CHAPTER I

INTRODUCTION

Activated carbon is the most widely used as adsorbent nowsaday in adsorption process to remove less polar contaminants from polar bulk streams, partically in water solution. Adsorption process utilize the concept of contaminant removal by concentration on the surface of a solid material. This method has been in commercial practice for several decades (Mantell, 1951).

In practice, the adsorption process proceeds until the solute concentration in the outlet reaches an unacceptable level, at that time the carbon needs to be regenerated.

In many of those industrial applications, recovery and reuse of the removed pollutants have become feasible since under these conditions, the process is reversible. This characteristic can convert this rather expensive process in to a source of net profit. In general, some organic compounds which are likely to be a good adsorbate on activated carbon have their molecular weight greater than 45 (Noll, 1992).

The usage of activated carbon is interesting for air and water pollution control due to the fact that it can be reused after a regeneration process. Therefore, regeneration of activated carbon is a major factor in the cost effectiveness in its utilization (Hutchin, 1973; Soffel, 1964).

Several alternative regeneration techniques for renewing spent carbon to its original adsorptive capacity make use of thermal, chemical, biology, hot-gas or solvent technique (Cheremisinoff, 1993)

Thermal regeneration is a standard method involves removal of the carbon from the bed and sending it to a multihearth furnace or a rotary kiln at 870-980 °C where the adsorbed organic are vaporized and carbonized. However, sometimes thermal reactivation may not be feasible. This may be due to inorganic salts having deposited on activated carbon or adsorbates which may cause air pollution upon regeneration (e.g., PCB'S), among other reasons (Hemphill, 1978). This process is energy intensive, labor intensive and time consuming. Further, the organic adsorbate is not recoverd and a large fraction of the carbon may be burned in the furnace (Cheremisinoff, 1993). An efficient , in-situ regeneration method would be a great improvement over this standard regeneration method.

Solvent regeneration is one of in-situ regeneration which involves the dissolution of the adsorbate into volatile solvent (e.g. acetone) (Sutikno and Himmelstein, 1983), followed by a steam or hot gas flush to remove residual solvent from the carbon(Cheremisinoff, 1993; Ychoskel, 1978). An important disadvantage of this is that when the process is complete, a hot gas regeneration must be performed to desorb the residual volatile solvent, making for an energy intensive process.

Hot gas regeneration is an another in-situ regeneration method (Ycholskel, 1978; Cheremisinoff, 1993), is appropriate to use only when adsorbed organic is very highly volatile in which a hot gas such as, steam or nitrogen is passed through the bed to desorb the adsorbate by a combination of purging, and of desorption by heat-up effect. A major disadvantage is an energy intensive process. Due to hot- gas must be performed to desorb a volatile solvent after the process is complete. Further, if regenerant is flammable solvent, safety considerations need to be considered (Wankat et al., 1980).

Biological regeneration (Cheremisinoff, 1993; Chudyk and Snoeylyk, 1984) is also an in-situ regeneration, bacteria are introduced into the bed to consume the adsorbed organic. Disadvantages include the process being very slow, the organic not being recovered, reduction of bed capacity from adsorption of some of the products of the degradation, the need to induce desorption of the bacteria when done, and finally the fact that the bacteria often can not digest a mixture of organics.

Surfactant-enhanced carbon regeneration (SECR) is a new in-situ process that utilizes surfactants (detergents) to remove adsorbed organics from activated carbon in order to regenerate for reuse. In SECR process, a concentrated surfactant solution is passed through the spent carbon bed. The adsorbate desorbs and is solubilized into micelles in the regenerant solution. Micelles are surfactant aggregates typically composed of 50-150 surfactant molecules. When the desorption process is complete, some residual adsorbed surfactant may be left on the activated carbon, while the regenerant stream contains concentrated solute and can be further treated to recover and recycle the surfactant. A water flush is then used to remove residual surfactant from the carbon, after the water flush is complete and almost of the residual surfactant is removed from the carbon, the bed can be used immedieatly for liquid phase applications or dried before reuse in vapor phase applications.

Toluene, amyl acetate, tert-butyl phenol and phenol are just four organics which have been shown to be essentially completely removed from spent activated carbon with less than 100 pore volumes of regenerant solution (Roberts et al., 1989; Blakeburn et al, 1989). The carbon presented no signs of serious degradation upon repeated regeneration.