Experiment n°2

Head losses comparison

Objectives

This experiment is designed to highlight head losses in pipe. 3 pipe will be used, the pipe n°1, 7 and 8. Linear head losses will be determined for each pipe in laminar and turbulent flow and the correspondence with the following laws will be stressed.

Description of the installation

The three pipes are different each other: the first pipe has a diameter of 16mm and is a smooth pipe, the n°7 pipe is a 20mm diameter, ribbed pipe. The n°8 pipe is a 20mm smooth pipe. The distance between the two pressure connector is about 77 cm.

Theories

The fluid is supposed in a permanent flow, adiabatic and incompressible. Between two points 1 and 2 in a pipe, head losses can follow the Darcy-Weisbach formula:

$$\Delta Ps = \xi * \frac{L}{D} * \frac{1}{2} * \rho * Um^2$$

The coefficient ξ depend on the flow of the fluid:

Laminar flow: $\xi = \frac{64}{Re}$ Poiseuille Formula

-Turbulent flow in a smooth pipe: $\xi = \frac{0.316}{\sqrt[4]{Re}}$ (Blasius fromula)

-Turbulent flow in a rough pipe: $\frac{1}{\sqrt{\xi}} = -2log10\left[\frac{\varepsilon}{3.71D} + \frac{2.51}{Re\sqrt{\xi}}\right]$ (Colebrook formula)

The flow regime is defined by the Reynold's number: $Re = \frac{\rho UD}{\mu} = \frac{UD}{\nu}$ U average speed in the pipe (m/s), D diameter of the pipe (m).

In hydraulic, linear head losses i is used: i=$\frac{\Delta h}{L}$ L length of the pipe

If head losses are noted Δh_{12}, the linear head losses coefficient is defined by:

$$\Psi = \frac{\Delta h12}{\frac{1}{2}\rho U^2 \frac{L}{D}} = 2i\frac{gD}{U^2}$$

Experience demonstrated that in a laminar flow regime, i is proportional to U; in a turbulent flow regime, i is proportional to U^n.

Material

U tube manometers

Experiment

a) Purge the pipes liking the bench to the manometers.
b) Check if the exit valve is open
c) Open the flow control valve
d) Open the two valve of the desired pipe
e) Open the rotameter control valve
f) Connect the manometers to the pipes
g) Activate the pump.

For laminar flow, open others pipe in order to reduce the flow rate in the used pipe.

Pick up the results in the following board:

Qv (m3/s)	h1 mm	h2 mm	Δh m	i	ln(i)	ln(U)

U (m/s)	i	Ψ	Re	$U^2/2gd$	Ψ (Poiseuille/Blasius)

Conclude on the