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COMMON PROBLEMS AND SOLUTIONS IN THE CHLORINATION OF DRINKING WATER STORAGE TANKS ALONG MERSİN PROVINCE

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ABSTRACT

Introduction
Existing literature indicates that the infant mortality rate is significantly reduced and the water-borne diseases are almost completely eradicated in developed countries where drinking water is effectively chlorinated.

Aim of the study
The purpose of this paper is to present the studies, the problems encountered, and the results obtained in the chlorination of drinking water storage tanks in Mersin province. It is also aimed to share the results of the study with other local authorities and the parties in terms of information and different solution proposals.

Material and methods
The General Directorate of MESKI introduced various methods in order to ensure success and the continuity of chlorination of drinking water storage tanks outside the city center. MESKI also took an important step in the use of renewable energy resources due to the dispersed geographical area of Mersin and the problem of electricity transmission line in these places.

Results
Approximately 45% of the total 1005 water reservoirs in different capacities located in Mersin province were successfully chlorinated with a solar-powered fully automatic chlorination system. With this new system, the General Directorate of MESKI drastically reduced both chlorine and energy costs and the city of Mersin has the lowest incidence of non-compliance in terms of drinking water audit monitor non-compliance ratios.

Conclusions
As a result of all these studies and applications, the General Directorate of MESKI has provided an institution managed by systems rather than people and ensured water quality, which is continuously monitored online by making all necessary improvements in water supply, distribution and quality.

Key words: local authorities, drinking water storages, chlorination, and sanitation.

INTRODUCTION

As it is known, according to the law numbered 6360 published in the Official Gazette dated 06.12.2012 and numbered 28489 (1), the borders of Mersin Metropolitan Municipality have become the provincial property limit as of April 1, 2014. In accordance with this law, the duty area of the General Directorate of MESKI is also defined by the provincial property limit. Water and sewage services before the law 6360 were carried out by the village headmen, Drinking Water Associations, Town and District Municipalities, and Provincial / District Special Administrations. These services, with this law, have passed to the General Directorate of MESKI together with their debts and liabilities. While MESKI was providing services an area of approximately 630 km^2 before the law numbered 6360, this area has grown to approximately 15,553 km^2 by approximately twenty five times. The population served has increased to 1.745.221 from 876.958. MESKI, which has turned this law into an advantage, has currently been conducting an intensive work in the whole of Mersin province so that people can drink healthy water safely from the tap. Despite dramatic improvements in general health levels and technologies, more than 5 million people die each year from disease caused by unsafe drinking water and lack of sanitation (2). According to the World Health Organization (WHO), nearly half of all diseases in the world are reported to be water-related diseases (6). Similarly, microbial water-borne diseases are observed in some residential areas of our country where the mains water system are not chlorinated. In developed countries where drinking water is effectively chlorinated, the infant mortality rate is significantly reduced and the water-borne diseases are almost completely eradicated (3). Therefore, drinking water chlorination has remained a cornerstone of water-borne disease prevention and no chemical substance like chlorine has contributed so much to human health up to today. Recognizing this success, Life magazine declared that “the filtration of drinking water plus the use of chlorine is probably the most significant public health advancement of the millenium” (4). In the light of the above information, the purpose of this paper is to present the studies, the problems encountered, and the results obtained in the chlorination of drinking water storage tanks in Mersin province. It is also aimed to share the results of the study with other local authorities and the parties in terms of information and different solution proposals.

MATERIAL AND METHODS

As the General Directorate of Water and Sewerage Administration of Mersin (MESKI), we have introduced the following methods in order to ensure success and the continuity of chlorination of drinking water storage tanks outside the city center. The district branch offices, within this scope, were primarily established after the local elections on 30 March 2014. A large number of experienced personnel responsible for the chlorination of the drinking water storage tanks were employed throughout all the province of Mersin after the establishment of the branch directorates. The core function of this position were performed and the job descriptions of these personnel who were taken to serve in the chlorination work were made. In addition, they were prevented from operating in other jobs and the centralized chlorination service was provided uninterruptedly. All personnel received with service procurement were given training on chlorination and legislation and thereby ensuring that continuous application of chlorination on site was carried out. Inventories of all drinking water storage tanks were taken and identification cards (ID cards) were created. Thus, the physical conditions of the water storage

tanks were revealed and repair and maintenance works were started. Chlorine addition follow-up charts were generated on the basis of water storage tanks and weekly activity reports were organized on a district basis and shared with the central unit. In addition, the chlorination process was determined by creating workflow diagrams. The perceived health and harmful effects of chlorine on the public were overcome by public education. During these trainings, it was stated that water had to be disinfected to be distributed in a healthy manner. Prior to the Metropolitan Law No. 6360, the chlorination of drinking water was the responsibility of the Provincial Special Administrations and the headmen. This complexity was prevented and the service was more efficiently carried out from the center with the Metropolitan Law No. 6360 while this situation would not be achieved due to the lack of budget of the headmen and the availability of economic power related to personnel employment. It was ensured that the chlorination operations were effectively carried out by taking the land vehicles in the settlement units where the land conditions were not suitable. Chlorine transfer pumps and chlorine containers and barrels of appropriate quality according to storage tank sizes were also provided for more efficient transfer of chlorine to drinking water storage tanks. The expropriation studies of the storage tank sites built with consent of the citizen at the time of Special Provincial Administrations also initiated. Additionally, the problems of road transportation experienced in the storage transportation started to be solved.

RESULTS

Cleaning of drinking water storage tanks is extremely important in that the chlorine is effective. In line with this purpose, cleaning procedures and instructions have been created by the General Directorate of MESKI and this application has been regularly connected to a system. The facilities of the technology such as intranet, mobile phone and internet were utilized and information exchange and sharing of chlorination teams throughout the entire Mersin province were successfully provided. A total of 13 districts and 509 villages converted into neighborhoods in Mersin, informative meetings about the importance of drinking water chlorination and water-borne diseases were held. In addition, meetings were held with the headmen to inform them and a collaborative work environment was provided. On the other hand, MESKI has taken an important step in the use of renewable energy resources because Mersin province has a dispersed geographical area and accordingly there is no electricity transmission line in the place where there are many water storage tanks. For this purpose, a solar-powered fully automatic chlorination system has been started to be installed in the water reservoirs. Thus, the water reservoirs that have not previously been chlorinated or manually chlorinated have been ensured chlorination. MESKI, which produces its own electric energy instead of attracting energy to the water storage tanks, distributes water to the neighborhoods with clean energy, thereby it is profitable in economic sense. Both internal and external illuminations of water reservoirs are also provided by utilizing the same energy. Ultimately, the chlorination process with the solar energy system, which was previously carried out by personnel, is currently practiced automatically. With this new system, MESKI drastically reduced both chlorine and energy costs. Given below are some visual images that show the practical applications of the chlorination process in Mersin.

This project has only been conducted at the water reservoirs where the electricity energy transmission line installation process will cost a large amount. The results obtained and evaluated in this study are given in Table 1 “Activity Report”, Table 2 “Water Storage Tank Tracking Chart”, Table 3 as “Drinking Water Chlorination Process”, and Table 4 as “Drinking Water Storage Cleaning and Maintenance Procedure”, respectively.

Table 1. Activity report (sample)

	WEEKLY ACTIVITY REPORT (CHLORING TEAM)	
RESPONSIBLE PERSONNEL	Technician	Burhan ZORLU
	Technician	Mustafa SAHIN
	Technician	A. Kerim DOYDU
	Technician	Ahmet TASYARAN
	Env. Engineer	Durdane BAYRAKDAR
DATE	27.06.2016 - 03.07.2016	
DESTINATION	EXPLANATION	
27.06.2016 Pınarbaşı Çiftepınar Çeşmeli Tömük Arpaçbahşiş Kocahasanlı Limonlu Kumkuyu Kızkalesi Ayaş Kızılalan İncirligöz	08.50: Went to Elvan - Chlorine measurement was done (0,2 ppm). 09.10: Went to Kargapınarı - Chlorine measurement was done (0,3 ppm) 09.25: Went to Çeşmeli - Chlorine measurement was done (0,3 ppm). 10.55: Went to Tömük - Chlorine measurement was done (0,4 ppm). 11.15: Went to Arpaçbahşiş - Chlorine measurement was done (0,4 ppm). 11.30: Went to Yeni Hast. Cad. - Chlorine measur. was done (0,2 ppm). 11.45: Went to Saim Göküş Park - Chlorine measur. was done (0,3 ppm). 13.00: Went to Kocahasanlı - Chlorine measur. was done (0,3 ppm). 13.20: Went to Limonlu - Chlorine measurement was done (0,2 ppm). 13.30: Went to Eski Elmas - Chlorine measurement was done (0,2 ppm). 13.45: Went to Limonlu - Checked for chlorine dosing. 14.05: Went to Kumkuyu - Chlorine dosing pump control and injector cleaning were done. 14.15: Went to Kumkuyu - Chlorine measurement was done (0,2 ppm). 15.00: Went to Kızkalesi - Chlorine measurement was done (0.3 ppm) and the connection quality control certificate was audited. 15.20: Went to Ayaş - Chlorine dosing control was done. 16.00: Went to Kızılalan storage tank - Chlorine dosing control was done. 16.40: Was left materials to İncirligöz.	
28.06.2016 Çeşmeli Kargapınarı Elvanlı Tömük Arpaçbahşiş Büyüksorgun	08.35: Went to Çeşmeli - Measured chlorine from the mosque (0,2 ppm). 08.50: Went to Çeşmeli - Chlorine dosing pump control and chlorine measurement were done (0,3 ppm). 09.00: Went to Kargıpınarı - Chlorine dosing pump control and chlorine measurement were done (0,3 ppm). 09.20: Went to Elvan - Chlorine dosing pump control and chlorine measurement were done (0.4 ppm). 10.00: Went to Tömük-Yeşildere - Chlorine dosing pump control was done. During the control, the chlorine hose was detected to be blown and the hose was changed. 10.20: Went to Tömük - Chlorine measurement was done (0,3 ppm). 10.40: Went to Arpaçbahşiş-Dayaklı - Chlorine measurement was done (0,2 ppm). 13.40: Went to Büyüksorgun - Chlorine dosing pump control was done. During the control, it was determined that the chlorine dosing pump was defective and the repair was done.	

Table 2. Water storage tank tracking chart (sample)

DRINKING WATER CHLORING TEAM (OCTOBER TRACKING CHART)																															
STORAGE TANK NAME	DEVICE STATUS	CAPACITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
AKDERE	ELECTRIC	150 m³																						X								
ARKUM	ELECTRIC	300 m³														X							X								
ATAKENT (BOZTEPE)	ELECTRIC	800 m³							X					X		X							X						X		
ATAKENT (DELLEK)	ELECTRIC	300 m³							X					X		X							X						X		
ATAKENT (KAPIZLI)	ELECTRIC	1000 m³							X					X		X		X					X				X		X		
ATAYURT	ELECTRIC	1000 m³							X					X		X							X						X		
AYAŞ TÜRKMENLİ	SOLAR ENERGY	50 m³																														
BAHÇE - SÖKÜN - ÇELTİKÇİ	ELECTRIC	200 m³																														
BAHÇE DERESİ	ELECTRIC	50 m³	X								X						X							X								
BALANDIZ	MANUAL	100 m³																X							X							
BAYINDIR	SOLAR ENERGY	100 m³																														
BOLACALI KOYUNCU 1	ELECTRIC	100 m³	X							X														X								
BOLACALI KOYUNCU 2	ELECTRIC	50 m³	X							X														X								
BURUNUCU	ELECTRIC	100 m³	X							X														X							X	
BÜKDEĞİRMENİ (CENTER)	SOLAR ENERGY	200 m³																									X					
BÜKDEĞİRMENİ (ŞIHLAR)	MANUAL	50 m³																														
CANBAZLI	SOLAR ENERGY	150 m³																		X												
CAMBAZLI (TAŞKINCIK)	MANUAL	75 m³																														
CANBAZLI (KÖŞKALANI)	MANUAL	75 m³																														
CILBAYIR (KAVAKLI)	ELECTRIC	50 m³																							X							
CILBAYIR(TOLAS)	ELECTRIC	50 m³																							X							
ÇAMLICA (ÇALTI)	MANUAL	100 m³																X														
ÇADIRLI (POMPA)	ELECTRIC	130 m³									X						X							X								
ÇALTIBOZKIR (CENTER)	MANUAL	75 m³																														
ÇALTIBOZKIR (YENİÇIKTI)	SOLAR ENERGY	150 m³							X				X														X					
ÇALTIBOZKIR (SİNA)	MANUAL	150 m³																														
ÇALTIBOZKIR(HAMZALI)	MANUAL	75 m³																														
ÇALTIBOZKIR (ÇUKUR)	MANUAL	75 m³																														
ÇALTIBOZKIR (MALIR)	MANUAL	75 m³																														
ÇAMLIBEL	SOLAR ENERGY	75 m³																X														X
ÇATAK	SOLAR ENERGY	150 m³																														
DEMİRCİLİ	SOLAR ENERGY	75 m³							X				X							X							X					
DEMİRCİLİ (TOP TANK)	MANUAL	25 m³																														
EKŞİLER	SOLAR ENERGY	100 m³																														
EVKAF ÇİFTLİĞİ	ELECTRIC	50 m³																														

Table 3. Drinking water chlorination process

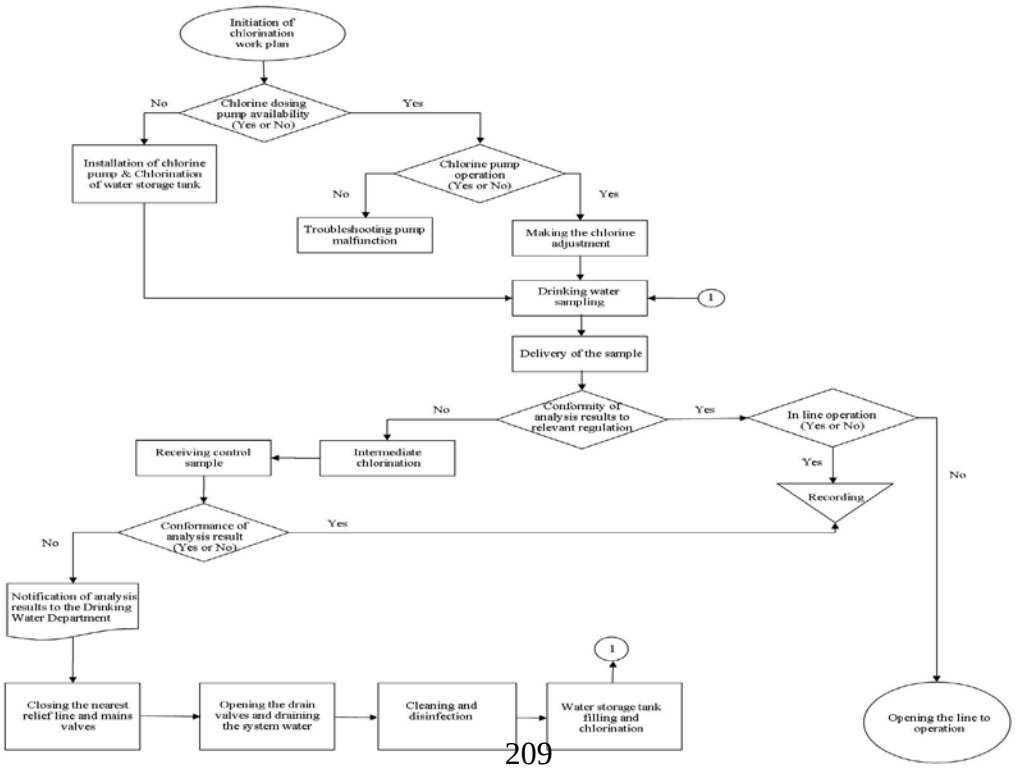

Table 4. Drinking water storage tank cleaning and maintenance procedure (sample)

1	The existing water in the storage tank is completely drained and cleaned.
2	Lighting is provided in the water storage tank.
3	The inside the tank is washed with pressurized water by the personnel wearing special clothes such as coveralls, boots, gloves, etc.
4	Coarse dirt such as sludge, rust, and iron particles in the storage tank is removed with necessary materials.
5	Appropriate disinfectant is applied to contact the entire surface of the storage tank.
6	The disinfectant solution which is kept waiting for a sufficient time is discharged by the pump.
7	The water storage tank is thoroughly rinsed.
8	Once the tank is cleared, clean water is stored again.
9	Acidic material is not used when cleaning the tank.
10	Installation and maintenance of the water booster pump are periodically performed (semi-annually). Technical service is informed in case of malfunction.
11	Water float maintenance and changes are done regularly.
12	The cover is tightly closed after cleaning and disinfection of the water storage tank. Lid control of the tank is also performed at specific intervals.
13	Input and output water quality measurements are performed at regular intervals.
14	It is checked whether there is leakage in the pipe connections in the water tank.

CONCLUSIONS

The delivery of healthy, clean and safe drinking water is legally the duty of the local authorities in our countries. The quality of these waters is determined and monitored by the Ministry of Health. Therefore, it is of great importance that the local authorities, the Ministry of Health, and the parties concerned work in cooperation with the solution of the problems. It is also important that the Water and Sewerage Authorities have a drinking water laboratory for in-situ and a timely intervention. Accordingly, it is a great convenience and advantage that MESKİ has a laboratory accredited by TURKAK. Water analysis is carried out in the MESKI laboratory with the aim of monitoring and assessing water quality throughout the entire Mersin province. Drinking water samples are taken from the focal points of the Directorate of Health upon request/complaint and the great divide routinely.

Approximately 45% of the total 1005 water reservoirs in different capacities located in Mersin province are currently chlorinated with a solar-powered fully automatic chlorination system. According to the " Regulation Concerning Water for Human Consumption (5)", the purpose of the General Directorate of MESKI is to keep the concentrations of chlorine within the range of 0,2-0,5 ppm at the end points of all drinking water networks and to ensure that the people throughout Mersin Province consume healthy drinking water. As a result of the "Regional Health Assessment Meetings in Local Governments" which was carried out by the Public Health Authority of Turkey in 2015-2016, the city of Mersin has the lowest incidence of non-compliance in terms of drinking water audit monitor non-compliance ratios. Moreover, Mersin is among the lowest provinces in drinking water residual chlorine non-compliance rates. As a result of all these studies and applications, the goal of the General Directorate of MESKI is to provide that it is an institution managed by systems rather than people and to ensure that water quality is continuously monitored online by making all necessary improvements in water supply, distribution and quality.

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