What is the air pressure at the top of the Burj Khalifa, which has a height of 828 m (2717 ft)? If there was a pipe containing water that extended from the top of the Burj Khalifa to the ground, what would be the gage pressure in the water at the bottom of the pipe?

SOLUTION:

Assuming constant air density,

$$p_{y=H} = p_{y=0} - \rho_{\text{air}} g H \tag{1}$$

where

ρ = 1.225 kg/m^3
g = 9.81 m/s^2
H = 828 m
$p_{y=0}$ = 101.33 kPa (abs) (= p_{atm})

Thus, $\boxed{p_{y=H} = 91.4 \text{ kPa (abs) or } p_{y=H}/p_{y=0} = 0.902.}$

If we treat air as a compressible, ideal gas and assume the air temperature varies according to the U.S. Standard Atmosphere,

$$p_y = p_{y=0}\left(1 - \frac{\beta y}{T_{y=0}}\right)^{\frac{g}{R\beta}} \tag{2}$$

where the previous values for g, $p_{y=0}$, and H are assumed, and,

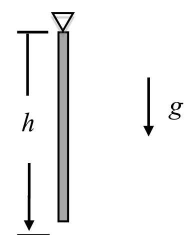
β = 0.00650 K/m
$T_{y=0}$ = 288 K (= 15 degC)
R = 286.9 J/(kg.K)
$\Rightarrow$ $\boxed{p/p_{y=0} = 0.906}$, which is nearly identical to the previous calculation.

The gage pressure in a water column with a depth of 828 m is given by,

$$p_{\text{gage}} = \rho g h, \tag{3}$$

where

ρ = 1000 kg/m^3
g = 9.81 m/s^2
h = 828 m
$\Rightarrow$ $\boxed{p_{\text{gage}} = 8.12 \times 10^6 \text{ Pa}}$ = 80.2 atm!



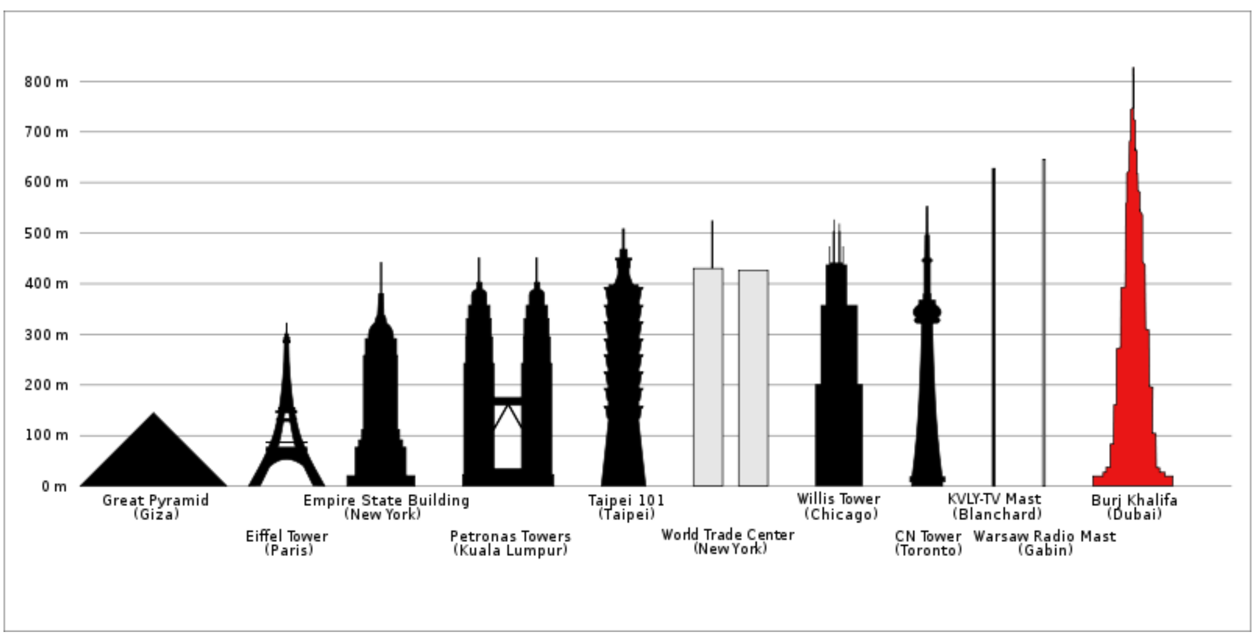


Image from Wikipedia (2012 Jan 10; http://en.wikipedia.org/wiki/File:BurjKhalifaHeight.svg)