1st Post Combustion Capture Conference

Characterization of Packing Materials for CO_2 Absorption

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Keywords:CO_2 Capture; Structured packing; Pressure drop; Liquid hold -up; Effective mass transfer.

1. Introduction

Capturing and storage of CO_2 from fossil fuelled power station and industrial exhaust gases by absorption is one of the most feasible technologies for mitigating global warming. To reduce the energy requirement, and in particular the heat duty, of these processes, more and more efficient solvents are being developed; having high carrying capacities of CO_2. At the same time, reduction of the pressure drop in both absorber and desorber will be important contributions to reducing the need for electrical energy in the process. One may thus foresee operation in shorter and wider columns, with very small liquid loads(m^3/m^2h), and with liquid having higher viscosities. In addition, mass transfer between gas and the solvent must be maximized to obtain close to equilibrium rich loadings in the absorber bottom combined with very low pressure drops (<< 100 mbar for the absorber), and as close to ideal plug flow as possible. Column packings are normally not designed for these conditions and most studies so far relate to distillation systems. Reactive absorption is quite different from distillation and it may be that old correlations are of limited use for new absorbent systems. Thus there is a demand for new and improved data and correlations for estimating effective mass transfer area, transfer resistance factors and other hydraulic (pressure drop, liquid hold-up) properties. The objective of this work was to perform absorption and hydrodynamic studies in different structured packings under conditions possible with new solvents. This paper presents data for two structured packings; Mellapak 2X from Sulzer and Flexipac 2Y HC49 from Koch-Glitsch. Air was used as gas, and water, amine and sugar solutions with liquid viscosity up to 12 cP were used for pressure drop and liquid hold-up measurements. Effective mass transfer area was measured in two different systems: $NaOH/CO_2$ and MEA/CO_2.

2. Pressure drop

Pressure drop was measured based on pressure measurements in 6 positions along the packing height; just below the packing, 0.5, 1.5, 2.5, 3.5 and 4.5 meters up in the packed bed. Liquid flow was between 0 and 60 $m^3/(m^2 \bullet h)$, and the gas flow was between 0 and 17000 m3/(m2•h).

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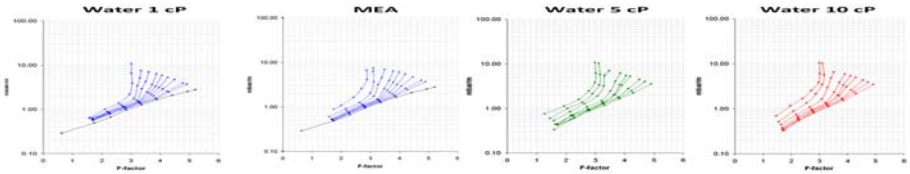

Figure 1:Experimental pressure drop vs. f-factor for Koch-Glitsch Flexipac 2Y HC49

The column showed flooding-like behaviour at superficial gas velocities of about 3 - 4 m/s depending on the liquid flow. The pressure drop increases slightly with the increased liquid viscosity.

3. Liquid hold-up

Liquid hold-up in the column packing was measured at different gas and liquid flows. For high liquid loads, the hold-up was close to constant as a function of gas flow, with a sharp increase at very high (close to flooding) gas velocities. This is in agreement with trends found in the literature. Liquid hold up was measured for different viscosities such as 2.5, 6 and 12 cP. Liquid hold up increases gradually with increased liquid viscosity as shown in Figure 2.

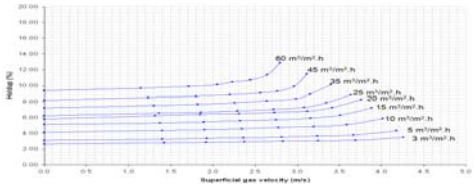

Figure 2: Experimental liquid hold-up vs. super velocity for Koch-Glitsch Flexipac 2Y HC49

4. Effective mass transfer

The effective areas for mass transfer of the Mellapak 2X and Flexipac 2YHC 49 were measured under pilot plant scale operating conditions with a broad range of gas and liquid flows in the packing.

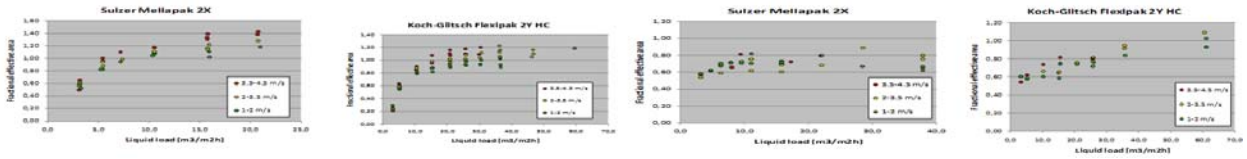

Figure 3: Experimental fractional area vs. liquid load for NaOH,MEA.

Both for NaOH and MEA solutions the active area increases with liquid load. There is also an increase in the active area with increasing gas flow rate. The values of measured effective mass transfer area are close to values found in the literature for the NaOH system. The values for measured effective mass transfer area for the MEA system are significantly higher than those of the NaOH system. The effect of gas and liquid load is also more pronounced for the MEA system, reducing the efficiency considerably at low values. More detailed information and also a comparison between our experimental data and other data will be presented in the full paper.

References:

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