TECHNICAL BULLETIN April 2011

LOW VELOCITY HEADERS FOR LTHW HEATING SYSTEMS

Clyde's Engineering Data Sheets require the inclusion of a Low Velocity Header (LVH) whenever a condensing boiler is installed in a new or existing heating system. It 'hydraulically decouples' the boiler from the distribution system, allowing the boiler to operate under temperature and flow conditions that may differ from those of the system. It also enables circulating pumps to be located at different positions on the boiler side and system side of the LVH (eg in the return on the boiler side and in the flow on the system side) without affecting their performance.

As an alternative, a plate heat exchanger can be used to completely separate a boiler from the system rather than just 'decouple' it. It enables a boiler to be used when its maximum allowable pressure rating is less than the static head of the system and will protect the boiler from the deposition of system particulates and debris. This protection will also be provided by a LVH that is fitted in conjunction with a filter or strainer. However, decoupling the boiler with a LVH rather than separating it with a plate heat exchanger offers some significant advantages that can be summarised as;

- Permits distribution pumps to be located on the flow, even though boiler pumps may be located on the return
- Enables effective heat exchange between boilers and the system when these are operating at different flow rates and different temperature gradients eg boilers at DT20K and system at DT11K.

This bulletin will consider some computer-generated thermal modelling that demonstrates how a correctly dimensioned LVH will bring together a boiler and a system working at different flow rates and temperatures.

Fig 1 below shows a typical vertical LVH.

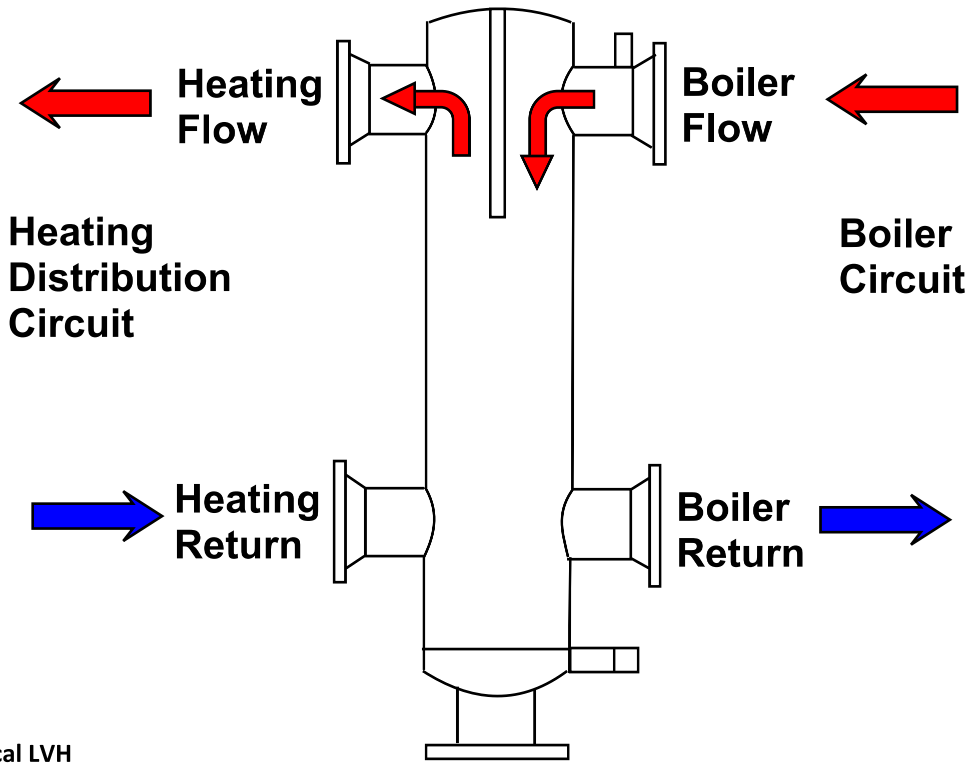


Fig 1 Typical vertical LVH

An air separator is often mounted at the top of the LVH because the relative stillness allows dissolved oxygen to escape from the water. A baffle plate may be fitted, as shown in fig 1 between boiler flow and heating flow, to divert and further reduce the water flow rate. If the LVH is also intended to act as a microbubble air separator, then a packing may be introduced into the area of laminar flow to which the microbubbles can attach and be removed by the air vent.

Most systems will have a turbulent flow (ie Re > 10,000[1] - refer to the Moody Chart in Fig 5). Due to the increased diameter of the main section of pipe forming the LVH, the mass flow rate of the system at this point is reduced to something closer to laminar (f [friction coefficient] = 16 / Re). The LVH diameter is calculated as a product of relative roughness (k / d) of the construction material, fluid density and mass flow rate. The ideal LVH diameter (d) is that which delivers the most suitable Re number[2]. Taking into account the different temperatures and flow rates that may exist between the Boiler side (Primary) and System side (Secondary) of the LVH is important in determining the correct sizing. A common complaint when this is not considered is that the boiler reaches set point temperature but the system does not.

Fig 2 demonstrates the typical temperature stratification that would be expected when there is equal temperature differential (DT), flow and pressure on both the primary and secondary sides of the LVH, the ideal situation.

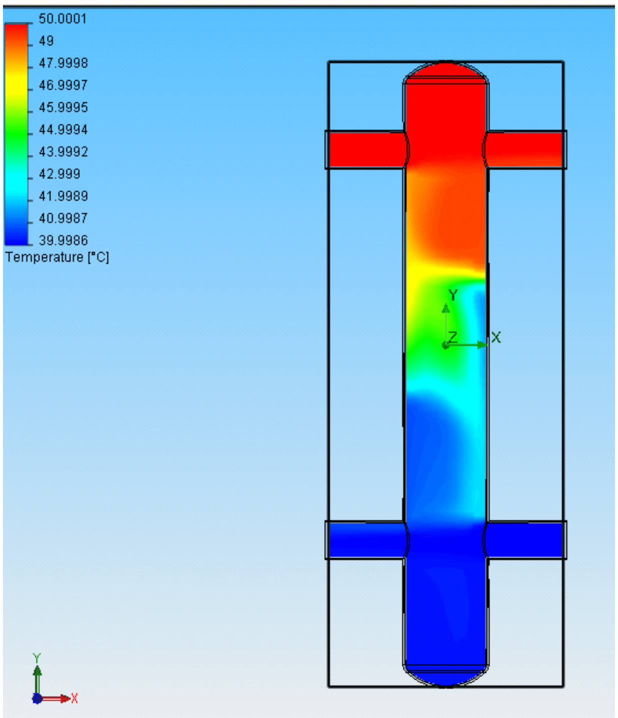


Fig 2a Thermal model for equal DT and DP primary and secondary circuits

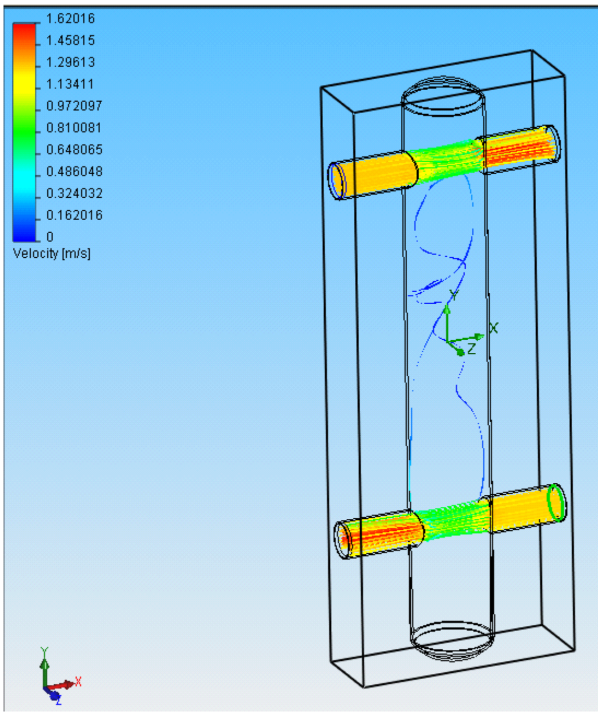


Fig 2b Diagrammatic flow

Fig 2b demonstrates the laminar-type flow of the water molecules, which is also ideal.

However, ideal situations are rare, especially when a condensing boiler is fitted to an existing system. A common situation when condensing boilers are installed in an existing system is an uneven DT and DP between the primary and secondary sides. Frequently, the boilers are designed for a DT20K circulation (eg 50°C flow and 30°C return), but the system is designed for a DT10K or 11K circulation (eg 82°C flow and 71°C return). Fig 3 shows how this will affect the same model LVH.

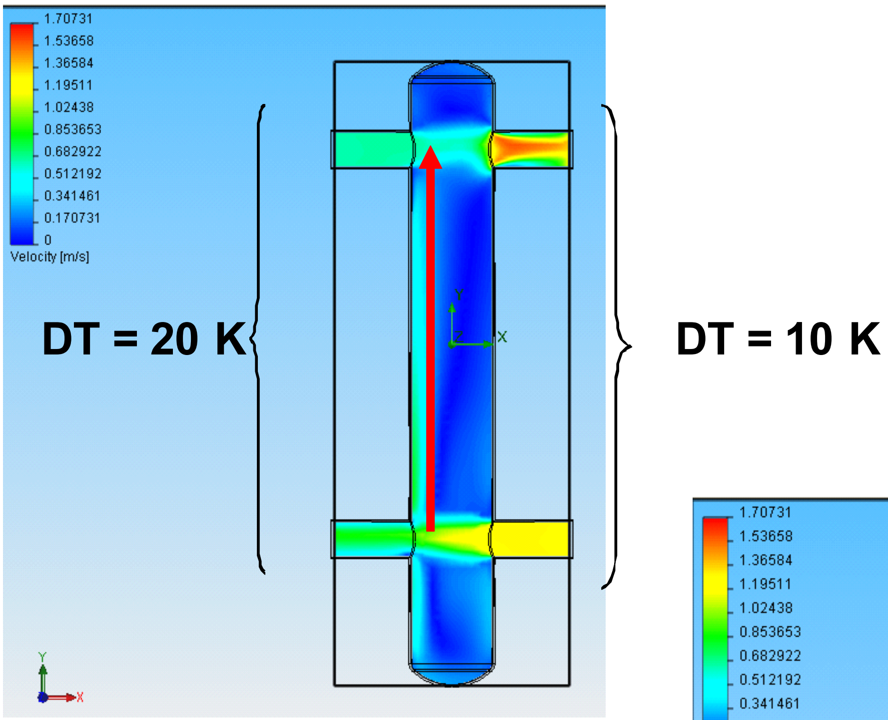


Fig 3a DT20 on primary side, DT10 on secondary side

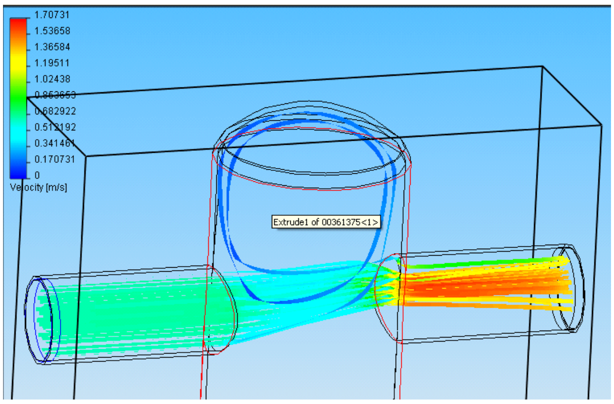


Fig 3b Turbulence at flow connections

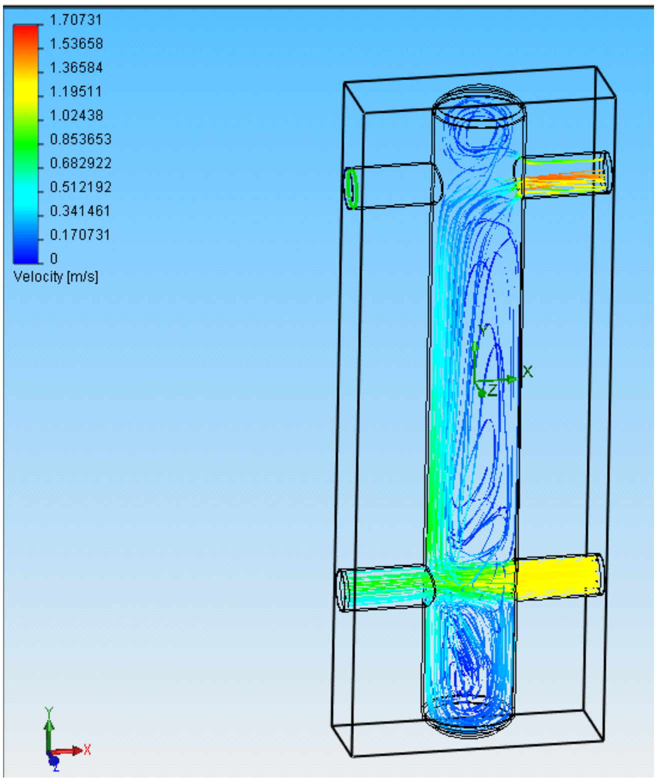


Fig 3c Turbulence throughout the LVH

From fig 3, the turbulence within the LVH has been increased and the heat flow to the secondary side has accordingly reduced. The tendency is for the water not to flow through the boiler and for a low rate of heat exchange to the system, evidenced by the colder colours. This will happen if there is no LVH, or if the LVH is too small (perhaps if it has been sized for boiler flow rates and not the sytsem flow rate). Consequently, the LVH sizing should be recalculated (ie increased) to restore a more laminar flow pattern and better-defined temperature stratification.

A more unusual situation is where the secondary side DT is greater than that of the primary. This is modelled in fig 4.

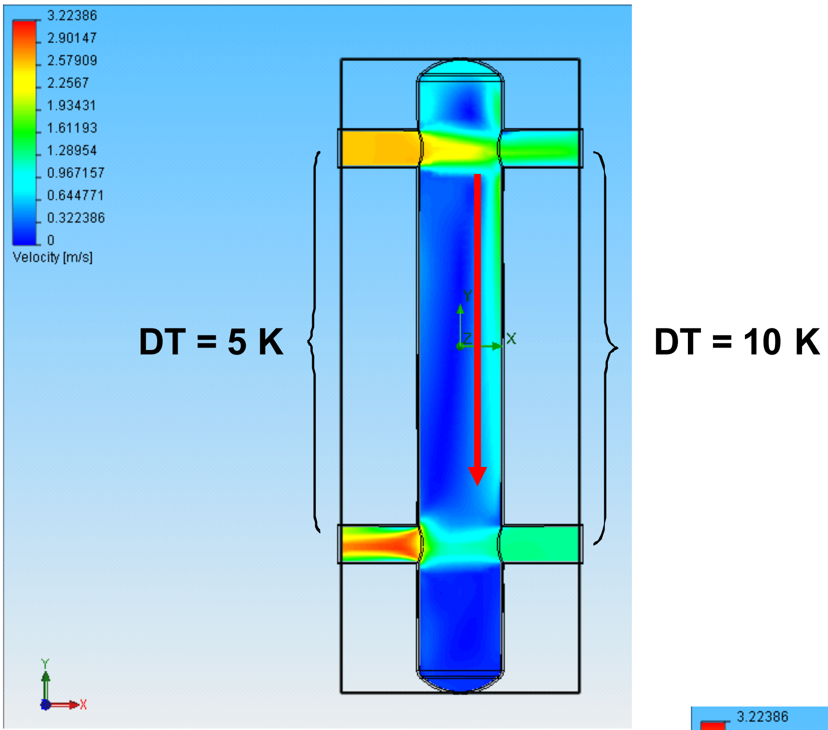


Fig 4a DT5 on primary side, DT10 on secondary side

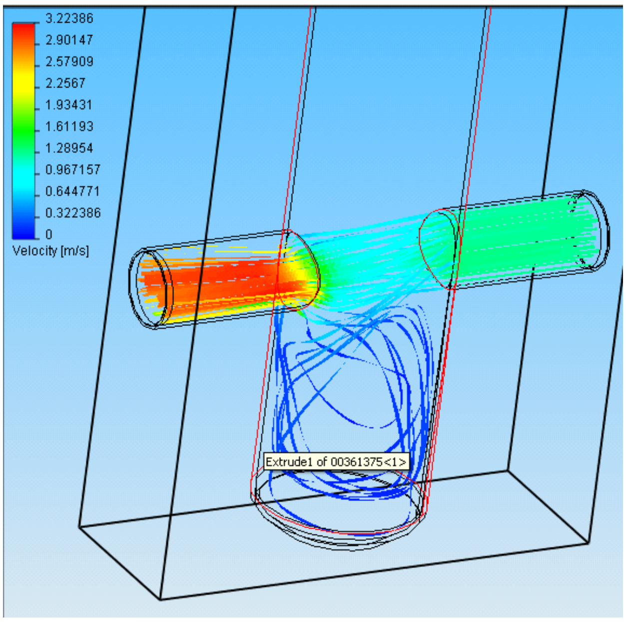


Fig 4b Greater turbulence in the return end of the LVH

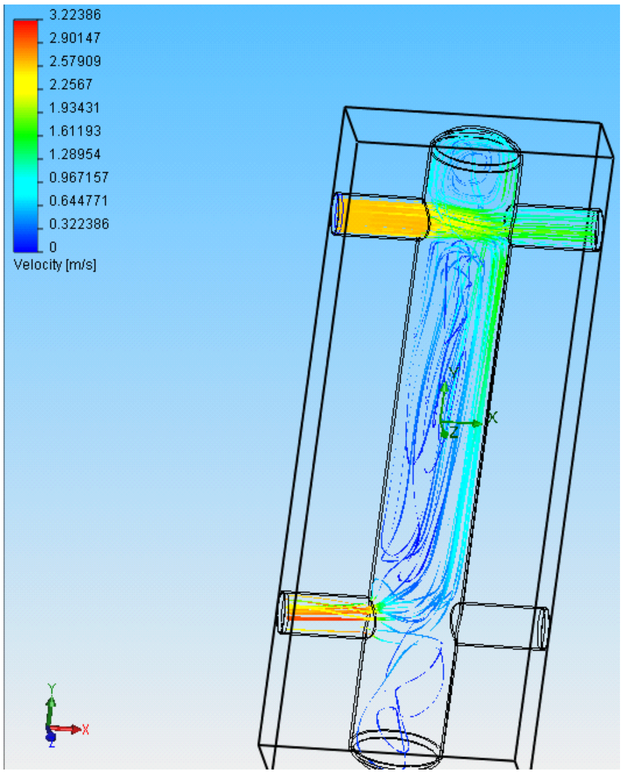


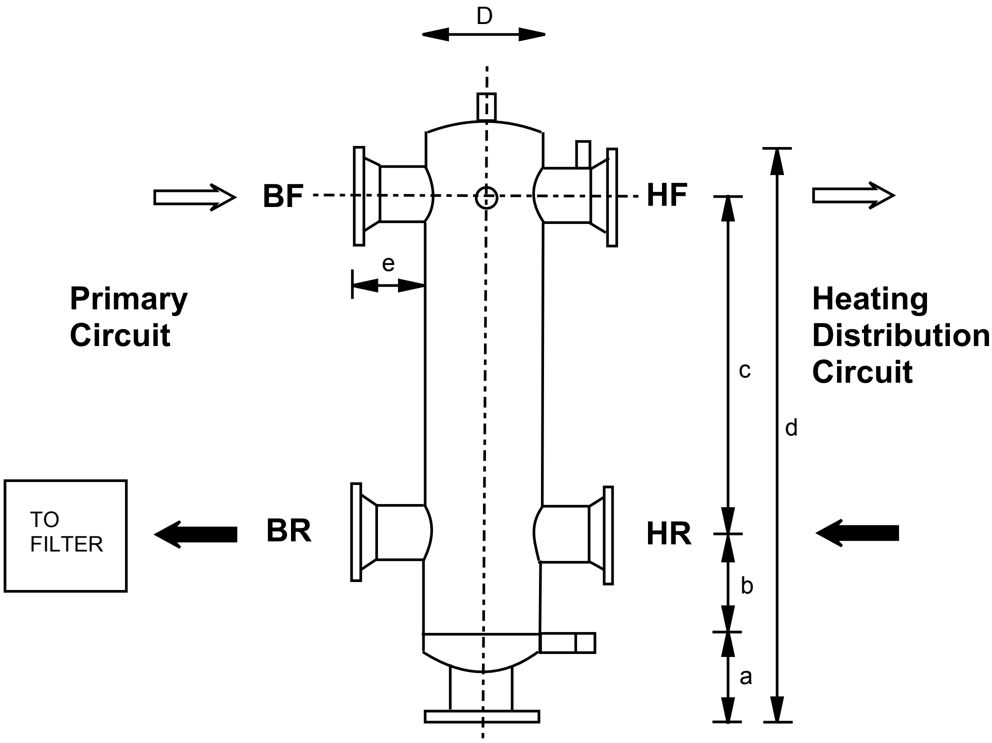
Fig 4c Lesser turbulence throughout the LVH

Fig 4a models the reduced turbulence that is expected from lower DTs between the two sides of the LVH and closer-matched flow rates. Fig 4b shows greater turbulence is now in the return end of the LVH, and it is also apparent from the thermal model that higher temperatures are present on the lower resistance side. The heat flow is through the boiler only rather than into the system. Again, the solution is a correctly dimensioned LVH.

Installing a variable speed rather than fixed speed pump on the primary side of the LVH will help maintain a constant flow rate that is ideal for minimising the DT and DP between the primary and secondary sides. Clyde Alkon and Modulex boilers have the facility to control such a variable speed circulator.

A LVH is an essential but often overlooked component when a condensing boiler is to be installed. When correctly sized for the boiler and system, it will allow pumps to be sited on either flow or return, eliminate the problems of mismatched boiler and system flow rates and temperatures, and (if used in conjunction with air separators, strainers or filters) will protect the boiler for many years to come.

Table 1 below gives suggested sizes for a whole range of LVHs used with LTHW boilers. Models up to 900 kW are available from Clyde - larger sizes may need to be fabricated in a workshop or on-site.



Max output (kW) ΔT 20 / ΔT 10	D mm ΔT 20	D mm ΔT 10	BF / BR ΔT 20 / ΔT 10	HF / HR ΔT 20 / ΔT 10	a mm	b mm	c mm	d mm	e mm
145*	140	150	DN65 PN16	DN65 PN16	200	300	1000	1650	200
550*	220	220	DN100 PN16	DN100 PN16	200	300	1000	1650	200
900*	400	400	DN150 PN16	DN150 PN16	275	300	1500	2275	200
< 3500 / 1750	500	500	250	250	300	400	1500	2500	200
< 4600 / 2300	600	600	300	300	300	400	1800	2800	200

Table 1 Low velocity header dimensions for ΔT 10 or 20 system
***Note: These first three listed low velocity headers are available from Clyde**
The last two are suggested sizes for workshop or on-site fabrication

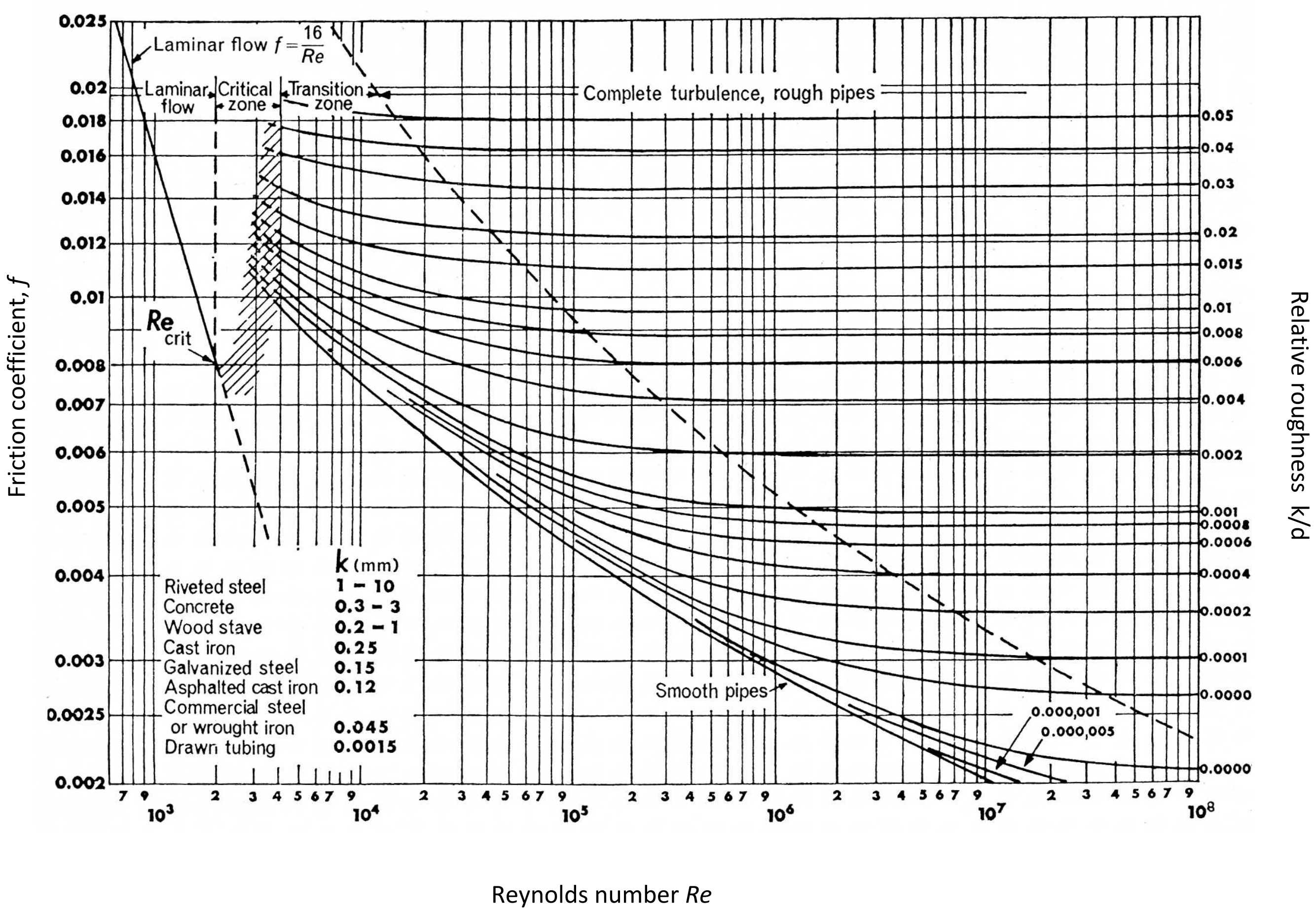


Fig 5 Moody Chart

NOTES

[1] For flow through a tube; $Re_d = p\, U\, d\, / \mu$

Where *d* = tube diameter, *p* = density, *U* = velocity and μ = dynamic viscosity

The Moody Chart above demonstrates that roughness is unimportant in the laminar flow region, is an important variable in the transition area, and ceases to be a function of *Re* number once the fully-developed straight lines are achieved. This interdependence of the qualities that form the *Re* expression above demonstrates how changing either tube diameter, *d*, or velocity, *U*, (for example) will affect the magnitude of the Reynolds Number

Re is a dimensionless number

[2] As will be expected, the length of the Low Velocity Header, the DT and corresponding DP from any difference in flow conditions on the boiler and system side of the LVH will affect the size selected. Note that at a mass flow rate of 0.2 ms^{-1} , any calcium carbonate in suspension in the system water will be precipitated out of solution.