



Removal of Methyl Ethyl Ketone (MEK) using Biofiltration

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ABSTRACT

Since the early twentieth century, biological treatment processes found wide applications in wastewater, air & solid waste pollution control. The need for alternate cost effective treatment technologies led to similar biological treatment processes for waste gas streams. One such treatment technology is biofiltration. Biofiltration technology utilizes the microorganisms to biologically degrade Volatile Organic Compounds (VOCs) and odor contained in waste air streams. In present study, the culture was developed for the removal of methyl ethyl ketone (MEK) as it causes adverse effects on health. The microbial culture obtained from Municipal Sewage Treatment Plant, Pilani was acclimatized with MEK as the carbon source in a mineral salt medium (MSM). The batch culture biodegradation of MEK was studied over a concentration range of 50-400 mg/l in 250 ml Erlenmeyer flasks. The optical density (OD) of microbial culture was measured using U.V. spectrophotometer. The bio-degradation of MEK is good and validated with the literature.

Keywords: Biofiltration; Volatile Organic Compounds (VOCs); Optical Density; MEK.

1. INTRODUCTION

Biofiltration is a technology, which is used for the treatment of gas streams contaminated with biologically degradable compounds. Biofilter contain packing materials such as compost, soil, peat, granular activated carbon or other porous media capable of adsorbing gaseous compounds and support biological growth. Contaminants pass into a wet biofilm layer surrounding the support particles and are aerobically degraded to carbon dioxide and water. The bed's moisture is maintained at constant level by introducing humid air to maintain a biologically active layer surrounding the media which is known as "biofilm". VOCs streams containing airstreams are transported to the air/biofilm interface where VOCs are adsorbed by biofilm and used as carbon / or energy sources by microorganisms (Babu and Smita, 2006).

MEK has been designated as high priority toxicity chemicals (Geoghegan *et al.*, 1997). The ketones is not so far extensively studied as far as biodegradability is concerned. Aerobic biodegradation tests have shown that (Bridie *et al.*, 1979; Price *et al.*, 1974), it is in general relatively easily biodegraded. The batch study is being carried out to establish the biodegradability of MEK. The work deals with the immobilization of mixed culture and then showing the results obtained for OD, specific growth rate and MEK concentration.

2. MATERIALS AND METHODS

2.1 MATERIALS

Methyl Ethyl Ketone and other chemicals which are used are of Merck grade. The 250 ml flasks were made of Erlenmeyer.

2.2 MICROORGANISMS CULTURE

The microbial mixed culture was obtained from the Municipal Sewage Treatment Plant, Pilani and was acclimatized with MEK as the carbon source in a mineral salt medium (MSM). The sludge was kept for the settling for almost 3-4 hours in cool place (away from sunlight). 10 gm of sludge was taken from it and mixed with 100 ml of distilled water. The shaking was carried out gently and sludge was allowed to settle. The supernatant was taken and centrifugation was carried out for 2 minutes at 10,000 rpm in Centrifuge. The pellet achieved after the centrifugation, was further on used for the microbial growth and supernatant was discarded.

2.3 PREPARATION OF MEDIA

The media was prepared which had the following composition (in g/l): K_2HPO_4 – 0.8, KH_2PO_4 – 0.2, $CaSO_4 \cdot 2H_2O$ – 0.05, $MgSO_4 \cdot 7K_2O$ – 0.5, $(NH_4)_2SO_4$ – 1.0, $FeSO_4$ – 0.01 in distilled water. 100 ml of MSM was taken in 250 ml Erlenmeyer flask and autoclaving was carried out to make it free from all the contaminants.

2.4 IMMOBILIZATION PROCEDURE

The immobilization was carried out in laminar hood chamber. The autoclaved MSM solution was added with 1 ml of glucose solution and loop full of sludge which was obtained after centrifugation. The solution was then added with 1 μ l of MEK. The solution was then kept in the rotary shaker at around 37⁰ C for around 48 hours. After obtaining sufficient biomass, the glucose utilizing culture was acclimatized with MEK at various concentrations by slowly increasing its concentration and decreasing the concentration of glucose in the mixture. This was done by a series of transfers at 48 hour intervals for a period of more than 3 weeks to obtain a final well acclimatized mixed culture grown in MEK. The stock culture was prepared fresh for carrying out each transfer after every 48 hours. The enrichment cultures showed extensive growth in MEK showing that MEK is biodegradable as reported in the literature.

3. RESULTS AND DISCUSSIONS

3.1 Optical Density (OD)

The OD of the microbial culture was measured at 540 nm in 10 mm cuvette with a model 119- Systronics UV-VIS Spectrophotometer with respect to distill water. The maximum absorbance value of 0.389 was achieved at 540 nm and after 2 days. This shows that MEK and glucose of amounts mentioned above was consumed by mixed culture in 2 days.

3.2 Specific Growth Rate

Culture dry weights were required to calculate the value of specific growth rate constant. The culture was passed through filter membrane. The filter was dried at 90⁰ C for 24 h and cooled in desiccators prior to weighing. Growth kinetics was obtained for microbial culture in aerobic environment showing three phases. Initially, there was no increment in the biomass concentration with time. In log phase, concentration of biomass was increased with time and after sometime (in stationary phase) there was no increment in biomass concentration. The specific growth rate increased till 40 mg /l of biomass concentration and it was found in between 0.1 to 0.3 h⁻¹. The Fig. 1 was obtained between biomass concentration and time. The growth was increased till 11 h and then became constant. The results show that MEK (400



mg/l) was consumed completely by microorganisms till 11 h and later on biomass concentration was constant because of complete consumption of MEK.

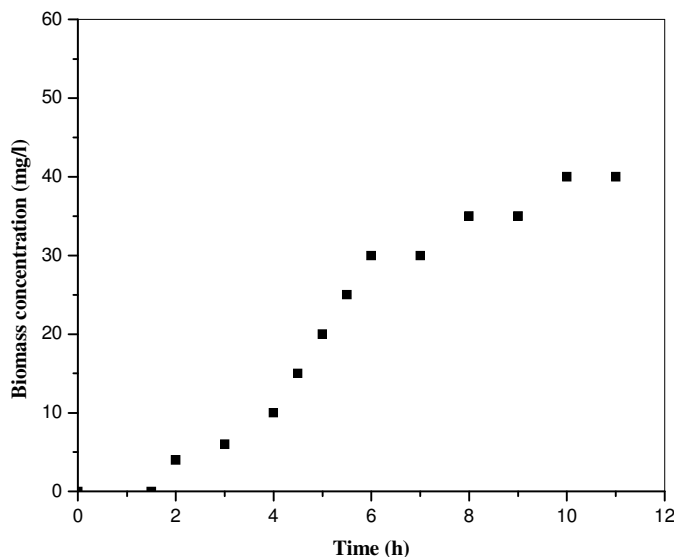


Fig. 1 Biomass Concentration (mg/l) Vs Time (h)

3.2 Dissolved Ketone Analyses

The batch culture biodegradation of MEK was studied for a concentration range of 20-400 mg/l individually in 250 ml Erlenmeyer flasks. 100 ml of MSM was inoculated with 5 ml of pre cultured suspension and incubated on a rotary shaker at 150 rpm. The temperature was maintained 37⁰ C throughout the inoculation process. Flasks were sealed with stoppers to minimize VOCs loss. Samples collected at regular intervals were analyzed for biomass and residual MEK concentration.

The concentrations of MEK in aqueous samples were determined by using a Model 5700 series gas chromatograph (Nucon Engineers) fitted with 2 m long stainless steel column with a packing and a flame ionization detector. Injections which varied in volume from 1 μ l to 5 μ l were introduced manually. The temperature of injection port, detector and oven was maintained at 150⁰ C, 150⁰ C and 200⁰ C, respectively. Nitrogen was used as the carrier gas. Fig. 2 shows the calibration plot for MEK between concentrations (ppm) versus area (mv-sec).

Fig. 3 shows the variation of MEK concentration in the aqueous solution with time. The MEK concentration was found decreasing from 400 mg/l to almost negligible in around 12 hours. It shows that MEK was consumed as food by the microbial culture and the complete removal was attained after 12 hours.

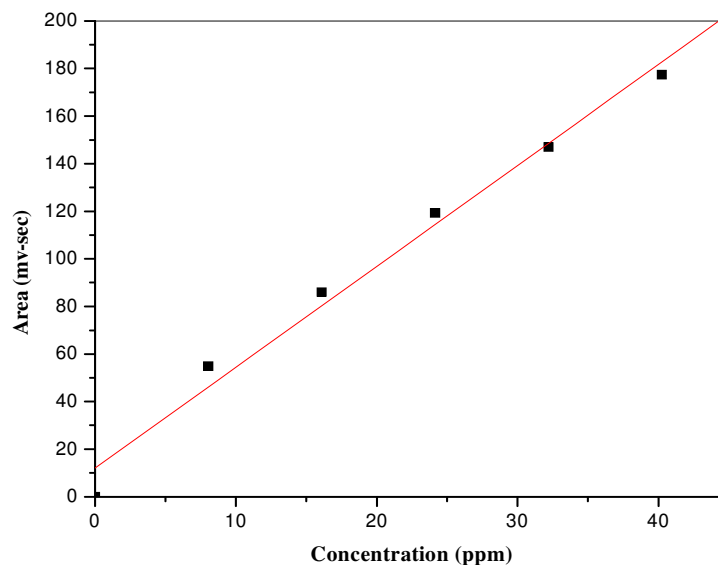


Fig. 2 Calibration Plot for MEK

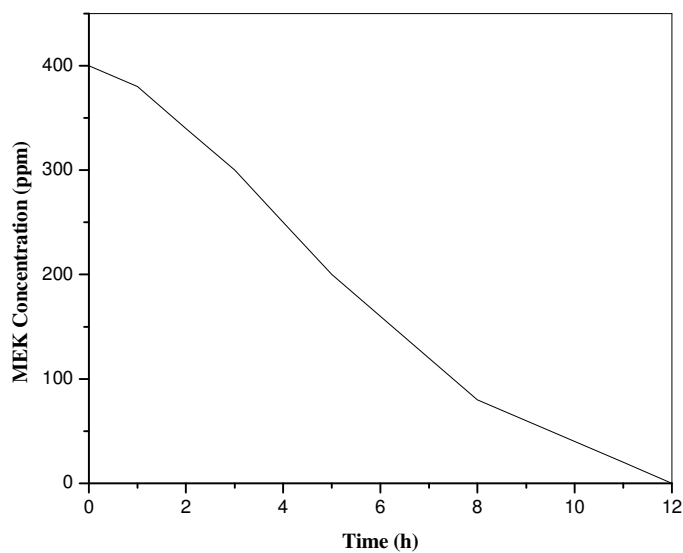


Fig. 3. MEK Concentration (mg/l) Vs Time (h)

Conclusions

The present study has shown that the concentration of biomass increases with time and then becomes constant. It was also concluded that the microbes take some time to acclimatized to the new environment. The growth of the microbial culture follows the lag, log and stationary



phase as was established in this work also. The performance of cultures needs to be seen and was well understood by carrying out the present study.

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