

In selecting a design velocity, it should be recognised that at high velocities high rates of heat transfer are achieved and fouling is reduced, but pressure drops are higher. Normally, the velocity must not be so high as to cause erosion which can be reduced at the tube inlet by fitting plastic inserts, and yet be such that any solids are kept in suspension. For process liquids, velocities are usually 0.3–1.0 m/s in the shell and 1.0–2.0 m/s in the tubes, with a maximum value of 4.0 m/s when fouling must be reduced. Typical water velocities are 1.5–2.5 m/s. For vapours, velocities lie in the range 5–10 m/s with high pressure fluids and 50–70 m/s with vacuum operation, the lower values being used for materials of high molecular weight.

In general, the higher of the temperature differences between the outlet temperature of one stream and the inlet temperature of the other should be 20 deg K and the lower temperature difference should be 5–7 deg K for water coolers and 3–5 deg K when using refrigerated brines, although optimum values can only be determined by an economic analysis of alternative designs.

Similar considerations apply to the selection of pressure drops where there is freedom of choice, although a full economic analysis is justified only in the case of very expensive units. For liquids, typical values in optimised units are 35 kN/m<sup>2</sup> where the viscosity is less than 1 mN s/m<sup>2</sup> and 50–70 kN/m<sup>2</sup> where the viscosity is 1–10 mN s/m<sup>2</sup>; for gases, 0.4–0.8 kN/m<sup>2</sup> for high vacuum operation, 50 per cent of the system pressure at 100–200 kN/m<sup>2</sup>, and 10 per cent of the system pressure above 1000 kN/m<sup>2</sup>. Whatever pressure drop is used, it is important that erosion and flow-induced tube vibration caused by high velocity fluids are avoided.