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The Wastewater Quality of the Combined Cycle Power Plant of Montazer Ghaem to be Re-used in Agriculture

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ABSTRACT: While the source of irrigation water is wastewater, there are some concerns about the pollution of crop products and the farm workers' contact with pathogens and environmental tensions in the farm's field. The purpose of this applied research was to investigate the quality of the wastewater of the combined cycle plant of Montazer Ghaem to be reused in agriculture. In this study, the characteristics of inlet wastewater and outlet effluent from the urban wastewater treatment plant of Montazer Ghaem-Kearj were investigated based on the statistics of the operation and sampling period. Moreover, the effects of the medium–term usage on the physical and chemical properties of the soil and several plants affected by this water were studied. For this purpose, three samples from the inlet wastewater and three samples of outlet effluents of the treatment plants were provided and eleven sewage quality parameters were tested. However, three soil samples from 0 to 30 cm depths of adjacent lands under irrigation with wastewater as well as a control sample were prepared and their physical and chemical properties were determined. The analysis of the changes in the physicochemical parameters revealed that, except for the pH which was approximately constant, all parameters including EC, TDS, COD, BOD, turbidity, fat, oil, heavy metals (Fe, Ni, Cr, Cd, Cu, V) in the inlet wastewater were reduced after refining and leaving the treatment plant. However, the amount of some parameters was higher than standard which indicates the improper performance of the refineries in the removal of physico-chemical contaminants. This study concluded that the wastewater treatment plant of Montazer-Ghaem failed to significantly eliminate the elements such as Ni (Average input 13.5- Average output 12.5) and Cd (Av input 0.16- Av output 0.1), but had the highest refinement in terms of the elements including Cu (Av input 36.8- Av output 8.8), V (Av input 284.9- Av output 84.5), Fe (Av input 5.6- Av output 1.6), and Cr (Av input 71.5- Av output 28.6) respectively.

Keywords: Wastewater, Combined cycle power plant, Agriculture

1. Introduction

The use of wastewater in agriculture, as a rich source of nutrients, is widely accepted in areas where fresh water scarcity is present (Nadau et al., 2012). Urban and industrial wastewater can be used for irrigation of urban parks and forested areas on the margin of the cities (Al Jamal et al., 2000), while helping to protect the environment and to restore urban landscapes (Pedro, 2011). Using waste water in applications such as irrigation, the soil and plant health should be considered. (Larinson et al., 2011). Heavy metals in wastewater are mainly due to the entry of waste from various industrial plants. Investigating the entry of heavy metals into soil is important to consider from the perspective of collecting toxic substances in soil, absorbing by plants and polluting of groundwater. Streic and Richter (1977) reported that the movement of heavy metals in soils irrigated with wastewater is very slow and more than 90% of cadmium, nickel and lead accumulate in the soil with of 10 to 15 cm depth. Singh et al. (2009) reported that irrigation with urban wastewater has an impact on the accumulation of heavy metals in the soil. The penetration of urban wastewaters in the soil increases the total concentration and the application of heavy metals. Considering that wastewater has more salts and heavy metals than conventional sources such as rivers, aquifers and watersheds, it may have adverse effects on the soil. Larinson et al. (2011) reported that irrigation with urban wastewaters increased the amount of heavy metals up to 5 times, which were higher in soil surface than in the lower layers.

When the source of irrigation water is wastewater, then there are concerns about the pollution of crop products, the contact of farm workers with pathogens and environmental tensions on the farm's level. In this regard, it is important to pay attention to irrigation practices along with the consideration of environmental standards (Najafi et al. 2005; Kapra & Sklin 2004; Quadir et al. 2010). When using drip irrigation and mainly submerged drip irrigation, there is no contact between the workers and the upper parts of the plant with waste water, so there will be fewer problems for the health of the product and workers in this area.

Some researchers believe that reuse of wastewater by drip irrigation is the most effective and efficient way to cope with water scarcity for agricultural products and with environmental pollution. Abedi Kupai et al. (2006) reported that the effects of both surface and rain irrigation methods on increasing the amount of heavy metals in soil were not significant and considering the use of wastewater in agricultural lands near the refineries, little information is available in Iran regarding the effect of heavy metals pollution on soils in forest areas, as well as effects of different systems of irrigation with wastewater on the accumulation of heavy metals in the soil. Strike and Richard (1977) reported that heavy elements moved slowly in irrigated soil with sewage, so that more than 90% concentration of heavy nickel, cadmium and lead in 10-15 cm depths was observed. Abedi Kupai et al. (2006) found that irrigation systems had no effect on the accumulation of heavy metals in the soil in evaluating the effects of irrigation with refined wastewater on the chemical and physical properties of the soil in a dry area. But application of sewage caused significant accumulation of lead, manganese, nickel and cobalt compared to groundwater treatment. Also, accumulation of lead, manganese, nickel, cobalt, copper and zinc has decreased with soil depth. Also, Kelly et al. (2010) showed that the concentration of heavy metals in the soil, especially for lead and cadmium, has increased with irrigation during the irrigation period. Research has shown that the use of sewage is effective on the fertilizer and organic matter due to its high concentrations (Hosseini et al., 2002). Hosseini et al., 2002), in their research, reported the increase of nutrients such as nitrogen and phosphorus and the increase of the salts and heavy metals in the soil after the use of sewage. Nasri et al. (2012) reported that the use of refined sewage resulted in an increase in available phosphorus and increased heavy elements such as cadmium, nickel and chromium. Irrigation with untreated wastewater for a long time, depending on the source of wastewater, can lead to an increase in heavy metals and thus a decrease in soil quality (Locho Konstantino et al., 2005; Makanda et al., 2005). Therefore, wastewater treatment is recommended before use for irrigation. Irrigation with water that does not have the proper quality will cause various problems in the soil and plant including the problems caused by irrigation with inappropriate water and the problems of salinity, permeability and toxicity. Therefore, irrigation water should be of appropriate quality from a variety of aspects that can be considered in a set of physical, chemical and biological properties. In Iran, the standards for reusing wastewater in various cases are provided by the Environmental Protection Agency and other authoritative sources. The Montazer Ghaem Power Plant in 1350 was built on an approximate area of 100 hectares, located at km 7 of the Mallard-Karaj Road in Shahriar, and currently has 4 units each with a nominal capacity of 156 MW and a practical capacity of 150-140 MW and 6 units of gas each with nominal capacity MW 116, installed in 1993. In the development plan, 3 steam units are considered as a combined cycle of each with 125MW. With regard to the presented information, the present study investigated the quality of the wastewater of the Montazer Ghaem combined cycle power plant for reuse in agriculture.

In this study, in order to keep pace with sustainable development, it is important to determine the qualitative and quantitative characteristics of the wastewater of the Montazer Ghaem power plant and its compliance with the standards of the Environmental Protection Agency for reuse in greening or agricultural irrigation in order to use it with the least harmful environmental effects. For this purpose, a number of sampling stations have been determined by using the opinions of the relevant experts. For each of the stations, pH, EC, turbidity, fat, soluble solids (TDS), DO, BOD5, COD, heavy metals (such as Fe, Ni, Cd, Cr, Cu, V...) were measured. Another objective of this study was to evaluate the performance of the plant's wastewater treatment system and its efficiency in removing pollutant parameters and thus the comparison of the qualitative analysis of the input and output parameters was made and then environmental effects of the effluent on the environment were investigated.

2. Materials and methods:

2.1. Materials

In this study, in order to keep pace with sustainable development, it is important to determine the qualitative and quantitative characteristics of the wastewater of the Montazer Ghaem power plant and its compliance with the standards of the Environmental Protection Agency for reusing in greening or agricultural irrigation in order to use it with the least harmful environmental effects.

Detection and visiting Power Plant of Montazer Ghaem and determining the sampling stations are essential for qualitative and quantitative wastewater treatment of the power plant.

The review of the resources associated with the Power Plant of Montazer Ghaem indicates that the waste water of the power plant is mainly composed of the following five categories:

A: Salt wastewater

these wastes are mainly due to water purification systems. The sources of this wastewater collection are:

- Clarifiers
- Physical filters (sand)
- Cooingly towers
- Pillars or ion converters

B: Toxic waste which results from the chemical washings of the metal surfaces of the water and steam section during the startup and preheater of air and wastewater of the laboratory

C: Oily waste

Includes wastewater contaminated with fuel or various oils used in the power plant

D: Sanitary Wastewater و WC, toilet and bathroom

Hot effluent including boiler blow down effluent

For this purpose, a number of sampling stations have been determined by using the opinions of the relevant experts. For each of the stations, pH, EC, turbidity, fat, soluble solids (TDS), DO, BOD5, COD, heavy metals (such as Fe, Ni, Cd, Cr, Cu, V ...) were measured.

2.2. Sampling of farm soil

Three soil samples were taken from a depth of 0-30 cm (after removal of litter). The specimens were harvested in unpackaged form so that after drying, 80 meshes (about 2 mm) were passed. Then, they were poured into the appropriate bags and the number of the samples was labeled on them. The samples were numbered as numbers and codes. For example, in S1, the letter S is the first letter of station and the code 1 is the sample number. In the laboratory, the specimens were dried and then passed through the 2 mm sieve after milling. Then 2 grams of soil were added in two duplicate flasks and 15 ml of normal nitric acid were added. Then the flasks were placed in warm water bath for 12 hours at 80 °C. After passing the mentioned time, the samples were smooth and the heavy metals concentration was determined by atomic absorption device (1995, Black). In addition to nitric acid, other compounds were used for the extraction of metals. The used reagents include distilled water, 0.1 molar of calcium chloride, and 0.05molar of di-ethylenetriamine pentacic acid (DTPA). The elements, of Ni, Cd, Cr, Cu, Fe, and V contained in the soil were measured by an atomic absorption device.

2.3. Sampling of the plant

Several samples of corn, walnut, beetroot, okra and grapevine, which were affected by irrigation with a wastewater treatment plant were used to determine the absorption of heavy metals by plants. Sampling was carried out in the following way and their absorption rate was investigated.

A. Systematic sampling of plants under irrigation with wastewater treatment plant.

B. Collecting the leaves of the plants and placing each sample in a paper bag after the inserting the code of each sample.

The samples were thoroughly washed in an ironing machine for 48 hours. Dry and powdered specimens were ashed out in an electric crucible at 450 ° C for 2 hours.

Ashes with 1 to 3 ml of wet water and kerosene were heated on a heater. Then, 5 ml of 6 molar chloride acid was added to the ashes and then heated on the heaters and the residue was solved in 10 to 30 ml of 0.1 N normal nitric acid The crucible was rotated carefully to allow all ash to be contacted with an acid and the clock of crucible was covered by the glass and kept constant for 2 hours and then transferred into the into plastic bottles previously washed with acid after shaking. The concentration of heavy metals was determined in samples.

In this study, the obtained data were analyzed. After measuring the quantitative and qualitative parameters of the wastewater of the combined cycle power plant of Montazer Gaem, the minimum, maximum and the average value of each of the parameters for each station were calculated and the results were compared with the standards of the Environmental Protection Agency and the feasibility of using this wastewater for irrigation Green space or agriculture was investigated.

2.4. Method

The main method and method of ecological exploration is to choose correctly the analytical method for samples. The importance of this stage can be likened to the foundation of a structure, which should be based on solid foundation.

2.5. Data Analysis Method

For the estimated data, two statistical analyses were performed including:

1. Single-variable analyzes: T-test and correlation analysis
2. One-way ANOVA

SPSS statistical packages were used to perform these analyses.

3. Results:

In this study, the characteristics of inlet and outlet sewage from the wastewater treatment plant of Ghaem-e-Karaj have been investigated based on the statistics of the exploitation period and sampling during the research.

Table 1: Changes in physicochemical parameters of wastewater before and after entering the refinery

Row	Test Title	correlation test	T-test	Description
1	EC value before and after wastewater treatment	۰,۷۷۶	۰,۰۲۸	Correlation was not significant, but there was a significant difference between the samples
2	pH value before and after wastewater treatment	۰,۴۸۲	۰,۴۱۱	Correlation was not significant, but there was no significant difference between the samples
3	TDS value before and after wastewater treatment	۰,۷۷۵	۰,۰۲۸	Correlation was not significant, but there was a significant difference between the samples
4	TU value before and after wastewater treatment	۰,۸۵۶	۰,۰۶	Correlation was not significant, but there was no significant difference between the samples

5	COD value before and after wastewater treatment	۰,۷۵۶	۰,۰۰۷	Correlation was not significant, but there was a significant difference between the samples
6	Fe value before and after wastewater treatment	۰,۳۵۹	۰,۰۰۷	Correlation was not significant, but there was a significant difference between the samples
7	Ni value before and after wastewater treatment	۰,۱۸۳	۰,۰۴۱	Correlation was not significant, but there was a significant difference between 8the samples
8	Cu value before and after wastewater treatment	۰,۱۷	۰,۰۰۴	Correlation was not significant, but there was a significant difference between the samples
9	Cr value before and after wastewater treatment	۰,۵۱۸	۰,۰۰۵	Correlation was not significant, but there was a significant difference between the samples
10	Cd value before and after wastewater treatment	۰,۱۹۸	۰,۲۶۷	Correlation was not significant, but there was no significant difference between the samples
11	V value before and after wastewater treatment	۰,۲۴۴	۰,۰۰۸	Correlation was not significant, but there was a significant difference between the samples

The dependent t test on the significance of changes before and after the treatment of wastewater showed that there is a significant difference among all samples except the contents of pH and Cd.

Table 2: Changes in heavy metal absorption in irrigated plants by treatment plant effluent

Row	Test Title	ANOVA Test	Description
1	Fe value before and after wastewater treatment	۰,۰۰۰	There was a significant difference between Fe
2	Cu value before and after wastewater treatment	۰,۰۰۰	There was a significant difference between Cu
3	Cd value before and after wastewater treatment	۰,۰۰۰	There was a significant difference between Cd
4	V value before and after wastewater treatment	۰,۰۰۰	There was a significant difference between V

One-way ANOVA analysis table with heavy metal variables showed that there are significant differences between the treatments in terms of heavy metal adsorption.

Table 3: Comparison of Heavy Metals in Treatment Plants with Different World Standards

Row	Factor	Average in input waste	Average in output waste	Germany	IRAN	WHO	EPA	FAO
1	Cd	0.16	0.1	0.003	0.05	0.01	0.01	0.01
2	Cr	71.5	28.6	0.2	1	0.01	0.05	-
3	Cu	36.8	8.8	0.2	0.2	0.02	0.2	0.2
4	Fe	5.6	1.6	-	3	-	-	5
5	Ni	13.5	12.5	0.03	2	-	-	0.2
6	V	284.9	84.5		0.1			
7	Fat and oil	>2	<2		10			
8	BOD	5>	5>		100			
9	COD	8.9	4.2		200			
10	pH	7.2	7.3		6-8.5			
11	Darkness	32	12		50			

In the initial comparison of the heavy metals level in the wastewater entrance with the resultant effluent, it can be concluded that the wastewater treatment plant of Montazer Ghaem failed to significantly eliminate the Ni (Av input 13.5- Av output 12.5) and Cd (Av input 0.16- Av output 0.1) elements, but had the highest refinement in terms of the elements Cu (Av input 36.8- Av output 8.8), V (Av input 284.9- Av output 84.5), Fe (Av input 5.6- Av output 1.6), and Cr (Av input 71.5- Av output 28.6) respectively.

4. Conclusion:

During the study, the effects of the medium term on the physical and chemical properties of the soil and several plants affected by this water were studied. Also, three soil samples from 0 to 30 cm depths from adjacent lands under irrigation with wastewater and a control sample were provided and their physical and chemical properties were determined. Analysis of the changes in the analyzed physicochemical parameters showed that, except for the PH which was approximately constant before and after purification, all parameters including EC, TDS, COD, BOD, turbidity, fat, oil, heavy metals (Fe, Ni, Cr, Cd, Cu, V) inlet and outlet sewage after the treatment have decreased. However, some of the parameters were higher than standard level which indicates the improper performance of the refineries in the removal of physico-chemical contaminant. This high level of heavy metals suspended in outlet effluent from the water treatment plant of Montazer Ghaem and irrigation of the surrounding fields caused a rise in the level of metals measured in the soil of the soils, which after receiving three soil samples from 0 to 30 cm depth from adjacent lands under irrigation with wastewater and measurement of physical and chemical properties, as well as obtaining a control sample from distant farms far away from sewage effluent and comparing the elemental values in soil samples, it can be concluded that With the exception of the cadmium element, a multiplier enrichment of the measured elements is shown against the control sample. In general, it can be concluded that the wastewater treatment plant of Montazer Ghaem cannot be regarded as an important and desirable alternative to obviate agricultural water requirements and it can be used provided that level of its heavy metals reaches to the desirable level or it is used as a drip irrigation in the agricultural industry. Also, the results of this study indicate that in the current situation with water scarcity, the use of waste water is an option that is recommended, depending on the condition, provided that the waste water is treated correctly and in accordance with the standards or it is recommenced that drip irrigation is used for the farms.

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