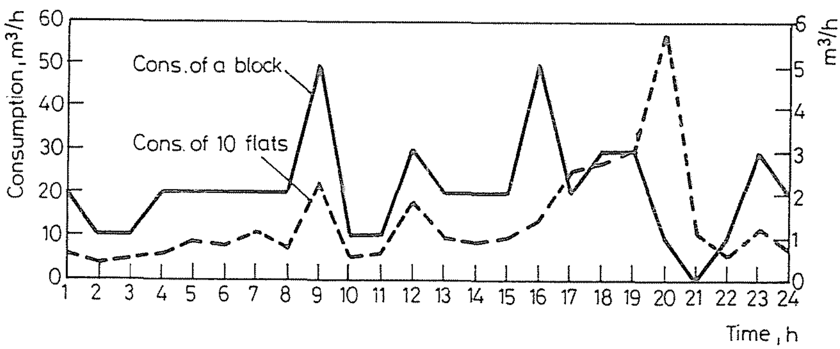

Fig. 2. Measured consumption of a bloc and 10 flats
———— cons. of 10 flats - - - - - cons. of a block

the comparison of the calculated consumption– characteristics of the whole zone and the merely communal consumption, it can be seen – as it was expected -, that the characteristics of the whole zone's consumption is more balanced than the communal curve, which is similar to the curves given in the standard.

Considering the limited extent of this paper, we are not going into details of the measurements and calculations, only some of the final results are given. In *Fig. 3* the changing of the level and the discharge of one of the reservoirs is described, according to the measured and calculated

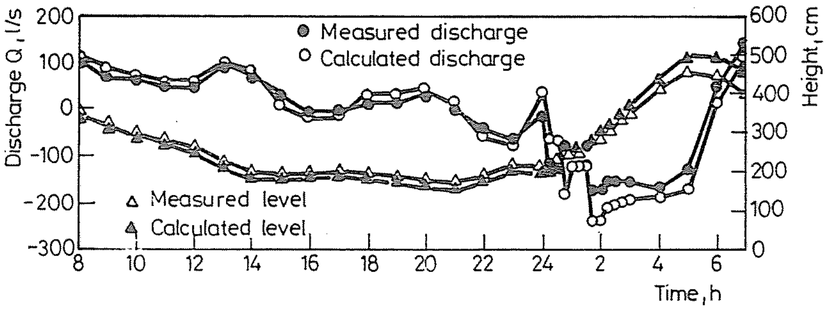

Fig. 3. Miskolc reservior comparision measured and calculated data

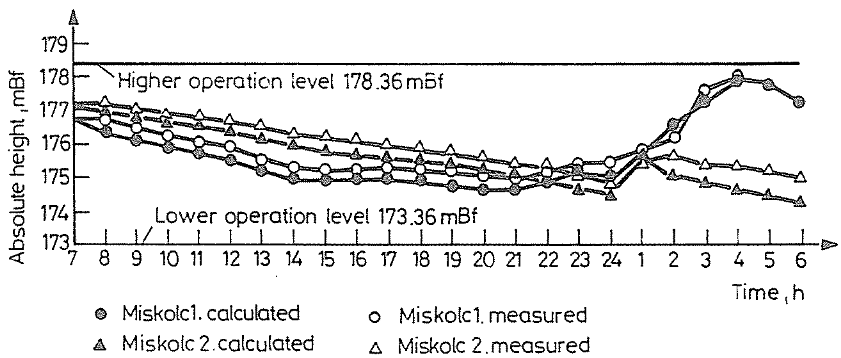

Fig. 4. Operation simulation investigation Calculated and measured levels of reservoirs

data. It can be seen that - except some night hours - the identification was satisfying.

In *Fig. 4* the comparison of results of the operation-simulation made on the model and the 24 hour measurement can be seen.

According to the comparison of calculated and measured values, the identification can be considered complete, for the values entirely conform to each other.

Summary

As a summary we would like to emphasize two important aspects of our experiences:

- The measurements made on the system are not only useful for the identification of the model but also afford possibility to reveal the problems of the system, which were unknown before (e.g. real condition of slide-valves, etc.)
- The measurements can only be carried out with the help of the specialist of water-works. A share work made with good technical knowledge in a good team can give satisfying results both for science and practice.

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