

## CHAPTER I



## INTRODUCTION

Organic vapours which are released to the atmosphere from industrial sources often constitute an air emission problem that require control [Noll et al., 1985]. For examples, benzene, methylbenzene (toluene), alcohol, xylene, hexane, acetone, etc. – as useful solvents – have been widely used in chemical plants for solvent-degreasing graphic arts manufacturing, surface-coating applications in furniture manufacturing, automobile assembly factory and garage, including those that make or use inks, paints, and adhesives [Yun and Choi, 1997]. However, it has been reported that organic vapours that leaked out during operation are harmful to the environment and human health.

Many separation processes, such as adsorption, absorption, condensation, oxidation, membrane separation, and thermal and catalytic incineration can be used in order to control the emission of hazardous air pollutants. Each process has demonstrated advantages and disadvantages. Selection of an appropriate separation technology depends on the specific details of the emission streams, site-specific constraints that may inhibit or prohibit at a given location, specific control efficiency, and economic considerations.

In recent years, the adsorption process for removing organic solvents in trace levels from air has attracted special interest as a means of protecting the environment from air pollution [Yun and Choi, 1997]. The adsorption method possesses many advantages for removal of organic vapours especially where a high degree of reversible adsorption is desired. Carbons adsorbents, known as activated carbons, have been proved to be effective adsorbents for adsorption of various organic and inorganic compounds based on either shape or size of adsorbate molecules [Khalil and Girgis, 1995]. With its high surface area, carbon adsorbent has been widely used as an adsorbent for such applications. To design the adsorption facilities, thermodynamic data on adsorption equilibria must be known over a broad range of temperature [Yang, 1987].

Although most carbonaceous materials from animals, plants, or mineral origins can be converted into carbon adsorbents with a proper process, commercial activated carbons have been produced from coals and coconut shells [Mantell, 1945; Yehaskel, 1978]. Several seasonally agricultural wastes, such as sugarcane bagasse [Bernardo, Egashira, and Kawasaki, 1997], rice husks, and corncobs [Pongsathorn, 1995; Supaporn, 1998] have been studied on conditions of preparation and applications. Water hyacinth is another alternative of carbonaceous materials for manufacture of activated carbons. In comparison with other carbonaceous materials, it provides several advantages, such as rapid growth with minimum resources and non-seasonal [Brij Gopal, 1987].

Up till now, water hyacinth which is a kind of weeds has been paid attentions world-wide due to its very rapid growth. From its motherland, South Africa, water

hyacinth spreads over almost the world sources of natural fresh water, even in North America, Africa, Europe, India, Indochina, Australia, New Zealand, or islands far away from main land. Wherever the water hyacinth reaches and survives, it will cover the fresh-water sources resulting in depleting the underwater animals, obstructing the transportation in the rivers, deposits on rice in fields due to its rapid growth depending on few factors of living. Moreover, the water hyacinth can reproduce by budding, rather than seeding, which can reproduce in any season.

So far, the destruction of water hyacinth from natural fresh-water sources wastes lots of money, time, and power. There have been a large number of researches in utilizing the water hyacinth in many ways, such as preparing fertilizer, producing leaf protein concentrate (LPC), biogas production, waste water treatment, producing pulp, and mixing in the food for pigs, poultry, and fishes, etc. [Boonthida, 1991; Gopal 1987]. Since water hyacinth comprises of 43-44% cellulose, 12-15% lignin, and 14-15% pentosan [Kadesucha, 1993], together with porous structure, it has been used as a starting material for producing a carbon adsorbent.

Accompanied with the weed, the agricultural wastes – owing to their high carbon contents – has been paid attention in producing the carbon adsorbents such as rice husk and sugarcane bagasse which are discarded in a large quantity each year. These wastes are normally utilized as animal food, fuel, and insulation etc. For illustration, rice husk is the byproduct of husking the rice crops, which is usually between 22.5-25.2% by weight or one-fifth of the rice crops. With ultimate analysis method, the basic elements of rice husk are 33.72% carbon (C), 4.04% hydrogen (H), 0.48% nitrogen (N), 10.30% silica (Si), and 37.6% oxygen (O) [Sakkhee, 1985].

Furthermore, various compounds in rice husk consist of 35% cellulose, 25% pentosan, 20% lignin, 4% protein, and 15% ash [Khanit and Chongchit, 1984]. While the sugar-cane which is an economically important plant of Thailand is planted in a large amount each year. Normally, the sugar-cane can be harvested at the age of 12–14 months. The sugar-cane bagasse which is the byproduct of sugar production process is approximately 30% by weight of raw sugar-cane comprising of 42–43% fiber, 46–52% moisture, and the others that is mostly the remained sugar of 2–8%. The major compounds in sugar-cane bagasses include cellulose, hemicellulose, lignin, and natural polymers [Sugar-Cane and Sugar Administration, 1996]. One of the most useful utilization ways for these agricultural wastes is producing carbon adsorbents which could be an alternative to evaluate these wastes.

The purposes of this research are the followings:

1. To study the preparation conditions of the carbon adsorbents from water hyacinth, rice husk, and sugarcane bagasse.
2. To compare the characteristics of carbon adsorbents from water hyacinth with those from rice husk and sugar-cane bagasse.
3. To study adsorption of benzene, toluene, and o-xylene vapours on carbon adsorbents from water hyacinth.
4. To determine adsorption equilibrium constants, heats of adsorption, and the overall mass transfer coefficients for the adsorption.