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Technical Note

If the Dittus and Boelter equation is really the McAdams equation, then should not the McAdams equation really be the Koo equation?

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ABSTRACT

In his technical note "Where did the Dittus and Boelter equation come from?", R.H.S. Winterton showed the likely creator of the modern version of the Dittus and Boelter equation was actually McAdams. The following note further investigates Winterton's claim and finds conclusive evidence that the Dittus and Boelter equation did indeed originate with McAdams. The fortuitous combination of the "so-called" McAdams equation for smooth tube friction factor with the Reynolds analogy provides the leading coefficient of 0.023. McAdams actually attributes the usage of fluid bulk properties to his form of the equation to the work of Dittus and Boelter. Along the way, it was also found that what is commonly known as the McAdams equation for smooth tube friction factor is actually the work of E.C. Koo, his graduate student.

This is a response and addition to the technical note "Where did the Dittus and Boelter equation come from?" by Winterton [1].

If one carefully reads the second edition of McAdams *Heat Transmission* [2], it is quite obvious that the equation regarded as unreferenced by Winterton,

$$\frac{hD}{k} = 0.023\left(\frac{DG}{\mu}\right)^{0.8}\left(\frac{c_p\mu}{k}\right)^{0.4}. \tag{1}$$

Eq. (4c) in the original work, is clearly attributed to Sherwood and Petrie. It is quite simply a typographical error on the part of McAdams (or possibly G.C. Williams). The original value of the leading coefficient for Sherwood and Petrie was 0.024.

Again if one reads carefully, the third edition of McAdams [3] obviously attributes the usage of bulk properties in the equation of form (1) to the work of Dittus and Boelter [4] and not the equation itself.

If one consults all three editions of McAdams work [2,3,5], it is plain to see his partiality to the work of Colburn where the leading coefficient is 0.023. The error could have been fortuitously created from the McAdams turbulent smooth tube friction factor correlation,

$$f = 0.184\mathrm{Re}^{-0.2}, \tag{2}$$

placed in the Reynolds analogy

$$\mathrm{St} = f/8. \tag{3}$$

This would give

$$\mathrm{Nu} = 0.023\mathrm{Re}^{0.8}\mathrm{Pr}, \tag{4}$$

which is surprisingly similar to the equation under question (Eq. (1)). Possibly the alteration was to enhance the link between his work on friction factor and the preceding works.

Another curious fact is the popular naming of the so-called McAdams correlation in Eq. (2), which is actually attributed by McAdams in all his editions to his graduate student Koo, see [6]. It might be an exercise in futility to find the origins of this misattribution. Most likely it is due to the fact that the equation is presented in McAdams' book.

In conclusion, I believe that Winterton is right with regards to the origin of Eq. (1) as McAdams. I say the fact that 0.184/8 = 0.023 is hard evidence that the leading coefficient came from McAdams. McAdams did not try to claim the correlation as his own or as an alteration or improvement made by him, which it apparently is. The continued misattribution of both of these equations shows some slip in thoroughness, luckily to the misfortune of no one. Nevertheless, engineers should take great care when using correlations of any kind. One should always thoroughly double check their references, rather than trusting word of mouth or reproductions.

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