OPTIMIZING PHOSPHORUS REMOVAL BY CHEMICAL ADDITION AT ORADEA WASTEWATER TREATMENT PLANT

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ABSTRACT

The effluent contains a range of pollutants, some of which are removed more or less conventional in the purification steps, while others are held very little or at all, in the conventional treatment plants. Acute problems of water protection have led to the imposition of the severe conditions of concentrations limit permitted to the effluent discharged into the natural emissaries.

Keywords: ferric chloride, phosphorus, sewage treatment plant

INTRODUCTION

The treatment plant receives wastewater from the city of Oradea and the surrounding villages, being connected to the two main collectors: the ovoid 70/105 cm bell 165/260 cm. Wastewater from the municipality's lowlands are channelled in the 10 pumping stations, where they are pumped to gravity sewers. Upstream of the sewage plant is a pool of compensation for the flows during heavy rains, flows that go back into the main collector and are taken to the treatment station. To compensate for the lack of capacity (Q > 2200 l/s) and preventing of accidental pollution, there are downstream, biological treatment ponds ~ 50 ha, where water is discharged into the river Crisul Repede in a controlled way, and approved by the competent authorities [5].

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The treatment plant is a mechanical-biological type, and purifies the domestic and industrial wastewater from Oradea and in some areas adjacent to the city, station effluent being discharged into the environment Crisul Repede, 10 km upstream from the point of crossing the border with Hungary.

MATERIAL AND METHOD

Given the fact that almost always wastewater treatment plant have a high investment value, it was necessary for the development of sludge processing norm NP 118-06/2006 treating sludge processing technologies retained and proposed treatment plants best parameters and methodologies for designing buildings and installations, and how the choice of machinery and equipment necessary to ensure that they are operating as a simple, safe, reliable, energy efficient, and to lend itself to automated processes treatment [1].

Automation of complex industrial processes required to ensure optimal functioning of these schemes, with minimal consumption of energy and materials, with a special security operation, was required in almost every industry today, and it represents not an option, but a necessity.

In these circumstances, it was a necessary arrangement to ensure stable and optimal economic operation, remote operation of various components of complex processes, gathering, transmission, storage and processing large volumes of information, provision of interdependence between the various parameters of the process, to meet performance criteria at the global optimum.

With the development of a computer system, is intended to provide certain requirements, it is necessary that both the design and its implementation to make in a short time, so, a cycle of low time of achievement, with significant savings of human and financial resources. Achieving this goal requires, besides a series of organizational measures, the increasing use of standard solutions [2].

The experimental research carried out in the Oradea Waste Water Treatment Plant revealed phosphorus concentrations exceeded maximum permissible limits, to remedy this shortcoming, the following operations are propose:

Given the processes of removing phosphorus from wastewater by chemical addition, to the actual situation existing at Oradea Wastewater Treatment Plant, the following procedure to reduce the phosphorus chemical reagents using FeCl$_3$ (+ H$_2$O) was proposed.

As the concentration of phosphorus in the legislation in force should be max.1mg/l in the purified water, and after testing in the laboratory of
Oradea Wastewater Plant, it was found that this value was exceeded in most cases, reaching values between 2 and 2.5 mg/l, values well above the limit of NTPA001/2005 [4].

At Oradea Wastewater Treatment Plant, phosphorus is partially reduced with the existing biological technology, for maximum values to be within permissible limits, special measures must be taken. For this purpose it is necessary to install a dosing station of an aqueous solution of ferric chloride FeCl$_3$ (+ H$_2$O) with an iron content of 14%.

Phosphorus in dissolved form ($\text{PO}_4^{3-}$) is precipitated by iron ions, thus forming a heavy to dissolved precipitation. The precipitation slurry is decanted into the final settling and can be removed from the system. If the wastewater has a pH value between 6 and 8, then the following equation describes the reaction of stoichiometric composition:

$$3\text{Fe}^{3+} + 2\text{PO}_4^{3-} + 3\text{H}_2\text{O} \rightarrow \text{Fe(OH)}_3(\text{PO}_4)^2 + 3\text{H}^+$$

(1)

Following this equation it can be stated that 1.5 mole of iron ions, to precipitate a mole of phosphorus. Depending on the technology station, the degree of interference may vary from one point to another in the wastewater circuit pathway on site. Determining the most favourable points it is for the designer.

At Oradea Wastewater Treatment Plant the dosage point is most favourable at the end of aeration tank, the point before the secondary settling (the final). Thus we ensure that the chemical, mix completely, after dosing, this contributing to the formation of the precipitation optimum level, helping to deposit the sludge, which will reduce the phosphorus content of water to be discharged into the environment, below 1 mg/l.

Central dosing pumps (a group composed of two pumps in operation + one backup) will be automatically controlled and the concentration of phosphorus in purified water will be analysed on-line, with a measuring apparatus before being discharged into the environment. If the phosphorus concentration increases, the dosing pump will respond immediately and will increase the quantity of reagent dosed, and if the concentration of phosphorus is reduced, will decrease the amount of chemical reagent determined.

For a better result, it is necessary to introduce ferric chloride in the supernatant from the centrifuge of dehydration, which in turn is fed back into the treatment process circuit.
Advantages of using ferric chloride are as follows:
- precipitation of phosphorus,
- neutralization of low sulphur bonds that inhibits the nitrifying,
- removing of suspended solids,
- elimination of sulphur components that easily produce toxic and corroding gasses,
- decreased oxygen consumption in the aeration tank and also the energy consumption of turbo air pumps,
- delay spread of filamentous formations and biogas desulphurization, to a lower factor of corrosion to engines that uses the gas [3].
Ferric chloride is a reddish-brown liquid, slight pungent odour, with freezing temperature at -37°C, boiling point at 100°C, with complete solubility in water, pH = 1, combustible, highly irritating and highly corrosive, strong damage to the metal. For this reason, it is necessary to use special plastic pumps for dosing. Staff coming in contact to the solution must use plastic utensils, to be equipped with rubber gloves, goggles, to avoid inhaling the gas, and storage and transportation will be made only in plastic.

Dosing tank from where the dosing feeds will be made of high density polyethylene (HDPE) with a capacity of approximately 30m$^3$ and the admission of the pumps must be fitted with a filter to prevent clogging of the dosing pumps with dirt.

It is estimated that the doses of ferric chloride used will range between 2% and 10% of dry matter and for Oradea Wastewater Treatment Plant it would be about 80 l/h.

CONCLUSIONS

Application of this technology is recommended for modern water treatment plants that have a low yield on nitrogen elimination, the main goal is finding the balance between nitrification and de-nitrification. The condition for an efficient de-nitrification is a low redox potential, on one side, and the presence of a larger proportion of dissolved CCO, on the other side. In nitrification case, it applies its opposite, so near the high redox potential is no need for dissolved CCO, or if there is, then you need a minimum level. This technology seeks to coordinate these two different conditions, however, its practical implementation, rests with the operator station. Most of the sludge resulting from wastewater treatment cannot be successful conditioned without the associated of ferric chloride with lime. Lime is used to correct the pH value, which must be larger than 6. Ferric chloride must be injected in the sludge before the lime, and the injection points of the two reagents should be separate.

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