Ain Shams Engineering Journal (2017) 8, 305–310

Ain Shams University

Ain Shams Engineering Journal

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CIVIL ENGINEERING

Design parameters for waste effluent treatment unit from beverages production

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Received 8 September 2015; accepted 25 April 2016
Available online 1 June 2016

KEYWORDS

Beverage industry;
Treatment technology;
Soft drinks;
Activated sludge;
Aeration process

Abstract Based on a successful experimental result from laboratory and bench scale for treatment of wastewater from beverages industry, an industrial and efficient treatment unit is designed and constructed. The broad goal of this study was to design and construct effluent, cost effective and high quality treatment unit. The used technology is the activated sludge process of extended aeration type followed by rapid sand filters and chlorination as tertiary treatment. Experimental results have been considered as the basis for full scale design of the industrial capacity of 1600 m^3/day treatment plant. Final effluent characteristics after treatment comply with Egyptian legalizations after reducing COD and BOD_5 by about 97% and 95% respectively. So it is recommended to reuse treated effluent in textile industry in dyeing process.

1. Introduction

Water consumption is one of the most significant cost factors in beverage industry, since water is one of the main ingredients of the products. Huge amount of freshwater is required for beverage industry so it generates large quantity of wastewater due to its high water consumption [1,2]. Bottle washing or cleaning of machines and equipment also requires enormous amounts of water. Wastewater from bottle washing is almost 50% of the total wastewater generated by this industry [3]. Process for soft drinks typically pollutes the process water with sugar and other easily biodegradable substances [4]. Pollutants in wastewater generated from soft drink industries are also due to the fact that they are mainly composed of washing water from production lines which is derived from the ingredients used in the final production [5].

Wastewater discharged from soft drink industries usually is contaminated by suspended solid, organic substances, high pH [6], COD, BOD, nitrates, phosphates, sodium and potassium [7–11]. Both economical and ecological benefits are the main results of water demand supervision and cleaner production concepts for combination of water demand [12]. Water intake can be reduced significantly by using processes in closed circuits, also minimize resource input and thus thereby reducing pollution of finite freshwater resources [12].

Biological treatment seems to be the most convenient treatment process for soft drink wastewater due to its content of organic pollutants [7]. The anaerobic digestion has become

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Peer review under responsibility of Ain Shams University.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.asej.2016.04.008

a promising treatment process mainly for energy recovery from organic pollutants of solid wastes [13]. Estimation of treatment efficiencies of full scale reactors can be obtained from the kinetic studies of experimental results [14].

The aim of this investigation was to treat beverage industrial effluent using activated sludge process of extended aeration followed by rapid sand filtration and chlorination as tertiary treatment to get treated water fulfilling governmental rules.

2. Experimental

2.1. Materials

Soft drink wastewater (SDW) was collected from National Beverage Co., Kalioub Plant, Egypt, with capacity 1600 m^3/day.

2.2. Experimental technique

2.2.1. Wastewater characterization

Samples collected from the 1600 m^3/day, resulting wastewater from this company are analyzed after screened through screen unit to remove big floating matters. Characteristics of wastewater discharged are summarized in Table 1.

2.2.2. Treatment process selection

To construct a wastewater treatment plant in any industry, wastewater characteristics, site conditions of the treatment plant and economical feasibility of the treatment process must be taken into considerations for selection of the treated process.

In our case study the activated sludge process of extended aeration type was followed by rapid sand filtration and then coloration system as tertiary treatment. The proposed treatment process unchecked on bench scale experiments.

2.2.3. Treatment lines

According to the general process flow scheme shown in Fig. 1 the investigated treatment plant has the following components:

Table 1 Characteristics of wastewater from Kalioub Plant effluent and corresponding maximum allowable results.[a]

Parameter	Average	Maximum allowable[a]
Wastewater flow (m^3/day)	1600	
(m^3/h)	67	
Chemical Oxygen Demand COD (mg/l)	1750	100
BOD_5 (mg/l)	875	60
Temperature (°C)	20–30	35
Suspended Solids (SS mg/l)	375	60
pH	7–8	6–9
Residual cholorine	< 1.5	–

[a] Ministry of Irrigation Decree 8/1983 implementing Law 48/1982; Section 6 sets regulations standards and specifications for treating wastewater. Article 66 describes criteria of treated industrial wastewater to be discharged to non fresh surface waters.

a. Liquid line

- Grease trap
- Inlet chamber
- Screen
- Grit removal chamber
- Balancing tank
- Extended aeration tanks
- Final settling tank
- Pressure filter unit
- Contact tank

b. Solid/sludge line

- Centrifugal return sludge pump
- Sludge holding tank

c. Services building units

- Control panel
- Laboratory
- Mechanical equipment
- Administration.

2.2.4. System description

The proposed plant system depends on three stage plant type. These stages are primary, secondary and tertiary treatment stages. The primary treatment that depends mainly on physical action to remove floating matters in the screen unit and to remove sand in grit removal chamber. A grease trap (fats, oil, greases removal unit) will be installed forward of the screens to serve the domestic wastewater inflow. The second treatment depends on biological aerobic action that takes place in the aeration tank and the oxidized matters are removed in the final settling tank. Biological treatment process is expected to have the purpose of removing organic pollutants from the effluent by oxidation with air. There are only two basic methods of containing the air and wastewater to allow oxygen transfer [15]. The first is to introduce air or pure oxygen in the wastewater to be treated by extended aeration which is used in this investigation. The second method mechanically agitators at the surface to transfer of oxygen to the wastewater from the atmosphere. The tertiary treatment depends on both physical and biological actions with chemical and electrical actions for completing the removal of both organic, solids and bacteria before reuse of water. The disinfection unit may be used for bacterial removal.

2.2.5. Units selection

a. Inlet chamber
b. Screen
c. Grit removal chamber
d. Balancing tank
e. Extended aeration tank
f. Final settling tank
g. Sand filter unit
h. Chlorination contact tank
i. Filter feeding unit
j. Sludge holding tank
k. Sludge dewatering system.