S3.5.2 ELECTROTHERMAL SWING ADSORPTION CONTROLLED BASED ON ELECTRICAL PROPERTIES OF ACTIVATED CARBON FIBER CLOTH

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An electrothermal swing adsorption (ESA) system with activated carbon fiber cloth (ACFC) is used to selectively remove vapors/gases from gas streams and then subsequent electrothermal heating is used to regenerate the ACFC. This system adsorbs a dilute vapor/gas (< 5,000 ppmv) and concentrates it to > 50 % by volume allowing for cost-effective vapor/gas disposal or reuse as a liquid. Typically, the end of an ACFC-ESA adsorption cycle and the heating part of a regeneration cycle are determined based on measurements from hydrocarbon sensors, which have capital costs and require periodic maintenance. Also, regeneration heating and cooling typically require direct-contact thermocouple measurements to determine electrothermal heating power requirements and when cooling is complete to initiate an adsorption cycle, respectively. However, these thermocouples can lose contact with the ACFC or create an electrical short circuit during regeneration from electrothermal heating that damages the system and/or adsorbent.

This work presents an automated system to monitor and control ACFC-ESA that is based entirely on remote electrical measurements of the adsorbent, which eliminates the need for hydrocarbon and local temperature sensors. For this system, the ACFC's electrical resistance was initially characterized based on adsorbent temperature and amount of adsorbed organic gas/vapor. These relationships were then used to develop control logic to monitor and control ESA cycles based on measured resistance and applied power values. Continuous sets of adsorption, regeneration, and cooling cycles were performed with this system achieving ≥ 99.5 % isobutane capture efficiency at inlet concentration of 2,000 and 4,000 ppmv isobutane in air demonstrating proof of concept of a novel cyclic ESA system that utilizes adsorbent electrical measurements to predict adsorbent temperature and adsorbed mass for control of adsorption and regeneration cycles.