Experimental characterisation of wire mesh demisters

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Introduction

Four different wire mesh demisters have been studied in two different experimental apparatuses, one low pressure rig and one high pressure rig. A wire mesh demister is made by knitting wires to form a layer that can either be rolled into cylindrical elements or folded up in several layers. Two examples of commercially available wire mesh demisters are shown in figure (1)

Figure 1: Wire mesh demisters

The materials used in the wire mesh demisters tested in this study were Polypropylene (PP) and stainless steel (SS). The porosity ranged from 95.4 – 99 % and the specific surface area ranged from 145 – 600 m^2/m^3. The design varied, including single layer, nested double layer, rolled and random configuration. The wire diameter varied from 0.27 – 0.30 mm. The height used was 100 mm. These data are summarized in table 1.

Table 1: Geometrical and physical data

	Unit	A	B	C	D
Porosity	[%]	95,4	99,0	97,6	98,0
Density	[kg/m^3]	42	80	192	145
Specific surface area	[m^2/m^3]	600	145	345	267
Wire diameter	[mm]	0,30	0,28	0,28	0,27
Height	[mm]	100	100	100	100
Geometry	[-]	Random	Single layer	Nested double layer	Rolled

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Experimental

The low pressure apparatus shown in figure 2 include a 4 inch steel column, liquid circulation pump, compressed air supply, pneumatic nozzle for mist introduction and a wire mesh demister.The gas/liquid system used in this apparatus was air/water. Mesh A,B and C were tested.

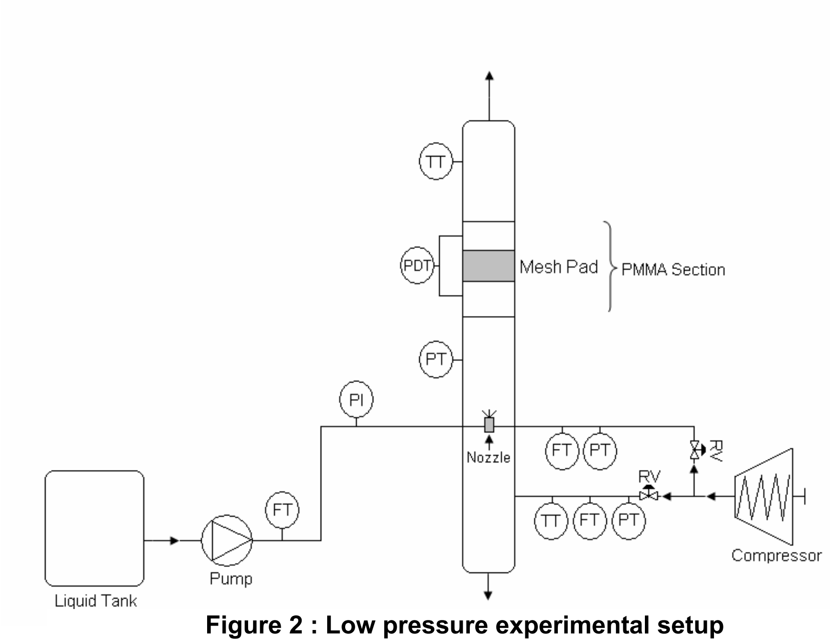

Figure 2 : Low pressure experimental setup

The high pressure apparatus include separate gas – and liquid loops, a 3 stage downstream separator and a 6 inch steel test scrubber with inlet device, wire mesh demister and cyclone pack (figure 3). In this apparatus two gas/liquid systems were tested; Nitrogen/Exxsol D60 and a Synthetic natural gas mixture (NG). The pressures tested were 20, 50 and 92 bars.

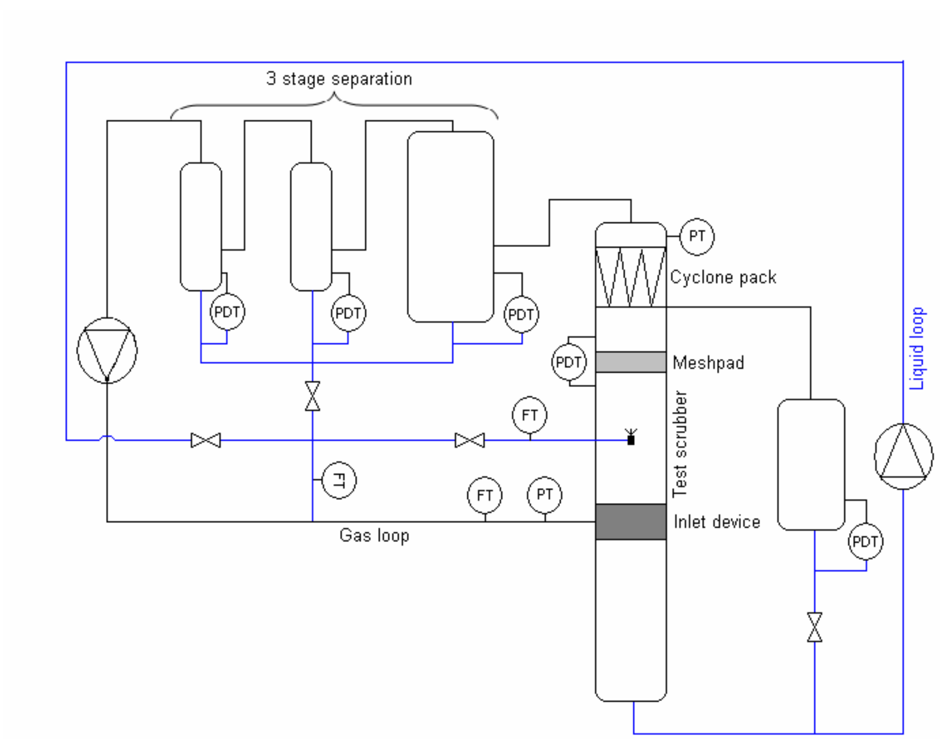

Figure 3: High presure experimental setup

Results and discussion

The pressure drop over a wire mesh demister is low. For a mesh exposed to a dry gas, the pressure drop lies in the range 0-1000 Pa. Normally, the total pressure drop over a wire mesh demister is expressed as the sum of the dry mesh pressure drop and the wet mesh pressure drop (York and Poppele, 1963).

$$\Delta P_{mesh,total} = \Delta P_{mesh,dry} + \Delta P_{mesh,wet} \tag{1}$$

Models presented in the literature for the dry term can be summarized as

$$\frac{\Delta P}{\rho_g U_{\sup}^2} = f_d\left(\mathrm{Re}, \varepsilon, S\right) \tag{2}$$

which is in the same form as the Ergun equation used for calculating pressure drop in packed beds. Experimental data suggest that the pressure drop is not a function of the superficial gas velocity squared. The velocity dependency of the pressure drop varies with the mesh used. Based on the experimental data gathered, a preliminary model has been formulated.

$$\Delta P_{mesh,dry} = f_d \cdot \rho_g \cdot U_{\sup}^n \tag{3}$$

By taking the logarithm on both sides of equation 3, the velocity dependency can be found. This is illustrated in figure (4) for mesh D. The factor *n* can be found as the slope of the curve.

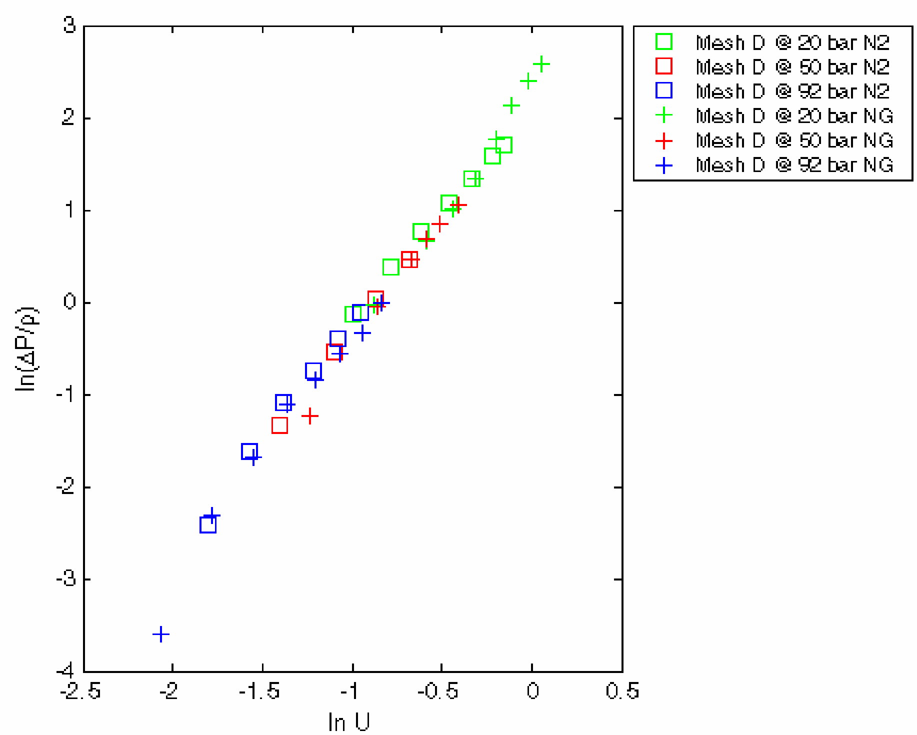

Figure 4 : The dependency of the superficial gas velocity

The *n* values found by these plots vary for the whole range of meshes. This suggests that the velocity dependency is dependent on the geometry of the mesh. The experimental data and results from the preliminary model are shown in figure 5 and 6.

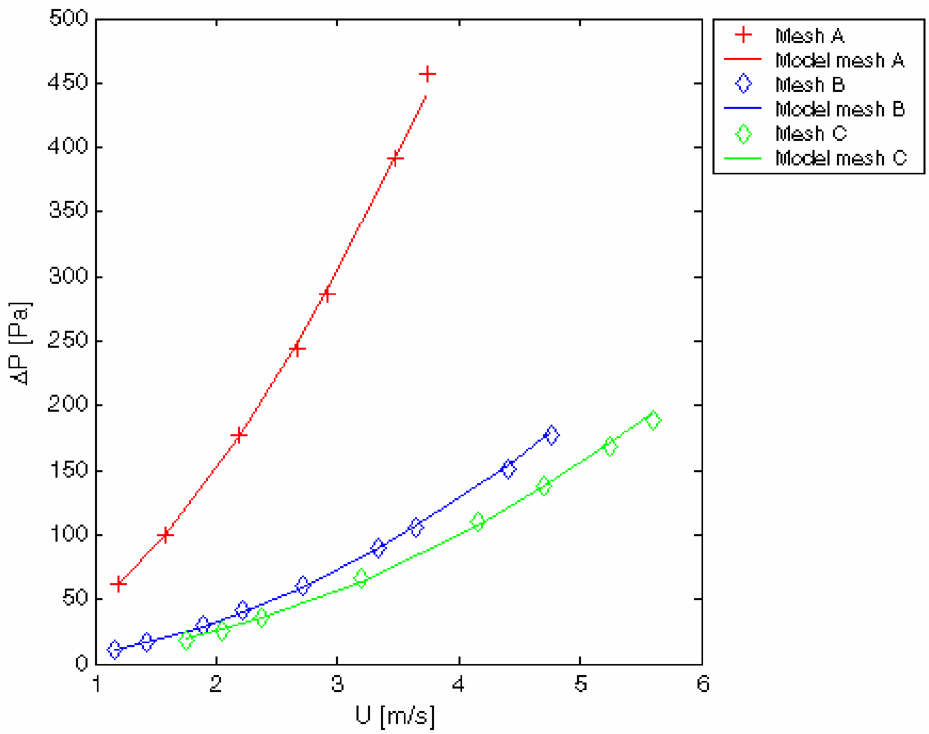

Figure 5 : Experimental results (Low pressure rig)

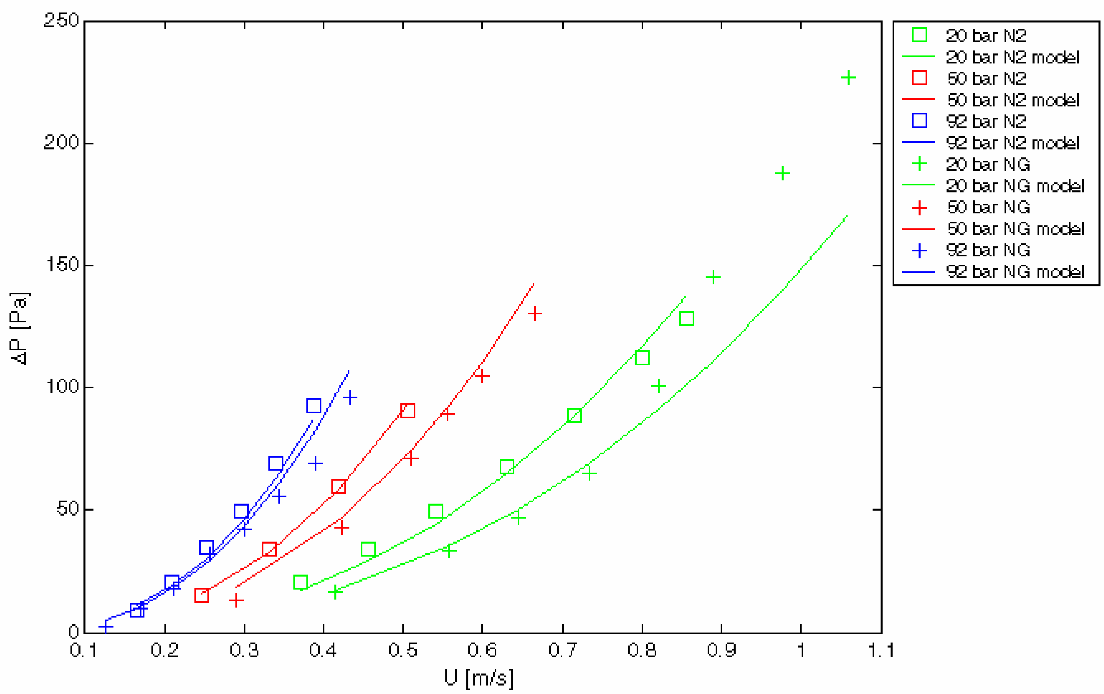

Figure 6 : Experimental results mesh D (High pressure rig)

The model, although in need of refinement, is in good agreement with the experimental data.

Tests with wet gas were also performed. A plot of the pressure drop as a function of the gas load factor ($K = U_{sup}\sqrt{\frac{\rho_g}{\rho_l - \rho_g}}$) clearly shows the point where the wire mesh demister gets flooded. At this point the pressure drop will increase rapidly. Such plots have been presented in the literature (El-Dessouky, *et.al.*, 2000), but not for high pressure experiments with real fluid systems and not for high gas load factors. In figure (7), pressure drop curves for mesh D and B are presented and show that the pressure drop stabilises again when increasing the gas load further beyond the flooding point. Even a small reduction in pressure drop can be seen in some cases.

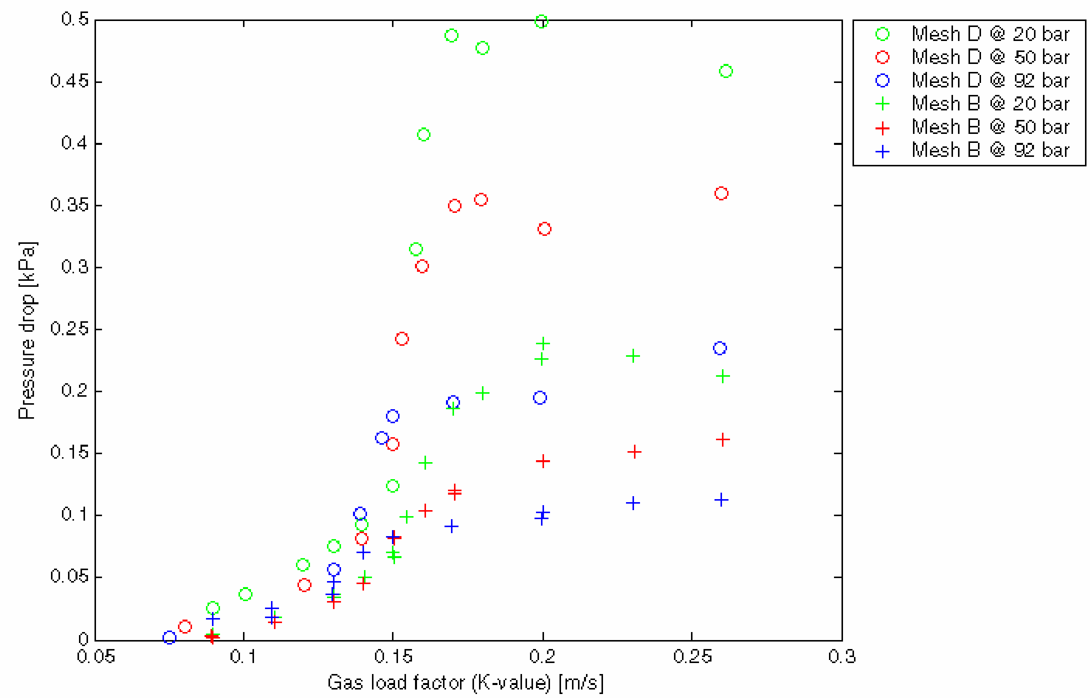

Figure 7 : Total pressure drop (Synthetic natural gas mix)

Bibliography

1. **El-Dessouky, H. T., *et.al.,*** "Performance of wire mesh mist eliminator", *Chem. Eng. Processes*, **39**, pp. 129-139 (2000)
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Symbols

K	Gas load factor (K-value)	[m/s]
Re	Reynolds number	[-]
U_{sup}	Superficial gas velocity	[m/s]
$\Delta P_{mesh,total}$	Total pressure drop	[Pa]
$\Delta P_{mesh,dry}$	Dry pressure drop	[Pa]
$\Delta P_{mesh,wet}$	Wet pressure drop	[Pa]
ε	Mesh porosity	[-]
ρ_g	Gas density	[kg/m^3]
ρ_l	Liquid density	[kg/m^3]