RESEARCH ARTICLE

• Arch Hyg Sci 2016;5(1): 33-38.
• Journal Homepage: http://jhygiene.muq.ac.ir

Investigation of Qom Rural Area Water Network Accident in 2010 and Minimization Approaches of Accident Frequencies

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A-R-T-I-C-L-EI-N-F-O

Article Notes:
Received: Oct 25, 2015
Received in revised form: Dec 2, 2015
Accepted: Dec 23, 2015
Available Online: Jun 1, 2016

Keywords:
Accidents, Water Network, Minimization Approach, Qom, Iran.

A-B-S-T-R-A-C-T

Background & Aims of the Study: Accidents in water networks can lead to increase the uncounted water, costs of repair, maintenance, restoration and enter water contaminants to water network. The aim of this study is to survey the accidents of Qom rural water network and choose the right approaches to reduce the number of accidents.

Materials & Methods: In this cross-sectional study, four sector of Qom province (Markazi, Dastjerd, Kahak and Qahan), were assessed over a period of 8 months (July – January 2010). This study was conducted through questionnaire of Ministry of Energy.

Results: The total number of accidents was 763. The highest number of accidents in the four sectors was related to Markazi sector with 228 accidents. According to the time of the accident, the highest and lowest number of accident was related to September (19.7%) and November (6.8%), respectively. According to the location of the accident on network, the highest and lowest number of accident was related to distribution network (64%) and connections (17.5%) and transmission pipe (18.34%), respectively. According to the type of the accident, the highest and lowest number of accident was related to breaking (47.8%) and gasket failure (1.2%), respectively. Considering with the pipes' material, the highest and lowest number of accident was related to polyethylene pipes (93%) and steel and cast iron pipes (0.5%, 0.5%), respectively.

Conclusions: Due to the high break rate of Polyethylene pipes, it is recommended to be placed in priority of leak detection and rehabilitation.

Please cite this article as: Jafari Mansoorian H, Yari AR, Ansari M, Nazari S, Saberi Bidgoli M, Majidi G. Investigation of Qom Rural Area Water Network Accident in 2010 and Minimization Approaches of Accident Frequencies. Arch Hyg Sci 2016;5(1):33-38.

Background

The accidents occurring in water distribution networks cause losses amounts of treated water (1). The annual budget for the development of urban water distribution network and value of water losses within one year in Australia is estimated 145 and 90 million dollars, respectively (2). In urban water distribution networks in Iran, occurs nearly one million accidents annually and more than 20 percent of total revenues in water and wastewater companies is consumed for repairing these accidents (3). The maintenance costs of water distribution network in Iran increased from 94 billion Rials in 1999 to 239 billion Rials in 2002 (4).

Accidents in water distribution network, in addition to the Water losses and the spending of rehabilitation huge cost, can enter the contaminants into distribution network (5). Pathogens such as Cryptosporidium and Giardia Lamblia may enter the water network due to pipe breakage (6,7). In Scandinavia (1975–1991) faulty connections caused 20% of water borne diseases. One study in Uzbekistan showed that the prevalence of diarrheal diseases could be attributed to cracks in pipes. In England (1995-1911) problems related to distribution system caused thirty-six percent of water-borne disease outbreaks (8). In the United States, between 2001 and 2002, contamination of water distribution network led to half of the water-borne disease outbreaks (9). Main factors that affect accidents of water distribution networks are pipe age, pipe length, pipe materials, pipe diameter, pipe depth, types of joints, soil conditions, traffic loading, quality of external underground water, break history, rehabilitation methods and water quality (10,11). Water and wastewater companies do not make appropriate effort to obtain the information about the accident. The knowledge level of the staff or workers of in repairing units, is such that related groups cannot able to correct record of available data, proper analysis of data, debugging the system and justifying the causes of accidents. Studying and analyzing the situation of accidents is important for reducing the number of accidents and unaccounted water (12).

Aims of the study:

The aim of this study is to investigate the rural area water network accidents in Qom province and choose the proper approaches to reduce the accidents' quantities.

Materials & Methods

In this cross-sectional study, four area of Qom province (Markazi, Dastjerd, Kahak and Qahan), were assessed over an 8 month period (July to January 2010). This study was conducted according to a standard questionnaire of Iranian Ministry of Energy. The questionnaire was contained six questions (Name & Family-completion questionnaire, address of accident, location of accident on network, time of accident, type of accident and damaged pipes and connections). In each area of Qom province, after contractors' were trained on how to complete questionnaire, the questionnaires were given to the contractors. Related variables to accidents in the water network were recorded during the day and night. Results were analyzed using Microsoft Excel software 2010.

Results

In this study, Qom rural area water network accidents were investigated according to the (a) time of accident, (b) location of the accident on network, (c) type of accident and (d) damaged pipes and connections. Total of accidents in the four areas, (Markazi, Dastjerd, Kahak and Qahan) in Qom province in water distribution network were 763 accidents. The highest number of accident in studied areas was related to Markazi area with 228 accidents (Figure 1). According to the time of the accident, the highest and lowest numbers of accidents were related to September (19.7%) and November (6.8%), respectively (Figure 2). According to the location of the accident on network, the highest and lowest numbers of accidents were related to distribution network (64%) and Connections (17.5%) and transmission pipe (18.34%), respectively (Figure 3). According to the type of the accident, the highest and lowest numbers of accidents were related to breaking (47.8%) and gasket failure (1.2%), respectively (Figure 4). According to the pipes material, the highest and lowest numbers of accidents were related to polyethylene pipes (93%) and steel and cast iron pipes (0.5%, 0.5%), respectively (Figure 5). The results showed that the breaking, bursting, and erosion of polyethylene pipes are the most common causes of accidents. Also accidents of water supply network and

connections in the cities and provinces of Iran are presented in Figure 6. As shown in Figure 6, the number of accidents of distribution network and connections in the Qom province was 1860 and 22187 respectively (15).

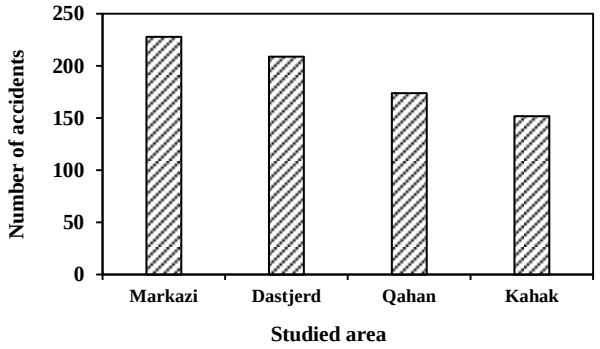

Figure 1) Number of accidents in studied areas

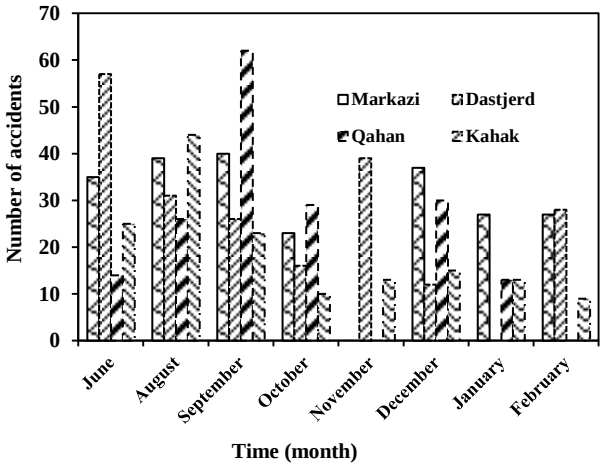

Figure 2) Number of accidents in the studied areas, according to the time of the accident

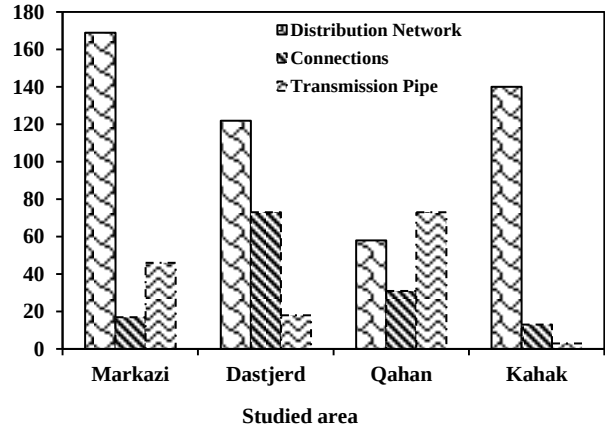

Figure 3) Number of accidents in the studied areas, according to the location of the accident on network

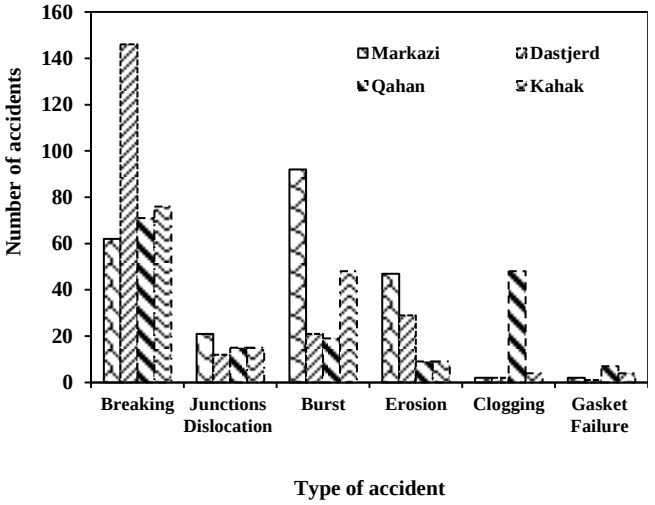

Figure 4) Number of accidents in the studied areas, according to the type of the accident

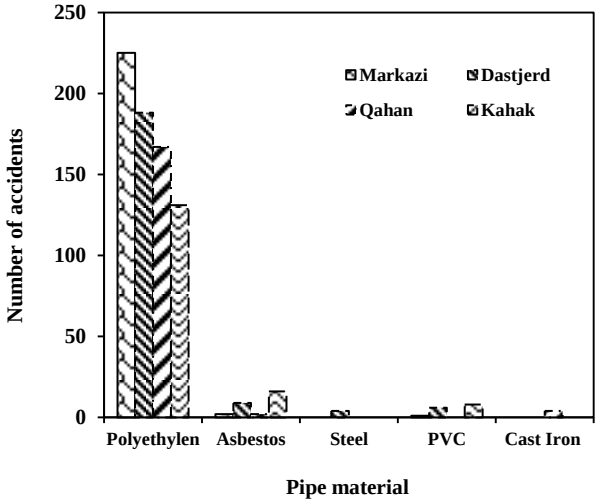

Figure 5) Number of accidents in the studied areas, according to the pipes material

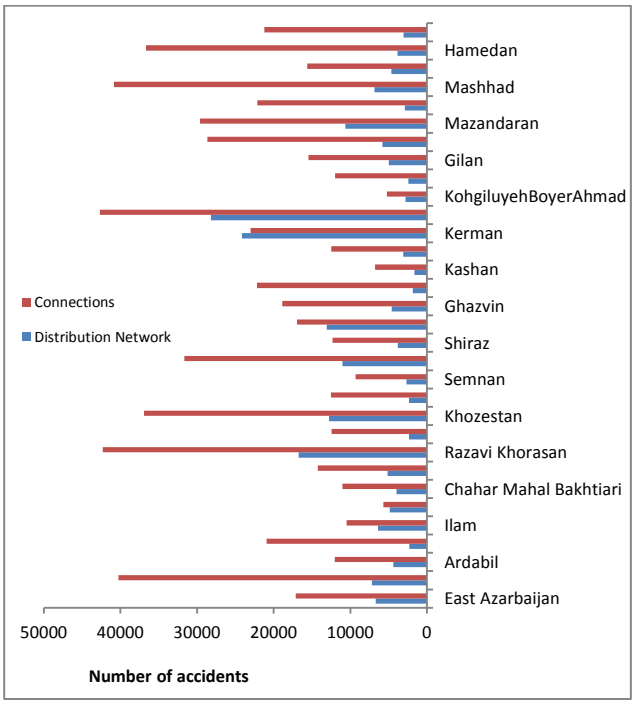

Figure 6) Number of accidents in the different cities and provinces of Iran (in year 2007-2008) (15).

Discussion

Based on results, the highest number of accident in the studied areas was related to Markazi area. According to the time of accident, the highest and lowest number of accident was related to September and November, respectively. According to the location of the accident on network, the highest and lowest number of accident was related to distribution network, connections, and transmission pipe, respectively. According to the type of the accident, the highest and lowest number of accident was related to breaking and gasket failure, respectively. According to the pipes' material, the highest and lowest number of accident was related to polyethylene pipes and steel and cast iron pipes, respectively. The results indicated that the breaking, bursting and erosion of polyethylene pipes are the most common causes of accidents.

Total number of accidents in the Tehran water distribution networks in 2011, were 12,707. The number of accidents in distribution network and connections was 363 and 12,344, respectively. The highest and lowest number of accident was related to September and October, respectively (13). The number of accidents in the Markazi sector of Ghaen city water distribution networks in 2008-2012, was 1,209. The number of accidents in Markazi and Zirkooh sectors network connections was 603 and 170, respectively (14). According to the Statistical annual report of the water in 2007 to 2008, the total number of accidents occurring in the water network in Qom were 24 047 accidents. The number of accidents related to the distribution network and connections were 1860 and 22,187, respectively (15). In a study, which conducted by Dadban et al, from April 2004 to June 2005 on Gorgan water distribution networks, total number of accidents, was 6600. 52% and 8% of accidents are occurred in connections and distribution network, respectively (16). In this study, the number of accidents occurred in the distribution network (489 accident) is greater than the number of accidents occurred in connections (134 accident), respectively. The results do not match with the above studies.

The highest number of accidents in the Tehran water networks in (2012) had occurred in October (13). Dadban et al, in year 2007 reported that the highest number of accidents in Gorgan water networks was related to June (16). In the present study, the highest and lowest number of accident was related to September and November, respectively.

Chaloos water distribution networks accidents were investigated by Tabesh et al. in year 2006 according to the pipes material, the highest and lowest number of accident was related to galvanized pipes (55%) and polyethylene pipes (8%), respectively (17). In a study that was conducted by Navayineya et al, in year 2003 Fariman city water distribution networks efficiency was investigated. The highest number of accident was related to polyethylene pipes (18). Dadban and et al. in year 2007 reported that the highest of break rate was

related to PVC pipes (44%). Causes of accidents in Gorgan city water distribution network relate to the high pressure of network, pipe depth, pipe decay and inappropriate pipes' material (16). Results of the present study showed that breaking, bursting and erosion of polyethylene pipes are the most common causes of water network accidents. The reasons for the high number of accidents of polyethylene pipes were noted. The extensive production in the country without standards required, buying low quality pipes and improper tubing (18).

The main approaches to contrast to the accidents of urban water distribution network, are divided into three methods; passive control (local deal with incidents), active control (continuous and regular leak detection), and the sanitation and rehabilitation of the network (17,19). The main priority for the accidents management in the water and wastewater company is local contrast to accidents. Contrast to accidents can be very costly in the long term (12). In continuous and regular leak detection program, it should be considered to reduce the leakage in the distribution system, to the level in which it can be economical. Reduce leakage rate of less than 5 liter.person^{-1}.hour^{-1}, need to spend high costs and is economically unjustified (17). Another way for contrast to accidents in urban water distribution network is sanitation and rehabilitation of the network. Rehabilitation and restoration of pipes and network installations are the two important factors that have the greatest effect on the leakage network. Increasing the pipes age and connections can cause reducing resistance network against physical and chemical factors (12). Cleaning, resurfacing and replacement of pipes and other components are the sanitation and rehabilitation of the network (17).

Several models have been proposed for the rehabilitation of water networks which included general rehabilitation guides' models, prioritization models and criticality models. In general rehabilitation guides models, the pipes to be rehabilitated is specified but not proposed prior to rehabilitation requirements. Prioritization models will prioritize the rehabilitation requirements of pipes by taking the performance status of the distribution network and budget amount. Rehabilitation planning in criticality models is based on the risk of pipe break and critical impact on the network (20-23).

Conclusion

Choosing an appropriate approach to reduce the number of accidents of water distribution networks is necessary to understand the current situation of water distribution networks and the available economic resources. Results of this study showed that the breaking, bursting and erosion of polyethylene pipes are the most common causes of accidents. From the three ways; passive control, active control, sanitation, and rehabilitation of the network, the best way to reduce the number accidents is sanitation and rehabilitation of the network. Sanitation and rehabilitation of the network will lead to reduce costs and increase the network useful lifetime and reliability of networks. Due to the high break rate of polyethylene pipes, it is recommended that be placed in priority of leak detection and rehabilitation. Rehabilitation planning models of water networks have studied to select a suitable model and run.

Footnotes

Acknowledgments:
The authors would like to thank the Urban Water & Wastewater Company of Qom province for their financial support and for providing the necessary facilities for this research.

Conflict of Interest:
The authors declared no conflict of interest.

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