REGENERATION GUIDELINES FOR TEMPERATURE SWING ADSORPTION BEDS

Adsorbents such as molecular sieves and activated aluminas are often used for drying and purification of gases and liquids in fixed beds which are periodically regenerated by heating and then cooling the adsorbent beds with a gas flow. This type of process is often called Temperature Swing Adsorption or TSA.

The regeneration process is designed to heat the adsorbent bed to sufficiently high temperatures that whatever contaminants were adsorbed during the process cycle will be vaporized and borne out of the bed by the flow of regeneration gas.

In most cases the TSA unit will comprise a pair of beds, such that one bed will always be available for duty while the other bed is being regenerated.

Gases Used in Regeneration

The gas used in regeneration should be relatively contaminant-free, relatively dry (at least for the cool-down step) and stable under regeneration conditions. Most commonly when the TSA is for gas treating, the same gas being processed is also used for regeneration; for example, a portion of the purified. This is possible if for example processing nitrogen, argon, or helium. In some cases methane can be used. In some cases air can be used but only if the process is not hydrocarbon based (air should not be used in such systems because heating with air could initiate combustion of carbonaceous deposits on the adsorbents). Reactive compounds including monomers such as ethylene or propylene should not be used for regeneration.

Temperature for the Regeneration

The temperatures needed to effect an efficient regeneration are somewhat dependent on the type of media and the contaminants involved. Generally a temperature of at least 200-225°C is recommended if moisture is the only contaminant, but somewhat higher temperatures may be required for regenerating certain types of aluminas e.g. the types used for acid gas removal or for contaminants which are less volatile such as mercaptans. The temperature limits of the media must also be considered, but most adsorbents used in TSA will withstand a good many cycles of heating to 250-300°C so long as heating and cooling rates are moderated as described below.

Please keep in mind that, in order to bring the adsorbent bed to the target temperature, one must take care to minimize the heat losses from the transport piping which carries the gas from the regeneration gas heater to the TSA skid/vessels. Thus it is important to insulate (and perhaps trace) this piping well. Additionally, the proximity between heater and TSA vessels must be taken into account in estimating heat losses and how much additional temperature is needed at the heater outlet in order that the gas be able to bring the media bed to the desired temperature.

Pressure for the Regeneration

The regeneration should be carried out at relatively low pressure, as lower pressure is more favorable than higher pressure for getting the contaminants to move from the surface of the media into the gas stream; thus pressures from about 15 to 75 psig (1 to 5 barg) are recommended.

Minimum and Maximum Gas Rates

Gas rates used in regeneration should provide between about 300 and 900 SCFH per cubic foot of bed volume – or between 300 and 900 NL/hr per L of bed volume. It is important to ensure that the gas flow is high enough to avoid channeling but not high enough to cause excessive pressure drop. For more information about channeling and pressure drop calculations please see our bulletin Fluid Dynamics in Packed Beds. (RCI can assist with these calculations if need be.)

Recommended Heating and Cooling Rates

For maximum lifetime of the adsorbents one must regulate the rate of heating and cooling properly. Rather than heating/cooling too rapidly, which can degrade the physical integrity of the media over time, it is recommended to minimize stresses caused by thermal expansion/contraction by ramping the gas temperature at a maximum rate of 80°F (50°C) per hour during both the heating and cooling steps.

"Hold Period" at Target Temperature

Once the adsorbent bed has reached the target temperature – which is typically 1 to 3 hours after the gas temperature has reached its maximum – a brief hold period of 1 hour will complete the heating portion of the procedure.

Overall Time / Complete Regeneration Procedure (excluding pressure/depressure time)

- Heating to Target Temperature, 4 to 6 hours
- Hold Period at Target Temperature, 1 hour
- Cool Down, 5 to 7 hours

TOTAL TIME: 10 to 14 hours / some additional time may be needed to pressure/depressure

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We hope this write-up has been helpful. Please feel free to contact us in case of any questions.

Sincerely,

David J. Artrip

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