Process Design

TRANSPORTATION OF MATERIAL AND EQUIPMENTS

Piping systems and pumps are frequently used for transportation purposes

Design engineers have to solve the engineering problems and select the appropriate equipment

The most important aspects in selecting the proper equipment are cost and meeting the systems' requirements

Pumps and Piping System:

Power requirement and friction have to be considered while designing piping systems

Power requirement:

-To overcome the friction,

-To satisfy the energy requirement due to changes in elavation

The power required for the system is usually supplied by the pumps

The Mechanical Energy Balance and Total Energy Balance will help you to calculate the power required.

The factors effective on frictional forces:

- Fluid velocity
- Fluid density
- Fluid viscosity
- Pipe diameter
- Length of the pipe
- Roughness of the pipe(ε).
- The number of valves
- Elbows and fittings
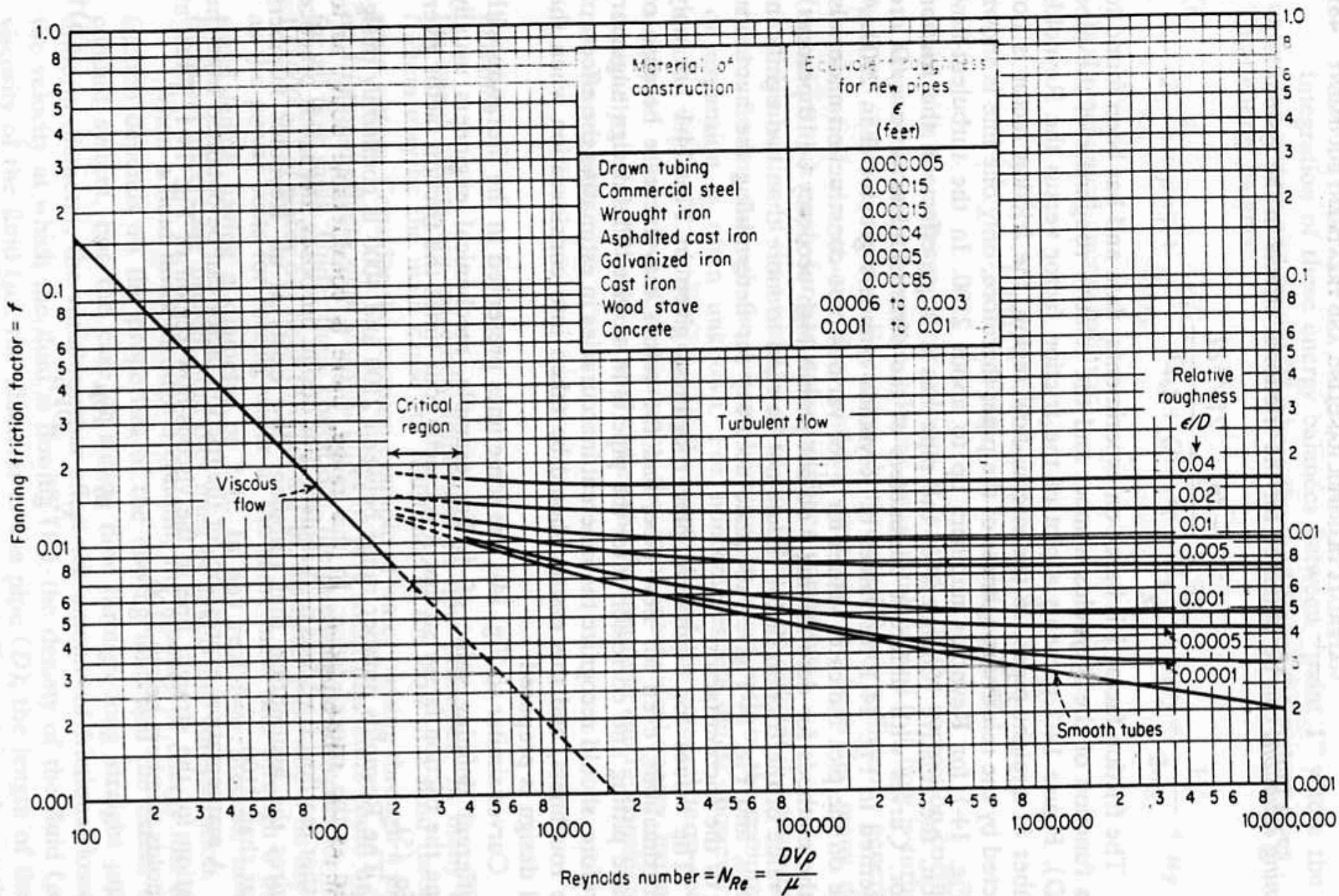
The friction in straight pipes:

For laminar flow:

f:fanning friction factor

$f=16/N_{Re}$

For turbulent flow:

f can be determined from the figure;

FIGURE 14-1
Fanning friction factors for long straight pipes. [Based on L. F. Moody, *Trans. ASME*, 66:671–684 (1944).]

The figure contains the following labels and data:

Vertical axis (left): Fanning friction factor = f, ranging from 0.001 to 1.0

Horizontal axis: Reynolds number $= N_{Re} = \dfrac{DV\rho}{\mu}$, ranging from 100 to 10,000,000

Labels: Viscous flow, Critical region, Turbulent flow, Smooth tubes

Right axis: Relative roughness ϵ/D with values 0.04, 0.02, 0.01, 0.005, 0.001, 0.0005, 0.0001

Material of construction	Equivalent roughness for new pipes ϵ (feet)
Drawn tubing	0.000005
Commercial steel	0.00015
Wrought iron	0.00015
Asphalted cast iron	0.0004
Galvanized iron	0.0005
Cast iron	0.00085
Wood stave	0.0006 to 0.003
Concrete	0.001 to 0.01

Pumps:

The pumps are used to transfer fluids from one place to another.

The transfer is achieved by increasing the fluid pressure and supplying the driving force for the flow.

The factors affecting the selection of pumps:

-the amount of fluid

-properties of fluid (density and viscosity)

-the pressure increase in the fluid

-cost and mechanical efficiency

Important points to be considered:

- The design engineer should first define the pipe diameter that will be used in the system.
  - Do not forget to consider the economical factors while selecting the pipe diameter
- Then, calculate the friction losses in the system
- Subsequently, using Mechanical Energy Balance the power of pump should be calculated.
- Performing the cost analysis