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Technical Note

A note on the confusion associated with the interfacial heat transfer coefficient for forced convection in porous media

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ABSTRACT

This note is provided to clear away possible confusion associated with the correlation proposed by Kuwahara et al. (2001) [1] for the interfacial heat transfer coefficient for forced convection in porous media.

1. Introduction

Our paper on the interfacial heat transfer coefficient for forced convection in porous media [1] came out in 2001. In this paper, the details of determining the interfacial heat transfer coefficient were described using a periodic structure, which, then, inspired a considerable number of investigators to determine macroscopic heat and fluid flow characteristics by integrating the microscopic numerical results over a periodic structure unit.

However, in 2010, Pallares and Grau [2] found out a substantial difference between our numerical prediction and that reported by Gamrat et al. [3]. Thus, Pallares and Grau [2] carried out numerical experiments using the same staggered arrangement of square rods as that used in the two previous studies. They noted, according to their simulations, if the right hand side of our correlation (as given by Eq. (21) in [1]) is multiplied by a factor of two, the results of the two studies and those of theirs are equivalent and also in good agreement with the experimental data collected by Wakao and Kaguei [4]. Thus, they modified our correlation as follows:

$$\frac{hD}{k}=\left(2+\frac{8(1-\varepsilon)}{\varepsilon}\right)+(1-\varepsilon)^{1/2}\left(\frac{u_D D}{\nu}\right)^{0.6}\mathrm{Pr}^{1/3} \tag{1}$$

Note h is the interfacial heat transfer coefficient, whereas k, ν, Pr, D, u_D and ε are the fluid thermal conductivity, kinematic viscosity, Prandtl number, rod size, Darcian velocity and porosity, respectively.

In this note, I would like to clear away possible confusion associated with our correlation for the interfacial heat transfer coefficient. Our publication record shows that the original version of the paper [5] written in Japanese was submitted to the Japanese Society of Mechanical Engineers, Aug. 25, 1999 and published in Trans. JSME Ser. B, May 2000. In this original version, the correlation for h (as given by Eq. (24) in [5]) was correctly provided:

$$\frac{hD}{k}=\left(2+\frac{12(1-\varepsilon)}{\varepsilon}\right)+(1-\varepsilon)^{1/2}\left(\frac{u_D D}{\nu}\right)^{0.6}\mathrm{Pr}^{1/3} \tag{2}$$

which is almost identical to the foregoing modified Eq. (1) proposed by Pallares and Grau [2].

Following the original version, its English translation was submitted to Int. J. Heat Mass Transfer, Jan. 12, 2000, and published in March 2001. However, the correlation (as given by Eq. (21) in [1]) was written somehow erroneously as

$$\frac{hD}{k}=\left(1+\frac{4(1-\varepsilon)}{\varepsilon}\right)+\frac{1}{2}(1-\varepsilon)^{1/2}\left(\frac{u_D D}{\nu}\right)^{0.6}\mathrm{Pr}^{1/3} \tag{3}$$

Most unfortunately, this error has been overlooked for many years. On behalf of the authors, I would like to apologize for this confusion and conclude that either Eq. (1) as proposed by Pallares and Grau or Eq. (2) as originally proposed by us may be used for the estimation of the interfacial heat transfer coefficient in porous media. However, at low Reynolds number, Eq. (2) is recommended since the effect of the porosity on $\frac{hD}{k}\big|_{(\frac{u_D D}{\nu})\to 0}$ is more faithfully described by $\left(2+\frac{12(1-\varepsilon)}{\varepsilon}\right)$

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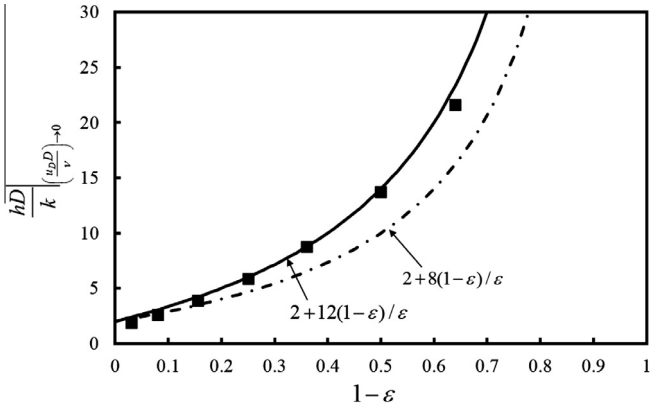

Fig. 1. Comparison of two correlations.

than $\left(2+\frac{8(1-\varepsilon)}{\varepsilon}\right)$ as can be seen from Fig. 1 which compares the two functions with the numerical data appeared in Fig. 7 in the original paper [5].

Conflict of interest

None declared.

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