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Sharad Khawal
M.Tech Student Chemical Engineering Department, Ujjain Engineering College, Ujjain – 456 010 (Madhya Pradesh), India.

Dr. Sanjay Verma
Associate Professor, Chemical Engineering Department, Ujjain Engineering College, Ujjain – 456 010 (Madhya Pradesh), India.

Correspondence:
Dr. Sanjay Verma
Associate Professor, Chemical Engineering Department, Ujjain Engineering College, Ujjain – 456 010 (Madhya Pradesh), India.

Comparison of biological and algal treatment of acidic wastewater of steel industry

Sharad Khawal, Sanjay Verma

Abstract
Steel industries have a common process of finishing metals to improve and strengthen steel, known as pickling process. The nature of effluent discharged by this process is ultra acidic and it also contains heavy metals and toxic gases. If this effluent is not treated properly and adequately, it can cause severe damage to flora and fauna and to other water bodies like ponds, river, lakes etc. This effluent cannot be successfully and economically treated using conventional physico-chemical methods. Two distinct secondary treatment methods viz.; biological using different biomass and algal treatment are found to be the best alternative methods for treating the steel industry effluent. In present paper, both methods are compared in terms of effectiveness and economy through comparison of experimental data. Algal treatment method was found more suitable to treat such effluent.

Keywords: Algal treatment, Biological treatment, pickling process.

1. Introduction
The physico-chemical process of treatment of acidic effluent comprised of treatment with hydrated lime. This neutralized effluent is not suitable for survival of flora and fauna due to presence of heavy metallic compounds (Mn, Fe, Cu, Zn etc) and/or their intermediates create toxicity in the water. When this effluent mixes with groundwater and other water bodies like river and ponds, it may cause contamination. In order to remove toxicity and make it suitable for living organisms this effluent required some microbial or algal treatment for further viability of creatures.

1.1 Biological Treatment
The use of microbes in this process has some distinct advantages over traditional physico-chemical methods. These processes are more environmental friendly, less energy consuming and useful for the low grade ore effluent (Rawling, 2002) [8]. The use of biomass for the anaerobic treatment of acidic effluent comprises of decomposition of organic material in the absence of free oxygen which produces methane, carbon dioxide, ammonia and traces of other gases and organic acids of low molecular weight (Lopes *et al*., 2004) [6]. The common microorganisms belong to *Genera*, *Thiobacillus* and *Leptospirillum* which are mesophile, acidophile and chemolithoautotroph. They obtain energy from oxidation of either ferrous ion to ferric ion or reducing sulfur compounds to sulfuric acid (Rawling, 2002 and Rohwerder *et al*., 2003) [8, 9].

1.2 Algal treatment
Algal technology avoids the use of chemicals and the process of effluent treatment become simplified. Considerable reduction in sludge formation is another advantage of this process. Using microalgae for wastewater treatment is an old idea and several researchers developed many techniques for exploiting the fast growth and nutrient removal capacity of algal mass. The nutrient removal is basically an effect of assimilation of nutrients as the algae grow, but other nutrient stripping phenomena also occur simultaneously, this include ammonia volatilization and phosphorous precipitation as a result of the high pH induced by the algae (Hammouda *et al*., 1994) [3]. Microalgae may provide heterotrophs in secondary treatment with oxygen, and can also be used to absorb metals from wastewater. The increase in pH during photosynthesis has also a disinfecting effect on effluent quality (Dela Noue *et al*., 1992). The term micro algae refer to all algae too small to be seen properly without microscope and often

include both eukaryotic and prokaryotic cyno-bacteria (Soeder, 1981) [11]. Treatment with microalgae found to very economical and safe for the environment (Kamleshwari *et al.*, 2007) [5].

2. Comparison of Biological and Algal Treatment Methods

The experimental data for comparison of the two methods is taken from our previous experimental work. In Biological treatment process, four biomasses, cow dung, chicken manure, pigeon drops and sewage were taken. The micro-organisms employed for these processes were aerobic bacterium. The experiments were performed and analyzed for uniform volumes of biomass on same temperature. Results obtained from these experiments indicate that different manures show different properties at same experimental conditions. The organisms show their reactivity for removing particular toxicity but not take different times in doing so. The use of biomass in removing heavy metals was found to be inefficient.

The algal material for algal treatment were carefully collected from different habitats and kept in polythene bags, wide mouth bottles and beaker, and then covered by foil. Multiple samples were collected at random. The neutralized effluent kept in different volumes using three apparatus viz.; bucket, tub and pilot plant. Results of the experiment showed that the pilot plant study depicts better performance than bucket and tub. Micro algae were found capable to absorb the metal ions also.

The parameters (pH, COD, DO and TDS) analyzed in both experiments were same. In biological treatment the sewage biomass, and in algal treatment pilot plant experiments produced effective results, hence these two are chosen for comparison.

2.1 Effect on pH

In biological treatment, sewage was active biomass collected from sewage treatment plant, and directly dissolved into the effluent. This oxidizes the effluent parameters, and shows it's effect in quick time. While in algal treatment, algal biomass form a net over the effluent, and thus it does not dissolve, and shows delayed effect compared to sewage. Effect of both treatments on pH is shown in figure-1. Many studies have shown that variation in pH is an important factor which further affect biosorption of heavy metals (Hauang *et al.*, 1990 and Sanchez *et al.*, 1999) [4, 10].

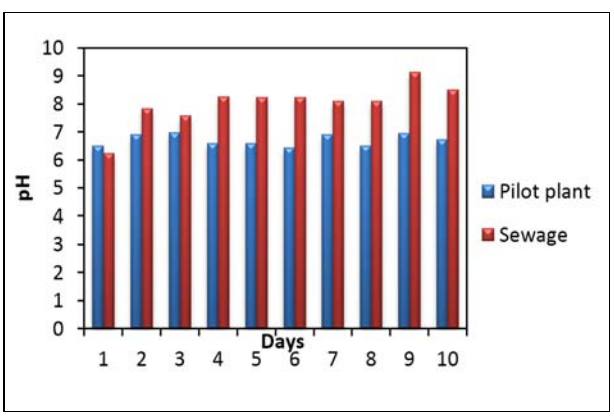

Fig 1: Comparison of pH variations

2.2 Effect on DO

Since the neutralized effluent has no dissolved oxygen initially, the DO in both pilot plant and sewage is zero. DO is the byproduct of organic decompositions in wastewater treatment. As the biomass and algae decomposes and grow gradually the experiments DO level increases continuously. In case of pilot plant (algal treatment) initial days shows constant DO level. This is because of initial time taken by the algae in adapting to the conditions and growth. Sewage biomass already contains microbial sludge and it gets distributed uniformly in the effluent as soon as it is mixed, causes start of biological activity. That is why DO increases at a constant rate in the effluent in case of sewage biomass. Comparison of increase in DO levels is shown in figure-2.

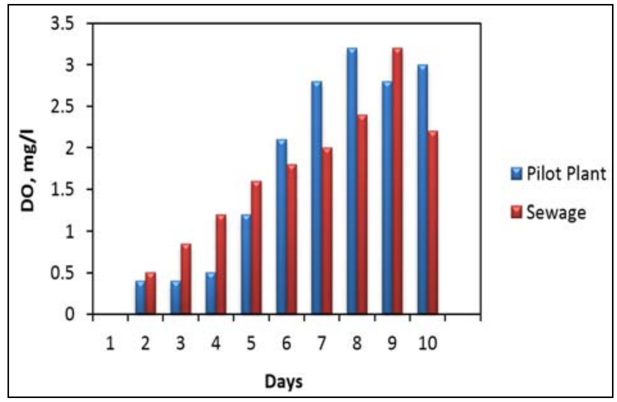

Fig 2: Comparison of DO variations

2.3 Effect on COD

As the biomass and algal addition oxidized the effluent, COD of effluent increases in initial days. After biodegradation and bio-remediation of effluent with sewage and algae as days passes, the COD started coming down and in both of the cases it come down to acceptable level after 10-11 days of experiment. Results of experiment shows that COD increases initially for 4 days and then started coming down. This was believed to be due to high COD exhibited by inoculums which leads to increase in COD concentration. In fact, it dominates the microbial activity thereby resulting in lower COD removal efficiency sometimes. This is shown in figure-3.

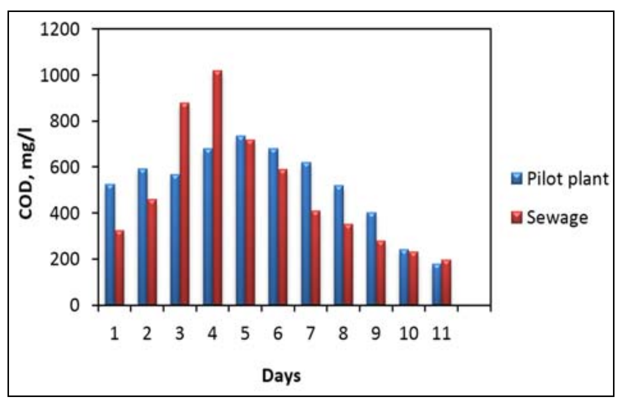

Fig 3: Comparison of COD removal

2.4 Effect on TDS

The change and reduction of TDS in biologically treated effluent is found after the absorption of dissolved salts. Sewage contains volatile fatty acid and proteins which does not decompose and absorb the metal ions, hence showing very little TDS reduction during experimental period. This was concurrent with the findings of Rao *et al.* (2000) [7] and Bujoczek *et al.* (2000) [1]. While algal mass continuously absorb the metal ions and shown reduction in heavy TDS and heavy metals. This is shown in figure-4.

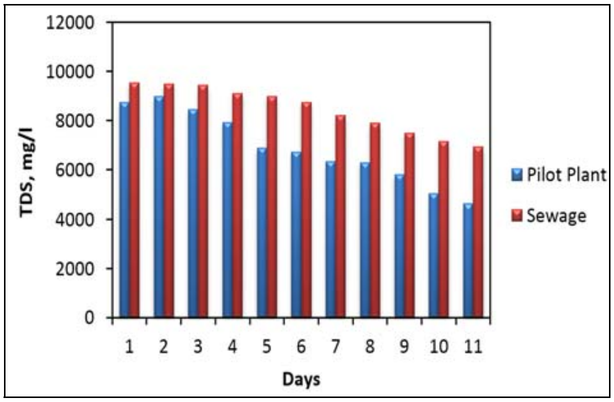

Fig 4: Comparison of TDS removal

3 Conclusions

Using biomass and its organic ingredients is good idea, but the problems like everyday collection of uniform biomass, dosing/addition of this into wastewater, after treatment filth and handling and disposal of sludge formed in secured landfill makes this option less attractive. All these stages make the biological process costly. While, Microalgae is derived from organic ingredients of water. These species changes its properties change of effluent and shows adaptation in any effluent and water body. Microalgae do not require any cultivation to grow it. Once it is dosed in pond it started growing automatically. Algae used all metallic and organic compounds for food preparations. The results and experiments procedure shows that algal operation is cheap and easy to handle.

4. References

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