ABSTRACT

Overall Convective Heat Transfer from Pipes

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The most popular correlations for free convection from horizontal pipes, free convection from inclined pipes, pipes in crossflow and in mixed convection conditions were selected through review of literature, and experimental data was used in these equations to produce values of Nusselt number for each correlation which were compared with $Nu_{experimental}$. None of the correlations were able to accurately represent the experimental data, with each showing varying degrees of deviation from the experimental. A semi – empirical mathematical model was developed to represent mixed convection from inclined pipes and was verified in the test range of $565<Re<2065$ and $1.56(10)^5<Ra<4.61(10)^5$.

Experiments were conducted on two Sch40 steel pipes of outer diameter 0.038 m and 0.05 m and tested at a heater input of 120 W at air velocities of 0m/s, 0.3m/s, 0.5m/s and 0.75 m/s. This simulated practical conditions experienced in industrial plants. Each pipe was tested at positions of 0, 15, 30, 45, 60, 75 and 90 degrees to the horizontal. The values of the heat transfer coefficient $h_{experimental}$ and Nusselt number $Nu_{experimental}$ both decreased with increasing angle of inclination from the horizontal.

The proposed equation $Nu_{theoretical} = 0.583\,\mathrm{Re}^{0.471}\,\mathrm{Pr}^{1/3}\left[1+\frac{Gr}{\mathrm{Re}^2}\cos\theta\right]^{0.298}$ was able to theoretically satisfy both the changing angle of inclination and also incorporate the contribution of both forced and free convective heat transfer. The proposed correlation was an excellent fit to the experimental data, showing variation no greater than 5% between the theoretical and experimental values of Nusselt number.

Keywords: Kimberly Ramroop, Angle of Inclination, Mixed Convection, Inclined Pipe, Nusselt Number