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Invention of a Method to Control of Nitrate Pollution (Case study: Wastewater Treatment Plant of Saipa car company-Iran)

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Abstract. From the standpoint of pollution, industrial wastewater has numerous physical and chemical pollutants. Various methods were being suggested for industrial wastewater treatment depending the nature of the industry. Saipa car industry emits various environmental pollutants in its different processes. Problems addressed in this study were related to central heating output effluent of Saipa Company, including water leakage in feeding water systems, high temperature and corrosive outlet effluent due to decreasing of pH. In this study several methods were carried out for effluent reuse as a pilot research. The pilot was based on waste prevention of water containing nitrate and its recycling in addition of cooling and solving the corrosion problem. The results showed that, the wasting water was avoided due to preventing leakage of feed water in system. Beside, by adding corrosion inhibitor material, in addition to reducing water temperature, the system's corrosion would be prevented. On the other hand, the components of corrosion inhibitor increased the nitrate level in effluent were reused using the research pilot. Meanwhile, the oxygen amount of in the water existed in system within a high volume was reduced by improvisation a heating coil. Finally, the percentage of water returned to the hot water system was up to 60%.

Keywords: Water leakage, nitrate, anti-corrosion materials, reuse.

1. Introduction

One of the most important factors in water resources' contamination is the discharge of the industrial wastewater due to its physical (high temperature) and chemical (being corrosive and high nutrients) parameters. Hence, it is obligatory to collect and treat it in an environmental friendly method and then, return the re-circulated water into the nature due to water shortage. The quotable note is that, if it is possible to prevent the discharge of contaminants in to the environment, there will be no need to treatment anymore. In the past years, regarding poor quality of circulating water in hot water system of Central Engine Room which was beyond the standard levels, welded pipes of hot water boiler and other fittings in Saipa Car Co. Engine Room were frequently suffered from severe corrosion influenced on the perforation of pipes and thus, leakage of hot water boilers. It should be noted that, pipes repairmen and replacement evolves a lot of cost.

There are different ways to reduce temperature and prevent corrosion, but one of the best methods is usage of nitrite-base materials. By adding such materials, in addition to prevention of pipes' decay caused by corrosion, it could be decreased the water temperature. Nonetheless, some problems will be occurred due to the emergence of compounds containing very high concentration of nitrate. Nitrate is water soluble and stable ion which has little potential to absorb or combine with other compounds, so its discharge into the central treatment plant will be caused a lot of elimination difficulties. Various methods have been used for

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removing nitrates from the wastewater[1][2] including reverse osmosis [3] ion exchange[4], distillation, Electrodialysis (ED)[5], biological denitration, ammonia release[6] nitrification[7] denitrification[1][2] and dilution[8] that each of them have their own advantages and disadvantages[9]. Among the mentioned methods the biological denitration is a new method which has been applied widely all over the Europe [2]. In this method nitrate removal rate is so fast and compared with ion exchangers has the ability to maintain water quality. Although, the aim of all the mentioned methods is elimination of nitrate but they are not suitable for situation of high nitrate concentration. Some mentioned methods are able to remove only some fraction of the nitrate or some others have limited capability and will required regeneration. Since, the effluent of the Saipa Car Co. Engine Room contains very high level of nitrate, none of the noted methods is effective to remove such a nitrate concentration and prevent it from discharge in to the wastewater treatment plant.

2. Material and methods

The research methodology includes field study and a pilot study, Fig. 1 is shown a schematic of this pilot. Whole of the study lasted for 12 months. The multi-stage research was carried out in the field as follows:

- Control of water consumption in hot water system wasted through pump umbilical, de-aeration faucet and system leakage
- Oxygen elimination of feed water
- Pilot design and construction to test corrosive material.
- Recycle and reuse of water discharged from the hot water system

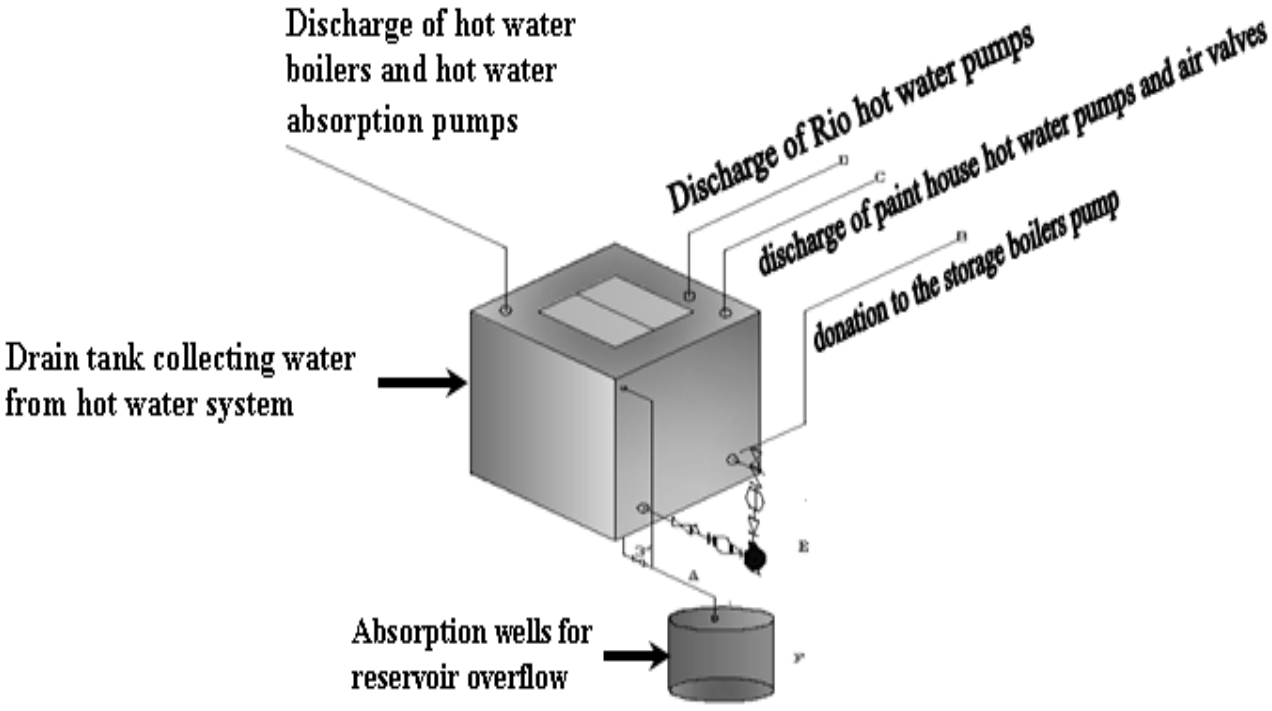

Fig. 1: Effluent reuse pilot for prevention of corrosion and nitrate discharge to the environment

Since, such a high concentration of nitrate entered in to the waste water treatment plant directly, the reuse of effluent in the cooling cycle of water was performed in the engine room boilers. In this cycle, the Corrosion Inhibitor liquid that produced by MBA Company contained high concentration of nitrite was used, the composition of corrosion inhibitor are shown in table 1.

Table1. Corrosion inhibitor composition

Chemical name	Weight (%)
Water	47-73
Sodium Nitrite	15-25
Hydroxy phosphonoacetic acid	5-10
Sodium hydroxide	5-10
1,2,3 Benzotriazole	1-5
Polyacrilic acid	1-5

This anti-corrosion liquid reduces the temperature of the pressurized water equal to 1200 ºC, and replaces the nitrate, subsequently; it is released in to the environment. Since, the effluent had some corrosion inhibitor containing nitrate with high potentiality of heat absorption as well as anti corrosion characteristic, it was returned into the cooling cycle once more, so that no environmental release would be occurred. For this purpose, 20 liters of engine room effluent were taken in place of its entrance in to the network within five periods, and then it was discharged in to the laboratory pilot which has a capacity of 100 liter. The pilot basis is based on waste prevention of water containing nitrate and its recycling in addition of cooling and solving the corrosion problem. Considering the obligation of Environmental Protection Department, all industrial samples should be taken based on composed sampling method. For this purpose, six containers with capacity of one liter were used. Sampling was performed from 7am once every two hours. All samples were kept in standard situation of Cold box. At the end of the day and after 12 hours, the samples were mixed together and one sample was transformed to the laboratory. The nitrate level of the engine room effluent in Saipa Car Co. was very high so that, even a simple sampling or any momentary sample in any time was reflected the high level of nitrate. However, the samples were taken according to the standards in the composed form. All samples were taken to the laboratory. Determination of pH, TH, NO2, PO4, Fe, TDS, EC, Phenolphthalein alkalinity and Total alkalinity were performed according to standard methods, 20th ed [16].

3. Result and discussion:

As it has already been mentioned, the first step of this research is control of water consumption in hot water system wasted through umbilical pump, de-aeration faucet and the system leakage. By performing this plan wasting water has been avoided more than twice in the worst case as well as higher than 5 times in the best condition. Fig. 2 shows the comparison of water consumption rate in Hot Water System in the years; 2008 and 2009.

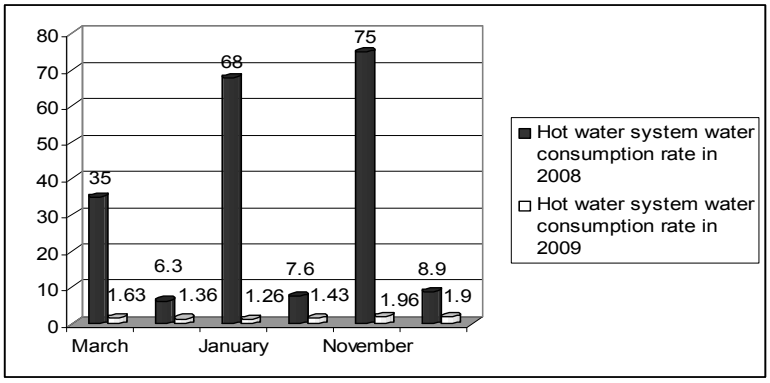

Fig. 2: The comparison of water consumption rate in hot water system in the years 2008 and 2009

The second stage is oxygen elimination using pre-heating feed water by installing a heat exchanger in feed water storage tank. By this action, oxygen was about 1.3 mg/l. Compared with previous case the elimination takes place more than 6 times. The amount of existing oxygen in feed water is presented in Table 2.

Table 2: The amount of existing oxygen in feed water in years 2008 and 2009

No.	Month	oxygen concentration in feed water in year **2008 (**mg/l)	oxygen concentration in feed water in year **2009 (**mg/l)
1	October	8.9	1.4
2	November	8.7	1.5
3	December	8.6	1.1
4	January	8.4	1.2
5	February	8.7	1.3
6	March	8.3	1.2
7	Average	8.6	1.3

The third step in pilot construction is the corrosive test. In this stage an anti corrosive material was injected in to the hot water while the quality of circulating water and feed water of Engine Room was also controlled.

After injection of these materials, pH, total dissolved solids and especially nitrite will be increased much more dramatically. So, control on the output should be done very carefully. Since, the control of the output materials especially nitrite are very difficult, a reuse process was applied to avoid discharge of pollutants into the environment. Additionally, economic efficiency will be upgraded due to recycling some of corrosion inhibitor wasted along with effluent. Table 3 gives the test results of water flow system before and after injection of anti-corrosion materials respectively.

Table 3: The test results of system water flow before and after injection of anti-corrosion materials

No.	Test Description		Before injection	After injection
1	pH	_	8.85	11.4
2	EC	µs/cm	710	5820
3	TH	Ca CO_3 (mg/lit)	0	0
4	Fe	mg/lit	0.81	0.238
5	TDS	mg/lit	454	3783
6	NO_2	mg/lit	0	1320
7	PO_4	mg/lit	1.86	4.13
8	Phenolphthalein alkalinity	Ca CO_3 (mg/lit)	0	440
9	Methyl orange alkalinity	Ca CO_3 (mg/lit)	90	1000

Regarding obtained results from Table 3, it is obvious that the exit of water with the mentioned quality will be definitely caused environmental pollution. So, recycling and reusing effluent of hot water system was placed on the agenda. Table 4 shows the situation of water used in hot water system of Central Engine Room as well as the percentage of returned water after and before the pilot performance.

Table 4: water used in central engine room hot water system in different Consumption periods

Consumption period	water consumed in hot water system (m3/month)	Amount of water returned to the hot water system (m3/ month)	Percentage of returned water to the hot water system
October 2008	87	0	0%
October 2009	80	50	62%
November 2008	69	0	0%
November 2009	85	51	60%
December 2008	78	0	0%
December 2009	50	29	58.8%

4. Conclusion

Considering the mentioned results at each stage of re-use plan of Saipa Car Company the following results were obtained:

- Severe corrosion prevention in welded pipes and thus prevention of wasting water from leaking parts
- Reducing feed water usage consumed by hot water boilers equal to 800 liters per day
- Saving anti-corrosion consumption rate equal to 14 liters per day without counting summer and New Year holidays
- Saving anti-corrosion consumption rate equal to 2000 liters per day in summer and New Year holidays and
- the most important environmental achievement is prevention of high daily rate pollution entrance of water (containing nitrate at least 1000 mg per liter) due to anti-corrosion material injection into the water system

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