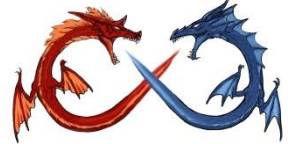
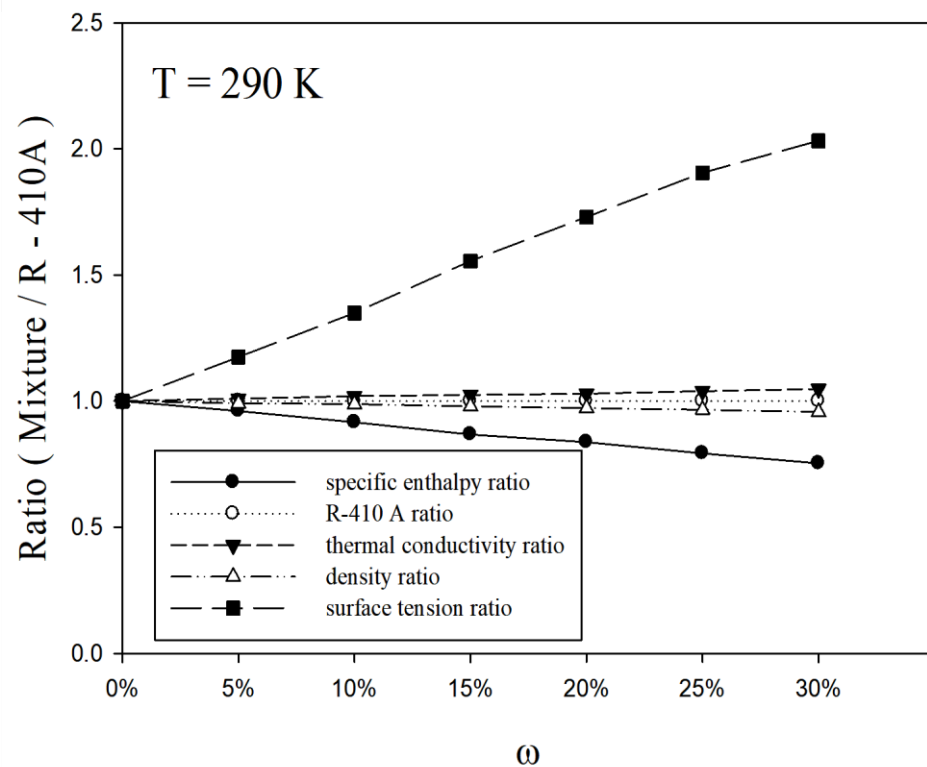
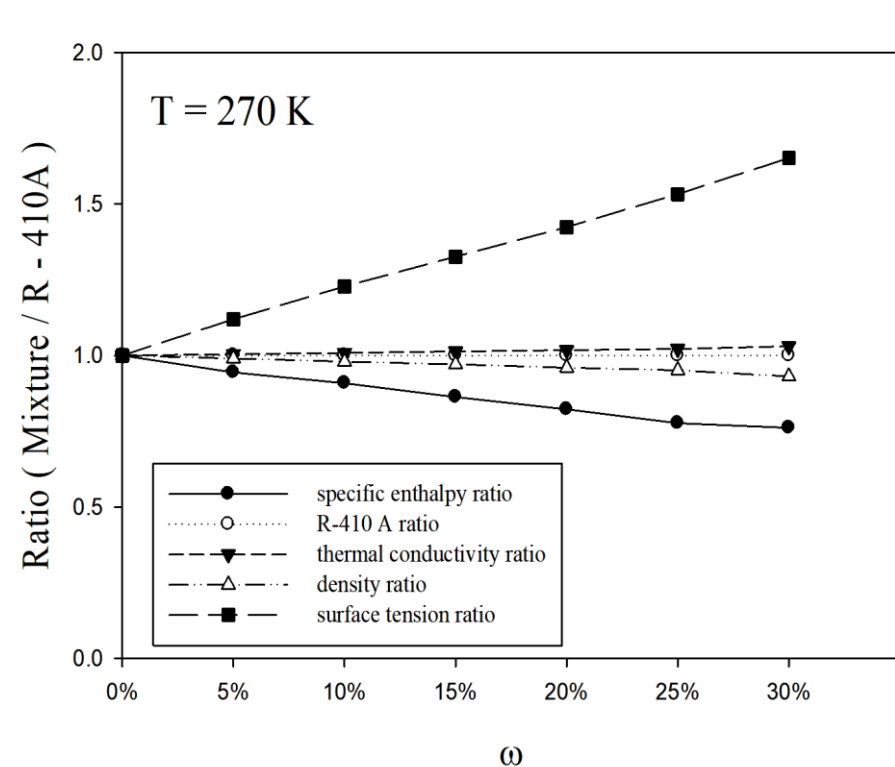


潤滑油的影響

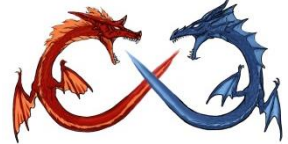
- 在冷凍或熱泵系統的蒸氣壓縮過程中，潤滑是非常必要的。
 - 滑動部位密封和氣瓶閥門減震
- 在空調或冷凍系統中
 - 少量的潤滑油可能會從壓縮機遷移至另一個系統的一部份，改變冷媒的熱傳和摩擦特性
- 作為壓縮機的冷卻液
 - 從軸承和機械元件傳熱到曲軸箱，並且減輕來自運動部件的噪音
- 影響冷媒的熱力及流動性質，尤其是冷媒會顯著改變以下性質
 - 黏滯力
 - 高於冷媒約二到三個冪次
 - 表面張力
 - 高於冷媒約一個冪次
- 在熱傳的特性造成一個顯著的影響



Models of thermodynamic and transport properties of POE VG68 and R410A/POE VG68 mixture. Frontiers of Energy, and Power Engineering in China 2008;2(2):227–34.

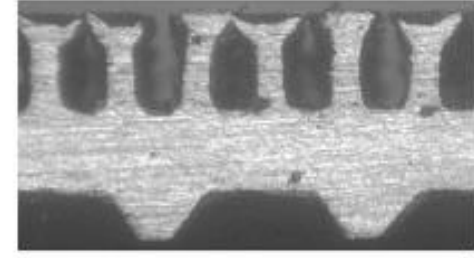
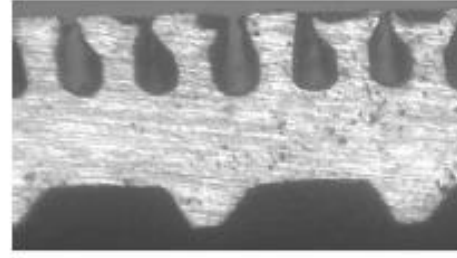
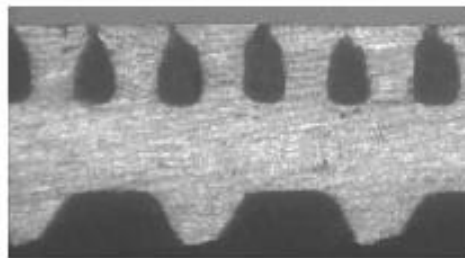
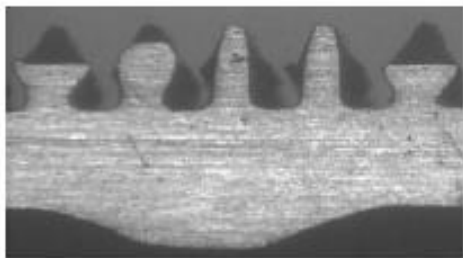


Schematic of the associated properties of R-410A/POE VG68 mixture based on the calculated results.



Test results for Ji et al.

Nucleate pool boiling heat transfer of R134a and R134a-PVE lubricant mixtures on smooth and five enhanced tubes. Journal of Heat Transfer 2010;132 111502-1-8.



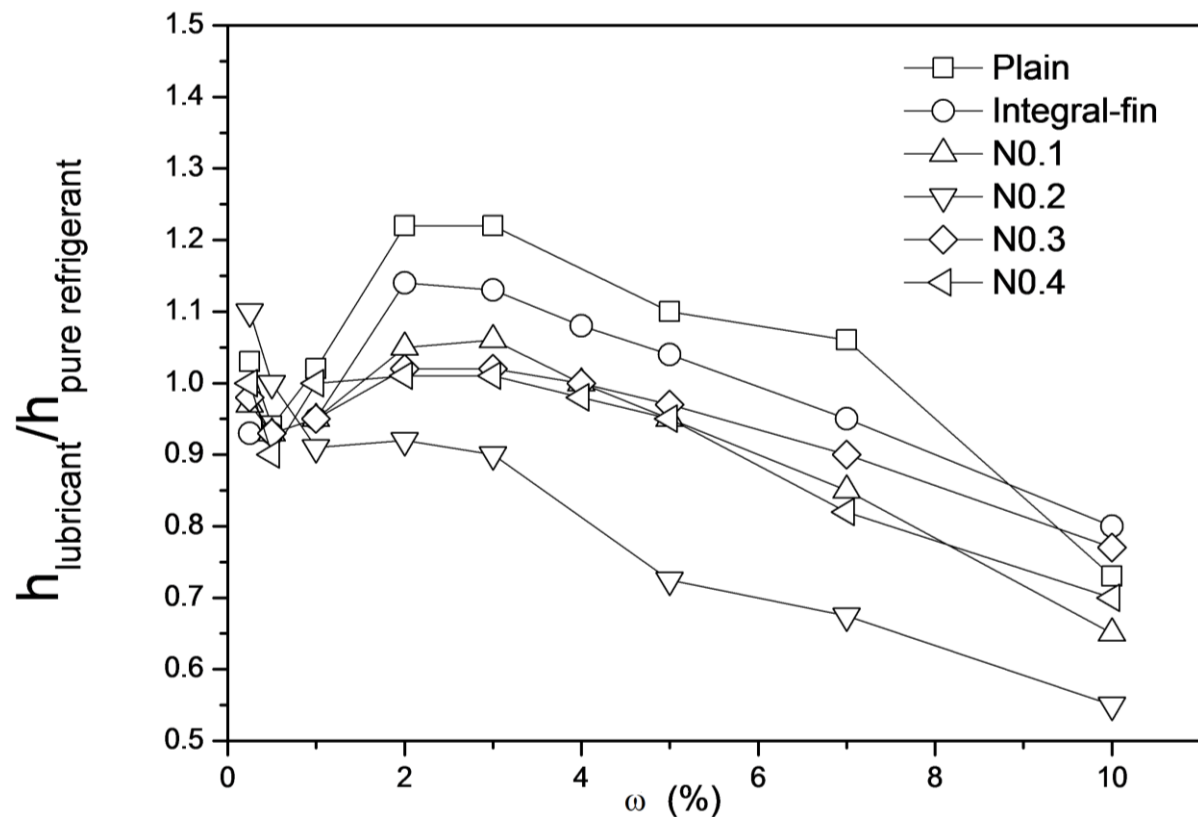
#1, 1435 fins/m

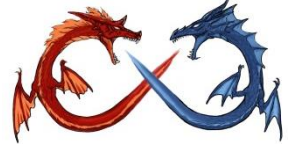
#2, 1561 fins/m

#3, 1696 fins/m

#4, 1761 fins/m

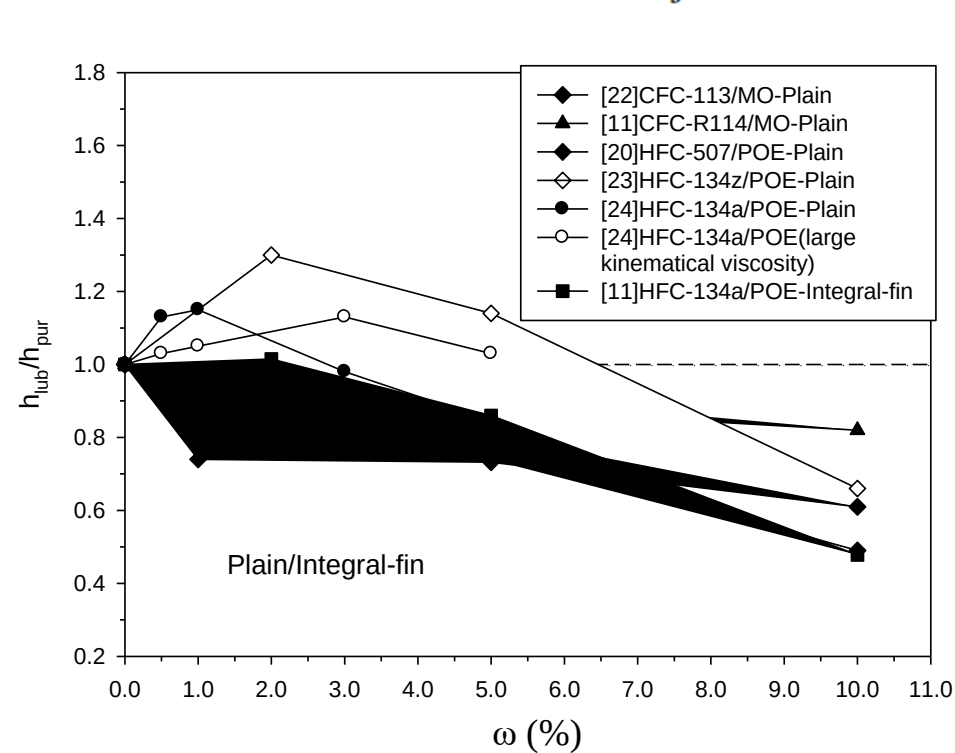
Schematic of the enhanced tube structure by Ji et al.



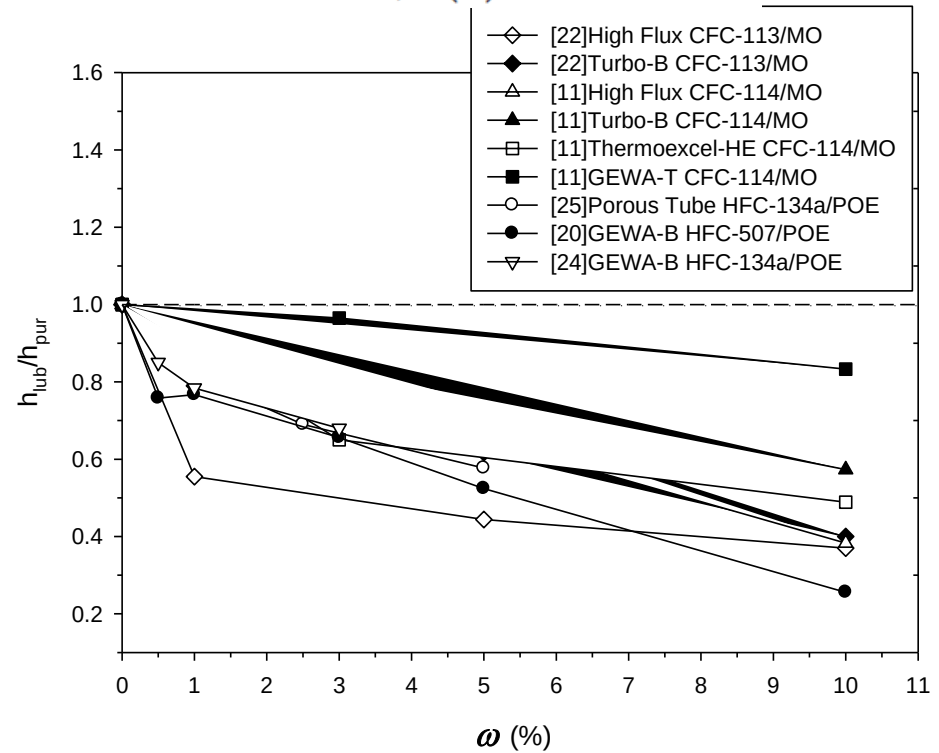


Memory S, Sugiyama DC, Marto PJ. Nucleate pool boiling of R-114 and R-114-oil mixtures from smooth and enhanced surfaces-I. Single tubes. International Journal of Heat and Mass Transfer 1995;38(8):1347–61.

Memory S, Sugiyama DC, Marto PJ. Nucleate pool boiling of R-114 and R-114-oil mixtures from smooth and enhanced surfaces-II. Tube bundles. International Journal of Heat and Mass Transfer 1995;38(8):1363–76.



Plain/integral tube



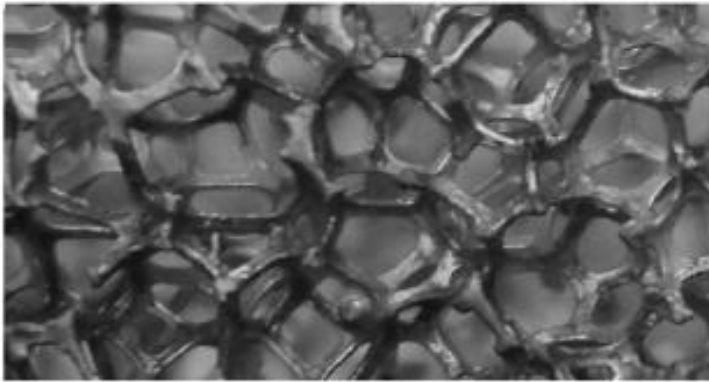
Highly structured tube

Variation in the relative boiling heat transfer coefficient of lubricant-mixed refrigerant reported in literatures

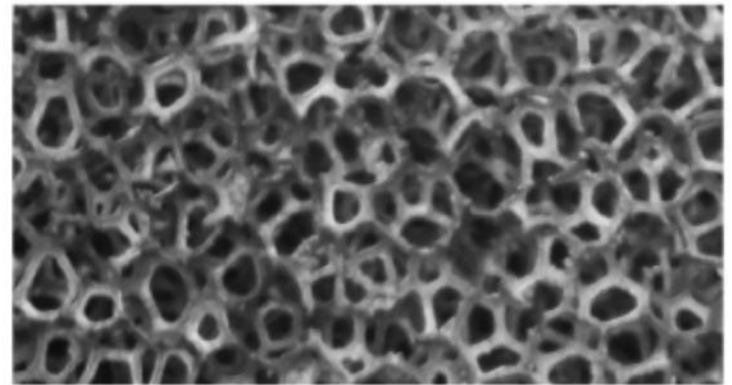


Zhu Y, Hu H, Ding G, Peng H, Huang X, Zhuang D, et al. Influence of oil on nucleate pool boiling heat transfer of refrigerant on metal foam covers. International Journal of Refrigeration 2011;34:509–17.

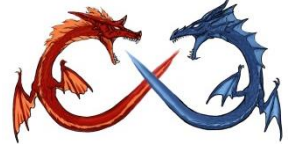
- 在90%至98%不等的金屬泡沫進行核沸騰與孔隙度試驗，並在R-113/VG68平板顯示了相反的趨勢



b Copper foam #2: ppi=10, Porosity=95%

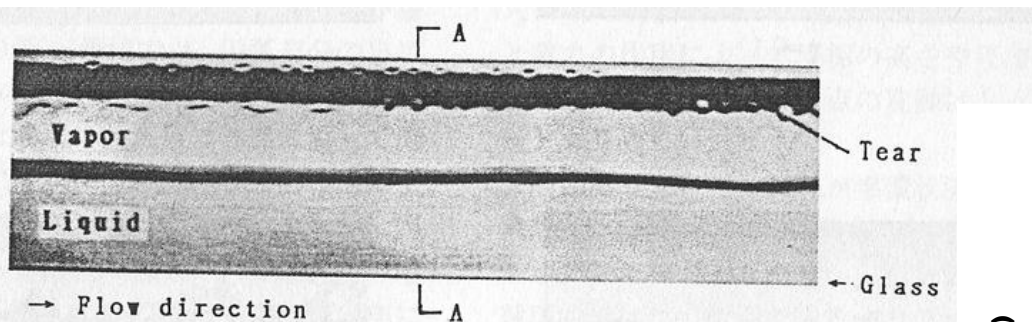


c Copper foam #3: ppi=20, Porosity=98%

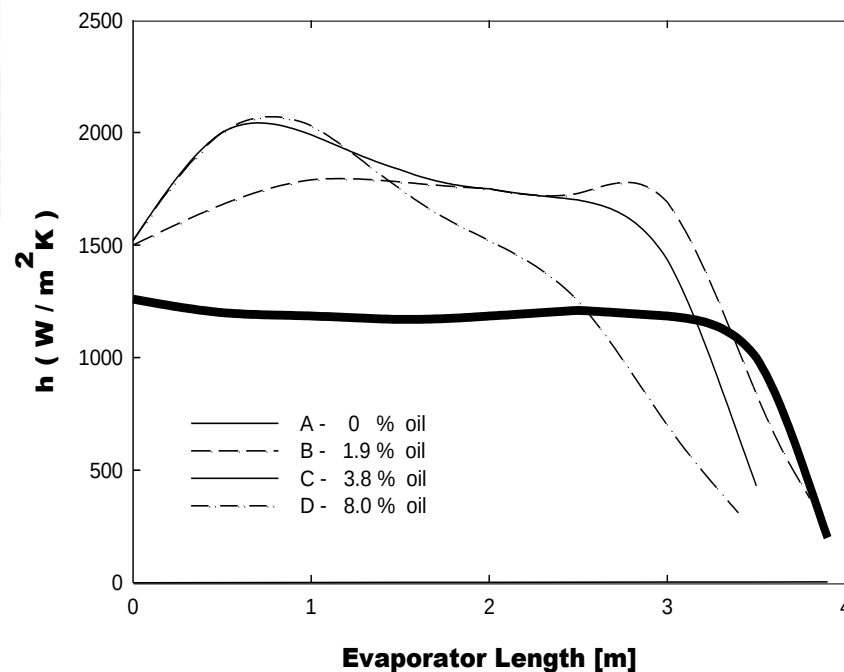
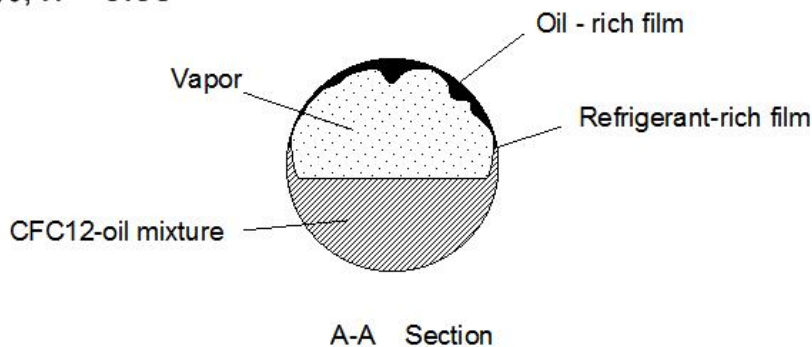


黏度的影響

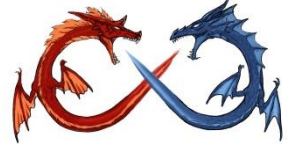
Worsoe-Schmidt P. Some characteristics of flow pattern and heat transfer of Freon-12 evaporating in horizontal tubes. International Journal of Refrigeration 1960;3(2):40-4.



CFC12-oil mixture
 $G = 110 \text{ kg} / (\text{m}^2 \cdot \text{s})$
 $\omega = 7 \%, x = 0.05$



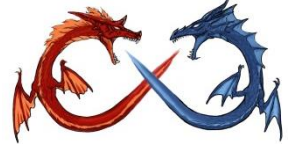
Schematic of the two-phase annular flow pattern of R-12/oil mixtures with oil-rich tear flow pattern at the upper part of the tube



管的幾何形狀的影響

- 即使在低質量流速，微鰭管也會促進環狀流
- 相對平滑管中冷媒的潤滑油可能會失去促成環狀流的效益
- 在較小的傳熱管中，即使是平滑管，也較容易形成環狀流，因此油存在的可能增益也隨之減小





潤滑油對CO₂熱傳特性之影響

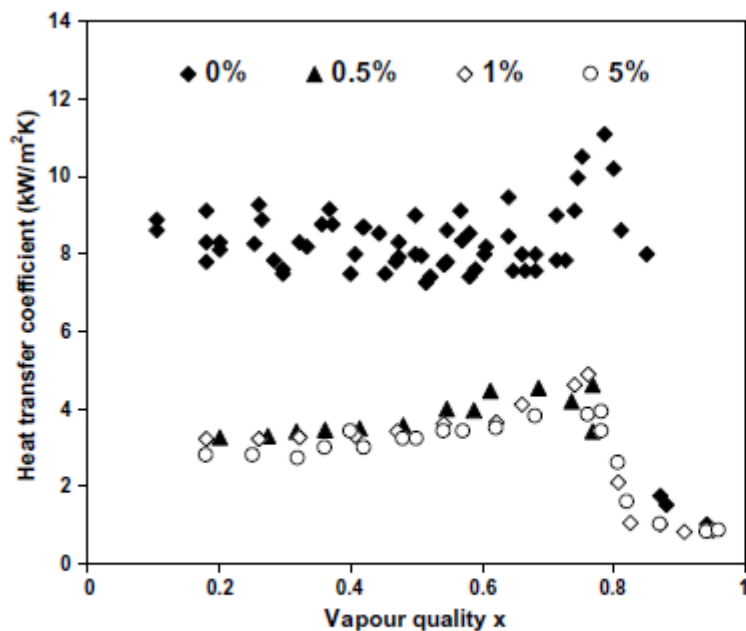


Fig. 1. Effect of oil concentration on h_{tp} of CO₂-PAG mixture (Dang et al. [32]) at $G = 360 \text{ kg/m}^2 \text{ s}$, $T_{sat} = 10 \text{ }^\circ\text{C}$ and $q = 9 \text{ kW/m}^2$.

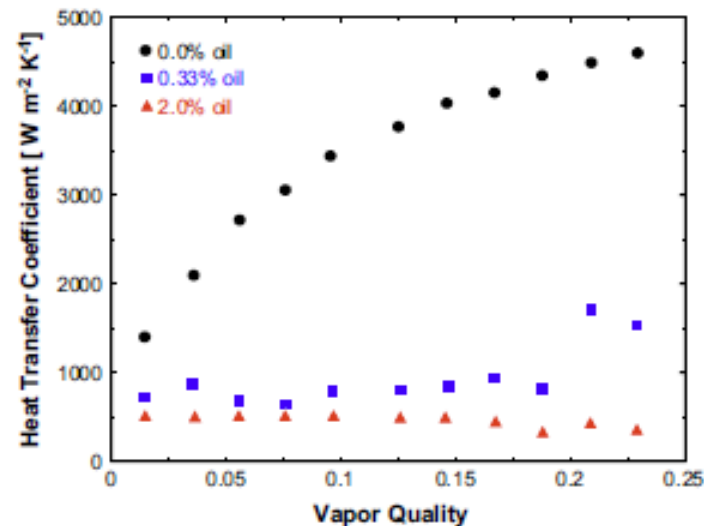


Fig. 5 – The lubricant oil effect on heat transfer coefficient in flow boiling, according to the data of Chaddock and Buzzard (1986) for the test conditions: $G = 65 \text{ kg s}^{-1} \text{ m}^{-2}$, $q = 6.3 \text{ kW m}^{-2}$ and $T_{sat} = 9.5 \text{ }^\circ\text{C}$ at several oil

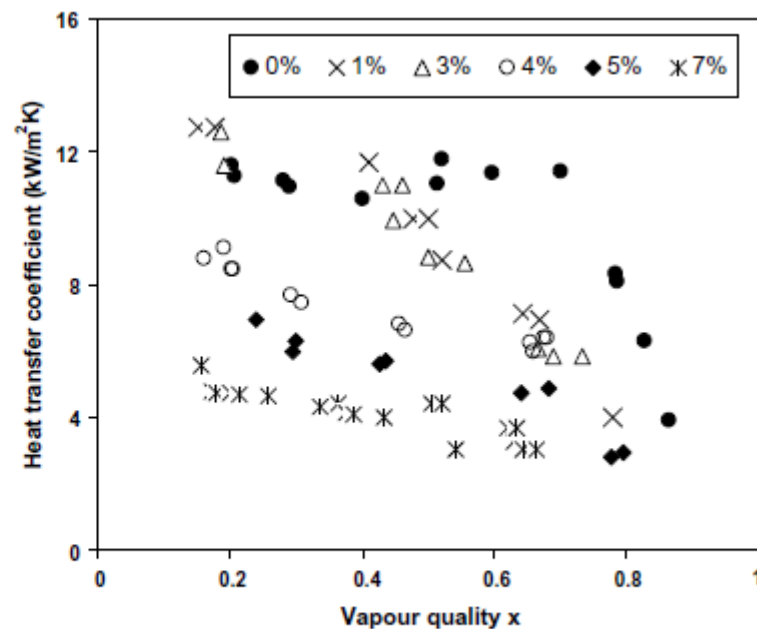
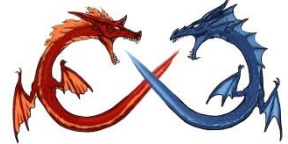


Fig. 3. Effect of oil concentration on h_{tp} (Zhao et al. [38]) at $G = 300 \text{ kg/m}^2 \text{ s}$, $T_{sat} = 10 \text{ }^\circ\text{C}$ and $q = 11 \text{ kW/m}^2$.



潤滑油對CO₂熱傳特性之影響 - 平滑管

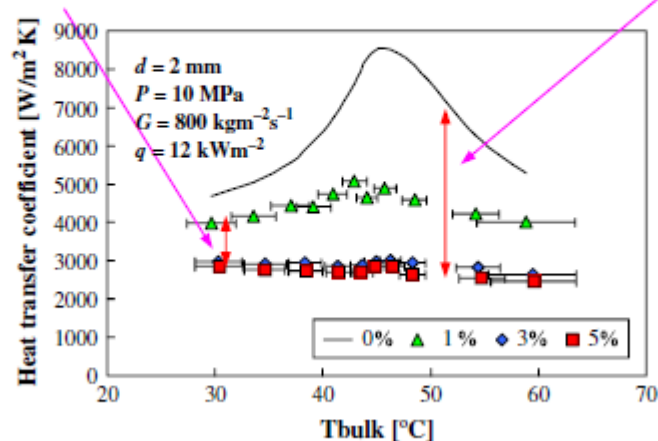
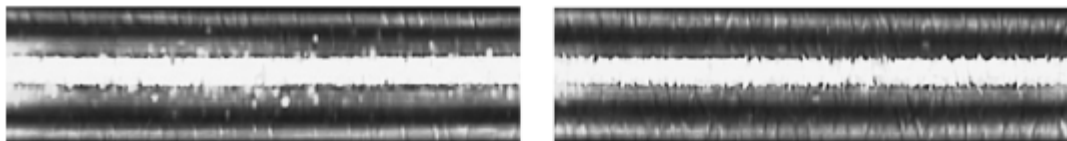


Fig. 9 – Flow pattern of CO₂-oil and heat transfer coefficient for 2 mm ID tube.

PAG type oil

Oil layer effect mainly @ 1~3%
Higher mass flux cause considerably degradation
(droplet vs. film)

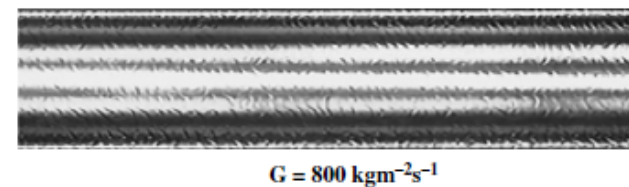
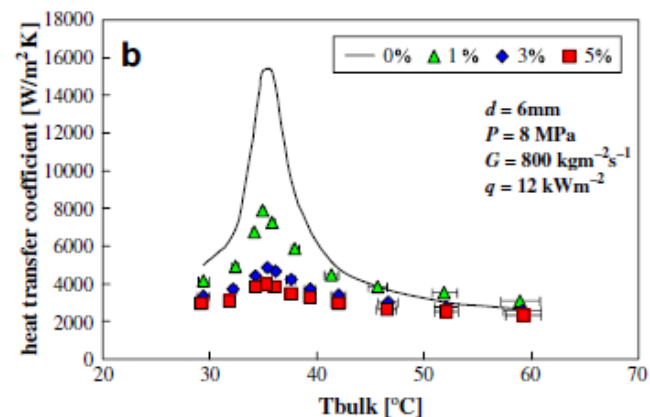
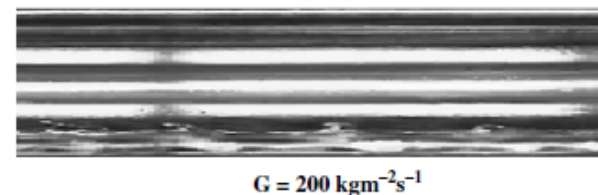
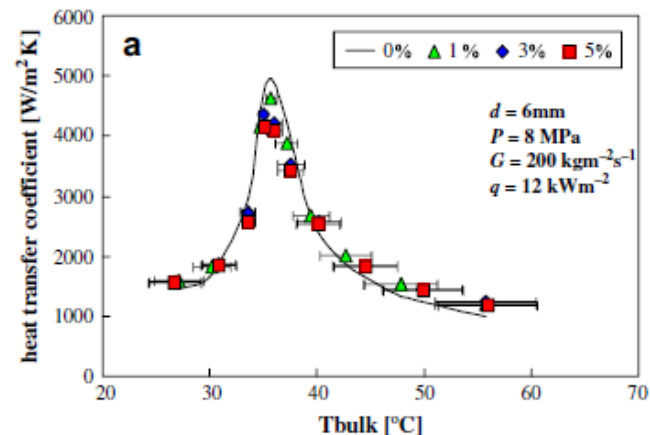


Fig. 10 – Flow pattern of CO₂-oil (40 °C) and heat transfer coefficient for 6 mm ID tube.

潤滑油對CO₂熱傳特性之影響 - 微鰭管

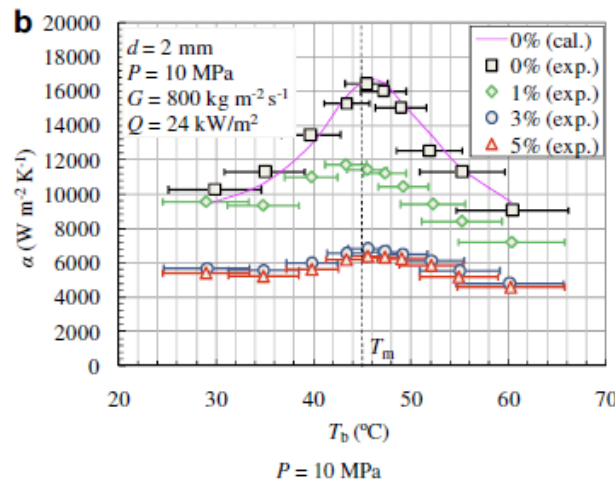
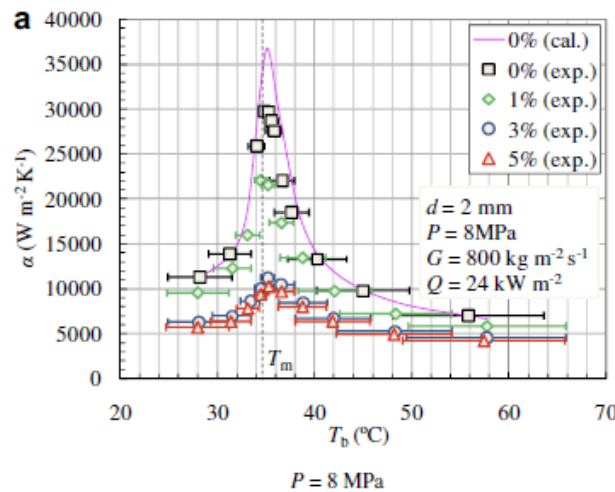
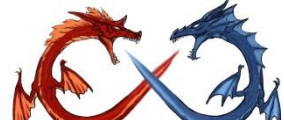


Fig. 7 – Change in α with T_b at different x values.

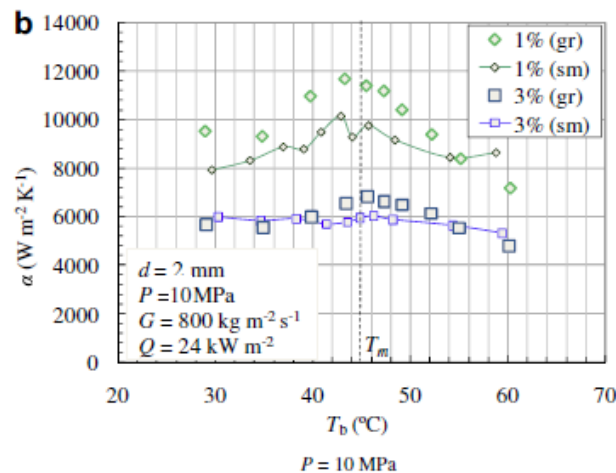
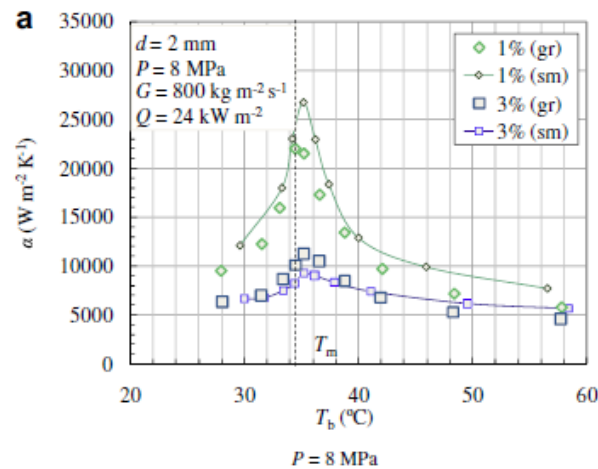


Fig. 8 – Comparison between the α values obtained for the grooved tube and smooth tube at $G = 800 \text{ kg m}^{-2} \text{s}^{-1}$.

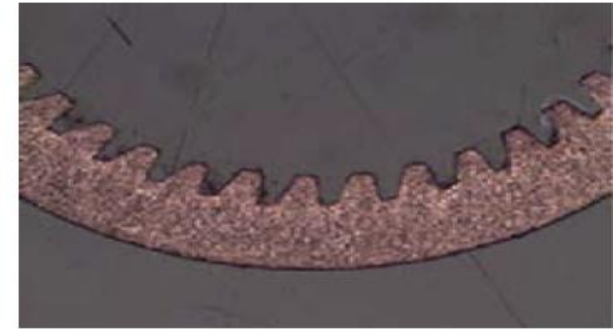


Fig. 2 – Enlarged view of cross-sectional shape of grooved tube.

Table 1 – Specifications of internally GROOVED tube.

O.D. [mm]	2.646	I.D. [mm]	1.996
Wall thickness [mm]	0.269	Fin height [mm]	0.117
Apex angle [°]	34.8	Helix angle [°]	6.3
Number of fins	40	Area enlargement ratio	2.0

Less effect of oil for microfin helps to break up the oil film



CO₂ 流動流譜 (潤滑油)

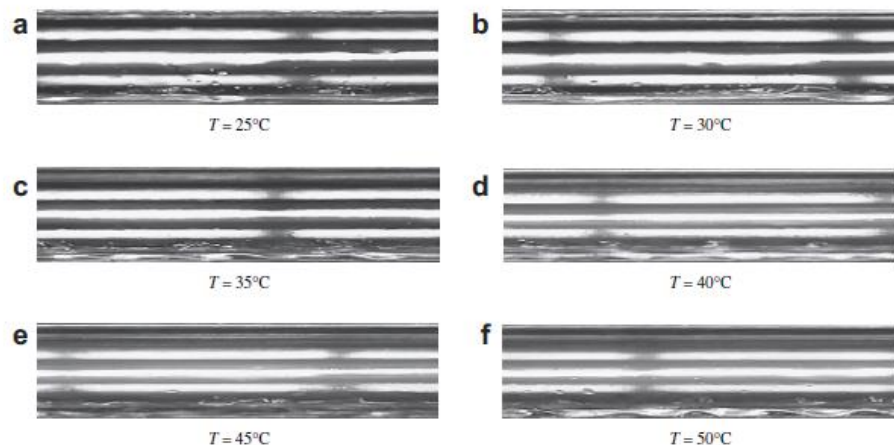


Fig. 6 – Comparison of flow pattern at different temperature for 6 mm ID tube; $d = 6$ mm, $P = 8$ MPa, $G = 200$ kg m⁻² s⁻¹, $x = 1\%$.

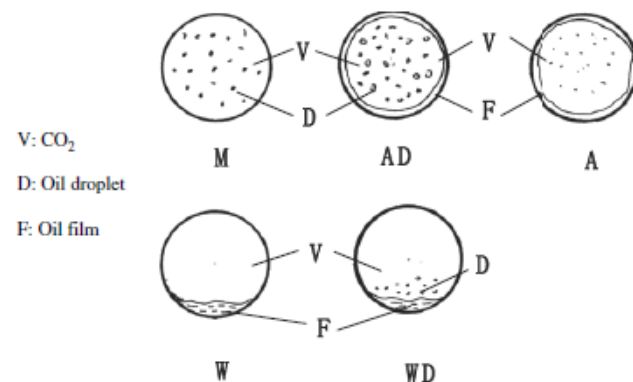


Fig. 4 – Classification of flow pattern. M: mist flow; AD: annular-dispersed flow; A: annular flow; W: wavy flow; WD: wavy-dispersed flow.

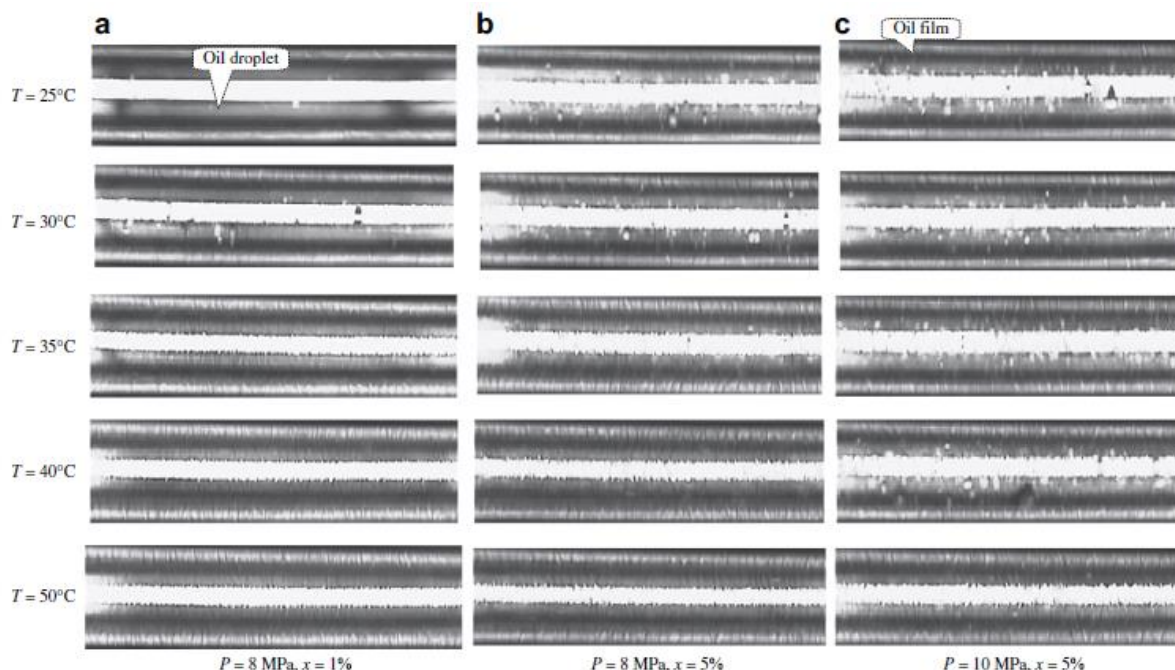
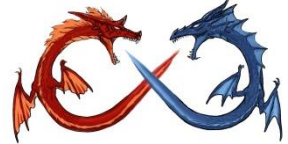


Fig. 5 – Flow visualization of CO₂ with entrained PAG oil; $d = 2$ mm, $G = 800$ kg m⁻² s⁻¹.



Conclusions

- 推薦Webb教授熱交換器性能的評價方法，評估熱傳性能有效改善，必須要有基本熱傳與壓降的數據。
- 熱傳型能的提升
 - $A \uparrow > h \uparrow > \Delta T \uparrow$
 - 增加面積有很多的side effect，與熱交換器型式及流體機械的使用有關聯
- 熱傳增強性能與流動型態有絕對的關係，相變化時差異尤其大，熱傳管的選取與評估應事先根據使用的工作流體、工作條件、流型轉換等因素的影響來考量
- 各式熱傳增強的開發與選擇仍需輔佐精確的實驗驗證
- 細徑化與LGWP冷媒為先今冷凍空調應用之傳熱管發展之重要方向
- 潤滑油對沸騰熱傳有相當的影響，使用上要特瞭解該油品與冷媒混合後的特性