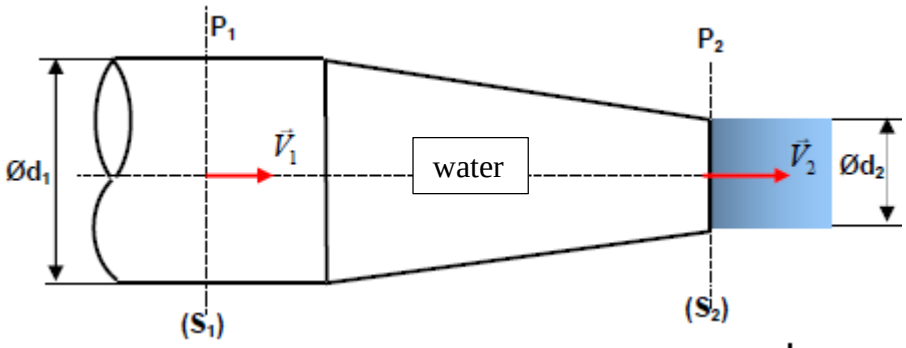
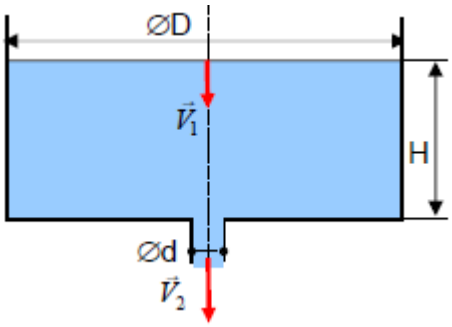
Department of Automatics **(TD 04: Fluid dynamics-1)**
2nd Year Electromechanical License (Perfect Incompressible Fluid Dynamics)
Hydraulic & Pneumatic

Exercise No. 1:
A nozzle connected to a pipe in which water is conveyed at a pressure P_1 =2.875 bar.
We give: ρ =1000 kg / m^3, the outlet pressure $P_2 = P_{atm}$ =1 bar, d_1 =20 mm and d_2 =10 mm.

1) Determine the ratio v_2 / v_1.
2) By applying Bernoulli's equation, calculate the flow velocity v_2.

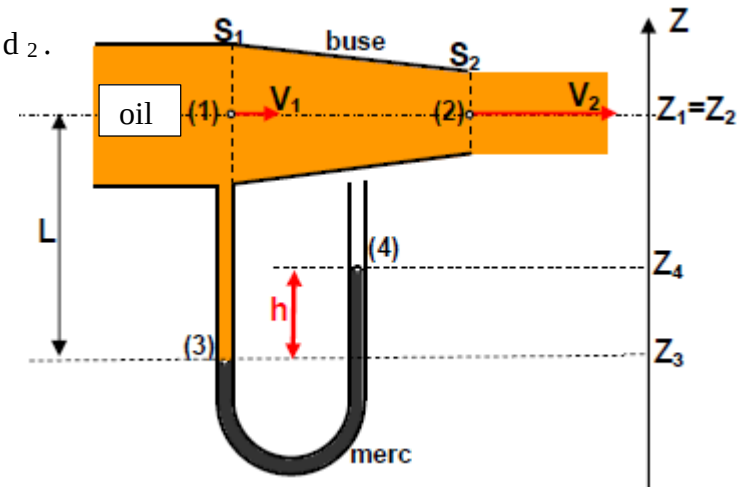


Exercise No. 2:
A cylindrical tank of internal diameter D = 2 m filled with water up to a height H = 3 m. The bottom of the tank has a orifice with a diameter d = 10 mm allowing the water to be evacuated.



1) Write the continuity equation. Deduce the expression of V_1 in function of V_2, D and d.
2) Establish the expression of the flow velocity V_2 as a function of g, H, D and d.
3) Calculate the speed V_2. It is assumed that the diameter d is negligible in front of D, that is, (d / D) <<1.
4) Deduce the volume flow rate Q_v.

Exercise No. 3:
The system is composed of a convergent cone-shaped nozzle and a U-shaped pressure gauge.
Part 1: Study of the nozzle which contains oil (ρ_{oil} = 800 kg/m^3)
A volume flow Qv= 0.4 *l* /s, the oil passes through the section S_1 of diameter d_1 = 10 mm at a flow velocity V_1, at a pressure P_1 and exits to the atmosphere through the section S_2 of diameter d_2 at a flow velocity V_2 =4.V_1 and a pressure $P_2 = P_{atm}$ =1 bar.
1) Calculate the flow velocity V_1.
2) Write the continuity equation. Deduce the diameter d_2.
3) Applying Bernoulli's Theorem between point 1 and point 2, determine the pressure P_1.



Part 2: Study of the pressure gauge (U-tube)
Pressure gauge, U-tube, contains mercury ($\rho_{mercury}$ =13600 kg/m^3).
We give: L= 1274 mm and h = (Z_4 -Z_3).
1) Determine the pressure P_3.
2) Determine the height difference h of the mercury.

Exercise No. 4:

A pump P supplies a water tower from a well at through a pipe with a diameter d= 150 mm.

We give: the pressures $P_1 = P_2 = 1$ bar, the speed of flow v = 0.4 m/s, and g = 9.81 m/s^2.

$Z_2 - Z_1 = H = 31$m

Required work :

1) Calculate the volume flow Q_v of the pump in *l* /s.
2) Write Bernoulli's equation between surfaces 1 and 2.
3) Calculate the useful power P of the pump.
4) Deduce the power Pa absorbed by the pump knowing that its yield is 80%.