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14/ENG01/011
CHE 311 : FLUID FLOW

ASSIGNMENT 2

Question 1: Derive the Bernoulli's from the Newton's 2nd Law.

Firstly let's define Newton's 2nd law;
Newton's Second Law states that the sum of the forces acting on a particle equals the particle's mass multiplied by its acceleration. ~~Since we ...~~
Mathematically; $\sum F = MA$

$\sum F_s = Ma_s$ (Newton's second law applied to s-direction)

$$\sum F_s = \frac{m\,dv}{dt}$$

$$= \left(P - \frac{1}{2}\frac{dp}{ds}ds\right)dn\,dw - \left(P + \frac{1}{2}\frac{dp}{ds}ds\right)dn\,dw - \rho g\,ds\,dn\,dw\sin\theta$$

$$= -\left(\frac{dp}{ds} + \rho g\sin\theta\right)ds\,dn\,dw$$

$$m = \rho\,ds\,dn\,dw$$

$$\frac{dv}{dt} = \frac{dv(s,t)}{dt} = \frac{dv}{dt} + \frac{dv}{dt} + \frac{dv}{ds}\frac{ds}{dt} = \frac{v\,dv}{ds}$$

$$\frac{m\,dv}{dt} = (\rho\,ds\,dn\,dw)\frac{v\,dv}{ds}$$

$$\sin\theta = \frac{dz}{ds}$$

$$\rho v\,dv/ds = -dp/ds - \rho g\,dv/ds$$

$$\rho v\,dv/ds + dp/ds + \rho g\,dz/ds = 0$$

$$v\,dv/ds + \frac{1}{\rho}dp/ds + g\frac{dz}{ds} = 0$$

$$v\,dv + dp/\rho + g\,dz = 0$$

$$v\,dv + \frac{1}{\rho}dp + g\,dz = 0$$

When density is constant, the above can be integrated with an indefinite integral resulting to the Bernoulli's equation

$$\frac{1}{2}v^2 + P/\rho + gZ = \text{Constant}$$