A Comparison of Pressure drop, Liquid hold-up and Effective mass transfer area in three Different Structured packings

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The VOCC (Validation of CO2 Capture) project is a user-driven innovation project with Statoil and SINTEF as partners. The objective of the project is to create a basis for qualification of improved post combustion absorption technologies by experimental studies in a 0.5 m diameter absorber column. The objective is to perform absorption studies and to study the hydrodynamic characteristics in different structured packings with a 0.5 m diameter and 5 m height packing. An advanced indoor absorber test-rig for packing materials has been designed and built at SINTEF Materials and Chemistry in Trondheim.
Experiments were performed with three different structured packings: Mellapak 2X from Sulzer, Flexipac 2Y HC from Koch-Glitsch and Montz-Pak B1-250M from Montz. Air and water, sugar and amine 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 liquid systems: $NaOH/CO_2$ and MEA/CO_2.

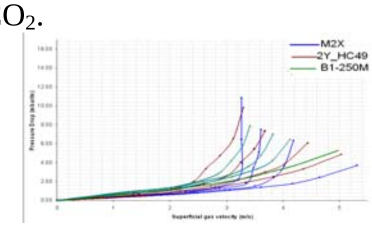

Figure 1: A comparison of pressure drop in 3 different packings

Pressure drops were measured based on pressure measurements at 6 positions along the packing height. Liquid flow was between 0 and 60 $m^3/(m^2 \cdot h)$, and gas flow was between 0 and 17000 $m^3/(m^2 \cdot h)$. The total pressure drop followed the expected pattern as a function of liquid and gas flows. The column showed flooding-like behaviour at superficial gas velocities of about 3 - 4 m/s depending on the liquid flow and packing type. The pressure drop increases slightly with the increased liquid viscosity.
Of the three packing materials tested, Sulzer Mellapak 2X had the lowest pressure drop, followed (in increasing pressure drop) by Montz-Pak B1-250M and Koch-Glitch Flexipac 2Y HC. The results show that pressure drop increases only slightly with increased viscosity of the liquid for viscosities between 1 and 12 cP. The results from the test rig are in reasonable agreement with correlations found in literature. Liquid holdup in the column (measured as percentage liquid volume of the total column volume) 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 1, 2.5, 6 and 12 cP. As can be seen in Figure 2, liquid holdup increases gradually with increased liquid viscosity. The

Montz-Pak B1-250M showed the lowest liquid holdup of the three different packings with a measured holdup of 4.6 % for liquid load of 10 m^3/m^2h 30wt% MEA and a superficial gas velocity of 2 m/s in the column. For the same conditions, Sulzer Mellapak 2X showed a liquid holdup of 5.5% and Koch-Glitsch Flexipac 2Y HC; 5.7 %. Liquid holdup was found to increase with increasing liquid viscosity and the influence is higher at high liquid load than at low liquid load. The results from the test rig are in reasonable agreement with correlations found in literature.

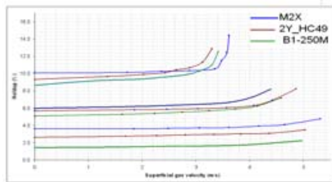

Figure 2: Comparison of liquid hold-up in 3 different packings

The effective area for mass transfer of the three different packings was measured under the pilot plant scale operating conditions for a broad range of gas and liquid flows.

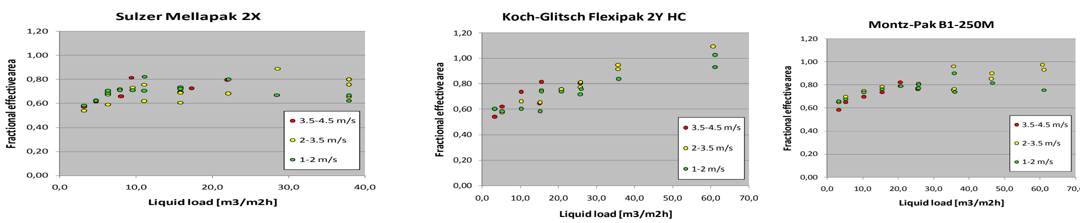

Figure 3: Fractional effective area (a_e/a_p) as a function of liquid load (m^3/m^2h) for three different rangesof superficial gas velocity. Absorption of CO_2 in 0.3 M NaOH.

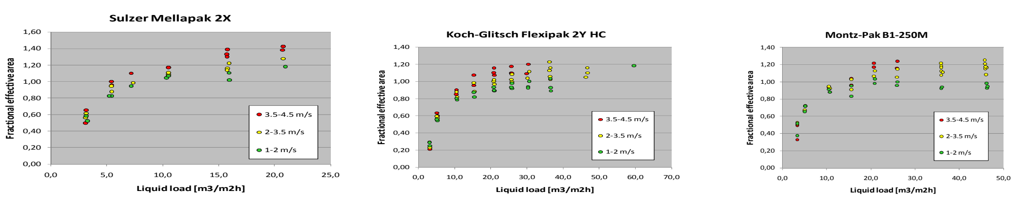

Figure 4: Fractional effective area (a_e/a_p) as a function of liquid load (m^3/m^2h) for three different ranges of superficial gas velocity. Absorption of CO_2 in 30wt% MEA.

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 literature for the NaOH system. The values of the 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. The results indicate the Sulzer packing has better wetting at low liquid loads and a broader operational range for liquid load than the Koch-Glitsch and Montz packings. This could be explained by the higher liquid holdup of the Sulzer packing.More detailed information and also the comparison between our experimental data and the other data will be presented in the full paper.

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