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OXALIC ACID: A REVIEW ON ANALYSIS, SYNTHESIS AND APPLICATION

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ABSTRACT

Production of various chemicals by low cost and effective method is major challenge to chemical engineering. Various chemicals and substances such as glucose, amino acids, citric acid, lactic acid etc. are widely used in chemical, pharmaceutical and food industries. Oxalic acid is one such important substance used in grinding, cleaning and rust removal applications. Various methods and feed stocks are used for its manufacture. The current review summarizes research on analysis and properties of oxalic acid, its synthesis from low cost feeds stocks, removal from water and its different applications.

KEYWORDS: *Yield, biomass, energy, cost, pretreatment*

I. INTRODUCTION

Chemical engineering is ever evolving field. Various chemicals can be produced by various alternate methods. The catalytic and non catalytic reactions can be optimized by using various methods. The manufacture of chemicals like ethanol, citric acids, amino acids, lactic acid etc. can be carried out by using biological pathways [1,2,3,4].

The use of biological or enzyme catalyzed reaction can be carried out comparatively at low temperature [5,6,7]. These enzyme catalyzed reactions are environmental friendly. Also starch, glucose can be isolated by from waste materials [8,9,10]. The production of compounds from waste serves twin purposes, one synthesis and second reduction in waste.

Oxalic acid is one of the important chemicals used for removing ink, food stains, and many other types of stains. It is also used as rust remover, grinding agent, cleaning agent etc. It is corrosive in nature and oral and topical applications of this acid are highly toxic. The oxalic acid is synthesized by the oxidation of carbohydrates or glucose. Various feed stocks are being explored for production of oxalic acid. The use of waste feed stocks is being explored by various investigators. The current review discusses research on characterization and analysis of oxalic acid, its synthesis, application and removal from wastewater.

II. RESEARCH ON ANALYSIS AND PROPERTIES

Ma et.al carried out studies on hygroscopic properties of oxalic acid[11]. They used Raman spectrometry and vapor sorption analyzer. According to these studies, hydrated particles represent the most stable state of oxalic acid and oxalates in the atmosphere. Nozal et.al. carried out investigation on determination of oxalic acid and other organic acids in honey[12].They used two ion inclusion columns in their studies. Mensah et.al. carried out an investigation on chemical and physical properties of oxalic acid and oxalate aerosol particles [13].Their high resolution analysis of oxalic acid revealed that a significant fraction of the cations was ammonium instead of hydrogen. Akyol and Yeninar carried out an investigation on use of oxalic acid to control varroa destructor [14].They observed that only one application of oxalic acid can reduce varroa population by 84 percentages. According to them, Oxalic acid is very good and effective way for varroa control as it is cheap, safe for beekeepers, and presents low variability between colonies in its final Efficacy.

III. SYNTHESIS OF OXALIC ACID FROM WASTE FEED STOCK

Kuponiyi et.al. carried out an investigation on production of oxalic acid from solid industrial waste [15]. According to them, land application, composting, open burning and placement in a land fill are few methods for solid industrial waste treatment. They processed Cocoa pods, palm bunches, and plantain peels for production of oxalic acid. They isolated oxalic acid with weight percentage 26.89 percent. Oxalic acid which finds application in laundry, pharmaceutical, hospitals was produced from waste by them in potentially important and feasible method. They concluded that the agricultural raw waste can be effectively utilized for production of various chemical.

Sethy et.al. carried out investigation on production oxalic acid from molasses [16].Oxalic acid is one of the mostly abundant substances present in the plants. They used molasses as raw material for 30 tpd of oxalic acid production. They studied aspects such as material and energy balances, cost estimation, instrumentation and process control of equipments used in the process. They used three reactors. They used first reactor for oxalic acid production from nitric acid and nitrogen oxide from first reactor was fed to second and third reactor. Vanadium pentaoxide was used as a catalyst by them. For the reactors, the parameter study was carried out for oxalic acid yield, temperature, quantity of sulphuric acid, catalyst, additional water and total air flow rate. The fermentation processes take more time so nitric acid process was more convenient.

Song et.al carried out an investigation on synthesis of oxalic acid from acetylene [17].According to them, it is necessary to study factors like energy, pollution and cost for manufacturing processes. Paired electrochemical reaction, according to them was an efficient, clean, energy-saving method. They found that oxalic acid is in-situ produced from acetylene in anodic room. Oghome et.al carried out comparative studies on oxalic acid produced from rice husk and paddy [18]. They carried out Nitric acid oxidation of carbohydrates. In their investigation, they observed that rice husk gave better yield than paddy.They obtained the maximum yield at 75 ^{O}C. They observed that oxalic acid produced by different raw materials had same properties such as the appearance, density and melting point.

Ojiako and Mokwe carried out an investigation on production of oxalic acid from rice husk and cocoa[19]. They used nitric acid oxidation of carbohydrates for getting better results. According to these studies, HNO_3:H_2SO_4 acid ratio plays important role in the production along with temperature. 75^{O}C was optimum temperature. The acid proportion of 60:40 yielded best results. They found the rice husk was better raw material with 13 percent more yield than cocoa.

According to Chandel et.al., agro-residues constitute the important part of total biomass available on earth [20]. In order to utilize the waste to its fullest capacity, pretreatment of agro-residues with dilute acid hydrolysis was most important step. The amenability of cellulosic enzymes towards the hydrolysis of the cellulosic fraction can be increased by using dilute acids. Various researchers have used different reactor modifications such as percolation, plug-flow, countercurrent and shrinking bed. Other most important considerations for the production are economics and environmental impact.

IV. IRON LEACHING BY OXALIC ACID

Mandal and Banerjee carried out China clay leaching for iron [21]. According to them currently available processes for iron leaching from China clay is energy- and cost-intensive, not sufficiently flexible, and may cause environmental pollution. As far as culture filtrate was concerned, oxalic acid was most active component. They observed that, with same oxalate concentration oxalic acid leached 5 times more iron than culture filtrate. They also observed that dissolution rate increased with temperature. The pH value of 1.75 was optimum. If pH was increased beyond 2, the amount of dissolved iron in the leached solution decreased rapidly. Baba et.al. used oxalic acid for bleaching of kaolin [22]. They studied factors such as the effects of acid concentration, reaction temperature and particle size, which affect dissolution of ore. The factors like acid concentration, reaction temperature and decreasing particle size had positive effect on the improvement of the ore whiteness. They used shrinking core models for analyzing the dissolution data. They concluded that the oxalic acid leachant was effective in the treatment and removal of iron impurities from the kaolin ore.

Legorreta et.al. carried out an investigation on the kinetics of iron leaching from kaolin[23]. They studied factors like the effects of acid concentration and temperature. They found that, with increasing of concentration and temperature, iron dissolution rate increased. According their studies, as compared to citric, and acetic acid, oxalic acid has been reported as the best for extracting iron from kaolin. The reason for this may be higher acidity, complexing power, and possibly better reduction ability.Nwoye et.al. carried out an investigation on analysis of the quantity of heat absorbed by oxalic acid solution during leaching of iron oxide ore [24]. In their work, they observed that the model depends on the value of the final solution temperature measured during the experiment. It was also found that the leaching process was endothermic in nature.

V. REMOVAL OF OXALIC ACID FROM AQUEOUS MEDIUM

Hata and Yamauchi investigated the oxalic acid reduction[25]. Their study revealed that TIO_2 exhibits excellent activities in the electro reduction of oxalic acid. Sharada et.al. carried out an investigation on removal of oxalic acid from aqueous system[26]. They carried out an investigation on adsorption of oxalic acid on low cost adsorbent. They used Tamarind bean raw material for preparation of adsorbent. They carried out an investigation on effect of various parameters like adsorbent dosage, contact time, pH of the solution mixture of adsorbent and toxic material on adsorption. They observed maximum removal at pH value of 3. Also with adsorbent dose the percentage removal increased. The Langmuir isotherm was better for explaining the data.

VI. CONCLUSION

Oxalic acid is important chemical used as rust remover, grinding agent, cleaning agent. It is corrosive in nature and oral and topical applications of this acid are highly toxic. Oxalic acid is very good and effective way for varroa control as it is cheap, safe for beekeepers, and presents low variability between colonies in its final efficacy. The agricultural raw waste can be effectively utilized for production of various chemicals including oxalic acid. It is necessary to study factors like energy, pollution and cost for manufacturing processes. Oxalic acid produced by different raw materials had same properties such as the appearance, density and melting point.

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