Dumping of Phosphate in Sources of Water: Impact on Rivers and Possible Solution

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***Abstract*— The main objective of this work is to address the contamination of the rivers due to the presence of phosphate, a highly harmful chemical waste. Phosphates trigger a high volume of algae, change river colour and reduce several oxygen levels, harming aquatic life and increasing water scarcity and waterborne diseases. In this work, two main approaches are presented to address this issue: biological phosphorus removal and chemical phosphate precipitation. Both methods have advantages and disadvantages in terms of environmental impact and economic costs. It is expected that this paper may generate a positive impact on the environment and aquatic life so as to contribute to the achievement of SDG6 by generating awareness among people about caring for the ecosystem.**

***Keywords:* phosphate, chemical products, contaminated rivers**

***Resumen*— El objetivo principal de este trabajo es abordar la contaminación de ríos con la presencia de fosfatos, un tipo de residuo químico muy perjudicial. Los fosfatos generan gran volumen de algas, cambia el color del río y reduce severamente los niveles de oxígeno, dañando la vida acuática e incrementando la escasez del agua y enfermedades transmitidas por la misma. Se presentan dos soluciones para abordar este problema: remoción biológica del fosforo y la precipitación química del fosfato. Ambos métodos poseen ventajas y desventajas en términos de impacto ambiental y costos económicos. Se espera que este trabajo puede generar un impacto positivo en el medioambiente y la vida acuática, como también contribuir al logro de SDG6 por generar conciencia en las personas sobre el cuidado del ecosistema.**

***Palabras clave*: fosfato, productos químicos, ríos contaminados**

I. Introduction

In today's world, dumping of highly polluting waste represents one of many problems affecting aquatic, terrestrial and airborne environments. In Argentina, water pollution is a serious problem since many people live both from marine resources and from freshwater resources.

The problem of water sources contamination has been addressed by the United Nations' 2030 Agenda, more specifically by means of Sustainable Development Goal (SDG) #6 (six), which is called "clean water and sanitation for all". The target that is more representative of the topic discussed in this work is target 6.3. This target states the need to reduce pollution, eliminate dumping and minimize release of hazardous chemicals and materials into the water [1, p.35].

As with every kind of project, it must go from smallest to largest, so the focus will be on the reduction of river pollution and, as a result of this, ocean contamination may decrease although all rivers are part of this problem.

The rivers have several types of pollution, including chemical, organic and inorganic products. However, the focus of attention here is on a highly damaging chemical waste: phosphate. This pollution product generates an imbalance in the river cycle, which increases the growth of algae, changes the colour of the river and kills fish due to oxygen reduction. Also, this increases the number of people suffering from water scarcity and water-borne diseases.

Given the urgency to solve this issue, it is very important to search for and research into solutions to guarantee a better quality of water in cities close to water sources. To fulfil this aim, this work will be presented in three parts. Firstly, phosphate, the most damaging residue, is analysed to determine its impact. After this, two approaches, biological phosphorous removal and phosphate chemical precipitation, are presented to address its elimination in the water. In the last part, one of these methods of water purification will be chosen according to its efficiency and its impact on the environment. It is expected that this paper may generate a positive impact on the environment and aquatic life so as to contribute to the achievement of SDG6 by generating awareness among people about caring for the ecosystem.

II. Problem description: Determination of the most frequent pollution waste in rivers

Trash is a major product of water pollution, composed of different types of products, for example, plastics and cardboard, organic components. Having a large diversity of waste types does not take away the relevance of this topic. Highly polluted water sources is typical of impoverished places and contexts with little environmental awareness and legislation to regulate industrial activity.

In relation to the chemical products, there are many industries that use phosphate for the fertilization of the soil and the care of their production. It is a problem that affects many aspects as its purification is very complex and demanding.

Phosphate generally comes from several places and can be found in different forms. It may come from fertilizers removed from the soil by rainwater or wind, humans and animal excretions and cleaning products. This chemical product is composed of three components: orthophosphate, which is in highest proportion, polyphosphate, and organic components of phosphorus.

The presence of phosphate in the water generates large amounts of algae, which is not desirable in the aquatic environment. As far as phosphate is concerned, it is a component that contributes the eutrophication in the river and lakes. That is, only one gram of phosphate in the water promotes the growth of up to 100 grams of algae. Its presence impacts on the water in several forms, including the cost increase in the cleaning of it when it arrives at the purification plant.

In [2, Fig.1] the accumulation of algae in wastewaters due to the impact by high phosphate concentration is shown. When algae die, the process of decomposition entails a demand of up to 150 grams of oxygen per 100 grams of algae [2, p. 2], which brings disruptions to the aquatic ecosystem.

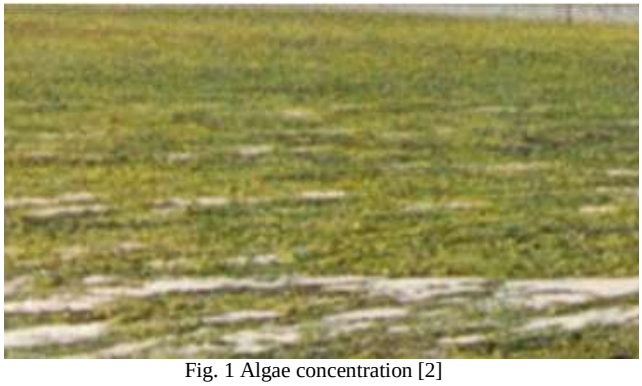

Fig. 1 Algae concentration [2]

III. Problem Approach: Processes for Phosphate Removal

Nowadays, the complete elimination of phosphate is a difficult task. Algae accumulations in rivers and lakes prevent the monthly cleaning of storage tanks for the derivations of different daily uses. Also, it is dangerous because the generation of toxins in these tanks is deadly for humanity [3, p.1]. In addition, this concentration of algae in these water bodies removes the oxygen of it reducing the aquatic life.

As stated above, in this work, two methods are presented: biological phosphorous removal and phosphate chemical precipitation.

A. *Biological Phosphorus Removal*

Biological Phosphorous Removal is the most used and depends on the presence of readily biodegradable organic agents. This method is carried out by establishing a chemical relation of oxygen at the inlet of the aeration tank in water plants making the phosphate die of asphyxia.

Regarding its operation, it consists in two parts. Firstly, an anaerobic stage is carried out, which means that there is no presence of oxygen, and the organic matter present in the water is captured by polyphosphate accumulating organisms (PAO). Secondly, an aerobic stage is carried out, which means that there is presence of oxygen. At this stage, PAO degrade the accumulated organic matter to transform it into energy. Part of this released energy is used to collect phosphate from the river. To finish the process, phosphate is eliminated through algae purge after the two stages mentioned before [5,p.2].

In [3, Fig.2] the biological process of phosphate elimination is shown.

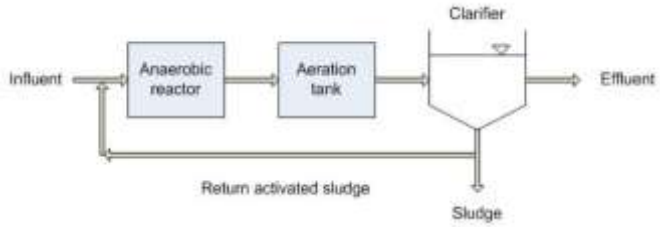

Fig. 2. Biological process of phosphate elimination [3]

B. *Phosphate Chemical Precipitation*

Phosphate Chemical Precipitation consists in adding precipitants such as iron or aluminium salts and lime slurry to the water, which are used in this process as coagulants. Although there are 3 precipitation methods, in this case, the solution called "post-precipitation" is proposed.

The process presented above is a treatment that uses only metallic reagents. These elements are added to the residual water to generate the coagulation of phosphate and its derivatives. To finish the process, chemical sediments are extracted to have clean and safe water once again in the river.

In [3, Fig.3] post-precipitation process for Phosphate Elimination is shown.

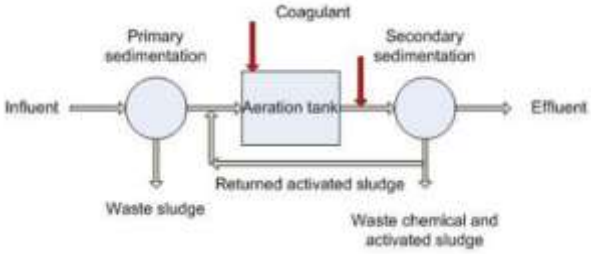

Fig. 3. Post-Precipitation process for Phosphate Elimination [3]

IV. Advantages and Disadvantages of the Proposed Methods

In connection with what was expressed above, there are some positive and negative aspects in these methods. These aspects are presented below.

One of the advantages that biological phosphorus removal presents is that it offers a sustainable alternative and is effective when in operation [5, p.2] because it does not produce much sludge [3, p.1]. For its part, phosphate chemical precipitation offers low prices, high sustainability but its effectiveness is not so robust. Taking these criteria into account, phosphate chemical precipitation is more effective than biological phosphorus removal because only one anoxic part is needed, that is, one less step, although in turn this process has a high cost and low sustainability.

V. Conclusion

To conclude this work, it is important to highlight the importance of eliminating phosphate to take care of our

ecosystem and the lives of people. Furthermore, the active participation of governments in these types of issues is of vital importance. As well as this, environmental education and technology investment in the improvement of these aspects of the ecosystems is very important to have a healthy and sustainable life in the rivers.

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