Progress Report of Ph.D. Work on

“Design & Development of Zero Pollution Air Engine”

By

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To

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1.0 TITLE OF WORK: "Design & Development of Zero Pollution Air Engine"

2.0 DETAILS OF WORK DONE TILL LAST PRESENTATION:

2.1 Literature survey about air engine / turbine and related turbo machinery has been completed. Details at Annexure –I.

2.2 Literature survey of motor bike available in India & its parameters has been completed. Details at Annexure- II.

2.3 On the basis of available parameters the 2-D design of air turbine rotor, casing, vanes, springs, pulley etc. has been done.

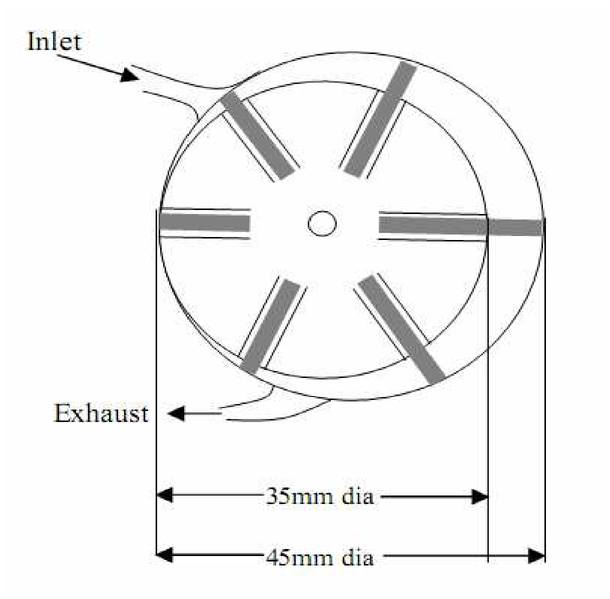
2.4 Fabrication of simple vaned type air turbine based on first design has been completed.

2.5 Vaned turbine has been run and part testing done for first design.

3.0 DETAILS OF WORK DONE SINCE LAST PRESENTATION (8TH JUNE' 2007):

3.1 Theoretical analysis of vaned type turbo machinery completed.

3.2 Based on mathematical modeling of vaned turbo machinery the mathematical model of vaned type air turbine has been developed.



$$w = n\left(\frac{\gamma}{\gamma - 1}\right) p_1 v_1 \left\{ \left(\frac{p_4}{p_1}\right)^{\frac{\gamma-1}{\gamma}} - 1 \right\} - n\left(p_4 - p_5\right) v_4$$

Where *w* = Theoretical work done

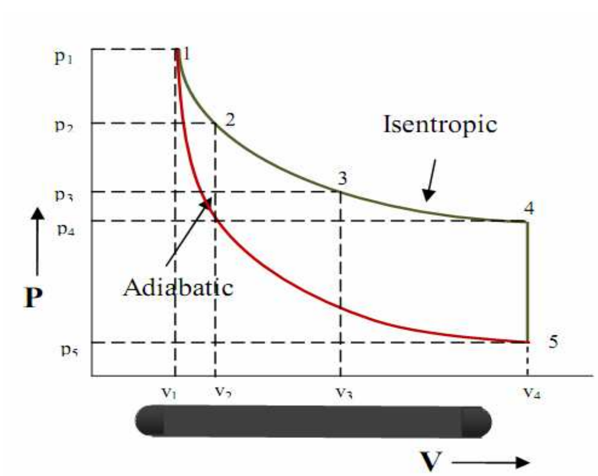
p_1 & v_1 are pressure & volume respectively at which air impinges upon the vanes of turbine,

p_4 & v_4 are pressure & volume respectively up to which maximum expansion of air takes place,

p_5 is the pressure at which turbine releases the air to atmosphere.

$$\eta_{net} = \frac{Actual - Workdone}{Net - Input}$$

3.3 Thermodynamic cycle for expansion process in vaned type air turbine has been identified and shown ahead



3.4 Parameters to be studied:-

i) Dependent parameters: Specific air consumption, Speed of rotation, Torque, Work output, Efficiency

ii) Independent parameters: Rotor diameter, diameter of casing (outer cylinder), number of vanes, dia of nozzle, air pressure, Vaned turbine design

Dependent parameters = f_n (Independent variables)

3.5 Optimization of mathematical model is done as shown below:

$$w = n\left(\frac{\gamma}{\gamma-1}\right)p_1 v_1\left\{\left(\frac{p_4}{p_1}\right)^{\frac{\gamma-1}{\gamma}}-1\right\}-n\left(p_4-p_5\right)v_4 \tag{1}$$

Let $\frac{\gamma-1}{\gamma}$ = k (constant)

$$w = \frac{n.p_1.v_1}{k}\left\{\left(p_4{}^{k}.p_1{}^{-k}\right)-1\right\}-n\left(p_4-p_5\right)v_4 \tag{2}$$

Applying Lagrange's Multiplier, the optimum value of shaft-work will be obtained when:-

$$\frac{\partial w}{\partial v_4}=0 \tag{3}$$

$$\frac{\partial w}{\partial p_4}=0 \tag{4}$$

Differentiating (2) with respect to *v_4*,

$$\frac{\partial w}{\partial v_4}=0,$$

$$-n\left(p_4 - p_5\right) = 0$$

or, $$\boxed{p_4 = p_5 \cong 1.0\ atm\ pressure \simeq 1.0132bar} \qquad \textbf{(5)}$$

Differentiating (2) with respect to p_4,

$$\frac{\partial w}{\partial p_4} = 0 \;,$$

$$n.\frac{p_1.v_1}{k}\, p_1^{-k}.k.p_4^{k-1} - n.v_4 = 0$$

or, $$n.p_1^{1-k}.v_1.p_4^{k-1} - n.v_4 = 0$$

Let $c = p_1^{1-k}.v_1$,

Then, $n.c.p_4^{k-1} - n.v_4 = 0$

Therefore, $$\boxed{p_4 = \left(\frac{v_4}{c}\right)^{1-k}} \qquad \textbf{(6)}$$

From the above, it is clear that for optimal shaft work, p_4 has direct relation with v_4, p_1 and v_1 , where $\left(p_1^{1-k}.v_1\right)$ is taken as a constant, $p_4 = p_5$ =1 atm pressure.

4.0 FURTHER WORK:

4.1 Optimization of vaned air turbine using mathematical model developed

4.2 Fabrication of engine for optimum parameters

4.3 Experimentation on fabricated air turbine / engine

4.4 Results and analysis

4.5 Conclusions

4.6 Thesis report writing

5 PUBLICATIONS FROM WORK DONE TILL DATE:

5.1 Publication in Journals:

- Singh, Onkar and Singh, B. R., - "Concept of Development of vaned type air turbine" –Pacific Journal of Transport Phenomena & Turbo-machinery-Honolulu, Hawaii- under peered review.

- Singh, Onkar and Singh, B. R., "Development of a vaned type novel air turbine"- Journal of Mechanical Engineers Sciences, London- accepted & reviewer's comments received for revision.

5.2 Papers presented and published in Proceedings of International Symposium / Conferences:

- ***"Development of a Vaned Type Novel Air Turbine",*** 12th International Symposium on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-12)- scheduled on 17-22, 2008 at Pacific Center of Thermal Fluids Engineering, sherton Mona Surfrider Hotel, Honolulu, Hawaii.
- ***"A Study of Compressed Air as an alternative to Fossil Fuel for Automobile Engines",*** International Conference on Challenges & Strategies for Sustainable Energy and Environment- held on 10th & 11th June'2006 at UPTU, Lucknow.

5.3 Papers accepted for International Symposium / Conferences:

(Papers are likely to be published in Journals, after peered review)

- ***Optimal Uses of Wind Energy leading towards a Novel Resource for Future Sustainability***-ASME 2nd International Conference on Energy Sustainability (ES-2008)- scheduled on August 10-14, 2008 at Jacksonville, Florida, USA".

- ***Study on Energy Storage System for 21st Century and Uses of Compressed Air as an Alternative to Fossil Fuel for Light Transport Engines*** - ASME 2nd International Conference on Energy Sustainability (ES-2008-54229) scheduled on August 10-14, 2008 at Jacksonville, Florida, USA.

- ***Thermodynamic Evaluation of Compressed Air Storage Engine*** -2nd International Conference on Thermal Issues in Emerging Technologies Theory & Applications (ThETA-2-2008) scheduled on December 17-20, 2008 at Cairo, Egypt.

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