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Considerable Reduction in Sewage Pollutants of Urmia City from Modernist view of Biolac Process

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ABSTRACT: The Biolac filtration system is based on active multi-stage sludge refineries. This system is a kind of modern biological methods in filtration of sewage waters and sludge's which is so efficient in upgrading of lagoons. This survey aims at the investigation of qualitative sewage polluters and comparison of output results with Environmental Protection Agency (EPA) standards in Iran. First, after studying the details about this system, we focused on analysis of experimental results which was collected during the first six month range of 2010 to 2012 and performance evaluation of system linked to the removal of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), N and P polluters. With regard to mentioned investigations and considerations, it can be concluded that the Biolac system was so successful in the removal of polluters such as BOD, COD and TSS. For BOD the average removal rates were more than 96 percent and the output value was less that 20 mg/lit. For COD the removal rates were more than 93 percent and the output value was less that 30 mg/lit. The average removal rate for TSS polluters was about 93 percent's and the output value was less than 13 mg/lit. The corresponding rate for P polluters was about 72 and less than 3 mg/lit, respectively. We consider the EPA Standards in Iran and comparing the mentioned results with these standards, it will be evident that the effluent of such system can be discharged to surface waters.

Keywords: Biolac, EPA Standards, Pollutant, Urmia Wastewater

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INTRODUCTION

Wastewater is not just sewage. All the water used in the home that goes down the drains or into the sewage collection system is wastewater. This includes water from baths, showers, sinks, dishwashers, washing machines, and toilets. Small businesses and industries often contribute large amounts of wastewater to sewage collection systems; others operate their own wastewater treatment systems. In combined municipal sewage systems, water from storm drains is also added to the municipal wastewater stream. Wastewater is about 99 percent water by weight and is generally referred to as influent as it enters the wastewater treatment facility. "Domestic wastewater" is wastewater that comes primarily from individuals, and does not generally include industrial or agricultural wastewater (Tchobanoglous et al., 2007). At wastewater treatment plants, this flow is treated before it is allowed to be returned to the environment, lakes, or streams. There are no holidays for wastewater treatment, and most plants operate 24 hours per day every day of the week. Wastewater treatment plants operate at a critical point of the water cycle, helping nature defend water from excessive pollution. Most treatment plants have primary treatment (physical removal of floatable and settle able solids) and secondary treatment (Mackenzie, 2010). Municipal wastewater is characterized by its physical attributes as well as its organic and inorganic contaminants. Physical attributes include colour, odor, and turbidity caused by dissolved or suspended solids. Organic contaminants include dissolved or undissolved VOCs which include phenols, chlorobenzene, hydrocarbons and dissolved or undissolved non-volatile organic compounds designated as biological oxygen demand (BOD), chemical oxygen demand (COD), and total organic carbon (TOC) such as carbohydrates, fats, starches etc., Inorganic pollutants may include compounds of trace minerals, sulphides, chlorides, nitrogen and phosphorous (Stenzel, 1993).

Wastewater refers to water used by human due to lose its quality and unusable, which include waste liquid of domestic resources, industrial, agricultural and commercial. Wastewater treatment systems are composed of unit operations in consideration of the wastewater properties, effluent quality level, cost performance, on-site environmental conditions, and the environment policy of the business. The conceptual relation between the treatment technologies and the treatment requirements in food processing factories are Wastewater treatment technologies either remove suspended particles and dissolved substances from water, or convert them into harmless and stabilized materials (Ekhaise and Omavwoya, 2008). Prakash (2008) studied the chemical and biological treatment of chrome liquor. Based on the study, he concluded that the proper balance of alkalinity and BOD can increase the treatment efficiency. The maximum BOD reduction was obtained at an organic load of 0.80 kg BOD/m3/day. Arumugam (1976) has reported on the recovery of chromium from spent chrome tan liquor by chemical precipitation using lime. Pathe (2005) has studied the properties of chromium sludge from chrome tan liquor and related the sludge volume, sludge settling rate, surface loading rate. Majlesinasr (2008) showed that measured BOD5, COD and TSS in the effluent were113, 188 and 99 mg/L respectively. Mesdaghinia et al. (2009) showed that Efficiency of the wastewater treatment plants was not appropriate Results of this study were confirmed by mentioned studies. Sarafraz (2006) showed that measured BOD5, COD and TSS in the effluent were 12.53, 51.7 and 19.68 mg/L, respectively, when the wastewater treatment plant was worked properly.

MATERIAL AND METHODS

The purification works at Manger provide both primary and secondary treatment processes. Primary treatment removes most of the solids from the effluent, but doesn't remove or degrade the dissolved organic matter. Secondary treatment uses microorganisms to convert these organics to simple compounds, and uses the energy of the sun to destroy pathogens2. The effluent is then safe to be discharged into the Manukau Harbour. The entire process is shown diagrammatically in (Figure 1). The works have been designed to take advantage of the natural features of the site. Oxidation ponds provide very economical secondary treatment and these were chosen because a suitable area of harbor mudflats could be formed into ponds and because Auckland has the sunny climate necessary for the efficient working of the ponds. Conditions in the ponds promote the growth of unicellular algae: minute plants which, like any other plants, absorb carbon dioxide in daylight and give off oxygen by photosynthesis. This oxygen oxidase's the organics, thus purifying the sewage by reducing its oxygen demand.

The typical processes and removal methods are shown in Table 1 while the screened residues, Separated oil, sludge, etc. generated during wastewater treatment are partly used for livestock Feed, fertilizer, and other purposes, and they are primarily reduced in volume by dewatering, drying, or incineration for disposal as industrial waste (Eckkenfelder et al., 1965).

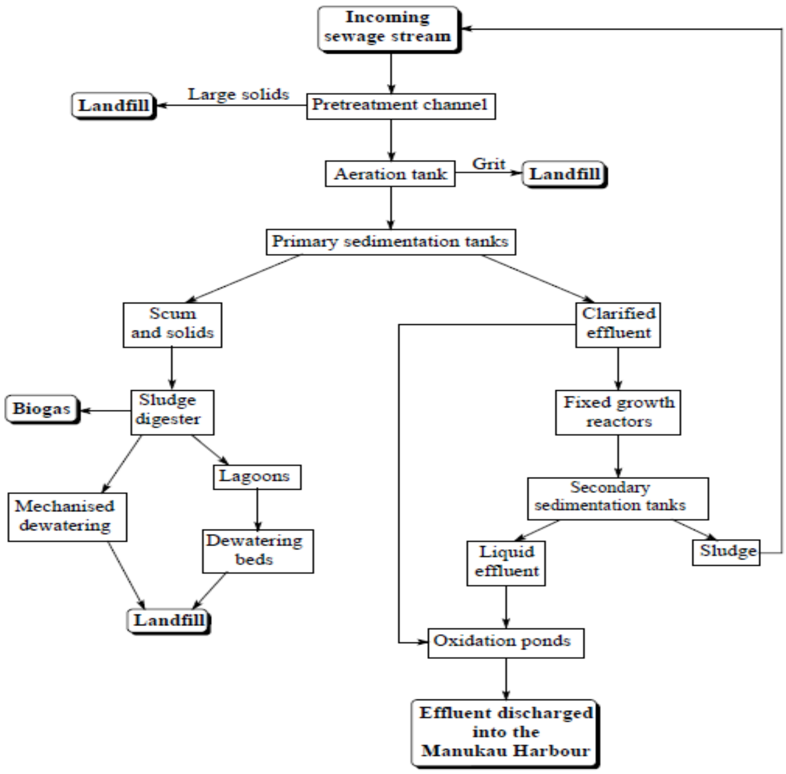

Figure 1 - Sewage treatment flow diagram

Table 1. Typical wastewater treatment processes and removal method

Treatment methods	Removal mechanisms	Typical processes
Physical Treatment	Screening , Filtering, Difference of gravity, Thermo-energy, Electric energy, Reverse osmosis	Screen, Filtration, Settling , flotation, Evaporation, drying, Electrolysis, Reverse osmosis membrane
Chemical treatment	Oxidation reaction, Reduction reaction, Double decomposition	Oxidation, Reduction, Neutralization, coagulation
Physical chemical treatment	Phase boundary potential, Adsorption, Ion exchange, Electrochemical reaction, Super critical phase	Coagulation-settling, Coagulation-flotation, Activated carbon adsorption, Ion exchange resin and membrane, Electric Dialysis, Electrolysis, Super critical water oxidation
Biological treatment	Aerobic decomposition, Anaerobic decomposition, Anaerobic-aerobic reaction	Activated sludge process, Denitrification, Phosphorous removal, Anaerobic digestion process, Denitrification, Biological phosphorous removal

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The conceptual relation between the treatment technologies and the treatment requirements in food processing factories are schematically shown in Figure 1. As shown clearly in the Figure, the major process used for treating wastewater is biological. In the pre-treatment stage, a screen is often used to remove floating materials such as labels and plastic sheets. A gravity oil separator is provided for oil containing wastewater generated by edible oil production. After the pre-treatment stage, normal level BOD is decomposed by an aerobic biological treatment, while high level BOD of several thousands to tens of thousands is diluted prior to treatment. In recent years this high level BOD wastewater tends to be treated, without dilution, by an anaerobic biological process in the pre-treatment stage, and then re-treated by an aerobic biological process. Introducing an anaerobic biological process benefits by reducing the load for the later stage aerobic biological process, converting organic materials in wastewater into fuel gas, downsizing the settling tank because of not using diluting water, and preventing sludge bulking. The BOD removal rate in the anaerobic biological process is normally between 80 and 90%. Then, the remaining BOD is removed by the aerobic biological process, which has a removal rate in the 95 to 99% range. When a factory is located in a sewer-serviced area, an aerobically pre-treated wastewater can be discharged directly to the sewer. When the factory's location is in a non-serviced area and the effluent quality is regulated strictly, then a tertiary treatment is required to reduce BOD, COD, and SS. In such cases, sand filtration, and coagulation-flocculation- sedimentation, and activated carbon absorption are, singly or in combination, added for the tertiary treatment (Bryant and Wiseman, 2003).

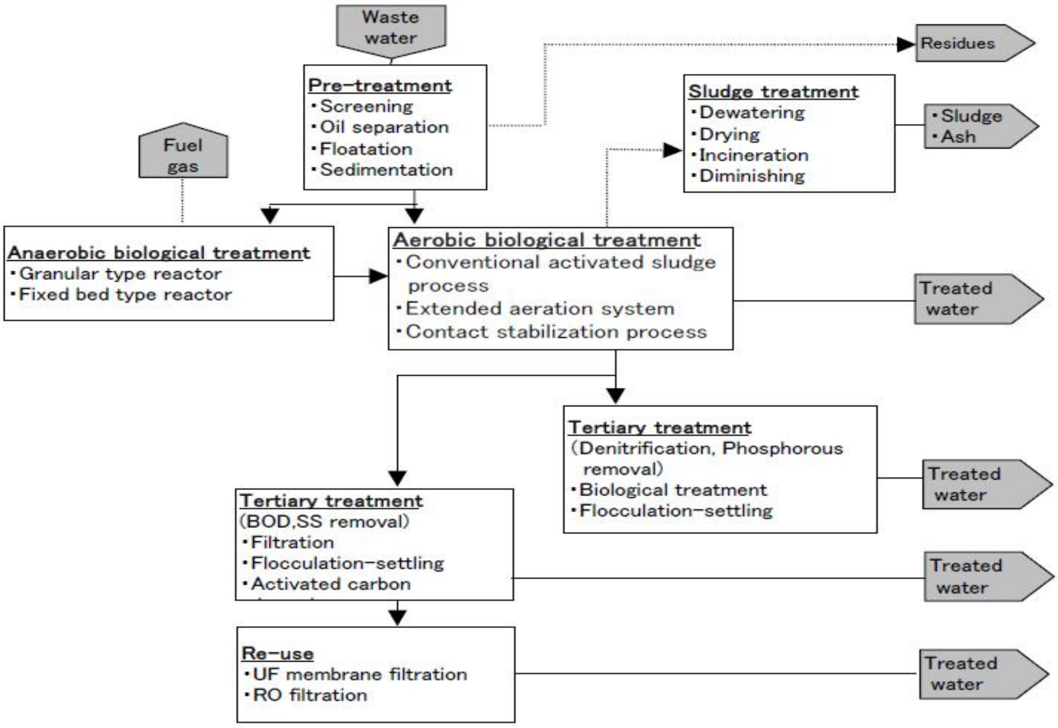

Figure 2. Typical wastewater treatment system

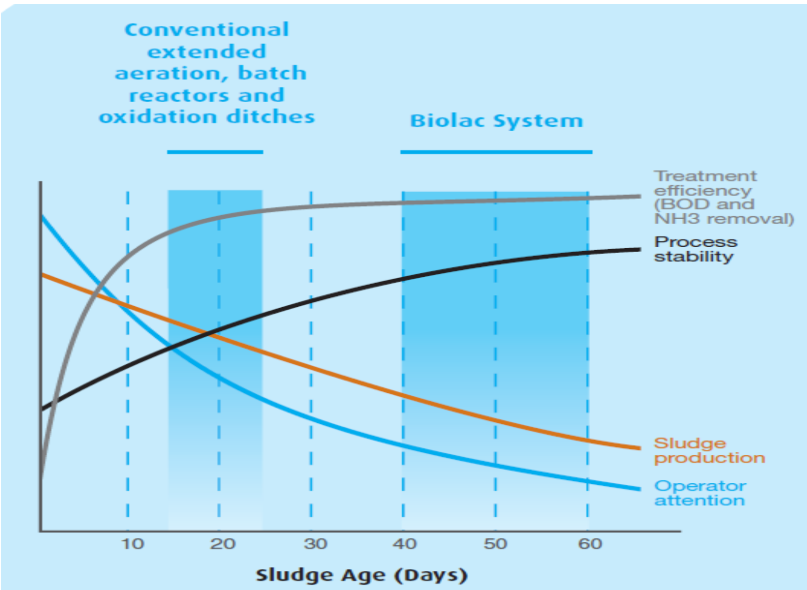

Figure 3. Sludge Age

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The Biolac system is an innovative activated sludge process using extended retention of biological solids to create an extremely stable easily operated system. The capabilities of this unique technology far exceed ordinary extended aeration treatment. The Biolac process maximizes the Stability of the operating environment and provides high efficiency treatment. The design ensures the lowest cost construction and guarantees operational simplicity. The Biolac system utilizes a longer sludge age than other aerobic systems. Sludge age also known as Solids Retention Time (SRT) or Mean Cell Residence Time (MCRT), defines the operating characteristics of any aerobic biological treatment system. A longer sludge age dramatically lowers effluent BOD and ammonia levels especially on colder climates. The Biolac long sludge age process produces BOD levels of less than10 mg/L and complete nitrification (less than 1 mg/L ammonia). Minor modifications to the system will extend its capabilities to Denitrification and–biological Phosphorus removal. While most extended aeration systems reach their maximum mixing capability at sludge ages of approximately 15-25 days, the Biolac system efficiently and uniformly mixes the aeration volumes associated with a 30-70 day sludge age. The large quantity of biomass treats widely fluctuating loads with very few operational changes. Extreme sludge stability allows sludge wasting to non-aerated sludge ponds or basins and long Storage times.

Simple Process Control and Operation The control and operation of the Biolac process are similar to that of conventional extended aeration. Additional controls required for Denitrification, phosphorus removal, dissolved oxygen control and SCADA communications are also easily implemented. Aeration System Components The ability to mix large basin volumes using minimal energy is a function of the unique BioFlex moving aeration chains and the attached BioFuser fine bubble diffuser assemblies. The gentle, controlled, back and forth motion of the chains and diffusers distributes the oxygen transfer and mixing energy evenly throughout the basin area. No additional airflow is required to maintain mixing. Stationary fine bubble aeration systems require 8-10 cubic feet per minute (CFM) of air per 1000 cu. ft. of aeration basin volume. The Biolac system maintains the required mixing of the activated sludge and suspension of the solids at only 4 CFM per 1000 cu.ft. Of aeration basin volume. Mixing of a Biolac basin typically requires 35-50 percent of the energy of the design oxygen requirement. Therefore, air delivery to the basin can be reduced during periods of low loading while maintaining effective food to biomass contact and without the risk of solids settling out of the wastewater.

System Construction

A major advantage of the Biolac system is its low installed cost. Most systems require costly in-ground concrete basins for the activated sludge portion of the process. A Biolac system can be installed in earthen basins, either lined or unlined. The–BioFuser fine bubble diffusers require no mounting to basin floors or associated anchors and leveling. These diffusers are suspended from the BioFlex floating aeration chains; The only concrete structural work required is for the simple internal clarifier(s) and blower/control buildings. Biological Nutrient Removal Simple control of the air distribution to the BioFlex chains creates moving waves of oxic and anoxic zones within the basin. This repeated cycling of environments nitrifies and denitrifies the wastewater without recycled pumping of mixed liquor or additional external basins. This mode of Biolac operation is known as the Wave Oxidation process. No additional in-basin equipment is required and simple timer-operated actuator valves regulate manipulation of the air distribution. Biological phosphorus removal can also be accomplished by incorporating an anaerobic zone. Biological phosphorus removal can also be accomplished by incorporating an anaerobic zone or Bio-P zone. With the Bio-P zone, phosphorus levels of <2 mg/L are standard. The Biolac Wastewater Treatment System is an activated sludge process utilizing a longer sludge age that reduces BOD to <10 mg/L and produces complete nitrification. The system is extremely stable and able to treat widely fluctuating loads with few operating changes. Fine bubble diffuser assemblies are suspended above the basin floor by the BioFlex moving aeration chains. The motion of the chains and diffusers distributes the oxygen transfer and mixing energy evenly throughout the basin. Depending on customer preference and budget considerations, Biolac systems can be installed in concrete basins or lined earthen basins.

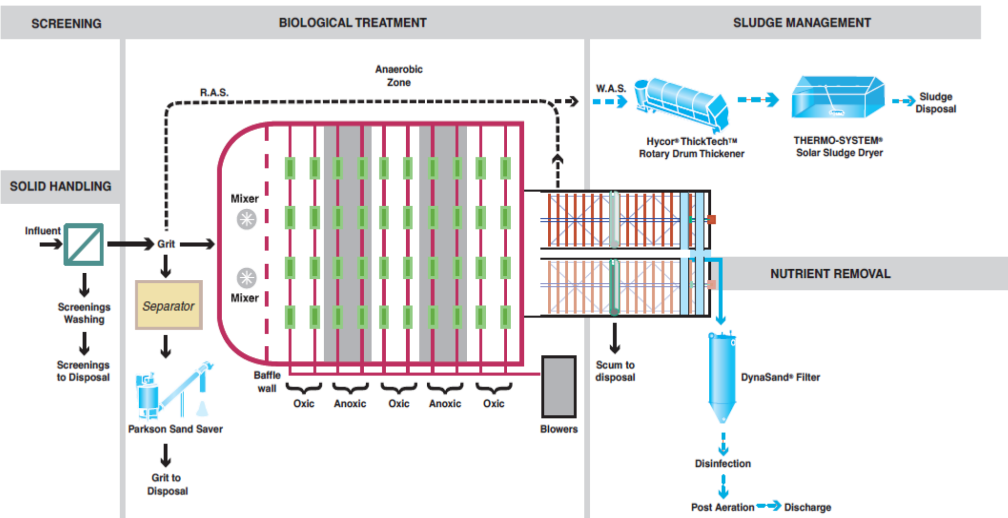

Figure 4. Biolac System Operating in Wave Oxidation Mode

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Wastewater treatment plant of Urmia is constructed vicinity to Reyhan Abad village in the approximate altitude (1330 m) from sea level. The average annual rainfall height in the city of Urmia is (370 mm), minimum temperature (-22° C) and the absolute maximum (38.4°C), minimum monthly average (-3.6° C), the maximum monthly average (31.31 ° C) and the average daily minimum (-2° C) and maximum (24° C). Its Area is (135 ha). Wastewater treatment plant is in five equal modules, each with a capacity of two hundred thousand people (200,000 people) and the population covered by the plant for the horizon year (1400) has predicted one million people. The amount of daily waste with acceleration is (0.575 square feet safely), the average daily wastewater without acceleration is equal to (4000 m) and a maximum of moment wastewater is 83,160 cubic meters and about 0.962 meters per second. BOD the effluent slop of this system is below 10 mg per liter, while in the other processes, BOD output is between 50 to 30 milligrams per liter. The length of sewage transmission lines is 51.5 km. Inlet pipe diameter is 1200 mm, length of input channels sewer is 5 m, sewer inlet channel width 2.5 m, there are two integrated Biolac poolin two modules with the same conditions, the length of the Bio Locke pool for each module is 120 mm, the width of Bio Locke pool for each module is 50 meters, the height (depth) of Bio Locke pool for each module is 4 m, the number of Fine screens is 6 with similar performance, the maximum capacity of fine screen is 170 liters per second, the number of pond sludge drying is 14, length of sludge drying pond is 140 meters, sludge drying ponds width is 22 m, height (depth) of sludge drying pond is 4 meters.

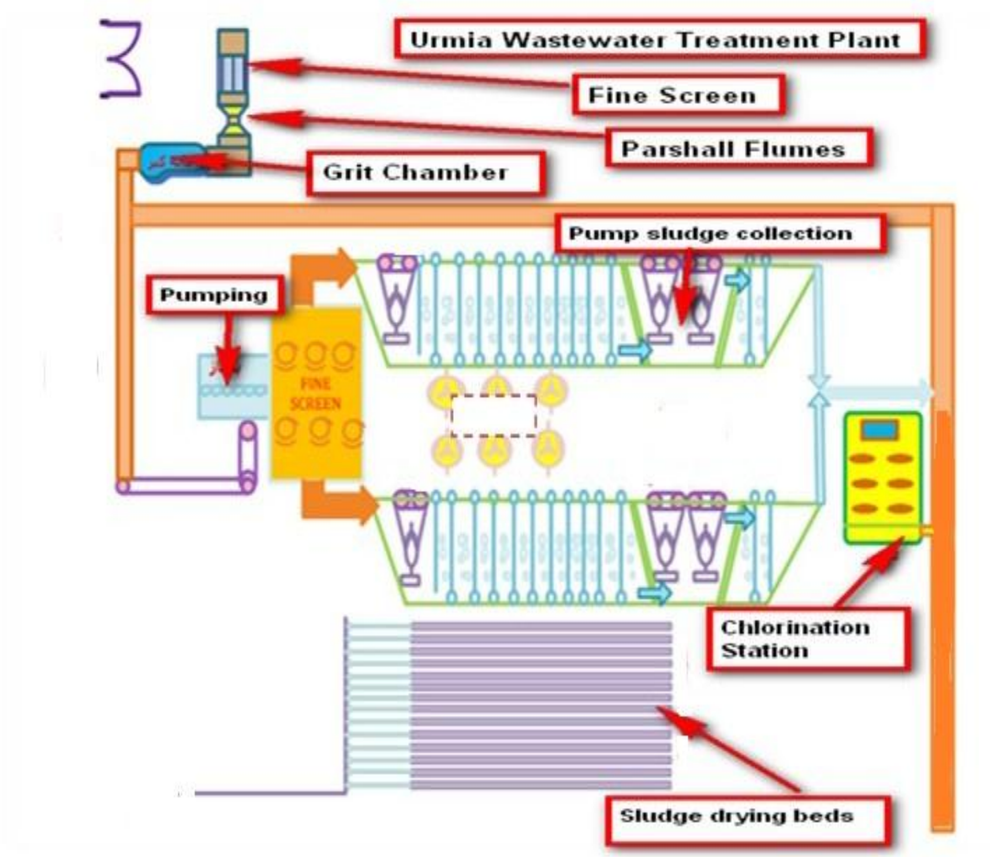

Figure 5. Schematic picture of wastewater treatment of Urmia city

Results

1-Filtering pollutants in reciprocating aeration method has better performance than fixed status.

2-Proper efficiency to remove contaminants and standardization of different parts of the plant hydraulically and full compliance with the standards of Iran.

3-According to the increasing population and the entrance of the plant, there is no specific matter about population prediction. So the project on the horizon is desirable.

4-Integrated system design and implementation of an integrated system that will reduce the economic costs. Integrated systems also make it possible for the operator to provide optimal surveillance.

5-Implementation of the pool and rectangular BIOLAC integrated, operational issues arising from the secondary settling tank reduces circular.

6-Number of BIOLAC pool was very convenient and efficient connections to other components are assessed together very well.

7-The results of contaminants in the input and output between the years 2010 to 2012 clearly demonstrates the increasing removal is pollutants. Also according to the environmental standards of waste water discharge into surface water has the ability to output.

8-Increase the skills and knowledge to optimize the operators of wastewater treatment system is one of the main indicators of the efficiency improvement contaminants have been removed. Also, an accurate and efficient monitoring of the different parts and replacement parts obsolete and outdated, are also the major factors.

9-The BIOLAC process according to high efficiency and fewer costs in comparison with the other approaches common in activated mud, also improving of airing and optimization of placing the airing diffusers and using the pendulum causes more efficiency in comparison with the other approaches.

10- BIOLAC process takes up less space than other common methods that employers BIOLAC this makes up the remaining space to easily assign phases other prospects on the horizon.

11-Wastewater generated by commercial, industrial and institutional facilities is typically referred to as "high-strength" compared to typical household wastewater.

Table 1 shows the typical concentrations (mg/L) of organics found in untreated domestic wastewater. This table can be used to understand how non-sanitary process wastewater compares to typical domestic wastewater.

Table 2. Technical specifications of a wastewater refinery of Urmia city (Mohammadi 2013)

Year	**1385**	**1395**	**1400**	**1410**
Population of city (people)	580000	707,000	780,000	1,000,000
Population covered (people)	350,000	650,000	650,000	950,000
Sewage with no leakage water (person liter per days)	198	203	203	210
Leakage water (cubic meters per day)	23	23	23	23
Average wastewater (Lit/day)	218	223	228	256
The average of total produced wastewater (Lit/Sec)	883	1678	1955	2529

Table 3. Hydraulic dimensions of dirt stuck in wastewater treatment Urmia (Ghomi 2013)

Hydraulic dimensions	**Executive (m)**
Channel width of screen	1.54
Open space between bars in screen channel	0.020
Height (depth) in channel of screen	2.8
Bar installation angle relative to horizon level	75

Table 4. Hydraulic dimensions of seeds screen channel in wastewater refinery of Urmia

Hydraulic aspects	**Executive (m)**
Channel length of grain screen	15
channel width of grain screen	3.2
useful depth with free height	3

Table 5. BIOLAC hydraulic characteristics of wastewater in the pond Executive Branch

The number of pool BIOLAC	2 integrated pool in two modules with the same condition
Length of BIOLAC pool for each module	120 m
Width of BIOLAC pool for each module	50 m
Height (depth) of BIOLAC pool for each module	4 m

Table 6. Executive specifications of fine screen in wastewater refinery of Urmia city

The number of fine screen devices	6 devices with similar performance
Maximum capacity of fine screen devices	170 liters per second

Table 7. Executive specifications of sludge drying ponds in wastewater refinery of Urmia city

The number of sludge dryer pond	14 Pond
The length of sludge dryer pond	140 m
The width of sludge dryer pond	22 m
The height (depth) of sludge dryer pond	4 m

Table 8. Executive hydraulic characteristics of inlet channel of sewage refinery of Urmia

Diameter of the inlet pipe	1200 mm, which enters the common manhole
Channel length of sewer entry	5 m
Sewage inlet channel width	2.5 m
The slope drain inlet channel	Two in thousand (2:1000) using reinforced concrete

Table 9. Examined parameters and test methods (EPA Standard Methods 2006)

Parameters	Test method	Resources necessary
PH	Device PH Meter	Device Catalog PH Meter
Temperature (° C)	Thermometer	Standard methods (testing site)
COD (Milligrams per liter)	OPEN	Standard Method
BOD5 (Milligrams per liter)	Winkler	Device Catalog
TSS (Milligrams per liter)	Gravimetric	Standard Method
Nitrite - Nitrate (mg)	Spectrophotometer - Brvsn	Catalogue of the measuring device
Phosphorus (mg)	Spectrophotometric	Standard Method

Table 10. Standard of EPA Iran

No.	Polluting substances	Discharge to surface waters. (Mg / lit)	Discharge to absorbent wells (Mg / lit)	The Farm (Mg / lit)
1	Total suspended solids (TSS)	40 (minute 60)	-	100
2	Ammonium times (NH_4)	2.5	1	-
3	Nitrite by (NO_2)	10	10	-
4	Nitrate by (NO_3)	50	10	-
5	Phosphate by phosphorus	6	6	-
6	BOD_5	30 (minute 50)	30 (minute 50)	100
7	COD	60 (spot 100)	60 (spot 100)	200

Table 11. Typical concentrations of organics in untreated domestic wastewater (Gary et al.2011).

Constituents	Unit	Typical Concentration		
		Low	Medium	High
BOD (biochemical oxygen demand)	mg/L	110	190	350
COD (chemical oxygen demand)	mg/L	250	430	800
TOC (total organic carbon)	mg/L	80	140	260
O&G (oil and grease)	mg/L	50	90	100

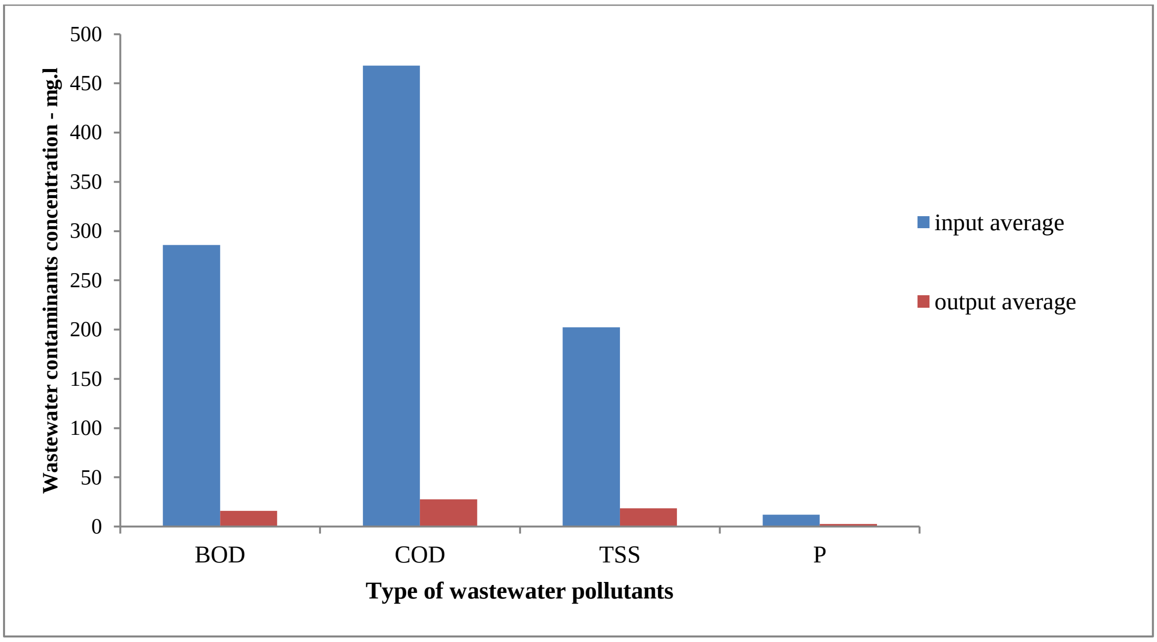

Figure 6. Average input and output results Wastewater Treatment Plant Urmia 2010

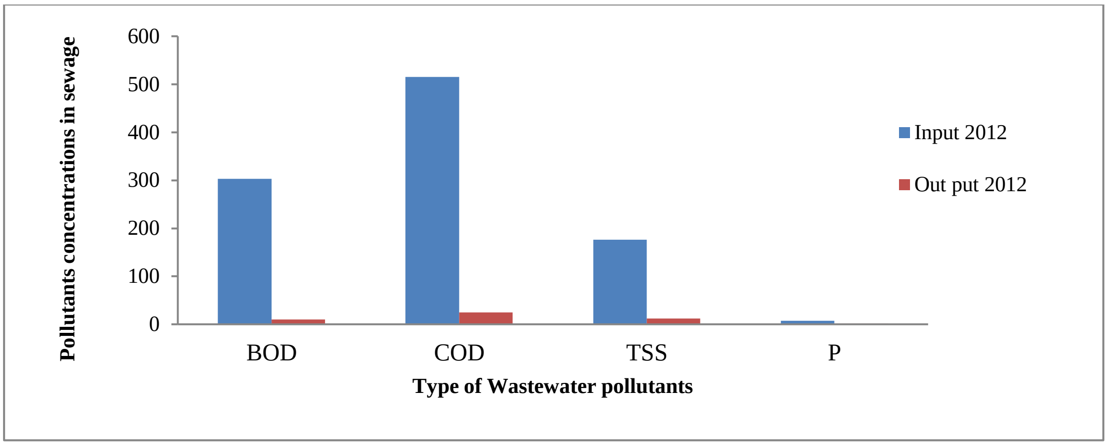

Figure 7. Average input and output results Wastewater Treatment Plant Urmia 2012

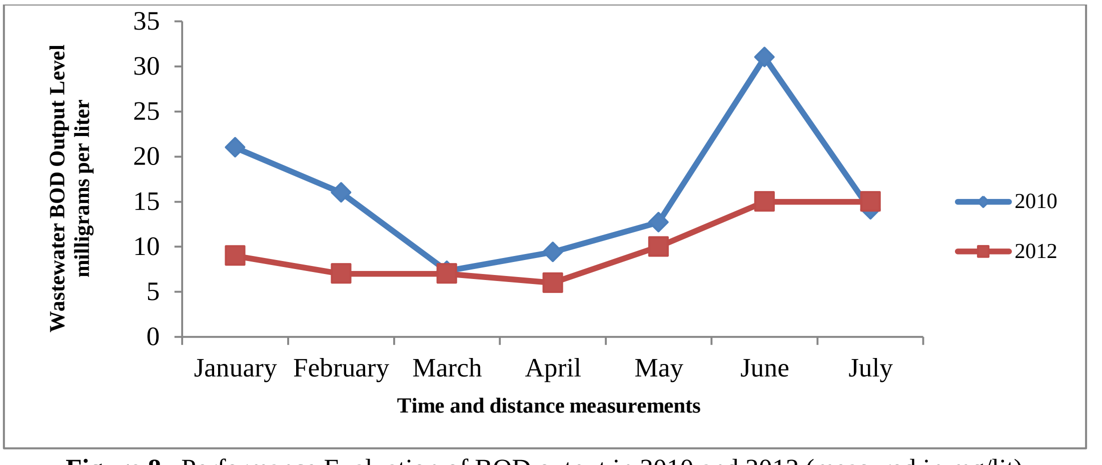

Figure 8. Performance Evaluation of BOD output in 2010 and 2012 (measured in mg/lit)

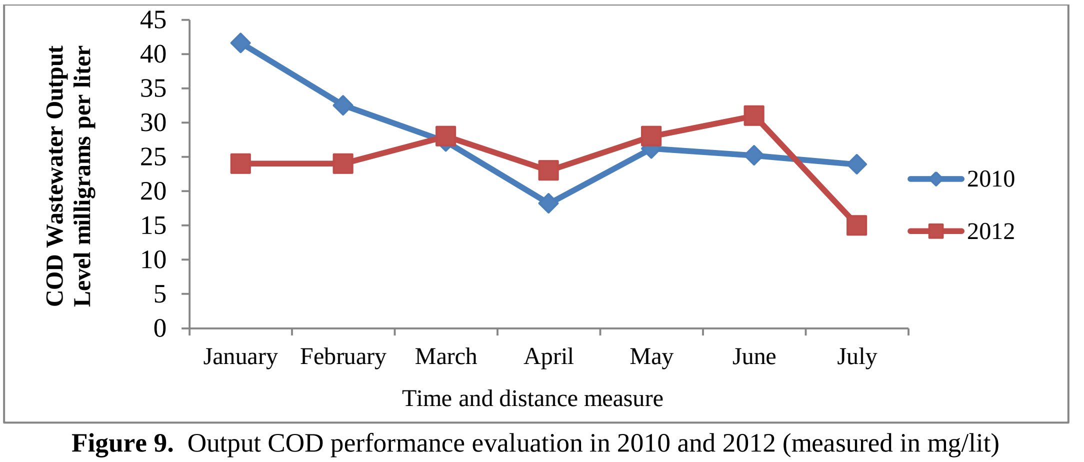

Figure 9. Output COD performance evaluation in 2010 and 2012 (measured in mg/lit)

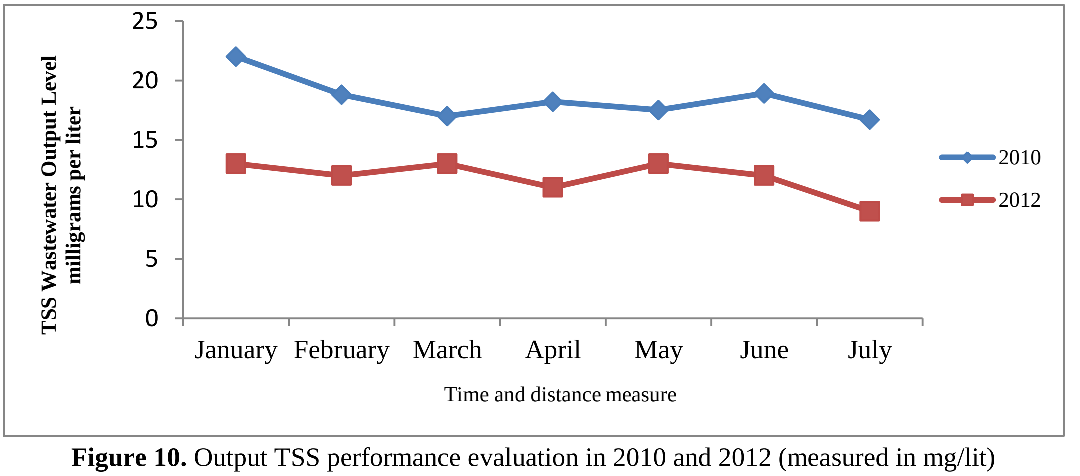

Figure 10. Output TSS performance evaluation in 2010 and 2012 (measured in mg/lit)

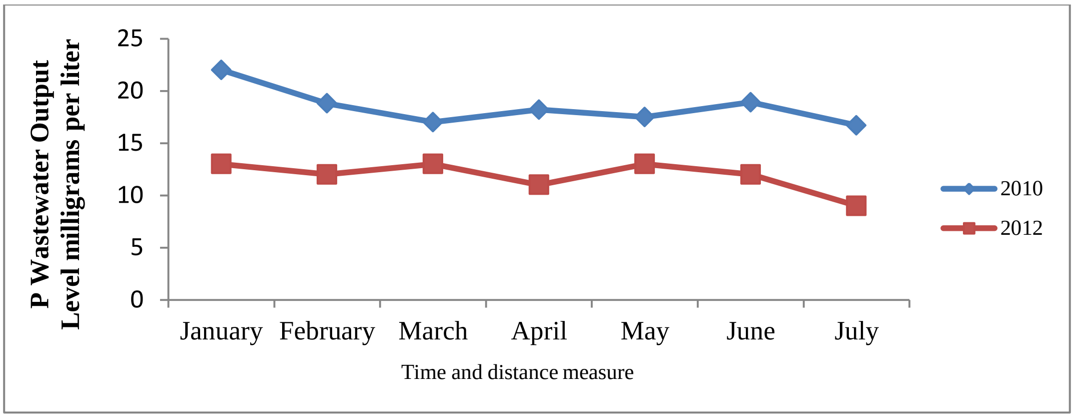

Figure 11. P performance evaluation of output in 2010 and 2012 (measured in mg/lit)

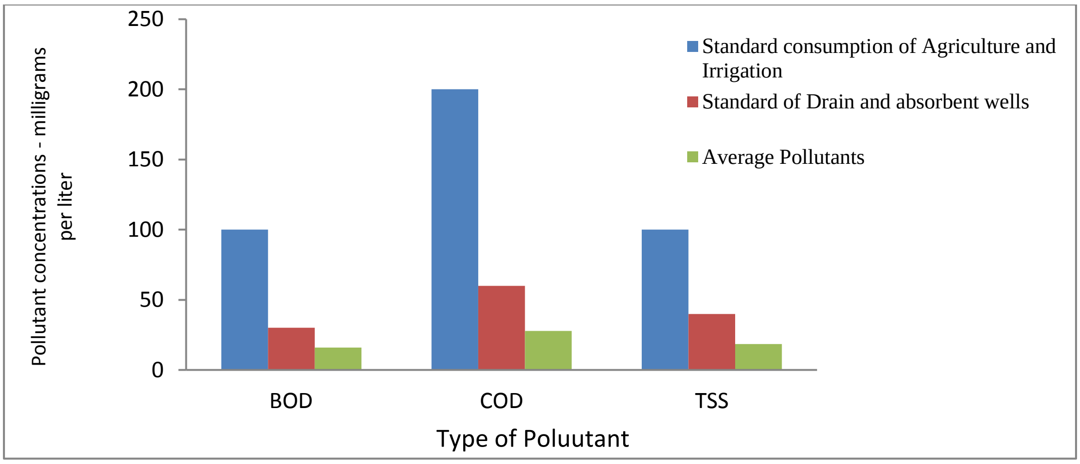

Figure 12. Comparison of pollutant concentrations in the effluent standards of environmental issues in 2010

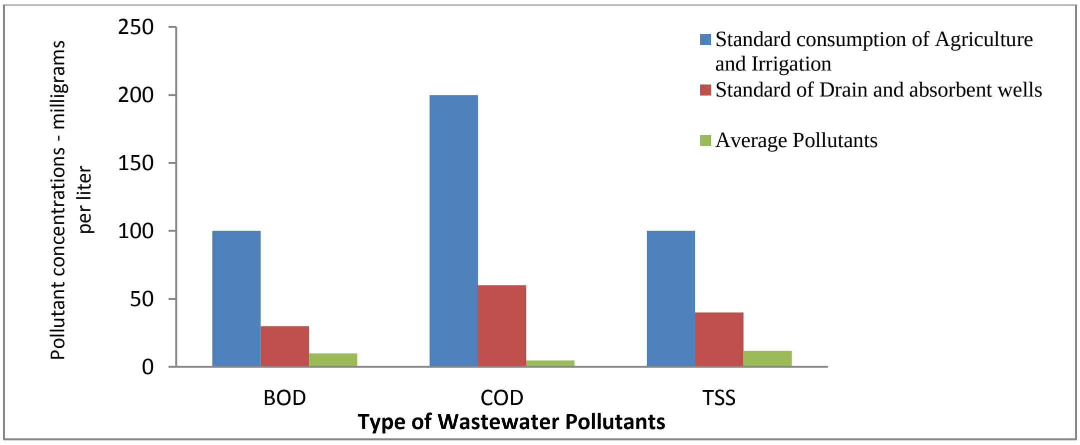

Figure 13. Comparison of pollutant concentrations in the effluent standards of environmental issues

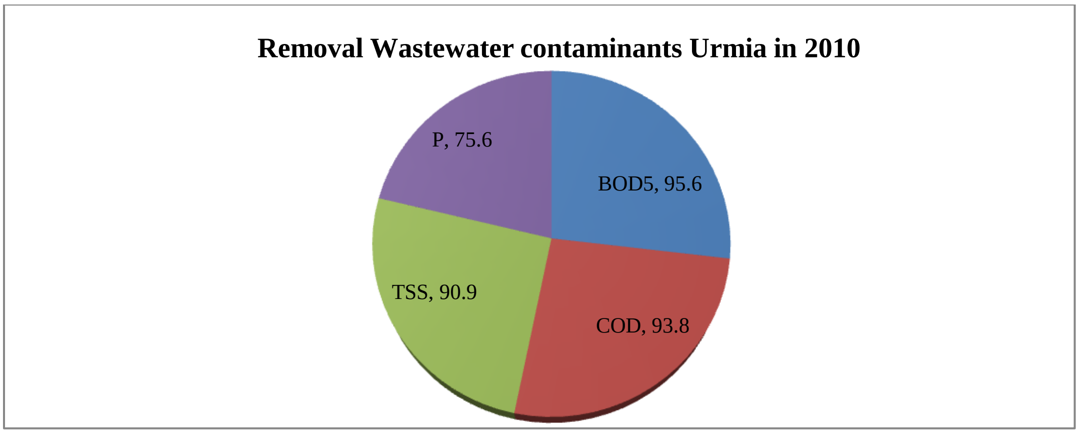

Figure 14. Removal Wastewater contaminants Urmia in 2010

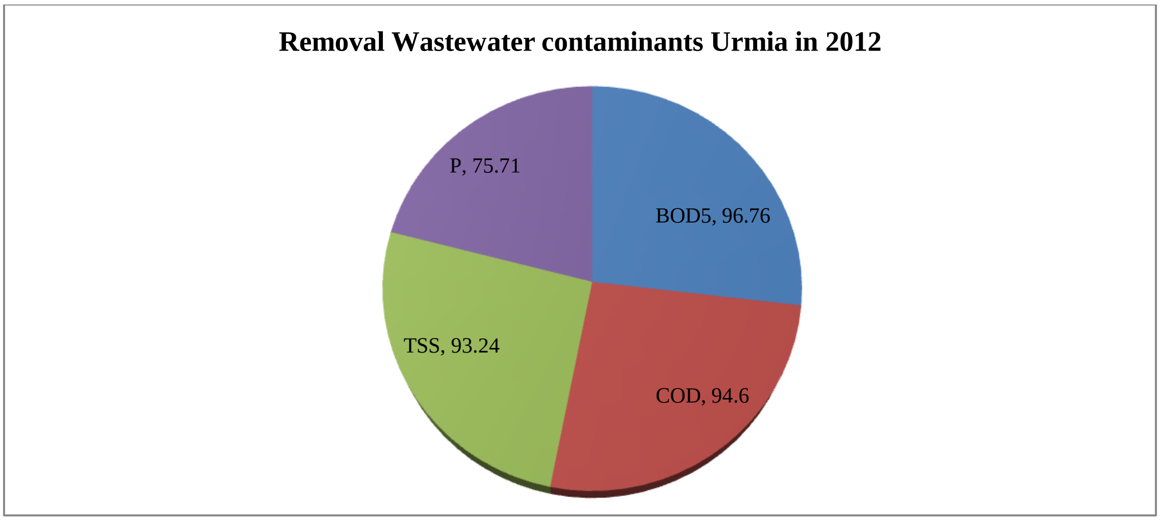

Figure 15. Removal Wastewater contaminants Urmia in 2012

DISCUSSION

Wastewater treatment systems are designed to remove oxygen-demanding substances (as measured by five-day biochemical oxygen demand, BOD_5, or BOD) and solid particles (measured as total suspended solids, or TSS). Chemical oxygen demand (COD) is a measure of all oxygen-demanding substances, including those not amenable to biological treatment, and these, too, are reduced through wastewater treatment. No reasonably constant relationship exists between COD and BOD values for either untreated or treated kraft (Sulfate) wastewaters (Bryant and Wiseman 2003). Wastewater may also contain toxic and nonconventional pollutants such as chlorinated organic compounds. Industrial and municipal wastewater discharges, as well as storm water runoff associated with urban, industrial, agricultural, contribute oxygen-demanding substances (measured as BOD) to receiving streams and can diminish dissolved oxygen levels. Suspended matter discharges (measured as TSS) may also be implicated in the depletion of DO, as well as other adverse aquatic impacts. Suspended matter, if settle able, can blanket the stream bed, damage invertebrate populations, block gravel spawning beds and, if organic, remove dissolved oxygen from the overlying water column. Suspended matter that does not settle may obstruct transmission of light into the water column, impairing aesthetics, as well as diminishing photosynthetic activity and the abundance of food available to fish and aquatic life.

By analyzing the data and drawing comparable charts and graphs of pollution parameters, the factors affecting the performance of the related plant are investigated and proposed solutions to solve the problems and improving the efficiency of removal pollution are provided.

Suggestions

1-All the design elements is use of empirical approaches to other countries and no design value is reassessed in the area. It is proposed to be designed to determine the coefficients in this country compared to other countries, practical design values can be obtained.

2-Using precision measuring input and output water quality in different types of wastewater treatment systems.

3-Evaluation of climate and environment, the efficiency of wastewater treatment.

4-The effect of each of the sewage treatment plants reduces pollutants in wastewater.

5-Different regionalization of water and wastewater based on quality and offer early treatment (treatment operations) before entering the wastewater treatment plant.

6-Optimization methods for wastewater treatment in communities large and small, based on the economic value of the Value Engineering Approach

7- Information and Culture of wastewater treatment techniques in the consumer society.

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