515d Concentration and Recovery of Carbon Dioxide at High Temperature with Heavy Reflux Psa Cycles

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An International Energy Agency study evaluated CO2 separation and capture using an adsorption system employing 13X zeolite as the adsorbent and both PSA and temperature swing adsorption (TSA) operational modes and concluded that these technologies are not attractive to the gas- and coal-fired power systems. This conclusion has lead many to extrapolate the findings and conclude that adsorption systems, in general, are not applicable for CO2 separation and capture. This is not necessarily true. It is true that the commonly studied adsorbents (e.g., zeolites and activated carbons) suffer from low capacity at elevated temperatures. However, there are new adsorbents such as the hydrotalcite-like compounds (HTlcs, also known as layered double hydroxides, LDHs) that selectively adsorb CO2 at elevated temperatures and release it simply by changing the pressure. When this high temperature CO2 adsorbent is combined with a heavy reflux PSA cycle, a host of adsorptive based separation opportunities arise.

This presentation will provide an overview of this new adsorption technology that is being explored for separation of CO2 from stack gas streams at elevated temperatures. High temperature HTlcs are being explored through process simulation in high temperature PSA cycles based on the heavy reflux concept. There are many ways to implement a heavy reflux PSA cycle. For example, it can be used alone or in conjunction with a light reflux step. In this later case, the PSA cycle becomes a dual reflux cycle. The heavy reflux gas can be obtained from a countercurrent depressurization step or from a countercurrent purge step if a light reflux step is included in the cycle. The beds can also be fed at high pressure as in conventional PSA or they can be fed at low pressure which is a non-conventional mode of operation. The former is termed stripping PSA and the later is termed enriching PSA. There are many other variants of these single and dual reflux PSA cycles. These different configurations of the heavy reflux PSA concept and its use in concentrating CO2 from a typical stack gas will be discussed in detail.