exhausted with adsorbed organic pollutants (Aktas and Cecen, 2007). It is well known that GAC is also a good support media for microbial growth. Thus, biological GAC (BGAC) with attached biomass can effectively remove organic contaminants both by adsorption and biodegradation (Nishijima et al, 1997; Carvalho et al, 2007). The concept of bio adsorption is that adsorption is more dominant before GAC is in full adsorption capacity and the biodegradation play major role after that (Hoang, 2005; Aktas and Cecen, 2007). The GAC bio adsorption is usually applied in the bioreactors either fixed bed or fluidized bed configurations (Aktas and Cecen ,2007) .The previous studies showed that GAC bio adsorption systems were very efficient (Zhao et al., 1999; Maloney et al, 2002; Loh and Ranganath, 2005; Persson et al., 2005; Hoa et al., 2008) due to their simultaneous adsorption of non-biodegradable matter and oxidation of biodegradable contaminants in a single reactor. Oxidation is defined as the transfer of one or more electrons from an electron donor (reductant) to an electron acceptor (oxidant), which has a higher affinity for electrons. Oxidation reactions that produce radicals tend to be followed by additional oxidation reactions between the radical oxidants and other reactants (both organic and inorganic) until thermodynamically stable oxidation products are formed The most powerful oxidants are fluorine, hydroxyl radicals (•OH), ozone, and chlorine with oxidation potentials of 2.85, 2.70, 2.07 and 1.49 electron volts, respectively(Dorfman and Adams, 1973). The end products of complete oxidation (i.e., mineralization) of organic compounds such as MTBE or benzene are carbon dioxide (CO_2) and water (H_2O). AOPs involve the two stages of oxidation discussed above: 1) the formation of strong oxidants (e.g., hydroxyl radicals) and 2) the reaction of these oxidants with organic contaminants in water. However, the term advanced oxidation processes refers specifically to processes in which oxidation of organic contaminants occurs primarily through reactions with hydroxyl radicals (Glaze et al., 1987).

Methyl tertiary butyl ether (MTBE) is a fuel additive used as a replacement for lead and to promote combustion efficiency to reduce air pollution (Squillace et al., 1996) It was first used in United States in late 1970s and has since become the oxygenate of choice and supply considerations (Keller et al., 1998). By 1998, MTBE has become the fourth highest produced organic chemical in the United States (Chemical Industry Statistical Hand book., 1999). The presence of MTBE in drinking water sources presents major problems while inhalation of MTBE in high concentrations has been shown to cause cancer in laboratory animal, the Agency concluded in 1997. Significant contamination is increasingly being detected in groundwater and surface water used for drinking water due to the many years MTBE has been used and as a result of its particular properties of persistence and high mobility in the environment. MTBE has since been classified as a potential human carcinogen in higher doses and will need to be replaced by environmentally friendly alternatives in the future.

MTBE is mobile and persistent in the environment due to its high water solubility, low Henry's law constant and relative bio recalcitrance under common conditions. Methyl tert-butyl ether (MTBE) has been frequently detected in groundwater (Baehr et al., 1999; Klinger et al., 2002; Schmidt et al., 2004; Squillace et al., 1996). MTBE treated by conventional techniques in water treatment. Recent developments suggest that synthetic resin sorbents may be economically competitive with other more established treatment technologies (air stripping, advanced oxidation processes, and granular activated carbon) for MTBE removal (Flores et al., 2000). Dealing with the pollution currently created by MTBE, however, remains problematic. Current technologies, including ozonation, microbiological methods, and traditional activated carbon filtration, are not sufficiently able to remove MTBE or the more recent ETBE during waste water or drinking water treatment processing. In this study, synthetic wastewater was used for all the experimental work.

Several important parameters have been investigated such as molar ratio of MTBE to hydrogen peroxide, air flow rate, and residence time. The aim of this investigation was to study the removal of pollutants (MTBE) from wastewater using adsorption, stripping and advance oxidation process and observe the efficiency of MTBE remove from wastewater using combine system of stripping, oxidation, invers fluidized, adsorption and internal loop reactor system at different operating condition. A series of experiments were conducted to investigate the effects of the percentage removal of MTBE from wastewater. In the ensuing experimental work, molar ratio of MTBE to hydrogen peroxide is 1:10, 1:15, 1:20, the air flow rate is 7 L/min, 8 L/min, and 10 L/min. For the residence time is 10min, 15min, 20min, 30min, and 60min was used to investigate its effectiveness to remove MTBE.

II. METHODS AND MATERIAL

2.1. Materials and Equipment's

The following chemicals will be employed for the adsorption ,stripping, oxidation and four design parameters (gas hold-up, mass transfer coefficient, mixing time and circulation time) process:-

1. Methyl tert-butyl ether (MTBE)
   Pollutants
2. Hydrogen Peroxide (H2O2)
   Oxidation agent
3. Granular Activated Carbon (GAC)
   Adsorbent
4. Pure Water (H2O)
   Solvent

Major equipment for experimental rig:

i. Combined invers fluidized and internal air lift loop reactor
ii. Compressor
iii. N2 cylinder
iv. Gage pressure meter
v. Pumps
vi. Pipeline

Analyze equipment's

i. UV-VIS spectrophotometer
ii. pH meter

2.2. Bench Scale Experimental

Oxidation Process

Five different H_2O_2 concentrations were prepared by adding appropriate amounts of H_2O_2 stock solution. The solution was mixed and circulated by dosing pump for 20 min to ensure sufficient mixing. Experiments were conducted at initial MTBE concentrations at 2ppm. The molar ratio of MTBE to the H_2O_2 also was varied from 1/10 to 1/20 the experiments were performed at range of pH between 6.5 and 7.5. Periodically, samples were withdrawn through the sampling port then stored immediately into cube vert for analyses.

Adsorption Process

The granular activated carbon (GAC) was washed with de-ionized (DI) water. Beaker used as reactors were wrapped with aluminum foil. Granular activated carbon, GAC (10g) was placed into the reactor. After that, the synthetic wastewater was added to the reactor. The concentration of MTBE on GAC was calculated based on the difference between replicates of the initial stock solution and the final aqueous MTBE concentration. Periodically, the aqueous samples were drawn and analyzed by using UV- spectrophotometer.

Experimental Procedure

Synthetic wastewater is used with concentration 2ppm. The oxidation agent, 100 ml of hydrogen peroxide (H_2O_2) added to 8 litre water at 25°C in feed box, and the granular activated carbon volume is 5072.463cm3. The molar ratio between MTBE to hydrogen peroxide is 1: 20 during the running of experiment, the test wastewater will be circulation by the driving force of air in loop reactor and pass through (GAC) to complete the adsorption process at the same time the stripping and oxidation process

simultaneously occur. The pump at synthetic wastewater tank will maintain at 100% flow rate while the pump at hydrogen peroxide tank will maintain at 80% flow rate.

The pressure will constantly at P (abs) = 2 bar. In order to get steady state for the system, the process required to run for 2 hours before conduct the experiments. The treated wastewater will be collected after 1.5 hour at the effluent. After 1.5 hour, ten samples will be collected for every 2 minutes. After that, the samples will be analysed by UV-spectrophotometer at wavelength = 340 nm. The same working procedure is to be repeated with different residence time.

2.3. Analysis Procedure

The concentration of Methyl tert-butyl ether (MTBE) was determined by using a UV-Spectrophotometer. UV absorbance measurements were completed using the UV-spectrophotometer (UV-VIS). By varied the initial concentration of MTBE at 2ppm, 1ppm, 0.8ppm, 0.5ppm, 0.2ppm, the standard curve was plotted with the $r^2 > 0.9798$. At wavelength 340nm, the UV absorbance data were collect.

The pH was measured using a pH meter. All the samples collected in the cube vert were analysed.

2.4. Experimental Rig Design

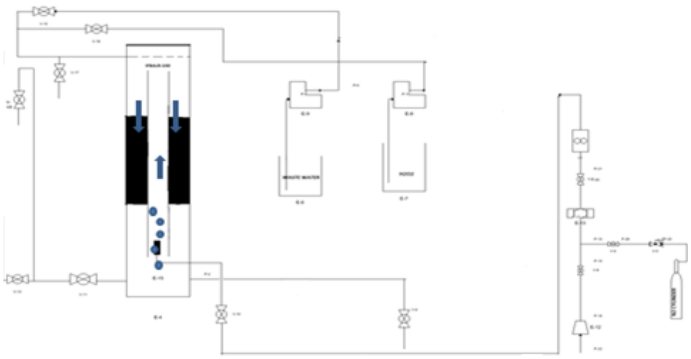

Figure 1: Schematic diagram of experimental rig design

III. RESULTS AND DISCUSSION

3.1. Experimental Rig

Calibration standard curve of the Methyl Tert-Butyl Ether (MTBE)

Five different initial concentration of MTBE at 2ppm, 1ppm, 0.8ppm, 0.5ppm and 0.2ppm were

Used to plot the standard calibration curve. Besides that, different wavelengths were conducted at range from 200nm, to 600nm. The data used to plot the curve is given and calibration curve are shown in Figure (2).

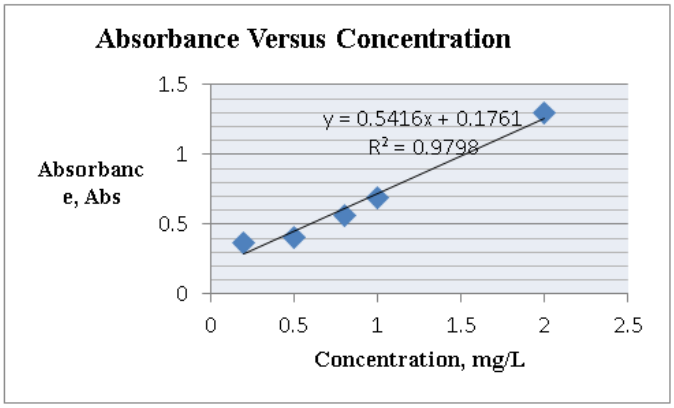

Figure .2: Standard calibration curve at wavelength, λ = 340nm

From the standard calibration curve, we know that the linear line equation is y =0.5416x + 0.1761 and the R2=0.9798.

The impact of contact time on the percentage removal of MTBE from synthetic waste water.

Figure 3 show the effects of contact time to the percentage removal of MTBE from synthetic wastewater. It can be noticed that the percentage of removal is rising with the increased contact time.

The percentage removal of MTBE at 20 minute for 2ppm, 1.5ppm, 1ppm, 0.8ppm and 0.5ppm were 90%, 71.70%, 59.95%, 48.32% and 39.47% respectively. For the higher concentration of MTBE in synthetic water will lead to higher percentage of removal.

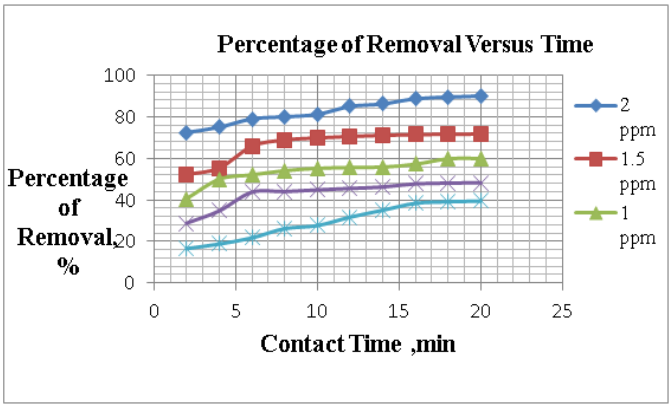

Figure 3: Effect of contact time on the percentage of removal of MTBE with different initial concentration of MTBE

The impact of contact time on the percentage of removal MTBE with different molar ratio of MTBE to hydrogen peroxide.

Figure 3 show the effects of contact time to the percentage removal of MTBE from synthetic wastewater by different molar ratio of MTBE to hydrogen peroxide . It can be shown that the percentage of removal is increasing with the contact time.

From the experimental result, we can observed that the higher molar of hydrogen peroxide with the synthetic wastewater will led to a higher percentage removal of MTBE. The percentage removal of MTBE at 20 minute for molar ratio 1/10, 1/15, 1/20 was 75%, 80.1%, and 90% respectively.

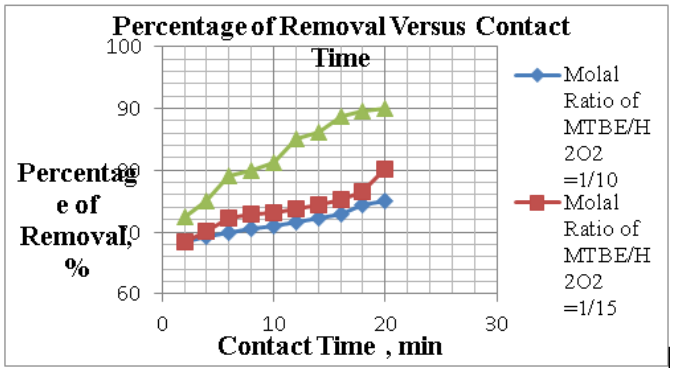

Figure 4: Effect of contact time on the percentage of removal with different molar ratio of MTBE to hydrogen peroxide.

The impact of contact time on the percentage of removal MTBE with different air flow rates

Figure 5 show the effects of contact time to the percentage removal of MTBE from synthetic wastewater by different air flow rates . It can be shown that the percentage of removal is approximately constant with the contact time.

From the experimental result, we can observed that the percentage removal of MTBE at 20 minute for air flow rate 7liter/min, 8liter/min, 10liter/min were 90%, 89.6%, 89.9% respectively.

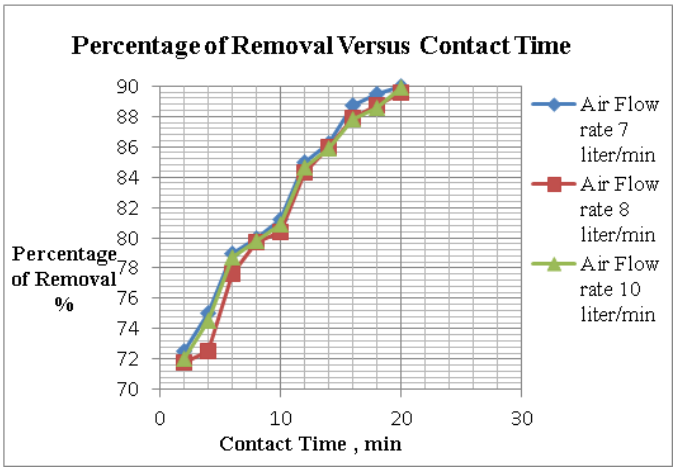

Figure 5: Effect of contact time on the percentage of removal with different air flow rates

The impact of contact time on the MTBE concentration with different molar ratio of MTBE to hydrogen peroxide.

Figure 6 show the effects of contact time on the concentration with different molar ratio of MTBE to hydrogen peroxide. It can be shown that the concentration is decreasing with the contact time.

From the experimental result, we can observed that the concentration at 20 minute for molar ratio 1/10, 1/15, 1/20 were 0.5ppm ,0.398ppm, 0.2ppm respectively.

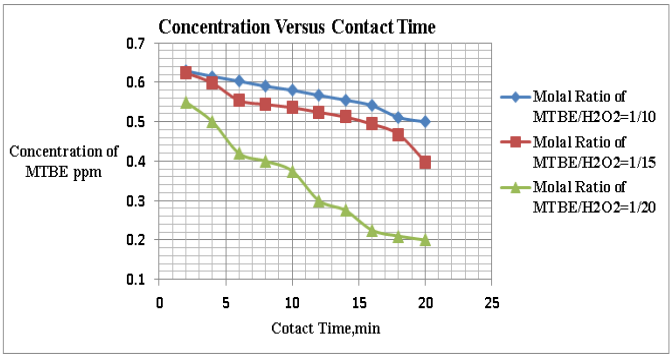

Figure 6: Effect of contact time on the concentration with different molar ratio of MTBE to hydrogen peroxide.

The impact of of contact time on the concentration with different air flow rates.

Figure 7 show Effects of contact time on The concentration with different air flow rates. It can be shown that the concentration is the Decreasing with the contact time.

From the experimental result, we can observed That the concentration at 20 minute for air flow Rate 7liter/min, 8liter/min, 10liter/min were 0.2ppm, 0.208ppm, 0.202ppm respectively.

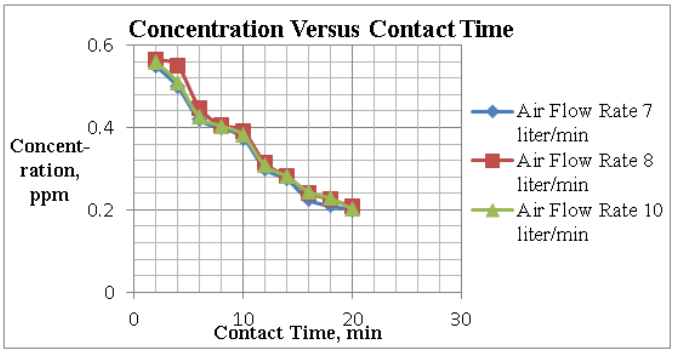

Figure 7 : Effect of contact time on the concentration with different air flow rates.

IV. CONCLUSION AND RECOMMENDATION

Conclusion

In this study, we developed a new different design treatment technologies to remove Methyl tert-butyl ether (MTBE) from synthetic wastewater. When combined the stripping, oxidation, invers fluidized, adsorption, and internal loop reactor processes was done, the percentage removal of MTBE will be higher. Furthermore, the increasing of surface contact between the MTBE molecules and hydrogen peroxide ion (H_2O_2) and granular activated carbon (GAC) by circulation a wastewater in air lift loop reactor will increase the percentage removal of MTBE for oxidation and adsorption process to reach 90%. Result indicates that the optimum molar ratio between MTBE and hydrogen peroxide is 1: 20, air flow rate at 7 L/min show the best performance to remove MTBE from wastewater.

Recommendation

Increasing quantity of granular activated carbon (GAC) can be get a better adsorption process with high percentage removal of MTBE from synthetic wastewater. For the combine effects of stripping, oxidation and adsorption process, the contact time should be higher from the previous study. This is because increase in the contact time will improve the surface contact between two chemicals. For actual operation use, a field test is recommended to test the ability and effectiveness of the removal under conditions of actual use which will have greater validity because of their greater specificity than laboratory tests.

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