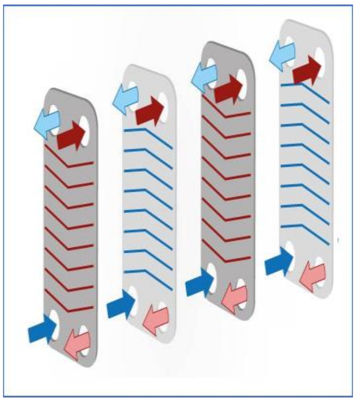
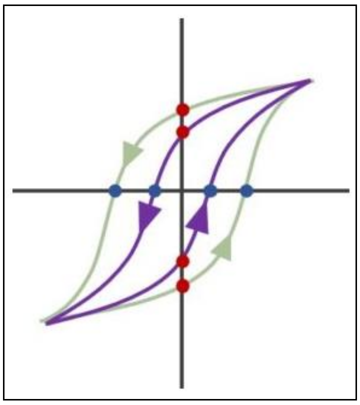
Different types of flow

A customer writes: *In theory, a plate heat exchanger for liquid media goes into the laminar range, when the mass flow decreases and the performance suddenly drops significantly. In practice, however, there are no known problems in this regard, but no one has ever been able to explain to me conclusively why this is the case.*



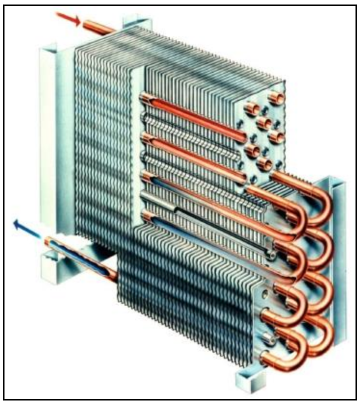
My answer: *I still have fond memories of laboratory tests at the University of Applied Sciences in Winterthur from 1970, where the speed in a tube through which water flowed was reduced until a laminar flow was established.*

A hysteresis was found, which means that the tipping point from turbulent to laminar occurred at a lower speed than from laminar to turbulent, i.e. with increasing speed. That was one realization.



The other finding was, that a very long tube (L/D > 100) without any disruptive influences, such as deflections, narrowing, widening, etc., was required for a laminar flow.

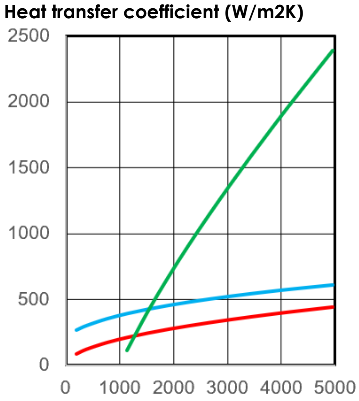
However, due to the structure of the plate heat exchanger for liquids, there are disruptive influences within a very short distance, which make a laminar flow impossible. Even if the calculated Reynolds is below 2,320, a laminar flow will never be able to develop. This is also the reason, that k-values of up to 6,000 W/m2K are achieved, i.e. three times as much as with shell and tube heat exchangers.



The same applies to finned heat exchangers for liquids in the tubes. There, the disturbing influences are the deflections, which trigger turbulence. It is therefore not necessary to project high pressure drops in order to avoid laminar flows with a large drop in performance in the partial load range, which has been proven by many laboratory tests at TUEV Süd in Munich.

The figure on the right shows heat transfer coefficients for water at 20 °C for an internal tube diameter of 10 mm.

- **After the Nusselt equations on laminar area**
- **After the Nusselt equations on transition area**
- **After the Nusselt equations on turbulence area**



The maximum value is always assigned, i.e. in this example up to Reynolds < 1,500 the heat transfer coefficient according to Nusselt in the transition area and for Reynolds > 1,500 the heat transfer coefficient according to Nusselt in the turbulence area, which is reflected in laboratory tests at TUEV Süd in Munich has confirmed.

However, what you should definitely pay attention to, is an even distribution of the liquid over the tubes, which is achieved by the fact, that the pressure drop in the tubes must be 5 times higher than in the collectors. However, there are said to be manufacturers of finned heat exchangers, who do not calculate this pressure ratio between tubes and collectors and are therefore unable to show it.