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Short communication

Calculation and interpretation of effluent discharge objectives of dairy industry: Case Edough's dairy – Annaba (Algeria)

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ABSTRACT

Aquatic environment owns vary from depend on using and hydrodynamic conditions vulnerabilities. The contribution of water effluent can profoundly affect the physico-chemical composition of the receiving environment. These changes are strongly related to the hydrological regime of rivers. In order to limit the burden and concentrations of contaminants in the receiving environment, several methods have been developed. Regarding to this study, it focuses on agro food waste (dairy) in a natural receiving environment (Seybouse wadi, Algeria NE). In earlier study (2011–2012), physico-chemical and organic analyses have been used by using the calculation method (EOD) to undermine the protection of the receiving environment. Based on release of environmental objectives calculation of each quality criteria and water use showed major overtaking conventional chemical contaminants studied causing an immediate threat to health and or the environment.

1. Introduction

The environmental impact of the dairy industry is directly having high impact on water resources. Large amount of wastewater discharge from this industry is loaded with strong pollutants, such as variable pH and high concentration of organic substance (Castillo De Campins, 2005; Pattnaik et al., 2008; Suthar, 2012). The discharged effluents by a dairy have a high PH as well as strong biochemical oxygen demand as a result of detergents and milk. The associated chemical oxygen demand have a sequence of various tons by year for the same site and furthers the proliferation of algae, that work prevent the oxygen to dissolve and cause damages at the level of the fishes' natural habitat. The treatment of these effluents by a filtration station at activated sludge is frequently used (Ramasamy et al., 2004; Castillo De Campins, 2005; Djelal et al., 2009) in action of the biodegradability of the effluent. The presence of detergents and disinfectants do not inhibit the development of bacteria of Activated sludge (Janczukowicz et al., 2008).

The dairy industry of Edough is a public company of whose capital is released actually by IGPM Group (Industrial Group of Milk Production), the social headquarters for instance of production plant is situated in El Bouni on the national road no. 4–5 km of Annaba city, it is located on ground of 6 ha, of which 1.692 ha built-up/developed surface and 3.308 non developed surface. The manufactured products are: partially pasteurized and skimmed milk, fermented milk (ELBEN) in polyéthyléne packets and Camembert cheese (Saint Augustin brand). In the shape of a rounded box of 250.0001/j. The milk bucket production consume and throw out or reject an enormous quantity of water. Nevertheless, we know that we generally 3.6 L of used water for the production of one liter of milk (Sachon, 1980). The great part of these waters (85%) is discharged as waste water. For the dairy industry, these amounts of water are channeled in concrete pipes of 1.20 m diameter and 2 km length towards Seybouse Wadi without any preliminary treatment where it is necessary to treat these discharges to preserve the receiver's natural habitat (National Action Plan for Environment and durable Development. And the plan of environmental performance of landscaping

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ministry of territory and the environment for the Edough dairy industry (2007).

2. Geographical situation

The study area is located in the north eastern part of Algeria, in the state of Annaba. It is surrounded by the Mediterranean Sea in the north, the Tarf state in the east, skikda state in the West, and Guelma state in the South. This region is known by its vast industrial activity with Arcelor Mittal Annaba (steel industry), Reposal Fertial Group that manage the complex of phosphatized and azotic fertilizers and the food- processing industry by companies like the dairy industry of Edough (DIE). Agriculture is observed on a set of plain with an enormous variety of truck farming, cereals, boricultural with a surface are of 14.134 km^2. The total population of the state is estimated at 609,500 dwellers, both a density of 429 dwellers/km^2 and a growth rate of 1.4%. The climate that predominates is Mediterranean marked by a heavy rainfall in the heights (Edough mountains) 2000 mm $year^{-1}$ and an average rainfall of 680 mm $year^{-1}$ in the plain, the average annual temperature is of the sequence 18 °C.

The geology of the region has demonstrated the existence of two types of formation, the first one represented by the metamorphic massif Edough formed a base crystallophyllian. The other is sedimentary occupying almost the whole area of study (Mebarki, 2005). The hydrogeology of the study area has two types of reservoirs; sheet of water reservoir, represented by the clayish silt- laden alluvium at the level of phreatic table by the sands of the dune sheet groundwater; gravel groundwater reservoir, represented by pebbles and inserted gravels with lenses of sand and clay. The geomorphology of the zone is characterized by a plane topography on the whole of the plain, marked by important inclinations on the edge of the plain, on the part of the west and south proving that metamorphic anticline mountains of Edough, Belelietais that of Numedien chain (Débieche, 2002). Hydrographics is dominated by two principles Wadi that run the plain, Oued Seybouse and Oued Meboudja River. The Seybouse watershed occupy an area of 5955 km^2 and a perimeter of 330 km, following a layout approximately South–West–Nort–East, Seybouse change direction to join toward the North, the Mediterranen sea, after crossing the coastal plain included between Dréan and Annaba (Mebarki, 2005).

3. Materials and methods

3.1. Materials

3.1.1. Location, mode and frequency sampling

In order to display the statistic series of physico-chemical (ANRH-1980–2010) analyses to calculate the median concentrations of contaminants at the location called Segman Amar (in Seybousewadi) five parameters have been selected; chlorides, nitrates, nitrites, total suspended solids, biochemical oxygen demand of five days. The follow-up of the different contaminants has been carried out in a period that started from January 2011 until December 2012. All of these samples have been possible thanks to a manual sampler with a foldable pole (of PVC) of a 3 m length, the depth of specimen being about 50 cm. The samples have been transported at a low temperature (4 °C) until the laboratory.

3.1.2. Physico-chemical parameters

The chosen parameters are those that allow to assess the better quality of water by knowing their potential effect on the receiver's aquatic natural habitat and the environment; the balance of chlorides' ions by the argentimétry method, the biochemical oxygen demand has been determined by DbometerOxi Top/Box115, total suspended solids have been determined by centrifugation and nitrates, nitrites by the spectrophotometer of the laboratory (HI83200) with the wave's length equal to 525 nm.

3.2. Methodology

The study of the contaminant's impact on the receiver's natural habitat introduced a subject of various approaches related to the complexity of aquatic ecosystems (MDDEP, 2007; Younes-Baraille et al., 2005; Marmonier et al., 2013). Among these methods, we have adopted one like MDDEP (2007) inspired by the U.S. Environmental Protection Agency (U.S. EPA) (2006) of which the conditions of applications limits came close to the ambient environment of the study. The effluent discharge objectives (EDO) are a value of fully loaded weight and concentration calculated for an associate parameter with an effluent that is shot on a precise point of the stretch of water. In order to calculate the EDO, it is necessary to know the criterion of water quality (contamination prevention criteria (water and fish consumption CPC(WF), contamination prevention criteria (fish only CPC(F) recreational activities and aesthetics criteria (RAAC), and in order to protect the living organisms, we have the chronic aquatic life criteria (CALC), and terrestrial piscivore criteria (TPC)), the flow of the effluent, the parameters of concentration in the flow rate and, usually, the critical low flow of the receiving environment. (MDDEP, 2007). The calculation of EOD is based on the report of applied loading on the portion of the stretch of water, this report is made out in a manner in which for every contaminant, and the addition of the effluent's load on the already present upstream load of discharge respects the maximal tolerable load on the limit of the restricted mixing zone. That zone is allocated, in the measurement where it does not damage the set of the waterbody. The rate of dilution of the discharge in the receiver's environment becomes frequently a determinant factor in the assessment of EDO's preservation.

3.2.1. Equation of the mass balance

For the majority of contaminants, the mass balance is represented by the following equation:

Upstream water load + allocated load on the effluent = maximal tolerable load at the limit of the mixing zone.

$$C_sQ_s + C_eQ_e = C_c(Q_s + C_e) \quad (1)$$

The allocated load on the effluent corresponds to the associate load respectfully of the quality criterion (maximal tolerable load on the limit of the mixing zone), of which is subcontracting the already present load in the environment (upstream load). These loads are defined that way:

$$C_eQ_e = C_c(Q_s + Q_e) - C_sQ_s \quad (2)$$

$$Q_s = Q_r - fQ_e \quad (3)$$

$$C_e = \frac{C_c(Q_r - fQ_e + Q_e) - C_s(Q_r - fQ_e)}{Q_e} \quad (4)$$

C_e (mg/L): the environmental objective of discharge in concentration, C_s (mg/L): median upstream concentration in the wadi, C_c (mg/L): quality of water criterion. Q_r (L s^{-1}): flow of recurrence: Q_e effluent flow, f = fraction of effluent's flow.

From Eq. (4), we defined, the daily load allotted to the effluent C_d (Kg d^{-1})

$$C_d = C_e \times Q_e \quad (5)$$