Design and Fabrication of Invelox

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Abstract – *Invelox is the system which is used for power generation by using wind energy. Invelox system uses the principle of venturi for increasing velocity of fluid. The main objective of this paper is to give detailed calculations for different friction factors for invelox system & Realistic approach for material selection for invelox system. For obtaining power output we have taken initial velocity at 2m/s. We have designed invelox system in such a way that it can be used for domestic purposes.*

Key Words: **Invelox, Wind energy, Material selection, Domestic purpose**

1.INTRODUCTION

Energy obtaining from non-conventional Energy sources has become very important due to depletion of conventional resources. All non-conventional resources are renewable or non-depleting do not cause any pollution. Conventional wind mill has some drawbacks like large size of blade complications in maintenance & harmfulness to ecosystem. Invelox is the system which is used for increasing velocity of fluid through convergent section of venturi, so we can get higher velocity at ground level. We have converted 50 Ft. Invelox system which is used for commercial purposes into smaller size invelox system so it can be used for domestic purposes.

2. THEORETICAL CALCULATIONS

Design of Inlet section of invelox system Mild Steel

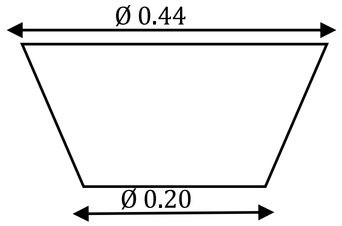


Fig 2.1 Inlet Section

Considering minimum air velocity at 2 m/s

Atmospheric pressure = 1bar = $1*10^5$ Pa.

Inlet Diameter of inlet section (D1) = 0.44 m.

Outlet diameter of inlet section (D2) = 0.20 m.

To find out pressure at outlet diameter.

$A_1 = \Pi/4*(D_1)^2$

$= 0.152\ m^2$

$A_2 = \Pi/4*(D_2)^2$

$= 0.0314\ m^2$

$P_1A_1 = P_2A_2$

$P_1/P_2 = A_2/A_1$

$1*10^5/P_2 = 0.0314/0.152$

$P_2 = 4.484*10^5$

By Using Continuity Equation,

$A_1V_1 = A_2V_2$

$0.152*2 = 0.0314*V_2$

$V_2 = 2.51$

Discharge of air at inlet section.

$Q = A_1V_1$

$= 0.152*2$

$= 0.304\ m^3/s$

Design of elbow section of invelox system.

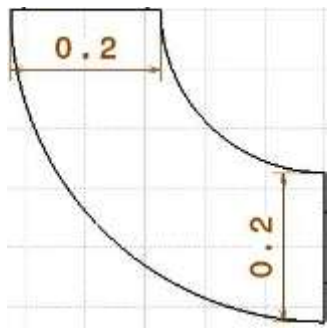


Fig. 2.2 Elbow Section

Here the inlet diameter of the elbow will be the outlet diameter of the duct section 0.20 m

Bends in pipes may causes losses, it gives head loss.

$k = L/D$

= 0.60/0.20

= 3

Friction factor for mild steel =1.05

K = F*k

= 1.5*1.05

= 3.15

By using Darcy Weisbach Theorem

Head loss = $FLV_2^2/2gD_2$

= $1.05*0.60*2.51^2/2*9.81*0.20$

= 1.05 m

HL = 1.05m

To find velocity at the exit of the elbow section,

By using Bernoulli's equation,

$$\frac{P}{\rho g} + \frac{V^2}{2g} + z = Const$$

$P_1 + V_2^2/2g = P_1 + V_3^2 - K(V_2^2)/2g$

$V_3^2 = V_2^2 + K(V_2^2)/2g$

= $2.51^2+3.15*2.51^2/2*9.81$

V_3 = 2.701 m/s

Design of venturi section of invelox

Taking air velocity obtained at the end of elbow section,

V_3 = 2.636 m/s

Venturi is the main section which will increase the velocity of the wind.

Taking diameter of venturi inlet (D_3) = 0.20 m.

$A_3 = \Pi/4*(D_2)^2$

= 0.0314 m^2

The throat section where the increase in velocity is expected.

D_4 = 0.12 m

$A_4 = \Pi/4*(D_4)^2$

= 0.01767 m^2

By Using Continuity Equation,

$A_3V_3 = A_4V_4$

$0.0314*2.636 = 0.01767*V_4$

V_4 =4.20m/s

Velocity step up ratio

V_4/V_3 = 4.20/2.636

= 1.5

Design of venturi converging section: -

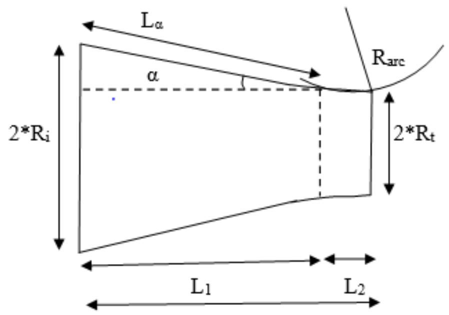


Fig. 2.3 converging Section

L_c=Length of converging section.

L_1=Length of converging section inlet of throat.

La= Length of converging side (actual).

= Converging angle

By rocket propulsion theory

When ratio of radius =10^5

Standard value of is R_{arc} = 1.5

And angle between 20° to 60°

Convergent angle = α =20° to 60°

α_c =30°

R_3=1.087/2= 0.5439

R_4= 0.4/2=0.2

$$L_1 = \frac{R_i - R_t + R_{arc}(\cos\alpha - 1)}{\tan\alpha}$$

= 0.54395-0.2+1.5(cos(30)-1)/(tan30)

= 0.3978 m.

$L_2 = R_{arc}$*sin

= $1.5*R_4*\sin30$

=1.5*0.091*sin30

= 0.0555 m.

Design of divergent section: -

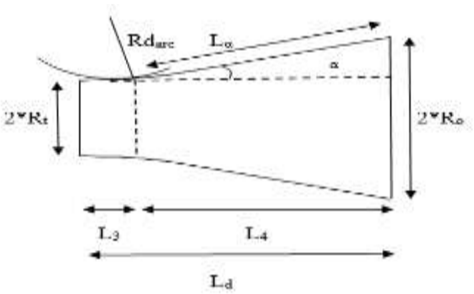


Fig. 2.4 Diverging Section

R_2 = Throat radius.

Ra = Diffuser outlet radius.

A_d= Divergent angle.

La= Length of specified in divergent design.

R_{div}=Divergent arc.

L_3= Throat length.

L_4= Length of diverging section.

$L_3 = R_{arc}*\sin 15°$

$=R_{arc}*R_4*\sin 15°$

$=0.4*0.091*\sin 15°$

$L_3 = 0.0942$ m

$$L_4 = \frac{R_o - R_t + Rd_{arc}(\cos\alpha - 1)}{\tan\alpha}$$

$= 0.1524-0.091+0.4*(\cos(15)-1)/\tan 15$

$L_4 = 0.5033$ m

Power available at inlet throat

$P_t = 1/2 * \rho * A * V^3$

$\rho = pa*n/(R*T)$

$= ½* pa*n/(R*T)\ A_3*V_3^3$

$= ½ *[101221*29/8.314*293]*10^{-3} *0.0314*2.636^3$

$P_t = 2.5$ W.

Power Available at outlet of throat section.

$P2 = 1/2 * \rho_4 * A4 * V_4^3$

$\rho_4 = [\rho *A_3*V_3/ A_4* V_4]$

$P2 = ½ *[\rho *A_3*V_3/ A_4* V_4] *A4* V_4^3$

$= ½* [875.88*0.0314*2.636/0.01767*4.20]*10^{-3}*0.01767*4.20^3$

= 6.39 W.

Considering actual losses and coefficient of performance of turbine 15%

= 6.39 * 0.15

= 0.9591.

Power Available = 6.36-0.9591

= 5.5 W

Similarly, we have calculated power cast iron and Fiber reinforced plastic (FRP)

Sr. No.	Name of material	Friction factor	Output
1	Mild steel	1.05	5.5 W.
2	Cast Iron	1.1	4.45 W.
3	Fiber reinforced plastic	0.5	6.19 W.

From this result, we have selected mild steel for fabrication considering FRP has some disadvantages.

3. FABRICATION OF INVELOX SYSTEM

Laser Cutting: -

It is used for cutting material used for fabrication of invelox system.

Bending: -

Material is bent by using bending machine at required angles.

Roll Bending: -

To obtain round shape for convergent and throat section of invelox system roll bending is done.

Welding: -

To assemble all the parts of the system welding process is used.

4. WORKING OF SYSTEM.

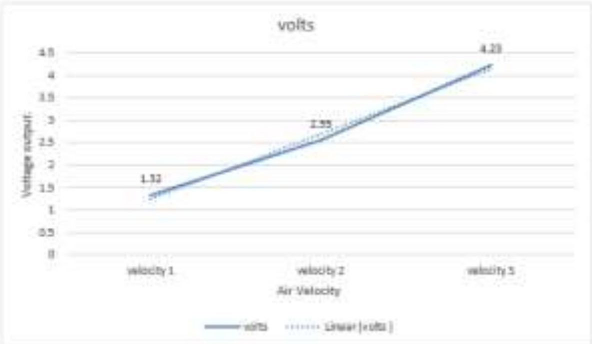
This system can specifically install at high air velocity places with the minimum air velocity of 2m/s

In Invelox, wind flow converges through funnel and increase the wind speed, this converts to electric power by using turbine-generators system. Wind is captured with a funnel and directed through a tapering passageway that naturally accelerates its flow. This stream of kinetic energy then drives a generator that is installed safely at ground level. Bringing the airflow from top to ground level increases the kinetic energy and thus allows for greater power generation with much smaller turbine blades.

RESULTS AND DISCUSSION: -

Voltage output at different air velocities.

Sr. No.	Air velocity at inlet section(m/S)	Output (Volts)
1.	1	1.32
2.	2	2.55
3.	3	4.23



CONCLUSION: -

In past decade man is constantly trying to gain more and more comfort by developing various technologies. Man, attempt has been made to develop more and more modified and advanced techniques with increasing aesthetics and economic concern. Hence, there is always scope of improving toward whatever man might have created. Following points are concluded on the basis of above study.

Velocity of air can be increase at higher rate if the funnel section is in circular cross section.

Battery can be charged at higher rate if the 12 V. DC motor is as a generator instead of 5 V. Dc motor.

Booster circuit is needed for boosting the voltage from 4.23 volts to 12 volts for battery charging.

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