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Assessment Of The Environmental Impacts Resulting From The Presence Of Surface Agents In The Discharge From An Urban Water Cleaning Station In Algeria By Life Cycle Assessment Method

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ABSTRACT/RESUME

***Abstract:** The poor assessment of the environmental performance of water treatment systems led us to apply the life cycle assessment approach to a wastewater treatment plant. The purpose of our work is to evaluate the environmental impacts of the surfactants release from an existing urban wastewater treatment plant with a capacity of 35000 m3/inhabitant located in the city center of Boumerdés 45 km from the capital Algiers*
The article presents an evaluation of the environmental impacts of the surfactants release .This evaluation was established using Simapro8.1 software and the Midpoint ILCD version 1.03 methods.
The results of evaluation show four impact categories are evaluated;
- Human toxicity, Fresh water eutrophication, Marine eutrophication and Fresh water ecotoxicity. All the impact categories evaluated contribute to the surfactants fixed in the functional unit alcohol ether sulfate (AES), hexadecyl trimethyl bromide ammonium (CTAB) and Betaine of lauramidopropyl (BLP) of three different anionic, cationic and amphoteric types, respectively.
Finally, we conclude from the results obtained that the value of the impact of ecotoxicity is the highest (3, 24E-4 CTUe) compared to the other impact categories whose impact category represents the impact significant.

I. Introduction

In recent decades, the role of purification systems has become profoundly diverse. A significant number of synthetic contaminants, classified as "emerging pollutants". Among them, biocides and detergents with surfactant properties are of particular concern because of their ubiquity and their widespread use in domestic and industrial applications (1).
These substances can be grouped, according to their charge, in several families, among which the anionic surfactants, the cationic surfactants, the nonionic surfactants and the zwitterionic surfactants (2).

Few surfactant measurements in wastewater effluents have been undertaken. Surfactant concentrations of up to 872 μg/L for alkylbenzene sulfonate (LAS) (3) and 0.9 to 964 μg/L for alkylphenol ethoxylates have been reported (4).
Life cycle assessment is a tool for the systematic analysis of the environmental performance of a product or its processes, including raw material extraction and manufacturing, often considered a cradle-to-grave approach. For the assessment of environmental impacts (5,6). Life Cycle Assessment (LCA) is a powerful tool for analyzing the environmental impacts associated with a product, process or service by creating an inventory

of applied inputs and releases to the environment (7, 8).

LCA is a standardized method. The International Organization for Standardization (ISO) adopted an environmental management standard in the 1990 as part of its series of 14,000 standards. (9,10).

II. Case study description

In order to avoid the problems of data collection, we chose to apply LCA on an existing wastewater treatment plant, it is a fairly recent station based on activated sludge treatment. With a capacity of 75000 Eq/Hab. Wastewater arriving at the station is pre-treated (screening, degreasing, grit removal) and then sent for biological treatment. Biological treatment is carried out in activated sludge tanks equipped with a bridging system. This arrangement ensures the treatment of organic pollution. The extracted sludge is thickened by flotation and then stored and packaged in a maturation tarpaulin.

Figure 1. *Situation of the boumerdes station*

III. Methodology of the assessment

The LCA methodology assesses the environmental impacts generated by the treatment plant. In this study, LCA is applied to evaluate the environmental impacts generated by the treatment process of the treatment plant.

III.1. Goal and scope definition

The purpose of this study is to evaluate the treatment of activated sludge surfactants in the step to identify the environmental impacts contribute to the rejected surfactants, by applying the LCA approach. The analysis of which was fixed on three surfactants of different types (AES, CTAB and BLP).

The functional unit chosen for this study is the flow of water treated by step by day 35000m^3.

III.2. Software and method

The primary energy demand and the environmental loads of the water treatment and end-of-life phases of the materials were quantified using the SimaPro 8.01 LCA software (11). The majority of the inventory data has been extracted from the Midpoint Version 1.03 ILCD database (12). Midpoint is a comprehensive database used in many LCA, including Iqbal et al. (13).

III.3.life cycle impact assasement

In this study we chose to evaluate the station on four impacts:

- Human toxicity
- Fresh water eutrophication.
- Marine eutrophication.
- Fresh water ecotoxicity.

For each impact, the result part will contain the following elements:

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- A presentation of the impact assessment results.
- The results will be interpreted and discussed.

III.4. Life cycle inventory

The complete inventory of pollutant emissions and consumption of the natural resources of the step is corresponding to the average of the parameters resulting from canceled reports provided by the operator for the year 2017.

- Energ

The daily electricity consumption of the station per day is 39330kwh/day.

- Consumables

Table1. *The consumption of the reagents of the station*

Reagents	Quantity(kg/day)
$Ca(OH)_2$	23.00
$FeCl_3$	05.00
H_3PO_4	06.00
NH_3OH	25.50
NaOH	13.50
HCIO	20.00
H_2SO_4	03.50
HCl	08.50

- Flow input and output of the station

The flows entering and leaving this study are presented by the raw water entering the station and the treated water of the station. They are characterized by the physicochemical parameters of pollution and three types of agents of anionic surfactant AES, cationic CTAB and amphoteric BLP to allow us to evaluate the impacts contribute to this molecule.

The table below represents the analytical parameters of the raw water and the treated water of the station; the values considered are the means of the parameters during the year 2017.

Table 2. *Analytical parameters of the raw and treated water of the station*

parameters	BOD5	COD	MES	NTK	NO_2	NO_3	AES	CTAB	BLP
Unit	mg O_2/l	mg O_2/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Raw water	298.20	810.00	379.00	57	0.1	0.9	677.13	50.86	19.36
Treated water	89.00	251.00	110.00	3.00	2.30	17.00	547.18	44.25	16.64
Efficiency %	70.13	69.01	70.79	94.73	-	-	15.76	13.66	19.33

The low efficiency of surfactant treatment is their adverse effects on the operation of sewage treatment plants. Let them be summarized in two points; the first is the effect on the filtration process and the second on the biological treatment process.

-The effect of the surfactants on the filtration results in an increase in the pressure loss, it was found that during sand filtration, which constitutes the final stage of the purification process, a concentration greater than 20 mg.L-1 of surfactant affects the efficiency of filtration for the removal of bacteria and flocs from subsequent treatments (14).

-Surfactants have a harmful effect on aerobic biological treatment because of the reduction of the oxygen transfer coefficient. In this case, the microorganisms will not always have at their disposal the oxygen necessary for biodegradation (14 ,15).

However some authors show that a decrease in the oxygenation coefficient of the order of 65% reduces the efficiency of the installation by 30%. Indeed, this study reported deterioration of bacterial beds starting from a concentration of 20 mg.L-1 (16).

IV. Resultats And Descution

In this work we followed the method of Midpoint ILCD version 1.03, the impact calculation results tested by this method are shown in Table 3.

Table 3. *Impact results calculated by the ILCD method*

Impact category	Unit	Quantity of Impact	Observation
Human toxicity	CTUh(comparative unit of toxicity for humans)	2.03E-10	Evaluates the chronic toxicological effects on human health due to emissions of organic substances. Gives an estimate of the increase in morbidity across the entire human population.
Fresh water eutrophication	Kg P eq	3.76 E-6	This is the enrichment of water in nutrients.
Marine eutrophication	Kg N eq	3.87 E-6	This is the enrichment of water in nutrients. This causes asphyxiation of aquatic ecosystems.
Fresh water ecotoxicity.	CTUe (unit of ecosystem toxicity)	3.24 E-4	Evaluates the toxicity of the emission of substances on ecosystems. Characterizes the potential risks induced by the presence of chemical compounds in a specific ecological system.

1) Eutrophication

Eutrophication is an important impact for the field of sanitation; it is indeed one of the main functions of sewage treatment plants to fight against nitrogen and phosphorus pollution. This category of impactsrepresents from 80 to 95% of the total impact of the rejection of the station, the two types of eutrophication (nitrogen and phosphorus) are close together (3.76 E-6 kg P eq). In fact, phosphorus is less harmful in the eutrophication phenomenon than nitrates (3.87 E-6 Kg N eq). The results obtained show two categories of eutrophication one and fresh water explain by the rejection of the step towards the Oued and the second category is marine eutrophication.

2) Toxicity

The impact of toxicity on human health is divided into two categories Human toxicity, the present method contributes the impact of human toxicity without carcinogenic effects to surfactants present in the releases to 2.03E-10 CTUh.

And human toxicity contributes to the presence of surfactants; these elements constitute a risk to human health through contamination of the food chain.

3) Aquatic ecotoxicity

The impact of aquatic ecotoxicity affects fauna and flora in the same way as do toxic substances on human health the same molecules contribute to the before are concerned; surfactants as organic pollution with an impact amount of 3.24 E-4 CTUe

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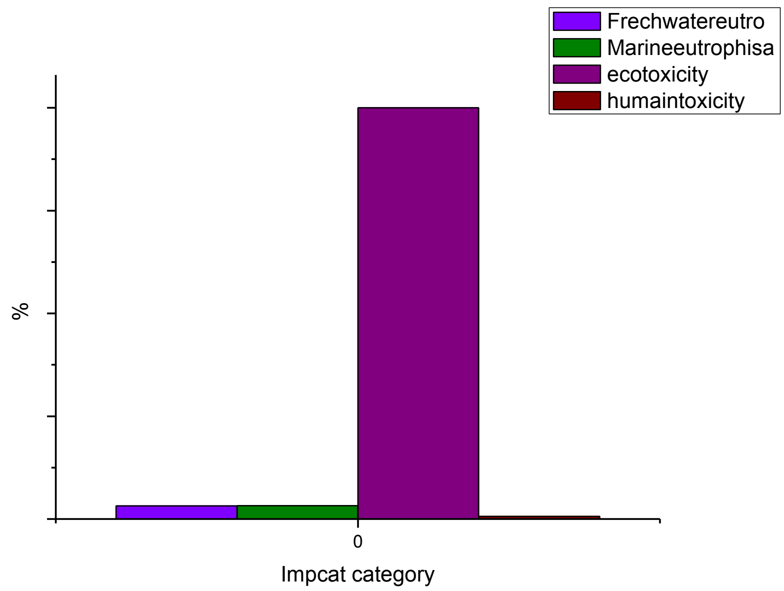

Figure 2. *The impact results calculated by the ILCD method*.

The impact assessment results show that the amount of ecotoxicity impact of freshwater is the highest with 3.24 E-4 CTUe,
In the literature, the toxicity of surfactants for the aquatic environment, and in particular the marine environment, is very poorly known (17). Of which the surfactants studied are LAS, sodium dodecyl sulfate (SDS), alkylethoxylate (AE) and dimethyl ammonium chloride (DTDMAC) (18, 19).
Most of the surfactant toxicity tests found in the literature describes in vitro alternatives for the purpose of studying gene distribution. Perez et al. Concentrates in their work on intrinsic toxicity testing of surfactants without consider specific applications. However in vivo tests in human volunteers are therefore crucial, at least to confirm in vitro results. They identified five different categories of procedures used to measure the toxicity of surfactants (20).
Cationic surfactants have the highest aquatic toxicity compared to other surfactants (21). Because of their antimicrobial properties, they are frequently found in home-use detergents (22, 23, 24, 25, and 26).
Toxicity studies are primarily focused on assessing acute toxicity, which means assessing the lethal concentration 50%. Very few studies are interested in the effects of exposure of organisms to surfactants (27).

V. Conclusion And Recommandation

Wastewater treatment plants have a variety of processes, their treatment processes also generate different impact categories that are difficult to identify, which has led us to apply the LCA method. Indeed this method is multicriterion and more representative; it allowed us to evaluate the direct and indirect impacts of liquid discharge of the step.
It has emerged as the most suitable method for assessing environmental impacts in the water treatment sector. Our analysis is based on a case study of an existing station. We analyzed four impacts (Human toxicity, Fresh water eutrophication, Marine eutrophication and Fresh water ecotoxicity) after presenting the elements of the field of study, data and assumptions.
This experience shows a certain number of conclusions, firstly LCA appears as an essential tool for assessing environmental performance in the field of water treatment, the global impact eutrophication is evaluated in a robust way unlike the local impacts of toxicity and ecotoxicity that are sufficiently weak to address health issues in the field of sanitation, it is possible to complement and deepen the local impact assessment study with experimental studies.

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