METHODOLOGIES TO SELECT FRICTION FACTOR AND CONVECTIVE HEAT TRANSFER CORRELATIONS FOR A SINGLE-PHASE FLUIDS

FRICTION FACTOR CORRELATIONS

The following questions can guide the selection of a suitable friction factor correlation for the situation of interest.

1) Is this an internal or external flow problem?

2) What is the geometry of the system? For example, round tube vs. triangular tube (in internal flow) or cylinder vs. sphere (in external flow)

3) Is the flow regime laminar or turbulent?

4) Is the surface of the channel rough or smooth?

5) For internal flow only, are entry region effects important? Can fully developed flow be assumed along most of the channel length?

Comments:

- In internal flow the effect of geometry is important in the laminar flow regime, but not very important in the turbulent flow regime. Therefore, for turbulent flow the use of a round tube correlation (e.g., the McAdams' correlation) in concert with the hydraulic diameter concept usually provides a reasonable answer.

- Surface roughness affects the friction factor in turbulent flow, but not laminar flow.

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HEAT TRANSFER CORRELATIONS

Systematically answering the following questions guides selection of a suitable heat transfer correlation for the situation of interest.

1) What is the heat transfer mode? Forced vs. free convection.

2) Is the fluid metallic ($Pr<<1$) or non-metallic ($Pr>\sim1$)?

3) Is this an internal or external flow problem?

4) What is the geometry of the system? For example, round tube vs. triangular tube (in internal flow) or cylinder vs. sphere (in external flow)

5) Is the flow regime laminar or turbulent?

6) What is the boundary condition? For example, constant wall temperature vs. constant wall heat flux.

7) For internal flow only, are entry region effects important? Can fully developed flow be assumed along most of the channel length?

Comments:

- The effect of the boundary condition on heat transfer is important in the laminar flow regime, but much less so in the turbulent flow regime. Therefore, the same correlation often can be used for any boundary condition in the turbulent flow regime.

- In internal flow the effect of geometry is important in the laminar flow regime, but again not very important in the turbulent flow regime. Therefore, for turbulent flow the use of a round tube correlation (e.g., the Dittus-Boelter's correlation) in concert with the hydraulic diameter concept usually provides a reasonable answer.

- Heat transfer in metallic fluids tends to be more sensitive to geometry and boundary conditions than in non-metallic fluids. This is true in both laminar and turbulent flow. Therefore, when dealing with metallic fluids you should try to find a correlation developed specifically for the geometry and boundary condition of interest.

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