

工程热物理

两组分有机气体等温吸附模拟与传热传质分析

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摘要: 理论与实验研究了丙酮和甲苯气体在活性炭中的吸附性能与温度变化, 根据吸附规律, 建立了丙酮和甲苯的线性驱动力模型(linear driving force, LDF)等温数学模型, 并应用有限差分方法求解模型。讨论了传热与传质系数对吸附床层温度和流出浓度曲线的影响, 并与实验进行了对比分析。结果发现吸附相传质系数 k_i 变小, 轴向导热系数 K_L 、内换热系数 h_i 和轴向质扩散系数 DL_i 变大时, 丙酮和甲苯的吸附饱和时间延长, 床层温度波动变小, 有利于吸附净化丙酮和甲苯的混合气体; 反之, 结果相反, 但有利于变压吸附分离甲苯和丙酮。同时通过模拟计算得到与实际情况相符的各组分传质传热参数: $K_L=0.003\ 19\ W/(m\times K)^{-1}$, $h_i=0.015\ 42\ W/(m^2\times K)^{-1}$, 丙酮 $DL_1=0.056\ 92\ m^2/s$, $k_1=0.060\ 5\ s^{-1}$, 甲苯 $DL_2=0.655\ 6\ m^2/s$, $k_2=0.007\ 56\ s^{-1}$ 。

关键词: 吸附性能 传热 传质 数值模拟

Simulation on Isotherm Adsorption of Two-component Organic Gas and Heat and Mass Transfer Analysis

LI Li-qing ZHU Zheng-shuang QIN Ying-xin SONG Jian-fei LIU Xiao-yan

Abstract: The adsorption properties and temperature changes of acetone and toluene gas on activated carbon were studied theoretically and experimentally. Based on the rule of adsorption, a linear driving force isothermal model was developed and calculated by finite differences method. The effects of heat and mass transfer coefficients on the temperature of adsorb bed and effluent concentration were analyzed comparing by experiment. The result is that it is good for purifying the mixed gas made up of acetone and toluene when adsorption saturation time of acetone and toluene becomes longer caused by smaller mass transfer coefficients of adsorbed phase k_i , bigger axial thermal conductivity coefficient K_L , internal heat transfer coefficient h_i and axial mass diffusion coefficient DL_i ; and on the contrary, it is good for separating acetone and toluene. The simulated heat and mass transfer coefficients in accordance with actual situation are as follows: $K_L=0.003\ 19\ W/(m\times K)^{-1}$, $h_i=0.015\ 42\ W/(m^2\times K)^{-1}$, $DL_1=0.056\ 92\ m^2/s$, $k_1=0.060\ 5\ s^{-1}$ (acetone), $DL_2=0.655\ 6\ m^2/s$, $k_2=0.007\ 56\ s^{-1}$ (toluene).

Keywords: adsorption property heat transfer mass transfer mathematical simulation

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