Equilibrium Theory Analysis of Adsorption and Thermal Regeneration of Water Vapour on Zeolite 13X

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Abstract

Air-drying TSA processes have been widely commercialized for reducing air humidity down to ppb levels, producing a dry air suitable for production of engineering plastics and food. In designing such a cyclic adsorption process driven by temperature swing, it is crucial to find optimal regeneration temperature, so that the adsorbents can be regenerated fully for the next adsorption run and simultaneously the time taken for regeneration has to be short enough for good bed productivity.

In this study, the regeneration temperature was optimized by Equilibrium Theory. The theoretical breakthrough curves and their temperature profiles were constructed by the hodography in which a Toth isotherm was taken as equilibrium isotherm [1]. Interestingly, the breakthrough curves constructed by Equilibrium Theory exhibited different trends with varying regeneration temperatures. Its initial part always consists of two plateaus connected by a shock. The second plateau is followed by a simple wave at a low regeneration temperature. With increasing regeneration temperature, however, a shock wave appears and evolves in the middle of the trailing wave. This interesting results indicates that the regeneration temperature must be sufficiently high so that the shock wave could be large enough to reach below the targeted dew point of the dry air.

It was also investigated the effect of capillary condensation on the breakthrough curve. To this end, Aranovich-Donohue isotherm [2] was taken for equilibrium isotherm of water vapour on zeolite 13X. Incorporating the Type II isotherm into the governing equations made the second plateau elongated in time, but did not affect much the rest of the trailing curve.

Full numerical simulations of the thermal regeneration breakthroughs were also carried out. Their results were coherent with the experimental data measured earlier by the author at three different regeneration temperatures (423K, 473K and 523K) [3].

Keywords: *Air drying; 13X; Breakthrough; Equilibrium Theory; Hodography*

References

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Biography

Dr Hyungwoong Ahn is currently a Senior Lecturer in Chemical Engineering , the University of Edinburgh. Dr Ahn has been working actively on gas separation by adsorption/absorption and chemical process design and integration. Upon completion of his PhD at Yonsei University, He went on his research on adsorption at University College London as a KOSEF Fellow. He returned to South Korea to join SK Energy as a Senior Process Engineer. He joined the University of Edinburgh as a Lecturer in 2009.