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RELIABILITY LEVELS IN WATER TRANSPORT AND DISTRIBUTION NETWORKS DUE MAINLY TO CORROSION

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ABSTRACT. The spontaneous phenomenon of metal's corrosion could be limited, controlled by o good corrosion management, which could be a rigorous application of accumulated knowledge or innovation. The diversity of each urban water system, the physical-chemical properties of water, soil, air and metallic materials, rule to a continuing development of nonconventional methods. The statistical analysis of data for a whole year, connected with the number of failures, at different elements of the cold water network, due to corrosion, could bring important information for a further reliability modelling, in order to a establish an improvement in the policies of energy efficiency increasing.
KEY WORDS: cold water network, reliability, statistics, energy efficiency

INTRODUCTION

In sustainable development perspective, the energy efficiency must move from science to education, from wasting the resources of energy to harmony with the environment.

The interest in a new scientific approach of energy efficiency in water transport and distribution networks is not as new as somebody could thought. The diversity of each system, the physical-chemical properties of water, soil, air and metallic materials, rule to a continuing development of nonconventional methods, based on applied sciences making this area to be a very interesting and promising one.

In the last century these interdisciplinary approaches of corrosion management were done by many scientists [1-18] in the areas of: mathematics [1], electrochemistry [2, 18], computer science and informatics[3, 5], operational reliability by investigating mechanical properties [4], failure analysis [11, 13, 15, 17], microbiology[6, 10], automation [7] and monitoring [4, 7], mapping [8], decision theory [9,12], biochemical sensors [14], statistics [16].

This paper is a part from a larger case study[19-22] on water transport and distribution network, from an urban area, Oradea, made for a whole year, 2013. The study wanted to reveal not only the main corrosion problems, but also the localization and the causes of it. An original approach, using data bases, statistics and some reliability principles applied for the water network could show the weaknesses of the water network, as well as the ways to remedy the corrosion problems and implicitly to increase the energy efficiency.

EXPERIMENTAL

The databases were made by collecting them from the daily analysis bulletins from the treatment and supply stations related to the S.C. Compania de apa Oradea S.A., as well as from the minutes of the interventions, also public data, available on company's site, for the whole year 2013. The data were collected in Microsoft Office-Excel 2010 files.

The database includes the date of the failure / intervention, its location and duration: highway pipes, distribution pipes, connection pipes, hydrants, other repairs, fountains, interventions to meet the quality requirements. The main purpose of creating this database is to highlight the type, location, frequency of occurrence and duration of failures in the cold water transportation and distribution networks, as well as the realization of an operational reliability study.

RESULTS AND DISCUSSIONS

From the data gathered in the databases and from the statistical analysis of the interruptions / repairs of the water transport and distribution networks, due to corrosion, an incipient hierarchy of corrosion defects can be made, namely the causes and the generating elements of unavailability.

Figures 1 and 2 show the percentages of defects and defects and the hierarchies are based on the values of the "number of failures in the analysis period".

To make an easier analysis, they were encoded according to the information in Table 1

Table 1. Interruptions / failures and their encoding at different levels of the cold water transport and distribution network with indication of the general type of corrosion in January 2013.

Network Element	Interruption	Code	Type of corrosion
I	Highway transport pipes	M1	In water
		M2	In water
II	Distribution pipes	D1	In water and soil
		D2	In water and soil
		D3	In water and soil
		D4	In water and soil
		D5	In water and soil
		D6	In water and soil
		D7	In water and soil
		D8	In water and soil
		D9	In water and soil
		D10	In water and soil
III	Connection pipes	B1	In water and soil
		B2	In water and soil
		B3	In water and soil
		B4	In water and soil
IV	Hydrants, External pipes	H1	In water and air
		H2	In water and air
		H3	In water and air
V	Others	A1	In water and air
		A2	In water and air
		A3	In water and soil
		A4	In water and soil
		A5	In water and soil
VI	Remakes	R1	In water and air
		R2	In water and soil
		R3	In water and soil
		R4	In water and soil
VII	Fountains, irrigations	F	In water and air
VIII	Quality assurance	Q1	In water and soil
		Q2	In water and soil
		Q3	In water and soil
		Q4	In water and soil
		Q5	In water and soil
		Q6	In water and soil

Interruptions / failures in the cold water transport and distribution network have been broken down into different levels but also by type of intervention.:

The elements of the cold water network are: M- highway transport pipe, D- distribution pipe, B- connection pipes, H- hydrants, external pipes, A- others, not directly connected to a corrosion damage, R- remakes, F- fountains, irrigation, Q- quality assurance.

The general type of corrosion that may occur was also indicated:

-Corrosion in water and soil (internal and external corrosion) - specific to buried pipes;

-Corrosion in water and air (internal and external corrosion) - Specific to air pipelines

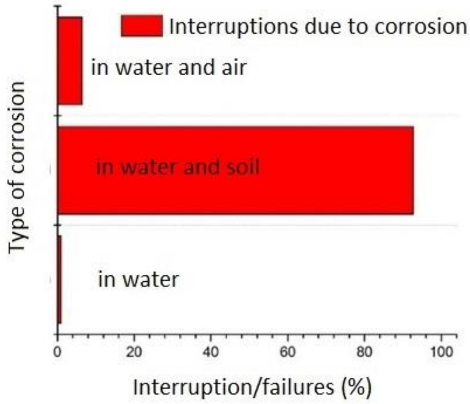


Figure 1 - Hierarchy of interruption / failure causes in the cold water transport and distribution network (1 Jan-31 Dec 2013) by type of corrosion.

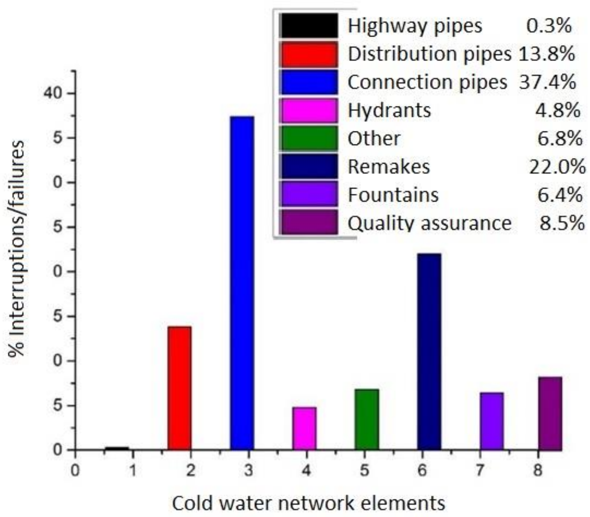
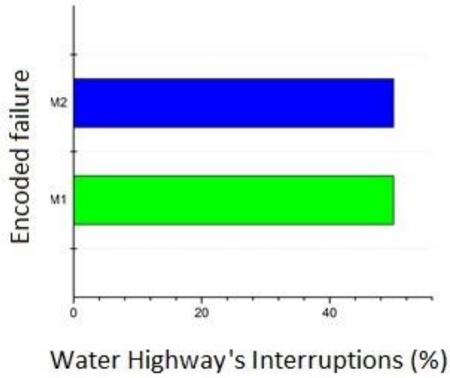
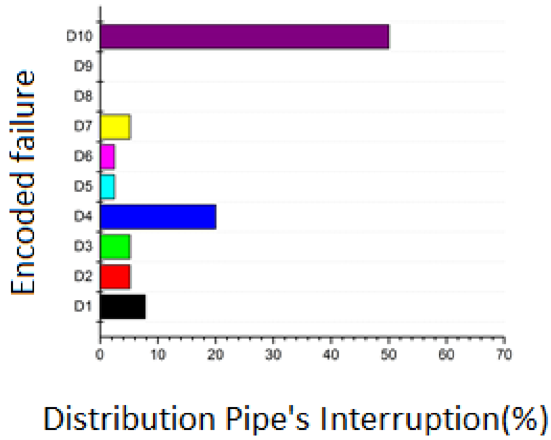


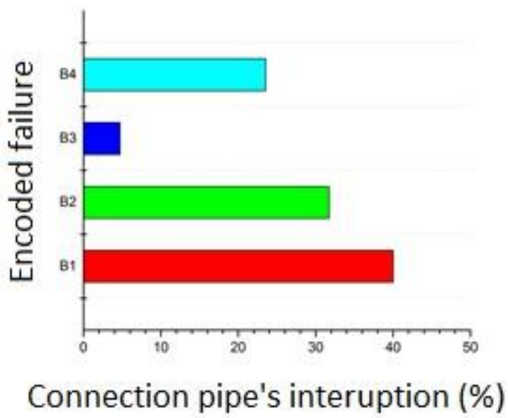
Figure 2 - The hierarchy of elements in the structure of the cold water transport and distribution network (1 Jan-31 Dec 2013), where corrosion occurred.

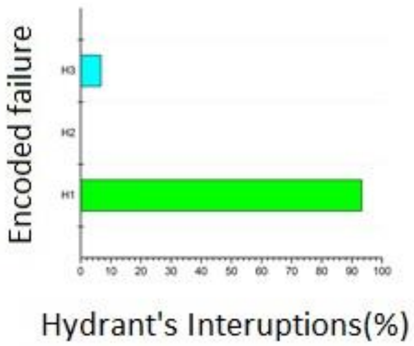
That means 8 different elements of the transport and distribution water network, each of it with specific types of interruptions / failures were establish for a month, January 2013.

For each element of the cold water network interruptions: highway-transport pipes, distribution pipes, connection pipes , other water network repairs, external hydrants, remakes, fountain and quality assurance works, a failure hierarchy can be made (Figure 3). The fountain, irrigation network part (F) does not work in the winter.









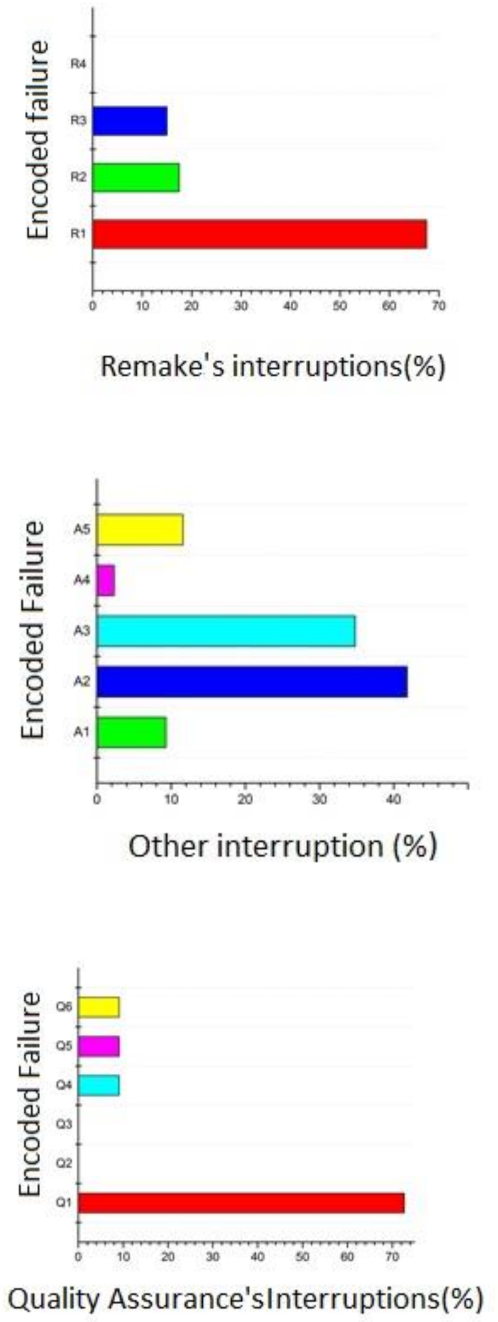


Figure 3. Detailed hierarchy of interruptions / failures for January 2013 in the cold water transport and distribution network.

CONCLUSIONS

Regarding the hierarchy and the reliability level of cold water transport and distribution networks, the following conclusions can be drawn:

- the causes of the defects were analyzed during January 1 - December 31, 2013, for the cold water network:
- On each element of network, the types of the interruption/failure were encoded and the percentage was determined
- the hierarchy were made on the basis of the values of the "number of interruptions / failures" indicator during the analysis period.

This case study can be continued, developed to identify the correlations between the failure of a network element caused by a certain form of localized corrosion, such as uniform corrosion, differential aeration corrosion, pitting and creep corrosion, bimetallic corrosion, corrosion tensioning, corrosion by selective dissolution, corrosion at the welding cords and all of these are unconventional ways of energy efficiency increasing.

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