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STUDY ON WASTEWATER TREATMENT SYSTEMS IN HOSPITALS OF IRAN

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ABSTRACT

Nowadays, water resources shortage is one of the most important issues for environmental engineers and managers as well as its conservation due to population growth and ever-increasing water demands. Besides, hospital wastewater has the same quality as municipal wastewater, but may also potentially contain various hazardous components. In this paper, physical and chemical specifications of produced wastewater in hospitals of Iran were investigated experiments. Results were compared with the effluent parameters of wastewater standards of Iranian Department of the Environment. 70 governmental hospitals from different provinces of Iran were selected by purposive (non-random) sampling method. For data analysis, SPSS and EXCEL softwares were applied. The findings of the study showed that 52% of the surveyed hospitals were not equipped and 48% were equipped with wastewater treatment systems. The mean of Biochemical Oxygen Demand, Chemical Oxygen Demand and Total Suspended Solids of the effluent of wastewater treatment systems were reported as 113, 188 and 99 mg/L respectively. Comparison of the indicators between effluents of wastewater treatment systems and the standards of Departments of the Environment, showed the inefficiency in these systems and it was concluded that despite the recent improvements in hospital wastewater treatment systems, they should be upgraded based on the remarks in this paper.

Key words: Wastewater, hospital, septic tank, activated sludge

INTRODUCTION

Water resources shortage is one of the most important issues due to the population growth and ever increasing water demands as well as its conservation. Wastewater treatment can serve as a logical way to recycle water to consumption cycle. Due to variety of water uses, it seems that there are certain treatment techniques for different types of wastewater, such as municipal and hospital wastewater, which are produced by sanitary centers. Hospitals are considered as high risk places because of being located within municipal and human societies (Pruss, 1999). Wastewater from hospitals is of similar quality to municipal wastewater, but also potentially contain various hazardous components like enteric pathogens, including bacteria, viruses and helminthes, small amounts of chemicals from cleaning and disinfection operations, pharmaceuticals and also radioactive isotopes, which may easily reach to water resources (Kummerer, 2001). In some developing and industrialized countries, the outbreaks of cholera are periodically reported. Sewers of hospitals where cholera patients are treated are not always connected to efficient sewage treatment plants, and sometimes municipal sewer networks may not even exist (Majlessi, 2001).

In developed countries, the rate of water uses is commonly high and the sewage is therefore greatly diluted; effluents are treated in municipal treatment plants and therefore no significant health risks should be expected, even without further specific treatment of these effluents (WHO, 1996). Only in some rare event of an outbreak of acute diarrhea disease, excreta from patients should be collected separately and disinfected. In developing

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countries, where there may be no connection to municipal sewage networks, discharge of untreated or inadequately treated sewage entering to the environment will inevitably pose major health risks (Pruss, 1999).

The toxic effects of any chemical pollutant contained in wastewater and the active bacteria of the sewage treatment process may give rise to additional hazards (Franceys,1992).

Although, many years have passed since the establishment of health and medical centers in Iran, but the problem of hospital wastes (solid and liquid) has not been solved yet. This paper aims to focus on an investigation about hospital wastewater treatment systems in Iran. Moreover, effective alternatives in reducing existing wastewater contaminants, based on the obtained results from hospital wastewater treatment techniques in other countries, have been surveyed and recommended.

MATERIALS AND METHODS

In order to obtain scientific data related to hospital effluents, library documents, reference texts, internet search and data from Ministry of Health have been used. To obtain this information, a questionnaire containing 5 sections was designed:

- Specifications of the studied hospitals
- Characteristics of consumed water and amount of produced wastewater
- Hospital wastewater specifications quantitative specifications of hospital wastewater
- Wastewater treatment and sludge disposal systems in the hospitals equipped with treatment systems
- Raw and non-treated wastewater disposal method in the hospitals without any wastewater treatment system.

The questionnaire was developed and then completed in each hospital based on the observations, dialogue with hospital responsibles and related documents. Moreover, sampling on the effluent wastewater treatment systems were carried out and the samples were transferred to the laboratory.

70 governmental hospitals from different provinces of Iran (Tehran, Fars, Hormozgan, Gilan, Golestan, Semnan, Khouzestan, Zanjan, West Azarbayjan and Yazd) were selected by non-random sampling method. For data analysis, SPSS and EXCEL softwares were applied and descriptive statistics (percentage, mean and standard deviations) were reported.

Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), pH, Total Suspended Solids (TSS) and residual chlorine were tested for raw and treated wastewater samples. pH and residual chlorine were measured on-site. These parameters are considered as significant factors by Iranian Department of the Environment (DOE) for monitoring of hospital wastewater disposal (DOE, 2004). Sample analysis was done according to the standard methods (APHA, 1998). All of the analyses were conducted in the water and wastewater laboratory of the Department of environmental health at Shahid Beheshti University of Medical Sciences.

RESULTS

According to the obtained data, the total number of the surveyed hospitals was 70 and most of them were located in Tehran, while the least were situated in Yazd province.

Average and standard deviation of the volume of produced wastewater was identified as 745 L and 272 L per each bed per day, respectively.

Findings of the study showed that 52% of the surveyed hospitals were not equipped and 48% were equipped with wastewater treatment system. 52% of the hospitals without treatment plant, disposed their raw wastewater into the wells, 38% disposed it directly into the environment and the rest into municipal wastewater network.

Fig. 1. shows the maximum, minimum and mean of TSS, COD, and BOD_5 in the raw wastewater of the hospitals.

This survey showed that there were two types of wastewater treatment systems: 78% of the hospitals used activated sludge system and 22% used septic tanks. The performance of wastewater treatment plants in hospitals was determined through comparison between TSS, COD, and BOD_5 values of the plants effluents and DOE standard (Fig. 2). Figs. 3 to 5 also demonstrate the comparison between each of the above-mentioned parameters in treatment plants influents

and effluents. According to these results, the mean of the influent BOD_5, COD and TSS were reported as 348, 527, 291 mg/L and the mean of the mentioned parameters in effluents were 113, 188 and 99 mg/L respectively.

In 43% of the hospitals with wastewater treatment plant, the hospital wastewater was disinfected with chlorine and no disinfection method was used in the rest 57%. The treated effluents disposal methods in the hospitals were as follows: 47% into the absorbing wells, 31% into municipal wastewater collection system, 19% for green area irrigation through open channels and 3% for agricultural irrigation (Fig. 6). 41% of hospitals with treatment plant disposed their sludge into the landfill and the other 59% rest 59% were transferred by contractors.

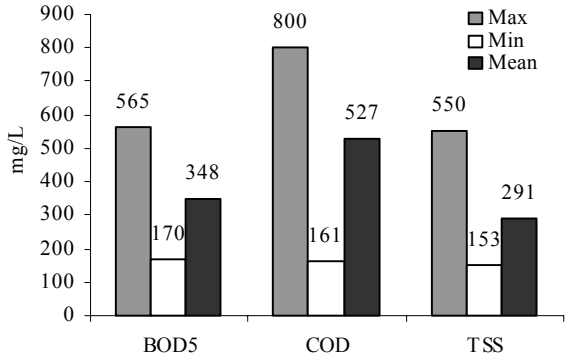

Fig. 1: Comparison between the influent wastewater qualitative specifications in hospitals with Department of Environment standard

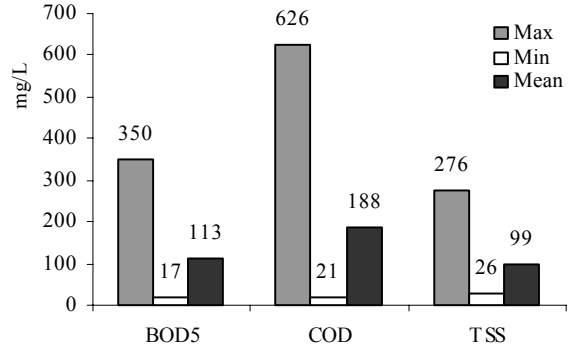

Fig. 2: Comparison between the effluent wastewater qualitative specifications in hospitals with Department of Environment standard

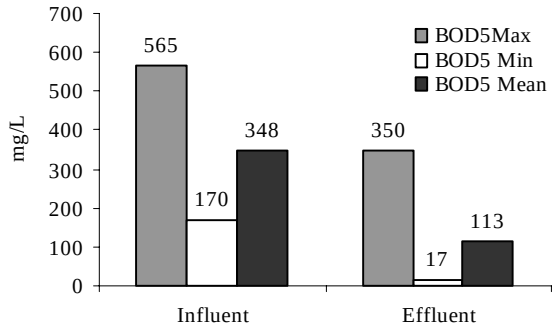

Fig. 3: Comparison between BOD_5 in influent and effluent wastewater

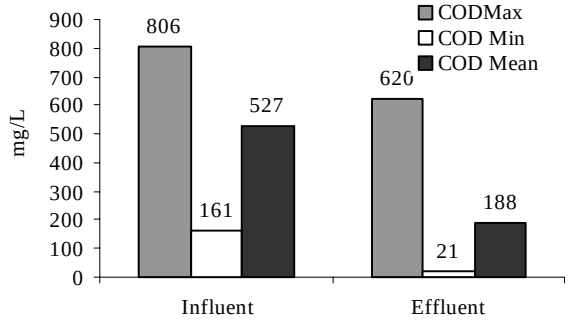

Fig. 4: Comparison between COD in influent and effluent wastewater

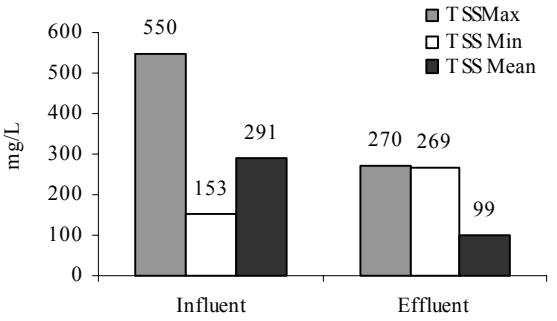

Fig. 5: Comparison between TSS in influent and effluent wastewater

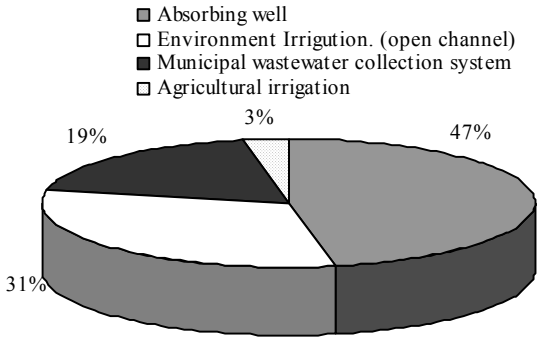

Fig. 6: Disposal or reuse method of hospital Wastewater treatment plant effluents

DISCUSSION

Since the produced wastewater quality in each hospital is considered as an important factor for designing wastewater treatment systems, proper attention has to be focused on precise determination of wastewater flow of the hospitals. According to the results of this research, the per capita produced wastewater depended on geographical and climatic conditions as well as number of beds and sections in the hospitals. Study on wastewater quality parameters (TSS, COD, and BOD_5) revealed severe potential of hospital wastewater contamination.

This research also showed that most of the well known hospitals in the country were not equipped with appropriate wastewater treatment system and the hospitals having treatment plant were not efficient to the extent determined by the standards of Iranian Department of Environment (DOE).

Comparison between this study and similar studies in Iran showed the same results. Majlessi (2001) showed that although the concentrations BOD_5, COD and TSS are decreased in the hospitals with wastewater treatment plants, but the mentioned parameters in the effluent were higher than the standard levels. This is because the treatment plants did not have the efficient conditions.

Rezaee (2005) showed the removal efficiency of COD for a hospital wastewater with the influent of COD700 mg/L was 95.1%.

Also Sarafraz (2006) showed that BOD_5,COD and TSS decreased from 242.25 mg/L, 628.1 mg/L and 231.25 mg/L to 12/53 mg/L, 51.7 mg/L and 19.68 mg/L, respectively, when the wastewater treatment plant was worked properly.

Low performance of wastewater treatment plants lead to the spreading of chemical and microbiological contaminants in the environment. Some of the reasons for this matter can be summarized as follows:

- Discordance between treatment system and required efficiency. As seen in the results, there are generally two types of treatment systems in the equipped hospitals, septic tank and activated sludge system, which is capable to remove TSS, COD and BOD_5 if used correctly, but the former is not.
- Improper operation of wastewater treatment systems due to employing untrained operation personel.
- Improper design of treatment system including discordance between system capacity and the amount of produced wastewater, low aeration capacity, deficiencies existing in pretreatment units, and lack of suitable storage, digesting and disposal systems for sludge produced through treatment, process.
- Deficiency and impairment of some units and treatment plant installations and low performance in maintenance and rehabilitation.
- Low performance of chlorination system due to improper operation and control on the amount of injected and residual chlorine.

Considering the above-mentioned results and conditions, it can be concluded that despite some accomplishments in the recent years, hospital wastewater treatment and disposal should be improvements considered as highly important issues. Following remarks can help to find the appropriate solutions:

- Implementation of proper treatment system with the capability to remove contaminants to the extent mentioned in corresponding standards. Such as film-fixed activated sludge system for biological treatment process or application of activated carbon columns to remove special contaminants such as antibiotics and drugs.
- Design of treatment plants based on appropriate qualitative and quantitative criteria along with optimization of existing ones.
- Higher attention of hospitals managers to wastewater treatment.
- Employing specialists for the system operation, including treatment plant supervisor and two or three part-time trained operators.
- As hospitals wastewater may be similar to municipal wastewater, it can enter into municipal wastewater collection systems to be treated provided that proper pre-treatment processes are initially applied.
- Holding training courses related to operation of wastewater treatment systems for the personel of the hospitals.

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