Heat Transfer to Granular Flows

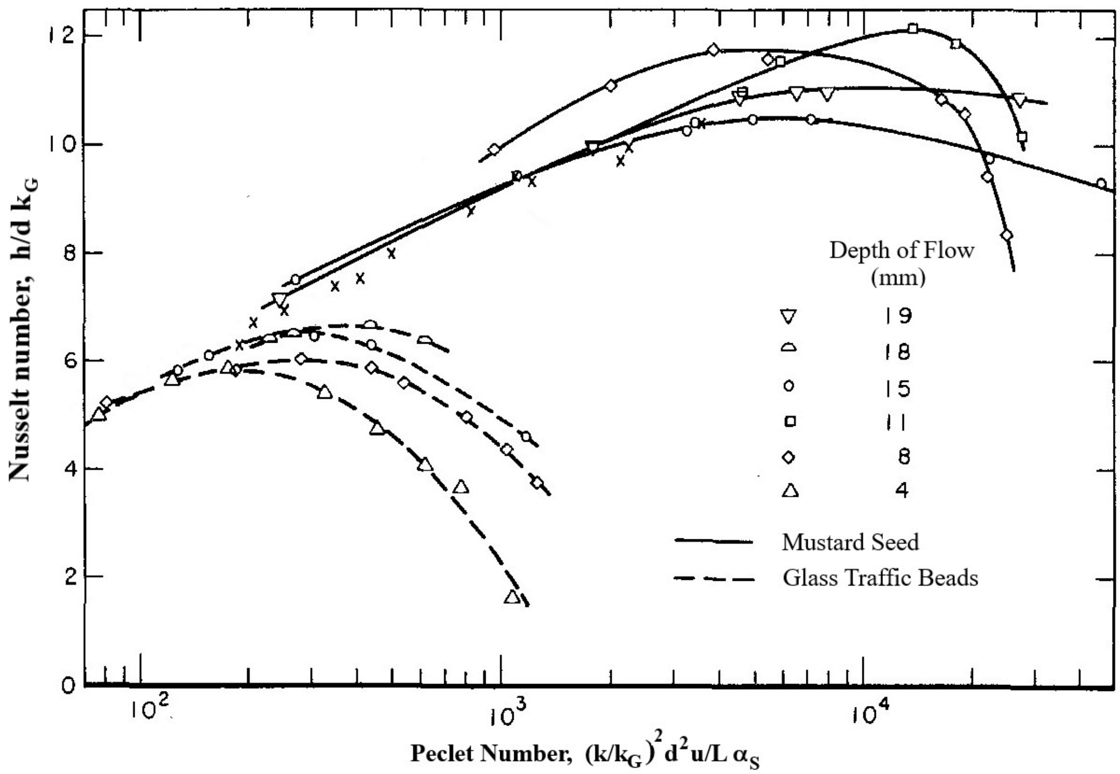

Figure 1: Data from Spelt *et al.* (1982) on the heat transfer from a heated plate to the granular flow in a chute. The heat transfer coefficient, h, is plotted as the Nusselt number, hd/k_G, against the flow velocity, u, plotted as the Peclet number, $(k/k_G)^2d^2u/L\alpha_S$. Data is shown for various depths of flow in the chute and for two different granular materials, glass traffic beads ($d = 0.33mm$) and mustard seed ($d = 2.1mm$).

Spelt *et al.* (1982) measured the heat transfer to a granular flow in a chute from a heated plate embedded in the base of the chute. They present the heat transfer coefficient, h, plotted as the Nusselt number, hd/k_G (where d is the particle diameter and k_G is the thermal conductivity of the gas phase), against the flow velocity, u, plotted as the Peclet number, $(k/k_G)^2d^2u/L\alpha_S$ (where u is the flow velocity, k is the thermal conductivity of the particle material, L is the length of the conducting plate and α_S is the thermal diffusivity of the particle material). The data is shown in Figure 1; note that the choice of the forms of the Nusselt and Peclet numbers has collapsed the data for the various depths of flow in the chute. Moreover, at the lower velocities the data for the two different granular materials appear to align.

At lower velocities or Peclet numbers the heat transfer or Nusselt number increases as one would expect with increase in the velocity. However, at higher velocities or Peclet numbers the heat transfer reaches a peak and thereafter declines at even higher velocities. For each of the two materials, the peaks are almost independent of the flow depth. Spelt *et al.* ascribe this to the decrease, at higher velocities and shear rates, of the solids fraction in the granular flow near the base. This unusual trend conforms with the evolution of a granular chute flow at higher velocities (see section (Npq)).