Calculations in this study can give good agreement with the measured pressure drop as seen in the Figure 8. However the little deviation can be explained as follows; In the experimental study of Jatuporn (2009) the evaporation pressure drop was measured by the differential pressure transducer mounted to the header at inlet and outlet of the test section. The total pressure drop includes the sudden contraction loss at the test section inlet, sudden expansion loss at the test section outlet, frictional pressure drop, and acceleration pressure drop. The results from the experimental study shows that the frictional pressure drop is 73– 95% of the total pressure drop.

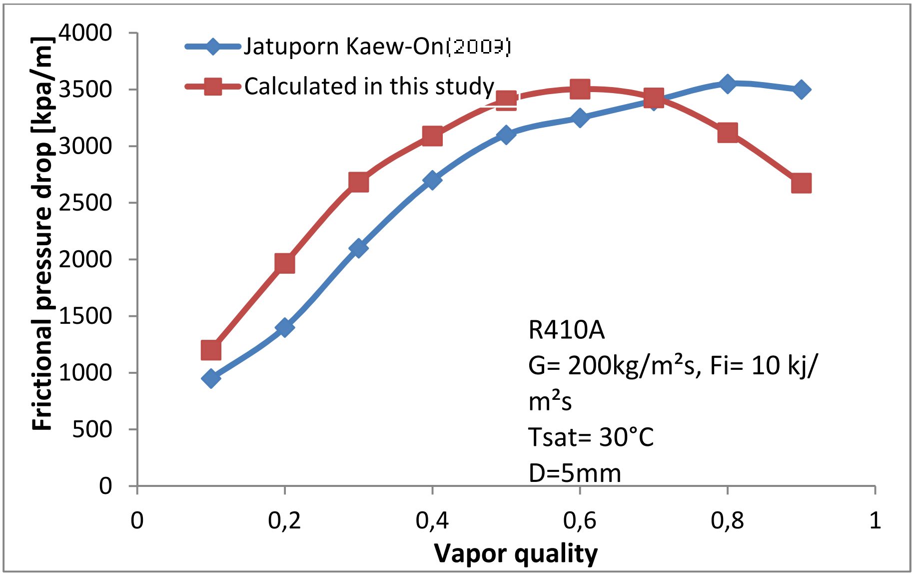


Figure 7. Comparison of calculated pressure drop with Jatuporn [4]

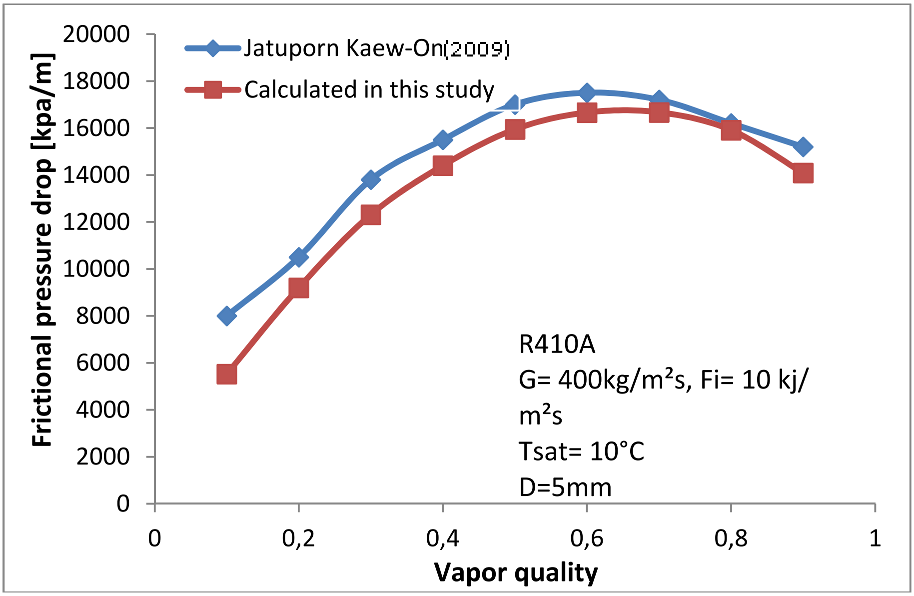


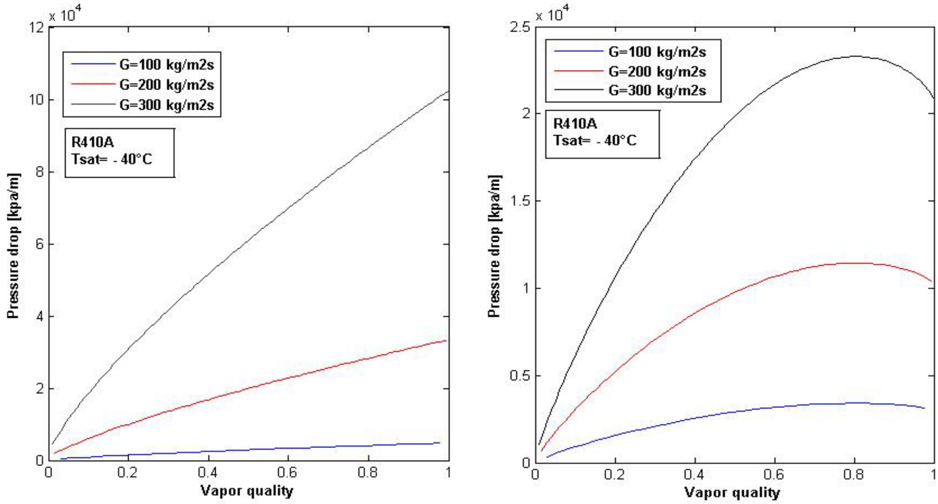
Figure 8. Comparison of calculated pressure drop with Jatuporn [4]

3.2.1. Effects of Mass Flux on Frictional Pressure Drop

The frictional pressure drops versus heat flux during evaporation of R410A and R32 at constant saturation temperature were calculated by the homogenous and Lochart-Martinelli models.

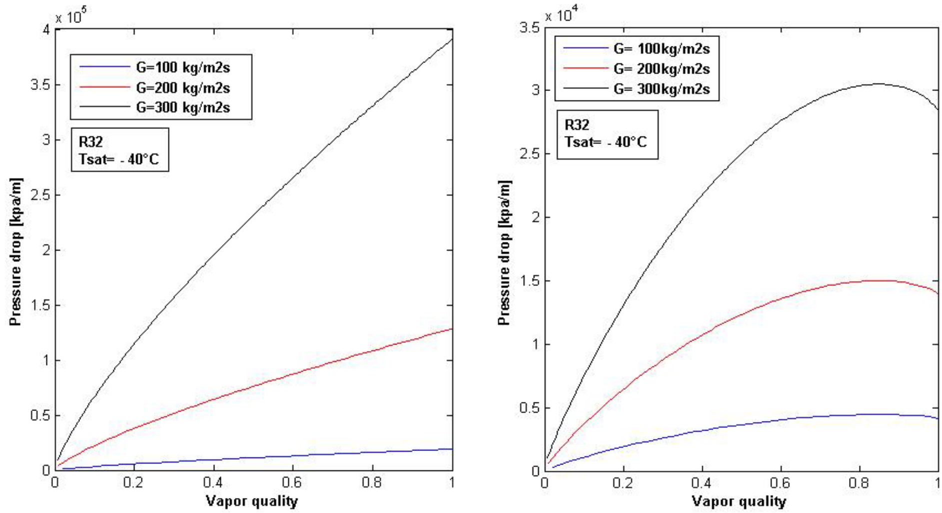
Fig. 9, 10 and show the effects of the mass flux on the pressure drop for the 5 mm OD at a heat flux of 10 kj/ m²s.

As shown, the frictional pressure drop increases with the average quality. At the same quality, the pressure at higher mass flux is always higher than at lower ones across the range of quality.



(a) (b)

Figure 9. Pressure drop of R410A according to the (a) homogenous and (b) separated flow model



(a) (b)

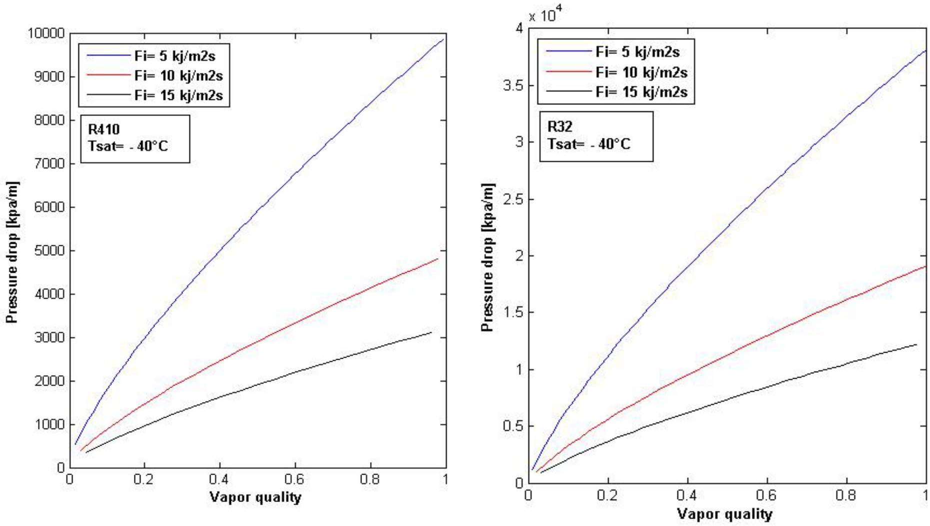
Figure 10. Pressure drop of R32 according to the (a) homogenous and (b) separated flow model

According to the both models pressure drops of R32 are always higher than R410A.

3.2.2. Effects of Heat Flux on Frictional Pressure Drop

Figure 11 presents the variation of the pressure drop with the quality at G $=100\,kg/m^2\,s$ and T_{sat} = 40 °C for the different heat flux values of 5, 10 and 15 $kj/m^2\,s$

On the Lochart-Martinelli model it is found that the heat flux has no significant effect on the pressure drop. This is because the increase in the total rate of liquid film vaporization in the wall surface is very small with the vapor flow rate at the inlet.

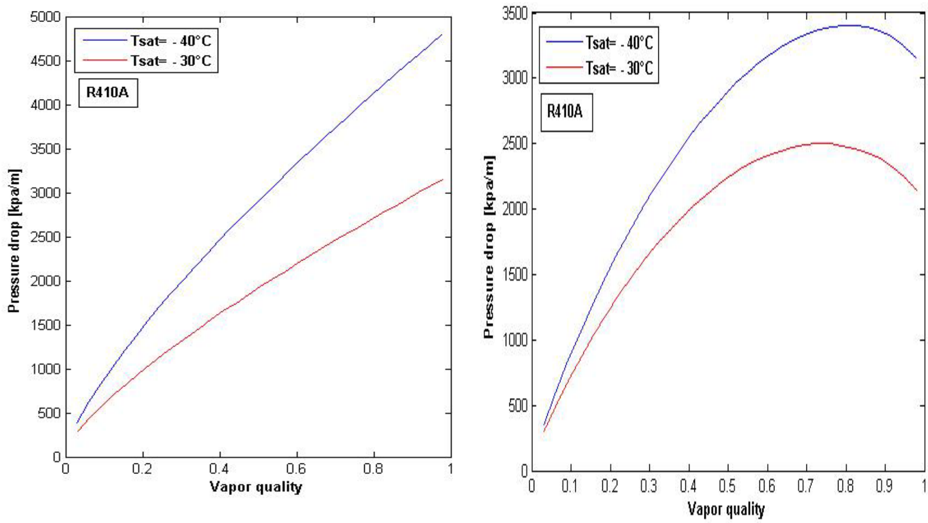


(a) (b)

Figure 11. Effects of heat flux on frictional pressure drop for (a) R410A (b) R32

3.2.3. Effects of Saturation Temperature on the Frictional Pressure Drop

Figure 12 shows the effects of the evaporating temperature on the pressure drop per unit length for the 5 mm OD smooth tube at a mass flux of $100\,kg/m^2s$ and heat flux 10 kj/m^2s. The pressure drop increased with the rise of the evaporating temperature.

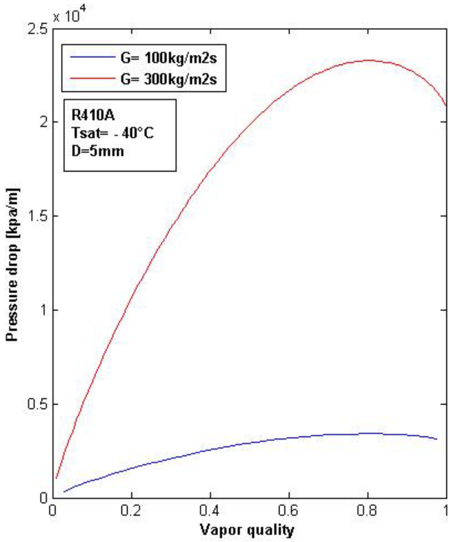


(a) (b)

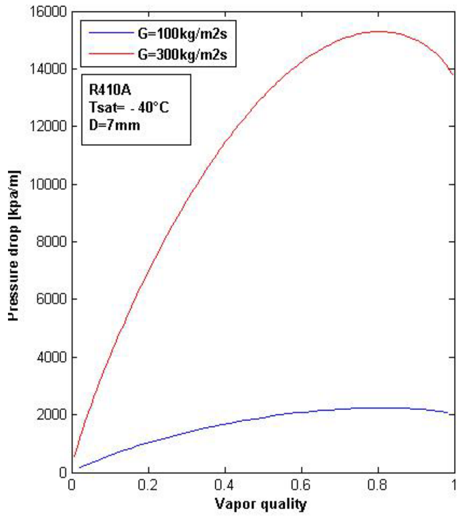
Figure 12. Effects of saturation temperature for (a) homogeneous and (b) Lochart-Martinelli model on the frictional pressure drop.

3.2.4. Effects of Tube Diameter on the Frictional Pressure Drop

The diameter of tube gives a considerable effect on two-phase flow pressure drop, and figure 13 shows the effects on R410A pressure drop for the saturation temperature of - 40 °C at the mass flux 100 and 300 kg/m^2s for the tube diameter 5 and 7 mm. The pressure drop increase with the decrease of tube diameter.



(a)



(b)

Figure 13. Effects of tube diameter for Lockhart-Martinelli model on the frictional pressure drop (a) D=5mm (b) D=7mm.

NOMENCLATURE

Greek symbols

α void fraction

μ viscosity, $N.s.m^{-2}$

ρ density, $kg.m^{-3}$

σ surface tension, $N.m^{-1}$

τ_W Perimeter average shear stress, Pa

Subscript

ac accelerational

fr friction

gr gravitational

in inlet

l liquid

lp liquid-phase

lv property difference between vapor and liquid

o outlet

ref refrigerant

sat saturation

tp two-phase

v vapor

vp vapor-phase

w wall

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