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Methodology for the estimation of the technical condition in the case of water treatment plants

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Abstract

The paper presents the methodology for determining the operating and technical indicators for a preliminary assessment of the elements of water supply system (WSS) such as water treatment plants. The necessary data and system of technical indicators (TI) evaluation using the multi-objective optimization and Failure Mode and Effects Analysis (FMEA) are defined. The proposed methodology allows for the selection and ranking of WSS critical elements for more detailed analyses and suggestions of the type of renewal, including the estimated financial costs. Water treatment plants can be assessed by means of the specific part of the methodology. With respect to the water treatment plants the authors of the methodology realize that it is hard to generalize the entire audit since there are many types of water treatment plants as well as technological elements used. The proposed set of assessment indicators is based on the function of the water treatment plant, i.e. production of drinking water in the required quantity and quality. When assessing the technical condition of the water treatment plant this facility may not be viewed simply in structural and technical terms but it is absolutely necessary and much more important to assess it in technological terms.

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Keywords: water supply; water treatment plants; technical condition

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1. Introduction

The basic mission of water companies is to supply safe drinking water which meets the quality requirements laid down by legislation. The most important issue when managing and planning the operation of a drinking water distribution system is to satisfy consumer requirements. A reliable distribution system means ensuring water of the required quality and pressure at any time for all consumers. A considered bonus is a water supply that enjoys consumer trust [1]. However besides this prime objective, water companies focus on how to operate the entire water supply system cost-effectively and sustainably. They endeavour to focus on the design and construction of new elements of water supply to achieve better efficiency and effective functioning of existing systems. In addition, the current condition of individual components of the system and its behaviour needs to be assessed constantly. Only detailed knowledge of the present condition of the system makes it possible to make a meaningful plan of investments or partial repairs.

As a consequence of the attempts to assess these systems some assessment systems have been developed based, for example, on a system of performance indicators (PI). Among the most important PI systems are systems developed under the heading of International Water Association [2] and a series of other projects [3,4,5,6,7,8,9].

2. Methodology

The assessment of the technical condition of water treatment plants is part of the complex water supply system assessment methodology. All components of the system are considered from withdrawal structures, water treatment plants, tanks and pumping stations to individual water mains.

The design of a single concept of methodology of a preliminary assessment of the technical condition of elements of water mains is based on the method FMEA (Failure Mode and Effects Analysis). The FMEA is a method of analysing reliability which makes it possible to determine faults with major consequences affecting the function of the system and its elements.

2.1. Principle of assessment

In contrast to the standard FMEA method the proposed methodology is enhanced by a further level – factors (F). The technical indicators are not assessed directly here, but a set of proposed factors for each individual technical indicator is used for their assessment. A single four-point assessment system is proposed for each individual factor with specifications and a recommendation for a specific points assessment of each factor. A sort of verdict that is valid for the assessed element complies with each points assessment. In addition, the weight of each factor is determined as part of the assessment of the relevant indicator. Factors are the single level into which data are entered in the assessment, and assessments at higher levels are calculated from data entered at the level of factors.

The selected points assessment of factors is as follows:

- 0 – factor is not assessed, there is insufficient information for assessing this factor;
- 1, 2 or 3 – whereas value 1 means the most favourable condition, in contrast value 3 is the least favourable condition in the assessment of the factor

The assessment of the analysed water supply system or its part is divided into two basic parts:

- Structural and technical – total structural and technical indicators,
- Technological and operational – total of technological and operational indicators which have no direct link to the structural and technological condition of the analysed structure.

Thus this involves a multi-criteria assessment. The proposed methodology [10] of assessment of the condition is based on the weighted sum method. It is particularly important in the weighted sum method to set the weighting of the individual factors and indicators. The weighting in the proposed methodology was set on the basis of findings and experience of the research team also obtained from consultations with water company workers.

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