Modification of the Float of the Dines Pressure Tube Anemometer

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ABSTRACT

Reliable data on wind speed and wind direction is frequently required in remote locations, where no external power source is available. Dines Pressure-tube Anemometer measures wind pressure to come across instantaneous wind speed and wind direction simultaneously on a single chart. The Dines Pressure-tube Anemometer consists of large diameter pitot-tube mounted on a vane, connected to a manometer. The manometer of Dines Pressure-tube Anemometer has complicated geometry, designed to obtain steady state float displacement that is linear with the applied wind velocity. Manometer consist of an open-bottomed tapered float in a water tank, with the pressure tube from the pitot head supplying into the airspace in the float as the wind speed increases, the pressure inside the float increases and the float rises, moving the recording pen. The material used for manufacturing of this instrument is copper and gun metal, which are costly. Also the weight of the instrument is more. Special type of manufacturing processes are required like brazing, soldering etc. There is need to design the instrument with cheap and light weight material. The paper reflects a study about modification of the float and float-tank to reduce the size, weight and cost of the instrument. The calculations for modified float are done by considering the maximum speed recorded by the instrument should be approximate 220kmph and reduced in size of float to half of the actual size.

Keywords*:* ***Dines Pressure-tube Anemometer, Float, Float-tank, Wind Speed, Wind Pressure.***

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1. INTRODUCTION

The maximum range of the Dines Anemometer with a float of normal weights is 197 kmph, this can be increased to 220 kmph by changing the diameter and length of the float and tank. The limitation to recording maximum velocity is at these velocities air from the inside of the float begins to bubble through to the space in the tank outside.

If an anemometer is required which will record on linear scale velocities higher than 197 kmph the dimensions of the float must be changed. This change can be made by altering the shape of the interior of the float and an increase of the range up to 220 kmph can be obtained in this way with decreasing the height of the tank.

Float weighted so that it remains at zero level until air bubbles through. This gives the absolute maximum velocity which the instrument can indicate. This case is examined below and the theoretical examination has been supplemented by experiment with a modified instrument.

2. CALCULATIONS

We work in the float relative co-ordinate system outlined in the fig.1. Let v be the wind velocity. The distance x is measured positive down from the top of the float, $x_1(v)$ and $x_2(v)$ are the water level outside and inside the float respectively, x_3 is the bottom of the floatation chamber, and $x_d(v)$ is the bottom of the manometer chamber. At zero wind, the float just rests on the bottom, so $x_b=x_d(0)$ is the length of the float.

Linear calibration of the anemometer implies that

$$\alpha v = x_d(v) - x_d(0) \qquad (1)$$

Where the constant α= (6 inches)/(100 mph) = 3.40909×10^{-3} s for a standard Dines Pressure-tube Anemometer, and half that for a high-speed unit.

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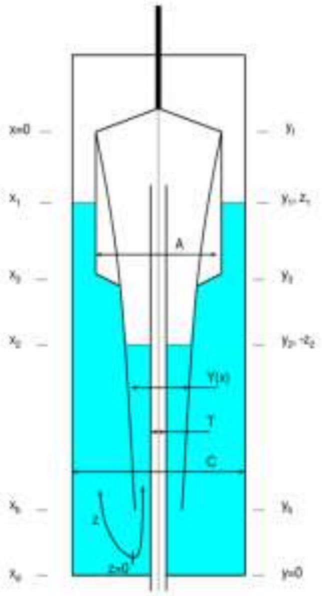

Fig-1: Cross-section of the Dines float and chamber, showing the co-ordinate System and variable definitions.[3]

2.1 Mass of Float:

For a tank diameter (c) =0.106m, Cross-section area of Tank (C) = 0.008825m^2

Float diameter (a) = 0.075m, Cross-section area of Float (A) = 0.004418m^2

Tube diameter (t) = 0.0127m, Cross-section area of Tube (T) = 0.0001267m^2

Calibration coefficient q= 8m^{-1},

Height of air jacket (x_3) =0.206m.

Mass of the float

$$m=\rho \{ax_3 – [a/2c^2q\ [(c-t)^2 ((1+4cqx/(c-t))^{1/2} -1) +2ctqx]\} \quad (2)$$

$$m=0.4215kg$$

Mass of float (m) = 0.421kg.

2.2 Volume of water required:

The total volume of water required with v=0 and the boundary conditions $x_1(0) = x_2(0) = 0$,
Length of the float $x_{d0\,=}$ 0.35m

$$V= x_{d0}(c-t) – x_3a+ – [a/2c^2q\ [(c-t)^2 ((1+4cqx)/(c-t))^{1/2} -1) +2ctqx]\} \quad (3)$$

$$V= 0.0026224m^3$$

Volume of water required (V) = 0.0026224m^3

In this case the whole of the water from inside of the float, 0.0026224m^3 is available to raise the outside level of the water.

2.3 Calculations for maximum velocity:

Total volume of submerged air (V_{sa}) = $\frac{m}{\rho}$ = 0.000421m^3

Water level outside the float (h) = $\frac{((Vsa)+V)}{A}$ = 0.32756m

For the steady-state, the pressure difference between the float and the tank is

$$\delta p = Kv^2 \quad (4)$$

Where K is the constant and v is the wind speed. Applying the hydrostatic equation to the liquid,

$$\delta p = \rho g(-x_1 + x_2)$$

By considering h=0.32756m and x_2=0.35m,x_1=x_2-h=0.002243m,

Pressure difference between inside and outside of float (δp) =$\rho g(x_2-x_1)$ = 3385.56N/m^2

From equation (4)

v=60.92m/s i.e. 219.30kmph

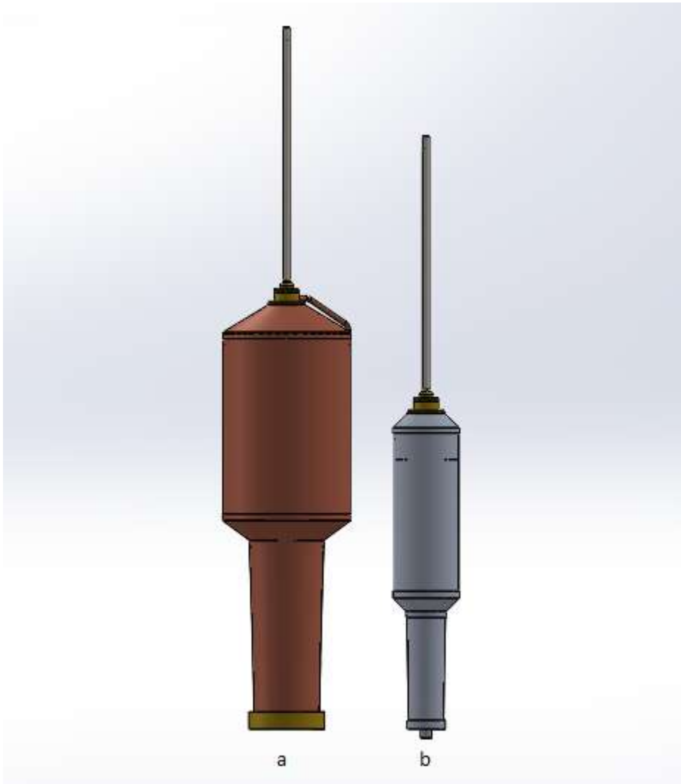

Fig.-2: a is actual float and b is modified float

3. CONCLUSION

In this study new model of float and tank proposed. Maximum velocity is taken into consideration in this study. The maximum velocity calculated is approximately 220 kmph but in actual practice air would bubble through at less speed than calculated. The change in the size of float and tank is not alone sufficient to enable much higher speed to be recorded. If no change were made in length of the float below the zero level, air would begin to bubble through at some speed less than considered length. To record higher speed for same diameter of float and tank it would be necessary to lengthen the float and tank.

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