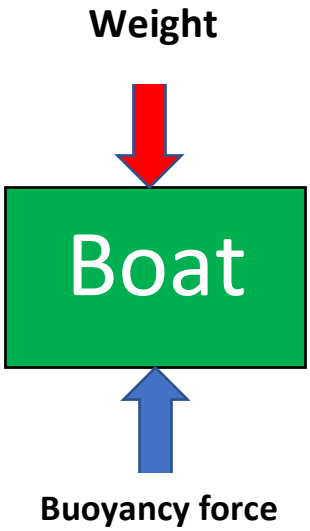
BOAT PROPULSION POWER

1) Calculations of immersed volume

Forces in the vertical direction are (Weight & Buoyancy)



a) Weight = mass * gravitational acceleration

Assume the total load = 12 kg (higher than 10 kg as a factor of safety)

So, Weight = 12 * 9.81 = 117.72 Newtons

b) Buoyant force = water density * gravitational acceleration * Immersed volume

So, Buoyant force = 1000 * 9.81* Immersed volume = 9810* Immersed volume

From forces equilibrium, Weight = Buoyant force

So, 117.72 = 9810 * Immersed volume

So, Immersed volume = 0.012 m^3

c) Boat volume = Air entrapping volume * (4/3)

So, Boat volume = [(pi/4) *D^2] * Length * (4/3)

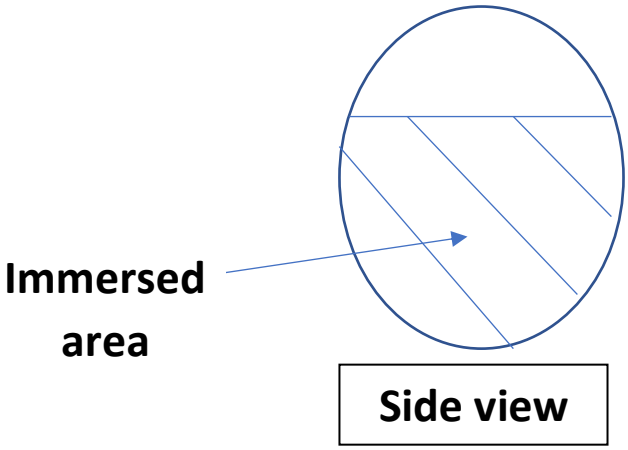
If D=13 cm, L=1.2 m…… Boat volume = 0.02 m^2

So, Immersed volume/ Boat volume = 0.012/ 0.02 = 0.6 = 60%

d) The immersed cross section area = 60 % the total circle cross section area

So, $A_{imm} = 0.6 * (pi/4) * D^2$

If D= 13 cm…… A_{imm} = 0.00796 m^2



2) Calculations of drag force resisting the boat

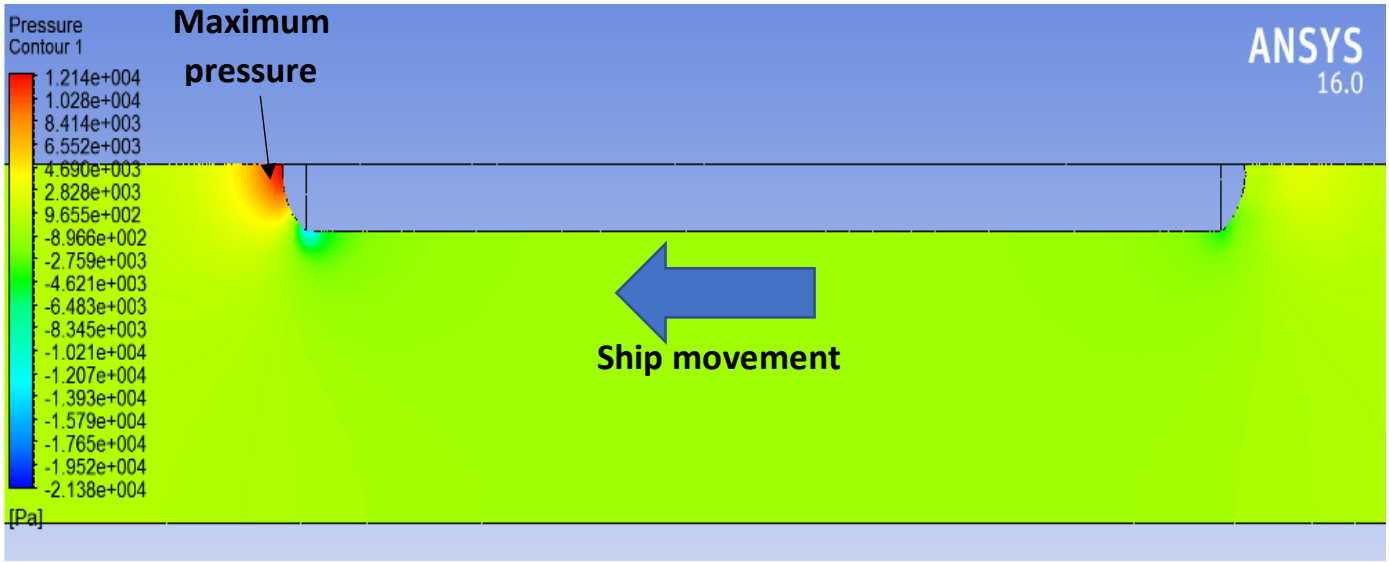
Drag force = 0.5 * water density * (Velocity^2) * Reference area* C_D

We have: water density = 1000 kg/m^3

Velocity = 20 km/hr = 5.5 m/sec

Reference area = A_{imm} = 0.00796 m^2

C_D = 0.28 using Ansys fluent software (see below)



So, drag force = 0.5*1000*(5.5^2) *0.00796*0.28 = 33.71 Newtons

3) Power calculations

a) The power required to overcome the drag force is called the effective power and can be calculated as follows:

Effective power = DRAG FORCE * Velocity = 33.71 * 5.5

So, effective power = 185.405 watts

b) The motor power has to be higher than this value because a portion of it will overcome friction in connections and turbulence in propeller.

Motor power = effective power / efficiency

Motor power = 185.405 / 0.5 (practical approximation)

Motor power = 370 watts

c) As a factor of safety multiply by 1.25 (for inaccuracies).

Required motor power = 460 watts = 0.62 hp

Results summary

Immersed volume / Boat volume	%60
Drag coefficient	0.28
Drag resisting force	33.71 Newtons
Required effective power	185 watts
Efficiency of propulsion system	%50
Required motor power	0.66 hp