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FLOW AND ABSORPTION CHARACTERISTICS OF AMMONIA-WATER MIXTURE IN A SLUG FLOW ABSORBER AT LOW SOLUTION FLOW RATE

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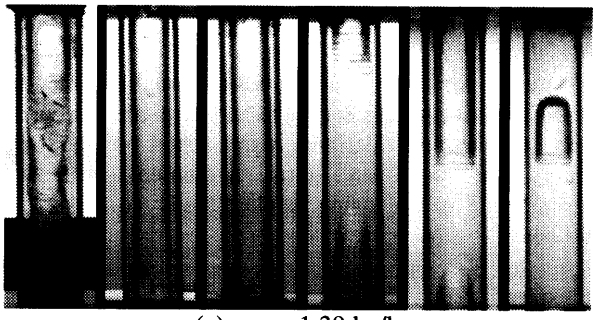
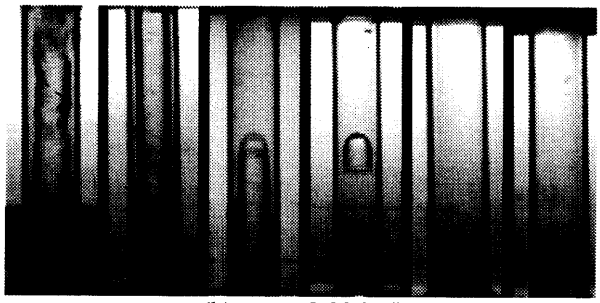
ABSTRACT

Absorption performance evaluation for a slug flow absorber on counter-current flow has been performed experimentally at low solution flow rate applied for the GAX (Generator absorber heat exchanger) cycle. The slug flow absorber is a promising absorber type that can improve the wettability problem. The wettability problem is supposed to happen in the GAX absorption system due to low solution flow rate, which results in low absorption performance. A test equipment is designed and developed to visualize flow pattern. Local heat flow along the tube length and absorption length are measured. Visualization results show that most of the flow patterns in this absorber are slug flow having long well-shaped Taylor bubble, except for short length starting from gas inlet port where frost (churn) flow pattern is observed. No wavy motion is observed in liquid film where the Taylor bubble passing by. Tests were performed by varying six main parameters; pressure in test section, coolant temperature, coolant flow rate, weak solution flow rate, ammonia gas flow rate, and weak solution concentration. As a result, it is confirmed that the suggested slug flow absorber is able to be operated well on counter-current flow with extremely small solution flow rate as low as 1.0 kg/h where film Reynolds number is 4.6. Volumetric mass transfer coefficient, K_La, defined with logarithmic mean concentration difference, absorption rate and absorption length is greatly influenced by changing the test parameters. However, when the solution flow rate decreases, influence on K_La decreases.



(a) $m_{L,i}$ = 1.39 kg/h



(b) $m_{L,i}$ = 2.22 kg/h

(P=5.7 bar, $T_{L,i}$ = 110 °C, $x_{L,i}$ = 21.6 wt%, $m_{G,i}$ = 0.6 kg/h, $T_{G,i}$ = 27.5 °C, $T_{c,i}$ = 30 °C, $L_{c,i}$ = 0.32 l/min)

Figure A-1. Flow pattern visualization inside Pyrex glass tube.

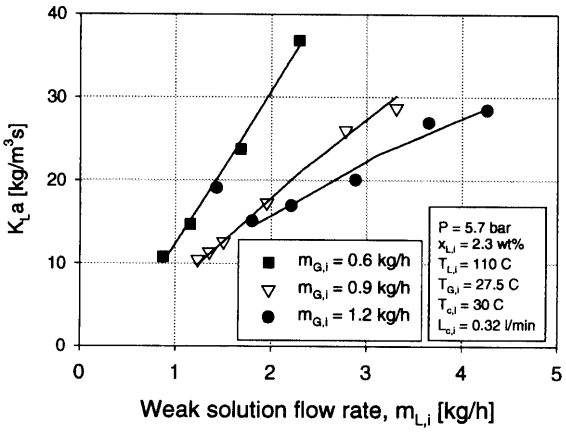


Figure A-2. Effect of weak solution flow rate on K_La at different gas mass flow rates.