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Instability in pool boiling of a wide boiling mixture on a horizontal tube

A. H. TARRAD and B. M. BURNSIDE
Department of Mechanical Engineering, Heriot-Watt University, Edinburgh, U.K.

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Abstract—Events occurring during pool boiling of the wide boiling range equimolar pentane/tetradecene mixture on a horizontal tube are described. Due to preferential evaporation of pentane, a film of liquid rich in tetradecene builds up on the lower part of the surface and breaks away from time to time causing fluctuation in the liquid temperature near the boiling surface. The effect of this phenomenon on heat transfer coefficients over a range of heat fluxes is discussed. It is shown that the measured heat transfer coefficients follow the same trend of variation with heat flux as that predicted by Schlünder. However, it is argued that this agreement is fortuitous and that no current prediction method may be used with confidence to estimate heat transfer coefficients of wide boiling range mixtures.

1. INTRODUCTION

THERE remain a number of unresolved problems to be solved before it can be said that circulation models for design of horizontal reboilers can be relied on completely [1–3]. This is particularly true when boiling mixtures. Concentration gradients build up near the boiling surface due to the greater rate of evaporation of the more volatile components. This reduces heat transfer rates by reducing bubble growth rates and by raising the bubble point at the heating surface above the bulk liquid value [4, 5].

A great deal of work has been done boiling mixtures on horizontal tubes in a pool [4–8]. This shows generally that boiling heat transfer coefficients, α, are less than an 'ideal' value, α_{ID}, based on the molar mean value, ΔT_{ID}, of the pure component wall superheats, at the system pressure

$$\Delta T_{ID} = X\Delta T_1 + (1-X)\Delta T_2 \quad \text{and} \quad \alpha_{ID} = q/\Delta T_{ID}. \tag{1}$$

The fall in α reaches a maximum at a bulk liquid composition, X_B, where the mass diffusion barrier to transfer of the more volatile components to the heated surface is greatest. This usually occurs where X_B corresponds to the greatest difference between dew and bubble point temperatures.

This paper describes pool boiling experiments on the equimolar pentane/tetradecene system at atmospheric pressure. Selected properties of this system are shown in Table 1 and the equilibrium diagram for the mixture in Fig. 1.

The difference between dew and bubble point temperatures of the equimolar mixture is 161°C, so that mass diffusion barriers to heat transfer are expected to be very high.

2. APPARATUS

A diagram of the boiler shell and tube section, 1, is shown in Fig. 2. The shell and backplate are brass, the tube section is 90 Cu : 10 Ni alloy and the front of the boiler is a toughened glass viewing window. The tube was machined and its surface reduced to a CLA roughness between 0.09 and 0.12 μm with emery cloth. Vapour rises into a condenser unit (not shown) which is vented to the atmosphere. Condensate is returned to the liquid surface, 5. Heating is supplied by a 250 W cartridge heater, 8, controlled by a variable transformer. Power is measured by a wattmeter. A cross-section of the tube and the seal to the backplate, 9, is shown in Fig. 2. Use of an insulating viton washer on the boiler side of the seal and a gasket at the back, together with a thick vermiculite block ensured that heat losses direct from the heater through the tube wall to the backplate were very low. At the window end, a short PTFE sleeve, 7, prevented direct heat loss to the glass.

Heat flux densities between 10 and 50 kW m^{-2} were used. At the lowest heat flux, therefore, the power supplied to the heater amounted to only 33 W rising to 167 W at 50 kW m^{-2}. Although the whole appar-

Table 1. Properties of the pentane/tetradecene system at 1 atm

	C_5H_{12}	$C_{14}H_{28}$	Equimolar mixture
T_b	36	251	62
T_d	—	—	223
ρ†	582	741	690
σ†	0.012	0.023	0.017
$10^3\mu$†	0.15	1.00	0.45
Δh_v†	333	—	—

† At bubble point of 62°C.

NOMENCLATURE

a	liquid thermal diffusivity [$\mathrm{m^2\ s^{-1}}$]
B_0	constant of equation (8)
c_p	liquid specific heat [$\mathrm{kJ\ kg^{-1}\ K^{-1}}$]
D	diffusion coefficient [$\mathrm{m^2\ s^{-1}}$]
Δh_v	latent heat of vaporization [$\mathrm{kJ\ kg^{-1}}$]
N_{Sn}	defined by equation (3)
p	pressure [$\mathrm{kN\ m^{-2}}$]
q	heat flux density [$\mathrm{kW\ m^{-2}}$]
T	temperature [°C]
ΔT	wall superheat [°C]
dT/dX	slope of bubble point line [°C]
X	liquid mole fraction of volatile component
Y	vapour mole fraction of volatile component.

Greek symbols

α	boiling heat transfer coefficient [$\mathrm{kW\ m^{-2}\ K^{-1}}$]
β_ℓ	mass transfer coefficient [$\mathrm{m\ s^{-1}}$]
μ	liquid viscosity [$\mathrm{N\ s\ m^{-2}}$]
ρ	liquid density [$\mathrm{kg\ m^{-3}}$]
σ	surface tension [$\mathrm{N\ m^{-1}}$].

Subscripts

b	boiling point
B	bulk liquid
C	Calus value [11]
c	critical point
d	dew point
I	interface
ID	ideal
ℓ	liquid
S	Schlünder value [12]
s	saturation
T	Thome value [9]
w	wall
1	pentane
2	tetradecene.

atus was covered with a thick layer of insulation, and the 6 mm thick window protected by a 3 mm transparent polycarbonate sheet, auxiliary heaters, 2, Fig. 2, had to be used to keep the liquid at its bubble point. To avoid any interference between convection currents generated by these heaters and pool conditions, a baffle system, 4, was developed by trial and error. This system also helped to avoid any non-uniformity of composition developing in the pool. That this was the case could easily be checked by the absence of refraction effects accompanying density gradients in the pool. During steady-state running, which usually took about 2 h to achieve, there was no boiling on the auxiliary heaters. The steady state was maintained by the return of condensate, which was practically pure pentane, to the liquid surface. The latter was maintained about 65 mm above the top surface of the heater.

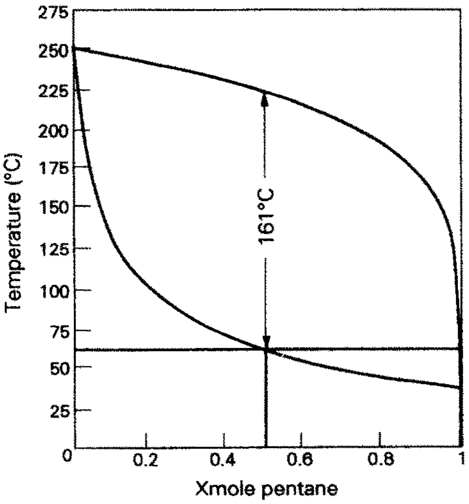

FIG. 1. Equilibrium diagram of pentane/tetradecene mixture at atmospheric pressure.

Chromel–alumel thermocouples soldered into the tube wall recorded temperatures. Three 0.5 mm overall diameter stainless steel sheathed thermocouples, 6, were positioned in the liquid at distances of about 0.5, 1.5 and 3 mm from the tube wall. Further out in the bulk liquid four 1 mm overall diameter thermocouples, 3, of the same type recorded the temperature. A port in the backplate, 10, Fig. 2, permitted the extraction of samples of bulk liquid for composition determination. The thermocouple e.m.f.s were recorded by a data logging system which could record temperatures at a rate of about 1 $\mathrm{s^{-1}}$.

Boiling tests on pentane were carried out on the same surface, also at 1 atm.

3. RESULTS

A series of runs was completed with heat flux densities, q, between 10 and 50 $\mathrm{kW\ m^{-2}}$. The results are shown in Fig. 3 and compared with data obtained in initial tests boiling pentane. In the figure the wall superheat ΔT is defined to be the difference between the wall temperature and the bubble point temperature of the bulk equimolar mixture. The latter was taken to be the mean value measured by the four thermocouples, 3, Fig. 2, surrounding the heater. The values of α, defined by the equation

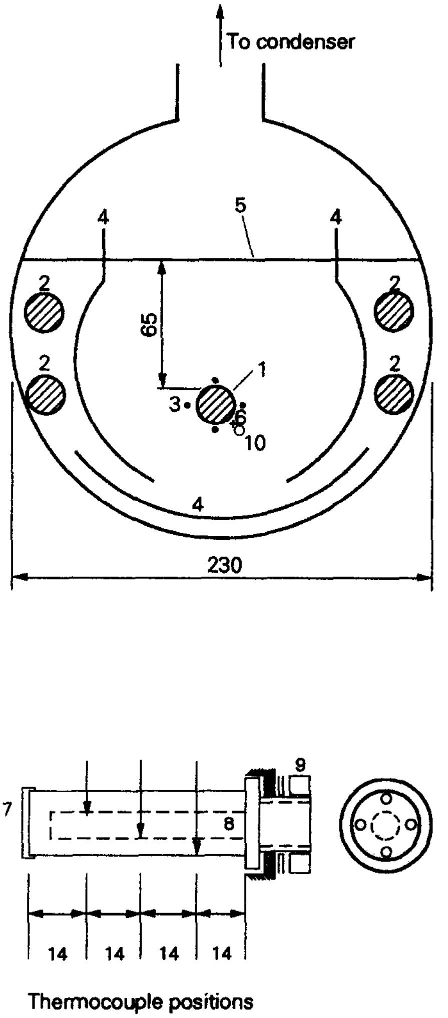

FIG. 2. Experimental boiler and tube section.

$$q = \alpha(T_w - T_B) \qquad (2)$$

varied from 0.42 kW m^{-2} K^{-1} at $q = 10$ kW m^{-2} to just less than 0.75 kW m^{-2} K^{-1} at 50 kW m^{-2} where ΔT reached nearly 70°C. The respective values of α_{ID} are 0.68 and 2.03 kW m^{-2} K^{-1}, considerably higher, Fig. 3.

An estimate of α/α_{ID} was made using Thome's equation [9]

$$(\alpha/\alpha_{ID})_T = N_{Sn}^{7/5} \qquad (3)$$

where the Scriven number, N_{Sn}, is defined as

$$N_{Sn} = \frac{1}{1-(Y-X)\left(\frac{a}{D}\right)^{1/2}\left(\frac{c_p}{\Delta h_v}\right)\frac{dT}{dX}}. \qquad (4)$$

For pure pentane boiling on the tube surface at 1 atm the data were fitted with an average standard deviation of about 1% by the equation

$$\alpha_1 = 0.20q^{0.67}. \qquad (5)$$

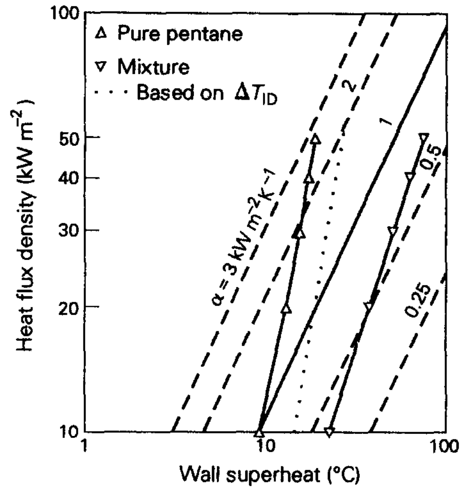

FIG. 3. Boiling curves for pure pentane and equimolar pentane/tetradecene mixture.

Since the normal boiling point of tetradecene was above the safe limit for the rig, the Mostinski generalized correlation [10] was used to determine its boiling curve

$$\alpha = 0.53 \times 10^{-3} p_c^{0.69} F(p/p_c) q^{0.7} \qquad (6)$$

where

$$F(p/p_c) = 1.8(p/p_c)^{0.17} + 4.0(p/p_c)^{1.2} + 10(p/p_c)^{10}.$$

Equation (6) reduces to $\alpha_2 = 0.11q^{0.7}$ for tetradecene and $\alpha_1 = 0.15q^{0.7}$ for pentane, at 1 atm. The predictions of equation (6) for pentane were between 12 and 18% lower than the measured values. This is within the margin of error expected for such a generalized correlation. In what follows, the measured pentane boiling data, equation (5), were used in preference to equation (6). Table 2 shows the calculated values of α_{ID}, Scriven number and α/α_{ID}. In the sixth row of the table the prediction according to Thome's relation, equation (3), is shown. The corresponding values calculated using the equation of Calus and Leonidopoulus [11]

$$(\alpha/\alpha_{ID})_C = N_{Sn} \qquad (7)$$

are shown in the fifth row of Table 2. In determining

Table 2. α/α_{ID} vs q pentane/tetradecene mixture, $X_B = 0.5$, 1 atm

q	10	30	50
α_{ID}	0.68	1.44	2.03
N_{Sn}	0.40	0.40	0.40
α/α_{ID}	0.59	0.42	0.35
$(\alpha/\alpha_{ID})_C$	0.40	0.40	0.40
$(\alpha/\alpha_{ID})_T$	0.28	0.28	0.28
$(\alpha/\alpha_{ID})_S$†	0.53	0.42	0.41

† $\beta_0 = 1.0$, $\beta_l = 1.2 \times 10^{-4}$ m s^{-1}.

the experimental value of the ratio ($\alpha/\alpha_{\mathrm{ID}}$), α_{ID} was based on the bulk liquid mixture composition, $X = 0.5$.

Similarly, Scriven number, liquid and vapour equilibrium compositions, the slope of the bubble point T–X curve and the properties were calculated at the bulk liquid equimolar composition and equilibrium bubble point temperature.

The last row in Table 2 shows $(\alpha/\alpha_{\mathrm{ID}})_{\mathrm{S}}$ predicted by Schlünder's equation [12]

$$\left(\frac{\alpha}{\alpha_{\mathrm{ID}}}\right)_{\mathrm{S}} = \frac{1}{1+\frac{\alpha_{\mathrm{ID}}}{q}(Y-X)\left(-\frac{\mathrm{d}T}{\mathrm{d}X}\right)\left[1-\exp\left\{\frac{-B_0 q}{\rho_\ell \beta_\ell \Delta h_{\mathrm{v}}}\right\}\right]}. \quad (8)$$

In equation (8), the constant B_0 was set equal to 1, as suggested by Schlünder [12]. Since no experimental data are available to estimate the mass transfer coefficient, β_ℓ, for the pentane/tetradecene mixture in the present circumstances, the value $\beta_\ell = 1.2 \times 10^{-4}$ m s^{-1}, was used here. This combination gave the best fit of $(\alpha/\alpha_{\mathrm{ID}})_{\mathrm{S}}$ to the experimental results, Table 2.

4. VISUAL OBSERVATIONS

An explanation for the extremely low values of heat transfer coefficient measured was afforded by visual observations.

4.1. $q = 50$ kW m^{-2}, $\Delta T = 70$°C

Boiling occurred only on the top half of the tube on about 40–50 sites. A stream of small bubbles with high frequency of departure emanated from each site. Density of sites was greatest in the middle of the tube although sites were active over the whole length. Looking at the tube from a number of different positions, a liquid film could be seen clearly on the bottom half. A sketch of the top side view is shown in Fig. 4. The film appeared to be about 1 mm thick at the bottom of the tube, becoming thinner towards the horizontal centre line. Above this it was discontinuous, being carried up to the top surface in waves by the convecting liquid around the tube, Fig. 4. Occasionally ripples could be seen at the bottom of the tube at the interface between film and bulk liquid.

Some of the liquid film became detached from the tube at regular intervals and was seen to disperse in the bulk liquid and disappear. This occurred at about 3–5 s intervals. Sometimes larger amounts of the film broke away from the tube more dramatically, Fig. 4. Beneath the film some small bubbles could be seen on the surface, apparently on sites rendered inactive by the film. None of these bubbles broke through the film except at the sides where it was thinnest and covered the surface only intermittently. In this position some sites became active from time to time. The stream of bubbles, rising from the top of the tube, was inclined at an angle of about 10° to the vertical.

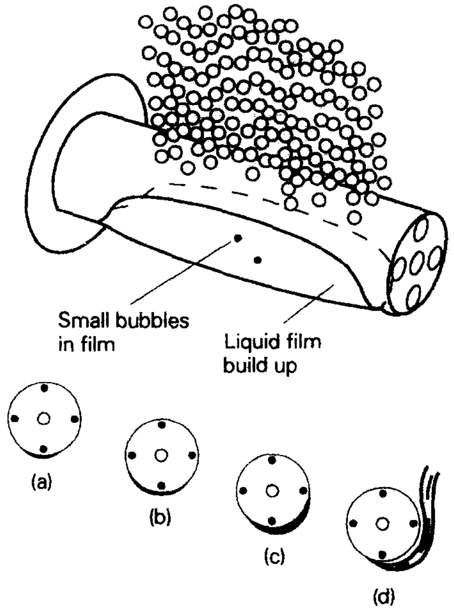

FIG. 4. Unsteady behaviour of rich tetradecene liquid film around the test tube.

There was no evidence from these observations that the tubewall temperature varied significantly around the circumference of the tube. Continuously monitored temperatures in the tube wall indicated unsteady temperatures in all positions. However, the thermocouple in the liquid, nearest the tube, indicated that the liquid temperature there fluctuated by as much as 17°C, Fig. 5. This showed that the film temperature

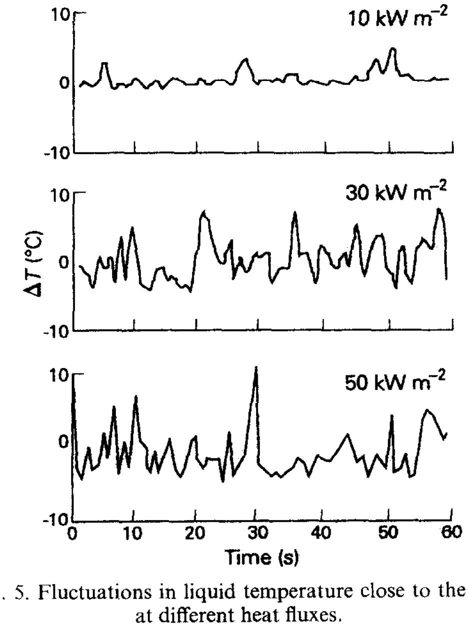

FIG. 5. Fluctuations in liquid temperature close to the wall at different heat fluxes.

was higher than the bulk value. Apart from this effect the measured bulk liquid temperatures were very close to the bubble point calculated from the measured composition of samples taken from the boiler.

4.2. $q = 30$ kW m^{-2}, $\Delta T = 50$°C

At 30 kW m^{-2}, again boiling occurred only on the top of the tube, with film occupying the bottom half as before. The number of active sites was reduced to about 30. Looking from below, the film could be seen streaming intermittently into the bulk liquid before dispersing and rising with it. The fact that the film seemed to be thicker towards the bottom of the tube, and that on leaving the surface its first motion was downward, suggests that it was tetradecene rich.

Again the bubble stream rising from the tube deviated from the vertical but the effect was less pronounced than at $q = 50$ kW m^{-2}. The peak to peak variation in temperature measured by the thermocouple in the liquid nearest the tube was reduced to 12°C, Fig. 5.

4.3. $q = 10$ kW m^{-2}, $\Delta T = 25$°C

At this heat flux only about seven boiling sites at the top of the tube were active. On boiling sites which had been active at the higher heat fluxes small bubbles could be seen trapped below the film. The film rose in waves to wash the top surface of the tubes suppressing all but the most active boiling sites. It broke away continually from the surface at either side of the tube. The bubble column rose vertically in this case because there was little or no circulation of detached film around the tube. The thermocouple nearest the tube showed a peak to peak fluctuation of about 4°C, Fig. 5.

5. DISCUSSION AND CONCLUSION

That the events described above could be seen is due to composition and density dependence of the refractive index of the liquid mixture. No data is available for the pentane/tetradecene mixture apart from pure pentane and tetradecene at 20°C, where the respective values of the refractive index are 1.358 and 1.435. This difference is partly a function of the difference in density, Table 1, and of the molecules of the two liquids. The same must be true of the mixture. Thus the interface between two regions of different composition at the same density, or of different densities, at the same composition, can be seen.

Compared to boiling pentane from the same surface the number of active boiling sites is much reduced when boiling the equimolar mixture. Because pentane is much more volatile than tetradecene the vapour produced is practically pure pentane, Fig. 1. This causes the build up of a mass diffusion film varying in composition from the bulk liquid value to a value richer in tetradecene adjacent to the surface. The surface tension of tetradecene is about twice that of pentane. Therefore, when there is a build up of concentration of tetradecene in the pores the wall superheat required for nucleation and growth rises. Further, the boiling temperature rises and those boiling sites which are covered by the film are rendered less active than if they contained bulk equimolar liquid mixture. At the top, where boiling does occur, it is noticeable that bubble size leaving the surface is smaller than when boiling pure pentane.

The production of pentane vapour releases tetradecene which feeds the film continuously. The equimolar liquid mixture contains 68% by volume of tetradecene. Therefore, the tetradecene rich film builds up rapidly and, its temperature may then rise without further boiling occurring. As a result of this, the tendency for its density to rise, as it becomes depleted in pentane, is counteracted by the rise in temperature which tends to reduce the density. Table 3 shows the dependence of the density of the pentane/tetradecene system on temperature and composition. It is evident that there is little change in density along the bubble point line from the equimolar mixture to $X = 0.1$, a range of about 70°C. The temperature of the liquid film is not likely to be far from its bubble point, so that it has much the same density as the surrounding equimolar bulk liquid. This explains the tendency for the film to remain on the tube wall down to the bottom of the tube rather than falling from the downward facing surface below the horizontal diameter, as it would if substantially denser than the surrounding liquid. The film and the surrounding liquid can be distinguished because of the difference in refractive index caused by their different compositions. Once portions of the film break away into the rising bulk liquid, they are carried up readily at first because their density is close to that of the bulk liquid. As they cool down by contact with the surrounding liquid, their density rises. However, at the same time they are dispersing in the surrounding liquid. The proposition that the film and bulk densities are of similar magnitude also explains the apparent ease with which the rising bulk liquid is able to carry the film upwards in waves on the surface. Oscillation of the film on the surface occasionally uncovers boiling sites with partially grown bubbles. Temporarily these sites become active before again being covered by the film.

The Schlünder correlation [12] predicts the measured trend of reduction of $\alpha/\alpha_{\mathrm{ID}}$ with increase in q very well, Table 3. β_ℓ was set equal to 1.2×10^{-4} m

Table 3. Density of pentane/tetradecene system at 1 atm

ΔT	0	25	50	70
T°C	62	87	112	132
X				
0.5	690			
0.3	714	696 (82°C)		
0.2	724	704	694 (102°C)	
0.1	733	714	694	675 (138°C)
0	741	723	712	689

s^{-1} so that the predicted values agree with the measurements at $q = 30\ \mathrm{kW\ m^{-2}}$. At $q = 10\ \mathrm{kW\ m^{-2}}$ the prediction is 10% lower than the measurement and 17% higher at $q = 50\ \mathrm{kW\ m^{-2}}$. Both the Thome [9] and Calus and Leonidopoulus [11] predictions contain no provision for variation with heat flux. The latter prediction is 32% lower than the measurements at $q = 10\ \mathrm{kW\ m^{-2}}$ but only 14% higher at $q = 50\ \mathrm{kW\ m^{-2}}$. The corresponding discrepancies of the Thome values from the measurements are 53 and 20% lower.

It is important to realize that the three correlations referred to above are based on the assumption that the number of nucleation sites active when boiling a mixture is the molar mean value of the pure liquid component boiling points at the same pressure. The experimental observations set out above, however, suggest that the number of nucleation sites active when boiling the pentane/tetradecene mixture is very much lower than this. Indeed, on a large part of the surface no boiling at all takes place. At first sight, therefore, it seems surprising that the measured heat transfer coefficients are higher than predicted. For example, at $q = 50\ \mathrm{kW\ m^{-2}}$ boiling occurred on about half of the tube. Therefore, if convection on the bottom half is ignored, the 'true' heat transfer coefficient on the half of the tube which is boiling is doubled. This makes it even higher than the predictions. However, at the wall superheat of 70°C obtained, convective heat transfer will be high, especially the enthalpy flux from the surface which accompanies the shedding of tetradecene rich film into the bulk liquid.

At the low average heat transfer coefficients on the tube it is possible that these modes of convection account for a greater heat flux density than exists on the area of the surface on which boiling does occur. If this were the case, the 'true' boiling heat transfer coefficient at the top of the tube would be lower than the overall measured value based on equation (2), bringing it closer to the predicted values. However, the correlations are largely untested at the levels of wall superheat required to sustain the heat flux densities of the tests. The comparisons with measured data suggest that they should not be used in their present form for very wide boiling mixtures and high wall superheats. This statement is made despite the apparently good agreement between the Schlünder prediction and the measurements.

In modelling mixture boiling, two heat transfer resistances are assumed to occur in series [12]. At the interface 'ideal' boiling takes place with temperature difference, $(T_W - T_I)$, without mass transfer resistance. Mass transfer resistance to heat transfer is assumed to occur between interface and bulk liquid with temperature difference $(T_I - T_B)$. It is logical therefore to use the interface mole fraction when calculating ΔT_{ID} and hence α_{ID} [12].

This mole fraction is unknown unless the bubble growth conditions are known. All three prediction methods used here contain approximations to remedy this. The main ones are that the difference between vapour and liquid equilibrium mole fractions is the same at the interface as in the bulk and that the slope of the bubble point line at the bulk composition is not too different from that at the interface composition. A glance at Fig. 1 shows that neither of these approximations is true for the wide boiling range pentane/tetradecene mixture. Consider the extreme case of about 70°C wall superheat at $q = 50\ \mathrm{kW\ m^{-2}}$. In early asymptotic growth at least, growing bubbles will be surrounded with liquid near this temperature. These 'interface' values of $(Y - X)$ and $\mathrm{d}T/\mathrm{d}X$ are 0.90 and −17°C compared to 0.5 and −83°C at the bulk equilibrium state. To this difficulty is added the inability of the predictions to allow for gross differences between the number of nucleation sites active when boiling the mixture and its pure components. Therefore, the relatively close agreement between experiment and theory for the equimolar pentane/tetradecene mixture is considered by the authors to be fortuitous.

The phenomena described above must have some bearing on the design of multitube boilers evaporating wide boiling mixtures. Clearly the strong scouring effect of the rising two-phase mixture will tend to reduce the thickness of the film which can build up before breakaway occurs. The relative wetting characteristics of the components at either end of the boiling range are clearly important. If the surface is preferentially wetted by a high boiling point component the effect could control boiling side heat transfer.

The use of enhanced surfaces under such conditions may be less effective than expected. Enhancement will only be an advantage if it is so great that the agitation due to growing and departing bubbles is sufficient to prevent build up of film on the boiling surface. Indeed in some cases the vapour trapped in manufactured pores on the surface, which form the nuclei for boiling, can be entirely replaced by the high boiling point liquid. The enhanced surfaces would then be no more effective than the plain ones they replace.

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INSTABILITE DANS L'EBULLITION EN RESERVOIR D'UN MELANGE A LARGE DOMAINE D'EBULLITION

Résumé—On décrit des faits qui apparaissent pendant l'ébullition en réservoir d'un mélange équimolaire pentane-tétradécène sur un tube horizontal pour un large domaine d'ébullition. A cause d'une évaporation préférentielle du pentane, un film de liquide riche en tétradécène se forme sur la partie inférieure de la surface et se brise en s'éloignant de temps à autre en causant une fluctuation de température du liquide près de la surface, L'effet de ce phénomène sur les coefficients de transfert est discuté pour un large domaine de flux thermiques. On montre que les coefficients de transfert mesurés suivent le même type de variation avec le flux thermique comme cela est prédit par Schlünder. Néanmoins cet accord est fortuit et il n'y a pas de méthode de prédiction utilisable avec confiance pour estimer les coefficients de transfert thermique pour des mélanges à large domaine d'ébullition.

INSTABILITÄT BEIM BEHÄLTERSIEDEN EINES WEITSIEDENDEN GEMISCHES AN EINEM WAAGERECHTEN ROHR

Zusammenfassung—Es wird über Beobachtungen beim Behältersieden des weitsiedenden äquimolaren Gemisches aus Pentan und Tetradekan an einem waagerechten Rohr berichtet. Aufgrund der bevorzugten Verdampfung von Pentan entsteht am unteren Teil der Oberfläche ein Flüssigkeitsfilm mit erhöhtem Tetradekan-Gehalt, der von Zeit zu Zeit aufbricht und dadurch Fluktuationen der Flüssigkeitstemperatur nahe der Siedeoberfläche verursacht. Der Einfluß dieses Phänomens auf die Wärmeübergangskoeffizienten wird in einem gewissen Bereich der Wärmestromdichte untersucht. Dabei zeigt sich, daß der Einfluß der Wärmestromdichte auf die gemessenen Wärmeübergangskoeffizienten qualitativ mit den Voraussagen von Schlünder übereinstimmt. Dennoch wird vermutet, daß diese Übereinstimmung eher zufällig ist und daß es kein gängiges Berechnungsverfahren gibt, mit dessen Hilfe Wärmeübergangskoeffizienten für weitsiedende Gemische zuverlässig abgeschätzt werden können.

НЕУСТОЙЧИВОСТЬ ПРИ КИПЕНИИ В БОЛЬШОМ ОБЪЕМЕ СМЕСИ НА ГОРИЗОНТАЛЬНОЙ ТРУБЕ

Аннотация—Описываются процессы, происходящие при кипении в большом объеме эквимолярной смеси пентан–тетрадецин на горизонтальной трубе в широком диапазоне изменения режимных параметров. Благодаря преобладающему испарению пентана в нижней части поверхности образуется пленка жидкости с большим содержанием тетрадецина, которая периодически срывается и вызывает флуктуацию температуры жидкости у поверхности кипения. Обсуждается влияние этого явления на коэффициенты теплопереноса в исследуемом интервале изменения теплового потока. Показано, что экспериментально найденные коэффициенты теплопереноса изменяются в зависимости от теплового потока в соответсивии с предсказаниями Шлюндера. Высказывается предположение, что полученное согласие является случайным и существующие методы определения не могут использоваться с уверенностью для оценки коэффициентов теплопереноса при кипении смесей в широком диапазоне режимных параметров.