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利用膜吸收技术分离沼气中CO_2

CO_2removal from biogas by using membrane absorption technology

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中文摘要:

为了综合沼气CO2化学吸收法和膜分离法技术的优点，采用疏水性聚丙烯中空纤维膜接触器作为反应器，以净化气中CH4体积分数、系统CO2传质速率和能耗因子为主要指标，研究了常压下乙醇胺（MEA）、二乙醇胺（DEA）和三乙醇胺（TEA）吸收剂对模拟沼气的CO2分离性能。结果表明，膜CO2吸收技术可应用于沼气CO2分离，当采用MEA作为吸收剂，且沼气流量为120 L/h时，净化气中CH4体积分数可达97.8%，而沼气流量为300 L/h时，系统CO2传质速率达到最高，为18.03 mol/(m2·h)，且吸收剂的CO2分离性能排序为：MEA>DEA>TEA>H2O。能耗因子分析结果表明，0.175～0.20 mol/mol为较优的MEA贫液CO2负荷，DEA的气液比可选择16.7 L/L。膜CO2吸收系统的经济性分析结果显示，膜吸收系统具有较低的CO2分离成本，且当沼气工程规模由1 000 m3/d增加到12 000 m3/d时，膜CO2吸收系统的单位沼气CO2分离成本将下降78.6%，达到0.50元/m3。该文研究结果可对沼气的高效提纯提供参考。

英文摘要:

In order to integrate the unique advantages of chemical absorption technology and membrane separation technology used to capture CO2 from biogas, membrane CO2 absorption technology was put forward in this study. Based on the CH4 volume fraction in the treated gas, CO2 mass transfer rate of absorption and energy consumption factor, CO2 removal performances from the simulated biogas by monoethanolamine (MEA), diethanolamine (DEA) and triethanolamine (TEA) were experimented by using hydrophobic polypropylene hollow fiber membrane contactor as CO2 absorber. Results showed that CO2 can be successfully captured from biogas by using membrane CO2 absorption technology. And when MEA was selected to act as CO2 absorbent and biogas flow rate was 120 L/h, CH4 volume fraction can be increased from 60% to up to 97.8%. But CO2 mass transfer rate of absorption can reach the maximum, approximate 18.03 mol/(m2·h) by adopting 300 L/h biogas flow rate. In addition, CO2 removal performance of these three absorbents can be ranked as: MEA>DEA>TEA. The operating conditions were also optimized on the basis of the calculation of regeneration energy consumption factor, where 0.175-0.2 mol/mol lean CO2 loading should be recommended for MEA, and 16.7 L/L gas-liquid ratio may be suitable for DEA. Finally, an economic analysis of CO2 removal from biogas by using membrane absorption process was also put forward in this study. The results showed that the cost of CO2 captured is relatively lower, and when the biogas production increases from 1 000 to 12 000 m3/d, CO2 removal cost can be reduced by about 78.6% to 0.5 Yuan/m3 of biogas. The results can provide references for selection of biogas upgrading technology with high efficiency.

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