458a Role of Adsorption and Desorption Cycles in a 2-Bed Adsorber in Stabilizing Biofiltration Performance

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Volatile organic compounds (VOCs) emitted from most industrial processes employing organic or petroleum based solvents are considered as major air contaminants for inducing direct health effects and for being precursors of tropospheric ozone. The removal of VOCs is, therefore, of significant interest in air quality control. In practice most off-gas streams that originate in industrial processes have variable flow-rates and transient loading. Such constraints limit the handling efficiency of biological air pollutant treatment, i.e. biofiltration, which has been recognized as cost-effective treatment for VOC abatement. Hence, attenuation in load fluctuation for air control treatment is deemed necessary for air-emission compliance.

For this purpose, this study evaluated the effectiveness of a 2-fixed bed adsorption unit in dampening fluctuating emission source. The 2-bed adsorption applied in this study was designed based on the concept of pressure swing adsorption (PSA). PSA is a very versatile technology for separation and purification for gas mixture. It includes separate feeding (adsorption), depressurization, purging (desorption & regeneration) and repressurization steps. When adsorption rate of solutes on adsorbent is hypothetically equal to their desorption rate, the concept of PSA would be simplified into a 2-step, i.e., feeding (adsorption) and purging (desorption). Figure 1 shows a typical 2-step cycle for 2-bed adsorption unit used in this study. In the 2-bed adsorption, a short term 2 step cycle of adsorption and desorption occurs in a fixed bed of adsorbent by using gas pressure variation as the principal operating parameter. Thus, this operation incorporates regeneration of adsorbents into the 2 step cycle.

The experimental work was performed on lab-scale reactors for controlling toluene as a single contaminant. Each adsorption bed was constructed of stainless steel with an external diameter of 2.54 cm and a length of 20.3 cm. Each bed was packed with bituminous base BPL carbon (Calgon Carbon Co., apparent density = 0.85 g/mL). A 2-step cyclic operation was generated through an electrically operated 4-way solenoid valve, which was controlled by an electronic timer. The duration of the cyclic operation

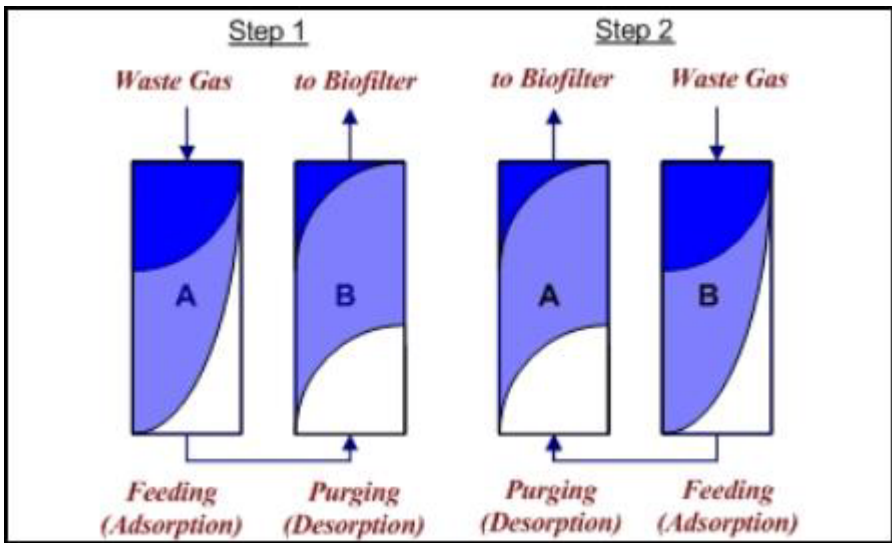

Figure 1. 2 step of adsorption and desorption for 2-bed adsorption unit

was determined to be 8 hours. The air supplied to the system was purified by complete removal of water, oil, carbon dioxide, VOCs, and particles by a Balston FTIR purge gas generator.

Adsorption and desorption properties was basically studied in the 2-bed adsorption unit under stable inlet toluene concentration of 3000 ppmv and air flow rate of 6.5 L/min without cyclic operation. Measured data well agreed with model data, which was simulated by using Adsorption Design Software (*AdDesignS*^{TM}).

Under a square wave change of inlet concentration (a base concentration of 200 ppmv with a peak concentration of 400 ppmv for 15 min per one hour) (see Figure 2a), the effluent response of the 2-bed adsorption unit with cyclic operation was explored. The experimental finding revealed that though a temporary peak (250 ppmv) of effluent concentration was observed right after the cyclic operation, the effluent range was 170-190 ppmv during the experimental period (see Figure 2b).

In order to apply the net effect of the 2-step cyclic adsorption/desorption, a hybrid process scheme of an adsorption unit followed by a biofilter was employed and its overall performance was compared to that of a stand alone biofilter (control). Figure 2c shows the comparison of the effluent performance for the 2-bed adsorption unit followed by a biofilter and the control unit. The experimental results clearly show that flattened and reduced VOC concentration in the hybrid unit was obtained while a fluctuating response was obtained from the control unit. The results of this study further revealed that the 2-bed adsorption unit can serve as: 1) polishing unit during initial acclimation of the biofilter, 2) buffering unit under fluctuating VOCs loading, and 3) feeding unit during non-use periods.

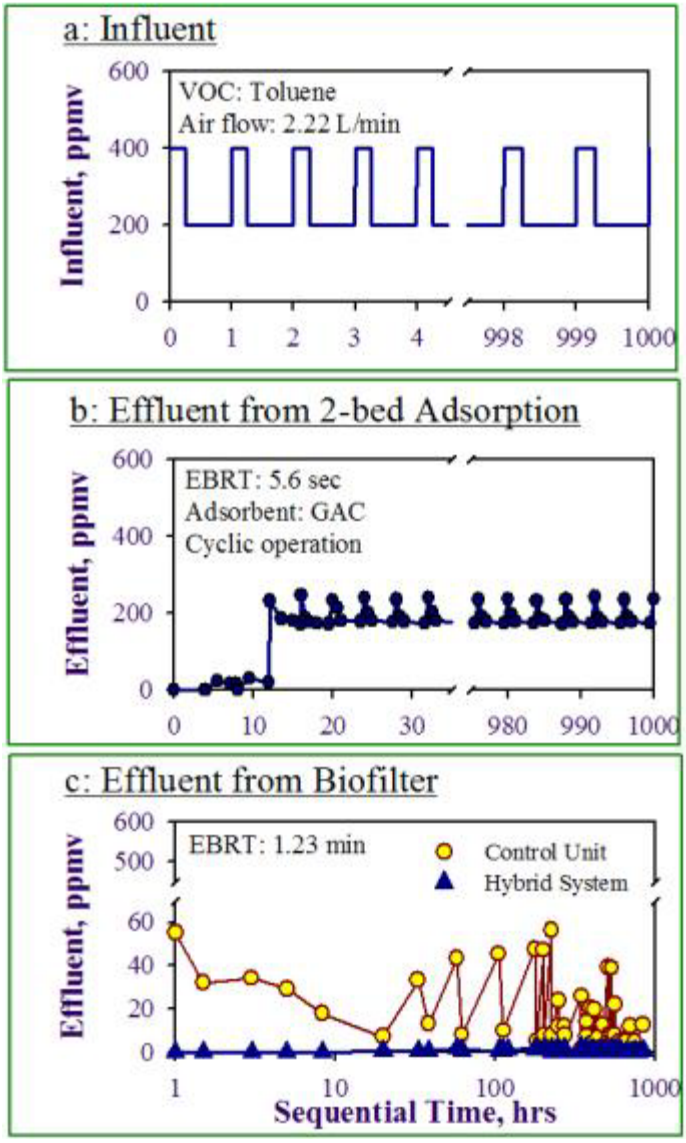

Figure 2. a) Square wave change of inlet concentration; b) Effluent concentration from a 2-bed adsorption; c) Comparison of effluent performance of a hybrid system, a 2-bed adsorption unit followed by a biofilter, to the control biofilter.