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SCIENTIFIC PAPER

UDC 66.048.91:665.71

DOI 10.2298/CICEQ110625041S

## DEVELOPMENT OF A NEW CORRELATION FOR ESTIMATING POOL BOILING HEAT TRANSFER COEFFICIENT OF MEG/DEG/WATER TERNARY MIXTURE

*The pool boiling heat transfer coefficient of monoethylene glycol (MEG), diethylene glycol (DEG) and water ternary mixtures has been experimentally measured up to heat flux 114 kW/m<sup>2</sup> at various volumetric concentrations of MEG and DEG. As expected, the heat transfer coefficient was strongly taken as a direct function of heat flux. Existing well-known correlations are shown to be unable to predict the acceptable values for the tested ternary mixtures, particularly at different concentrations of MEG and DEG. Furthermore, a new modified correlation is developed on the basis of the Stephan-Preusser correlation that predicts the values of heat transfer coefficients with an absolute average error of about 7% that is reasonable and acceptable values compared to other existing correlations.*

*Keywords: pool boiling; heat transfer; ternary mixture; MEG; DEG.*

Nowadays, having enough knowledge about situation and estimating heat transfer coefficient values in any power cycles or phase changing processes related to boiling and condensation operations is a key parameter in optimizing and design calculations of heat transfer industries. Although many researchers have worked on various aspects of the boiling phenomenon in pure liquids and binary mixtures but a wide field of investigations on ternary mixtures have been untouched. The trusty prediction of heat transfer coefficient is one of the major illustrious factors for optimum and economic overall heating tools design [1–3]. Furthermore, understanding the mechanisms of boiling of mixtures and the prediction of their boiling heat transfer coefficients should be improved [4]. During the last few years, many researchers tried to correlate their experimental results using characterizations and physical properties of the boiling fluids. Several authors proposed that heat transfer coefficient in the nucleate boiling of mixtures depends on the concentration difference of the more volatile com-

ponent between the vapor and the liquid phase. For example, Stephan and Krorner [5] suggested that as this difference decreases, the boiling heat transfer coefficient increases. They proved that the minimum heat transfer occurs at the maximum wall superheat corresponding to the maximum value of concentration difference vapor and liquid phase for the more volatile component. Thome and Davey [6] worked on the influences of the liquid composition and the concentration difference on the bubble growth ratio of nitrogen-argon mixtures and showed that the bubble growth rate decreases linearly with concentration difference. Alpay and Balkan [7] showed that the decrease in boiling heat transfer rates generally observed in binary mixtures increases with increasing of heat flux and the minimum heat flux is obtained at the maximum concentration difference. Additionally, there are several research studies that showed that the heat transfer coefficient of saturated pool boiling of mixtures varies with the boiling range of mixture (the difference between the dew point temperature and bubble point temperature of mixture) and noted that whenever the boiling range is larger, the heat transfer coefficient of mixture is smaller [8–10]. Monoethylene glycol (MEG) and diethylene glycol (DEG) are the main components of anti-freeze and anti-boil liquids that are widely used in car radiators and cooling-heating systems. This research focuses on the boiling

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Paper received: 25 June, 2011

Paper revised: 3 September, 2011

Paper accepted: 10 September, 2011

heat transfer coefficient of MEG/DEG/water ternary mixture at various heat flux and concentrations. Some well-known correlations for estimating the pool boiling heat transfer coefficient in mixtures have been presented in Table 1. This research considers these correlations as a reference for comparing with obtained experimental data.

**EXPERIMENTAL**

Figure 1 exhibits the experimental setup that has been employed in this research. The horizontal

cylinder of the apparatus has 200 mm length and 21 mm diameter. The main vessel is made of stainless steel with dimensions 200 mm×100 mm×100 mm and a DC 1000-watt rod bolt heater that has been installed for generating the needed heat fluxes and also a 1500 W DC power supply has been used during the experiments steps as a source of power.

Fourteen K-type thermocouples have been installed at circumference of cylinder to measure the surface temperature and a PT type (PT-100) was employed for estimating the saturation temperatures of mixtures. Figure 2 schematically shows the details re-

*Table 1. Well-known correlations for estimating pool boiling heat transfer coefficients of mixtures (especially binary mixtures)*

Author	Presented correlation	Application	Ref.
Palen	$\frac{\alpha}{\alpha_{id}} = e^{[-0.027(T_{bo}-T_{bi})]}, \alpha_{id} = 0.225 \times \left(\frac{k_L}{d_b}\right) \left(\frac{q d_b}{\delta \mu_L}\right)^{0.69} \left(\frac{P d_b}{\sigma}\right)^{0.031} \left(\frac{\rho_l - \rho_v}{\rho_v}\right)^{0.33} \left(\frac{C p_L \mu_L}{k_L}\right)^{0.69}$	Binary	[21]
Stephan and Preußer	$\alpha_{Stephan} = 0.1 \left[\frac{k_L}{d_b}\right] \left[\frac{q}{k_L T}\right]^{0.674} \left[\left(\frac{\rho_v^2}{\rho_l}\right)^{0.156} \left[\left(H_{fg} d_b^2, k_L^2\right)^{0.371}\right]\right] \left[\frac{k_L^2}{(\delta d_b)^{0.35}}\right] \left[\left[\frac{\mu_L C p_L}{k_L}\right]\right]^{-0.162}$	Ternary and multi components	[26]
Calus-Rice	$\frac{\alpha}{\alpha_{id}} = \frac{1}{\left[1 +  y - x  \left(\frac{\hat{\alpha}}{D_{AB}}\right)^{0.5}\right]^{-0.7}}$	Binary	[19]
Jungnickel	$\frac{\alpha}{\alpha_{id}} = \frac{1}{1 + K_s  y - x  \left(\frac{\rho_v}{\rho_l}\right)^{0.48+0.1x}}, \alpha_{id} = x_1 \alpha_1 + x_2 \alpha_2$	Binary	[14]
Schlünder	$\frac{\alpha}{\alpha_{id}} = \left\{1 + \frac{h_{id}}{h} \left[\sum_{i=1}^{n-1} (T_{sn} - T_{si})(y_i - x_i) \times (1 - \exp\left(\frac{B_0 q}{\rho_L \delta \beta_{LL}}\right))\right]\right\}^{-1}, B_0 = 1, \dots, \beta_{LL} = 2E - 4m / s$	Ternary and multi components	[13]
Unal	$\frac{\alpha}{\alpha_{id}} = \frac{1}{[1 + (b_2 + b_3)(1 + b_4)][1 + b_5]}, b_2 = (1 - x) \ln \frac{1.01 - x}{1.01 - y} + x \ln \frac{x}{y} +  y - x ^{1.5}$ $\frac{x}{y} = 1$ for $x = y = 0, b_3 = 0, b_4 = 152 \times Pr^{3.9}, b_5 = 0.92 \times  y - x ^{0.001} \times Pr^{0.66}$	Binary	[20]
Bajorek <i>et al.</i>	$\frac{\alpha}{\alpha_{id}} = \left\{1 + \frac{h_{id}}{q} \left[\left(\frac{dT}{dx}\right)(y_1 - x_1) \times \left[1 - \phi_1 \frac{\exp(-\psi_2)}{\xi_1 - \xi_2} + \phi_2 \frac{\exp(\psi_2)}{\xi_1 - \xi_2}\right]\right]\right\}^{-1}$ $\phi_1 = D_{22} - D_{12} \left(\frac{y_2 - x_2}{y_1 - x_1}\right) - \xi_2, \phi_2 = D_{22} - D_{12} \left(\frac{y_2 - x_2}{y_1 - x_1}\right) - \xi_1$ $\psi_1 = \frac{k_1 q \xi_1}{\rho_1 \lambda \det[D] h_{id} \sqrt{l e}}, \psi_2 = \frac{k_1 q \xi_2}{\rho_1 \lambda \det[D] h_{id} \sqrt{l e}}$	Ternary	[22]
Thome	$\frac{\alpha}{\alpha_{id}} = \frac{1}{1 + \frac{\Delta T_{bp}}{\Delta T_{id}} \left[1 - \exp\left(\frac{-b_0 q}{\beta_1 \rho_1 H_{fg}}\right)\right]}$	Binary	[6]
Inoue	$\frac{\alpha}{\alpha_{id}} = \frac{1}{1 + K \frac{\Delta T_e}{\Delta T_{id}}}, K = 1 - 0.75 \exp(-0.75 \times 10^{-5} q)$	Binary	[15]
Fujita	$\frac{\alpha}{\alpha_{id}} = \frac{1}{1 + K \Delta T_e / \Delta T_{id}}, K = 1 - 0.75 \exp(-0.75 \times 10^{-5} q),$ $K = 1 - 0.75 \exp\left[\frac{-60q}{\rho v h_{fg}} \left(\frac{\rho_v^2}{\sigma g (\rho_l - \rho_v)}\right)^{0.25}\right]$	Binary, similar to Inoue	[9]
Vinayak-Balakrishnan	$\frac{\alpha}{\alpha_{id}} = \left[1 - \left( y - x  \sqrt{\frac{D_{AB}}{\hat{\alpha}}}\right)\right]$	Binary	[10]

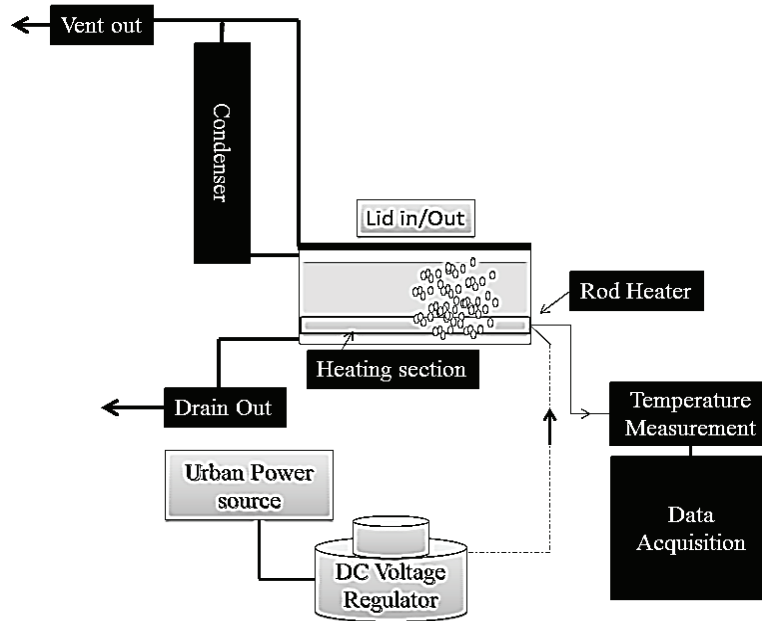


Figure 1. A scheme of pool boiling apparatus.

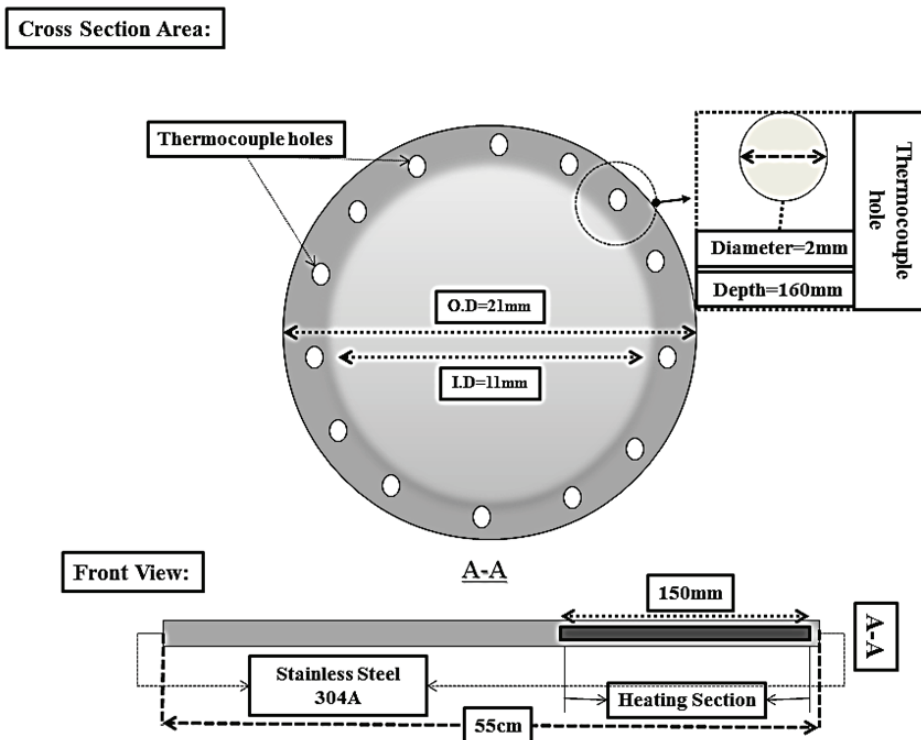


Figure 2. Schematic of heating section.

lated to the cross section of stainless steel horizontal cylinder. Additionally, to ensure elimination of surface roughness influence, the cylinder was polished by an emery paper ( $R_a = 400 \mu\text{m}$ ) several times. Also, high quality silicon paste was injected into the thermocouple wells to minimize the contact thermal resistance. To measure the uncertainty of experiment, ma-

thematical mean square method has been employed. According to heat flux estimating correlation:

$$q'' = \frac{VI}{2\pi r_0 L} = \frac{W}{2\pi r_0 L} \tag{1}$$

Experimental uncertainty is obtained by the following equation:

$$\Delta q'' = \sqrt{\left(\frac{\partial q''}{\partial w} \Delta w\right)^2 + \left(\frac{\partial q''}{\partial r} \Delta r\right)^2 + \left(\frac{\partial q''}{\partial L} \Delta L\right)^2} \quad (2)$$

Values for  $\Delta w$ ,  $\Delta r$  and  $\Delta L$  are 8.5, 0.3 and 0.03, respectively.

Accordingly, pool boiling heat transfer coefficient uncertainty, in respect to the obtained  $\Delta q''$  is obtained by the following equation:

$$\Delta \alpha = \sqrt{\left(\frac{\partial \alpha}{\partial q''} \Delta q''\right)^2 + \left(\frac{\partial \alpha}{\partial T} \Delta T\right)^2} \quad (3)$$

In this research,  $\Delta T$  equals to  $\pm 0.3$  °C according to accuracy of each thermocouple and  $\Delta q$  equals to 1.25% according to Eq. (2). Furthermore, the uncertainty of estimating heat transfer coefficient equals to  $\pm 4.8\%$ . More details are available in Figure 2.

To calculate the real surface temperature by correcting the minor temperature drop due to the small distance between surface and thermocouple location, the Furrier’s conduction equation is used as follows:

$$T_s - T_b = (T_s - T_b) - \left(\frac{s}{k}\right) \left(\frac{q}{A}\right) \quad (4)$$

where  $s$  is the distance between the thermocouple location and heat transfer surface and  $k$  is the thermal conductivity of the heater material. The value of  $s/k$  is determined for each thermocouple by calibration of the test heater. The average temperature difference was the arithmetic average of the fourteen thermocouple locations. The boiling heat transfer coefficient  $\alpha$  is calculated by the following equation:

$$\alpha = \frac{q}{(T_s - T_b)_{ave} A} \quad (5)$$

where  $T_s$  is the arithmetic average of fourteen thermocouples and  $T_b$  is the saturation temperature of the mixture,  $A$  is the side perimeter of the smooth cylinder at effected length which was 150 mm in this study. The main constituents of tested solutions, high quality MEG and DEG were provided from Marun Petrochemical Company, Iran.

**RESULTS AND DISCUSSION**

As the experimental data show, boiling heat transfer as well as bubble generation rate is a direct function of heat flux. Figure 3 represents the relation between experimental heat transfer coefficient and heat flux.

Additionally, the circumstances of bubble generation at different heat fluxes are another highlight for direct dependence of heat transfer coefficient on heat flux which is clearly demonstrated in Figure 4.

In fact, in comparison with experimental data and heat flux values, it is clear that with increasing heat flux, nucleate pool boiling heat transfer coefficient will strongly increase. Also, it is complicated to find direct or indirect parameters that influence the concentration of each component(s) and ternary mixture with heat transfer coefficient. As expected, the heat transfer coefficient of the mixture is less than that of pure state. Briefly speaking, due to the difference vapor pressures of mixture substances parti-

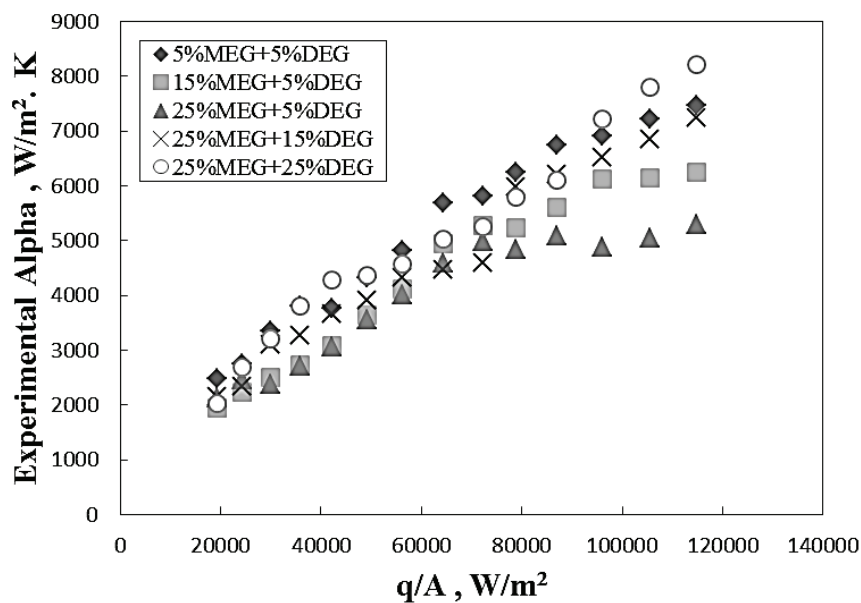


Figure 3. Presentation of experimental data at various heat fluxes and concentrations.

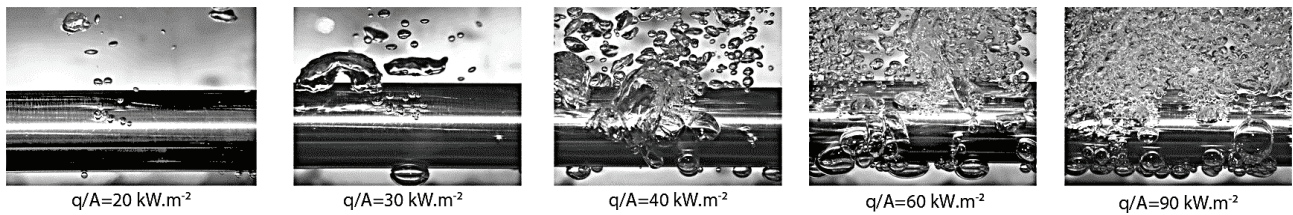


Figure 4. Circumstances of bubble generation at different heat fluxes.

cularly in vapor/liquid interface, heavier components remain in the interface zone and lighter components due to the higher vapor pressure leave the interface and mass transfer between the interface (enriched with heavier components) and vapor phase (the least heavier component phase) will be created. Therefore, mass transfer can be treated as a resistance against the heat transfer. However, this phenomenon is not observed in pool boiling of pure substance, because in pure pool boiling the interface is included with one component and the vapor phase is included with one component, too. On the other hand, regarding the higher heat transfer coefficient of DEG relative to MEG, it can be seen in Figure 3 that with increasing DEG concentration, heat transfer coefficient of mixture increases. Additionally, a deeper comparison with existing correlations is needed to propose a proper correlation for MEG/DEG/Water ternary mixture at various concentrations. Figure 5 presents a rough comparison between the obtained values and two well-known predicting correlations.

As shown, the Stephan and Preußer [26] and Schlünder [13] correlations are unable to predict acceptable values for ternary mixtures at various volu-

metric concentrations. Additionally, there are over predicting circumstances at other concentrations too. As seen in Figure 5, the Schlünder correlation and Stephan and Preußer correlation are not adopted with the experimental data. Similarly, the accuracy of these correlations in other volumetric concentrations of MEG and DEG is not reasonable, although Stephan and Preußer correlation predicts the better value in comparison with Schlünder correlation.

### Modeling

In fact, to estimate the boiling heat transfer coefficient accurately, a new correlation has been developed on the basis of Stephan and Preußer correlation [26] that was already used for binary and ternary mixtures. Schlünder has proposed a semi-empirical correlation for predicting the heat transfer coefficient in pool boiling condition. However, his proposed model does not provide reasonable values for the tested ternary solutions. Therefore, it is necessary to propose another correlation that is more accurate in comparison with the existing correlations. The results, particularly in Figure 5, indicate that the Stephan-Preußer correlation is more accurate in comparison

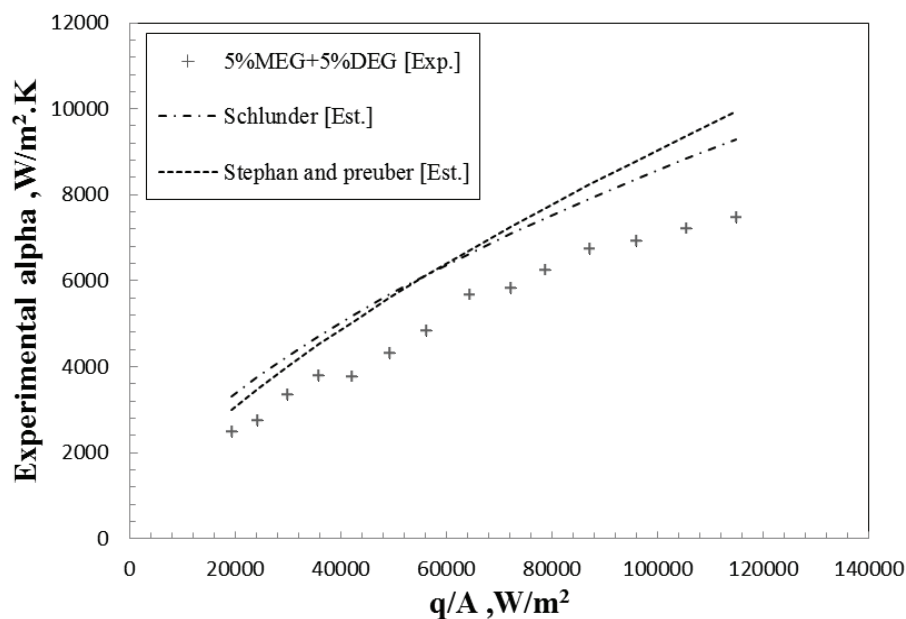


Figure 5. Experimental data in compare to obtained result of existing correlations at 5% MEG - 5% DEG volumetric.

with the other existing correlations. However, these values are not acceptable and this correlation needs to be modified. Mathematical and statistical calculations prove that substituting some of mentioned correlation exponents leads to enhancing its predicting ability compared to the original correlation form and other well-known existing correlations. It is important that correlations other than Schlünder and Stephan-Preußer that are not mentioned in this work had an unacceptable deviation in comparison with the experimental data. Therefore, they were not presented in Figure 5. Equations (6) And (7) present the original form of the Stephan-Preußer correlation and a modified redeveloped model based on the Stephan-Preußer correlation, respectively. Likewise, all the physical properties included in the correlations are estimated by existing correlations with the absolute average error lower than 10%. These relations are taken from Perry's Chemical Engineers Handbook [25]:

$$\alpha_{\text{Stephan}} = \left[ 0.1 \left( \frac{K_l}{d_b} \right) \left[ \frac{d_b}{q} \right] \left[ \frac{\rho_v}{\rho_l} \right]^{0.156} \left[ \frac{H_f d_b^2}{k_l^2} \right]^{-0.371} \right] \times \left[ \frac{k_l^2}{(\delta \cdot d_b)^{0.35}} \right] \left[ \frac{\mu_l C_{pl}}{k_l} \right]^{-0.162} \quad (6)$$

and modified correlation:

$$\alpha_{\text{Proposed}} = \left[ 0.1 \left( \frac{K_l}{d_b} \right) \left[ \frac{d_b}{q} \right] \left[ \frac{\rho_v}{\rho_l} \right]^{-0.2014} \left[ \frac{H_f d_b^2}{k_l^2} \right]^{-0.371} \right] \times \left[ \frac{k_l^2}{(\delta \cdot d_b)^{0.35}} \right]^{-0.9987} \left[ \frac{\mu_l C_{pl}}{k_l} \right]^{0.18} \quad (7)$$

As shown in Figure 6, the developed correlation estimates the pool boiling heat transfer coefficients more reasonable than the other correlations. For better understanding, these values have been presented at various volumetric concentrations of MEG and DEG in comparison with experimental measured data.

## CONCLUSIONS

Original research has been experimentally carried out on pool boiling heat transfer of monoethylene glycol (MEG), diethylene glycol (DEG) and water ternary mixtures at various volume concentrations of MEG and DEG up to heat fluxes 114 kW/m<sup>2</sup>. As expected, values of heat transfer were direct functions of heat flux, and increasing heat flux led to increase in

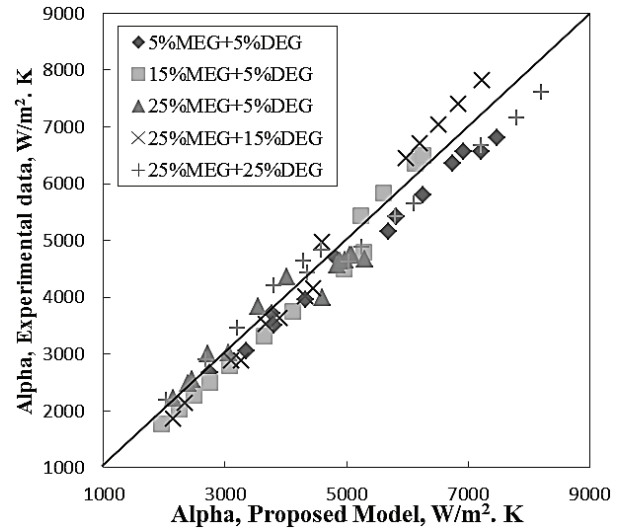


Figure 6. Proposed model prediction in compare to experimental data at all volumetric concentrations of tested mixtures.

the heat transfer coefficient. Most commonly used earlier correlations were unable to predict the values of heat transfer coefficient. Furthermore, a new correlation has been developed using optimization and mathematical method, providing reasonable values compared to other correlations with approximate experimental error close to 7%, while the for the well-known Schlünder and Stephan-Preußer correlations were 14 and 11%, respectively.

## Acknowledgements

Authors of this article tend to appreciate Islamic Azad University, Branch of Mahshahr for their financial and mental supports.

## Nomenclature

$A$	Area, m <sup>2</sup>
$b_0$	Ratio of the interfacial area of heat transfer to the interfacial area of mass transfer
$b_1$ - $b_5$	See Unal equation
$c$	Heat capacity, J kg <sup>-1</sup> K <sup>-1</sup>
$d_{ab}$	Diffusivity coefficient, m <sup>2</sup> s <sup>-1</sup>
$d_b$	Bubble departing diameter, m
$g$	Gravitational acceleration, m s <sup>-2</sup>
$h_{fg}$	Mass heat of vaporization, J kg <sup>-1</sup>
$k$	Thermal conductivity, W m <sup>-1</sup> K <sup>-1</sup>
$n$	Number of components
$p$	Pressure, Pa
$q$	Heat, J
$q''$	Heat flux, W m <sup>-2</sup>
$r_a$	Roughness, m
$r_o$	Cylinder outer diameter, m
$s$	Distance, m
$t$	Temperature, K
$w$	Power, W

$x$  Liquid mass or mole fraction

$y$  Vapor mass or mole fraction

#### Subscripts

$b$  Bulk

$c$  Critical

$i$  Component

$id$  Ideal

$l$  Liquid

$o$  Reference

$r$  Reduced

$s$  Saturated or surface

$th$  Thermocouples

$v$  Vapor

#### Greek symbols

$\alpha$  Heat transfer coefficient,  $W m^{-2} K^{-1}$

$\hat{\alpha}$  Thermal diffusion,  $m^2 s^{-1}$

$\beta$  Mass transfer coefficient,  $m s^{-1}$

$\Delta$  Difference

$\rho$  Density,  $kg m^{-3}$

$\sigma$  Surface tension, Dyne/cm, or somewhere  $N m^{-1}$

#### REFERENCES

- [1] W.R. McGillis, J.S. Fitch, W.R. Hamburg, V.P. Carey, Boiling binary mixtures at subatmospheric pressures, Technical Note TN-23, Western Research Laboratory, Palo Alto, California, USA, 1992
- [2] M. Jamialahmadi, A. Helalizadeh, H. Muller-Steinhagen, *Int. J. Heat Mass Tran.* **47** (2004) 729-742
- [3] E. Hahne, U. Grigull (eds.), *Heat transfer in boiling*, Hemisphere Publ. Corp., Washington, USA, 1977
- [4] Y. Fujita, Q. Bai, *Int. J. Refrig.* **20**(8) (1997) 616-622
- [5] K. Stephan, M. Korner, *Chem. Ing. Technol.* **41** (1969) 409-417
- [6] J.R. Thome, G. Davey, *Int. J. Heat Mass Tran.* **24** (1981) 89-97
- [7] H.E. Alpay, F. Balkan, *Int. J. Heat Mass Tran.* **32** (1989) 2403-2408
- [8] D. Jung, K. Song, K. Ahn, J. Kim, *Int. J. Refrig.* **26** (2003) 764-771
- [9] Y. Fujita, M. Tsutsui *Int. J. Heat Mass Tran.* **47** (2004) 4637-4648
- [10] G. Vinayak Rao, A.R. Balakrishnan, *Exp. Therm. Fluid Sci.* **29** (2004) 87-103
- [11] L.D. Boyko, G.N. Kruzhilin, *Int. J. Heat Mass Tran.* **10** (1967) 361-373
- [12] I.L. Mostinski, *Teploenergetika* **4** (1963) 66-71
- [13] E.U. Schlünder, *Int. Chem. Eng.* **23** (4) (1983) 589-599
- [14] H. Jungnickel, P. Wassilew, W.E. Kraus, *Int. J. Refrig.* **3** (1980) 129-133
- [15] T. Inoue, M. Monde, Y. Teruya, *Int. J. Heat Mass Tran.* **45** (2002) 4409-4415
- [16] J.R. Thome, S. Shakir, *AIChE Symp. Ser.* **83** (1987) 46-51
- [17] Y. Fujita, M. Tsutsui, *Int. J. Heat Mass Tran.* **37** (1994) 291-302
- [18] B. Xiao, B. Yu, *Int. J. Therm. Sci.* **46** (2007) 426-433.
- [19] W.F. Calus, P. Rice, *Chem. Eng. Sci.* **27** (1972) 1687-1697
- [20] H.C. Unal, *Int. J. Heat Mass Tran.* **29** (1986) 637-640
- [21] J.W. Palen, W. Small, *Hydrocarb. Process.* **3** (1964) 199-208
- [22] S.M. Bajorek, J.R. Lioyd, J.R. Thome, *AIChE Symp Ser.* **85** (1989) 54-59
- [23] K.G. Joback, M.Sc. Thesis, Massachusetts Institute of Technology, Cambridge, MA, 1984
- [24] C.F. Spencer, R. P. Danner, *J. Chem. Eng. Data* **17** (1972) 236
- [25] B.E. Poling, G.H. Thomson, D.G. Friend, R.L. Rowley, W.V. Wilding, *Perry's chemical engineers handbook*, 8<sup>th</sup> ed., McGraw Hill, New York, 2008, p. 513
- [26] K. Stephan, P. Preusser, *Ger. Chem. Eng.* **2** (1979) 161-169.

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NAUČNI RAD

## KORELACIJA ZA IZRAČUNAVANJE KOEFICIJENTA PRENOSA TOPLOTE PRI KLJUČANJU ZASIĆENIH TERNERNIH SMEŠA MONOETILEN GLIKOL/DIETILEN GLIKOL/VODA

*Koeficijent prenosa toplote za monoetilen glikol (MEG), dietilen glikol (DEG) i njihove ternerne smeše sa vodom eksperimentalno su merene pri ključanju zasićene tečnosti na različitim fluksovima toplote do 114 kW/m<sup>2</sup> i pri različitim koncentracijama MEG i DEG. Kao što se očekivalo, koeficijent prenosa toplote je direktna funkcija fluksa toplote. Pokazano je da postojeće, dobro-poznate korelacije ne mogu biti korišćene za predviđanje koeficijenta prenosa toplote za ispitivane ternerne smeše. Zbog toga je razvijena nova korelacija zasnovana na Stephan-Preusser-ovoj korelaciji koja predviđa vrednosti koeficijenta prenosa toplote sa srednjom apsolutnom greškom od oko 7%, što je prihvatljivo u poređenju sa drugim korelacijama.*

*Ključne reči: ključanje zasićene tečnosti, prenos toplote, ternerne smeše, MEG, DEG, voda.*