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After conducting a Literature survey i found that

Large differences exist in the reported friction factors and heat transfer coefficients for single-phase flow through channels.

Some of the questions and problems we have to address are the following :

What phenomena are responsible for this wide disparity in heat transfer and pressure drop data?

Down to what channel sizes can we confidently apply the continuum theory and the conventional Navier-Stokes (N-S) equations?

Some studies indicate that in micro-/meso-scale passages, laminar flow starts changing to turbulent flow at critical Reynolds numbers not expected by us.

Similarly, fully developed turbulent flow has been reportedly established at Reynolds numbers less than expected.

Does this early transition really occur? If so, why, and what impact does it have on the design of meso- heat exchangers ?

For single-component condensation of refrigerants, the heat transfer coefficient increases with a decrease in the channel dimension.

Will this trend continue when the surface tension is dominant?

For boiling, the heat transfer coefficient decreases with decreasing channel dimensions.

What causes this phenomenon, and is it possible to achieve an increase in the boiling heat transfer coefficient in micro-/meso-channels?

If the channel dimensions are of the same order of magnitude as the critical bubble nucleus, it is likely that nucleation may be affected. Will the boiling phenomena observed in such channels be different from those seen in conventional channels?

Interfacial effects, such as the electric double layer (EDL), are ignored in macroscale fluid mechanics. In very small microchannels, will such electrokinetic effects influence the flow and heat transfer characteristics, and in what direction?

Fouling will be an important design consideration for micro-/meso- surfaces, even with the so-called non-fouling or less-fouling fluids.

What are the issues for fouling with such clean fluids, and how can fouling be minimized or eliminated in micro-/meso- heat exchangers ?

To answer many of the questions

we need experimental results in order to shed further light on the physics of fluid flow and heat transfer in microchannels. For that

Flow visualization needs to be undertaken for single-phase and two-phase flow in the micro-/meso- heat exchangers.

Visualization of single-phase flow would help identify either the initiation of unsteady laminar flow or the initiation of transition from laminar to turbulent flow.

Visualization of two-phase flow would enable identification of flow patterns and facilitate flow modeling and the correct application of pressure drop and heat transfer correlations.

Inconsistencies in the friction and heat transfer data need to be reconciled. In particular, the effect of the surface relative roughness needs to be quantified. For that we need capable equipment or new methods with existing hardware.

Specific studies are essential to quantify when rarefaction becomes important in micro-/meso- heat exchangers and to what extent.

In two-phase flow, the maldistribution of phases in multiport micro-scale heat exchangers could be a major problem.

Different designs of inlet and outlet headers need to be studied. This study should be helpful in designing headers to minimize the flow maldistribution problem.

Surface tension and electrokinetic effects on heat transfer and friction in microchannels merit a more focused investigation.

Finally, validated models for two-phase pressure drop and the heat transfer coefficient over a wide range of relevant parameters are needed.