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EMPIRICAL STUDY OF DESIGN FOR ANALYZING ROTOR, STATOR AND BLADES OF THE AXIAL FLOW COMPRESSOR

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ABSTRACT

Axial flow mechanical device is one in all the foremost vital elements of turbine. In style of Axial flow mechanical device the work conferred contains of basic flow parameters and dimensions of elements, this makes the more style method quite easy and also the results are useful to require more changes or improvement at the time of careful style. the target of labor conferred is to style Axial flow mechanical device by victimisation mean line technique for a given mass rate and needed pressure magnitude relation. The parameters determined additionally embrace thermodynamically properties of the operating fluid, stage potency, variety of rotor and mechanical device blades, tip and hub diameters, blade dimensions (chord, length and space) for each rotor and mechanical device, ratio, flow and blade angles (blade twist) . constant parameters also are determined for all 5 stages. The twist of the blades will be calculated on the blade length at any needed variety of sections designated by the designers to get swish blade twist profile. NACA 65410 profiles is employed to come up with coordinates of the blade. Further, within the method the primary stage of axial flow mechanical device blade is developed victimisation Solid works modeling. additionally CFD simulation has been administered victimisation Ansys CFX to validate the results. additionally Static structural Analysis has been performed to examine whether or not the rotor is safe at given speed.

***Keywords:* Compressor, NACA, Axial flow, rotor, stator**

I. INTRODUCTION

Axial-flow compressors square measure employed in medium to massive thrust turbine and jet engines. The mechanical device rotates at terribly high speeds, adding energy to the flow whereas at constant time press it into a smaller area. the planning of axial flow compressors may be a nice challenge, each aerodynamically and automatically. [1] The mechanics mechanical device style method primarily consists of mean line prediction calculation, through flow calculation, and blading procedures. The mean line prediction is that the commencement among mechanical device style. it's an easy one dimensional calculation of flow parameters on the middle height line of the mechanical device wherever international parameters because the annulus pure mathematics, the quantity of stages, and therefore the stage pressure ratios square measure scaled [2]. it's necessary {to style|to style} Axial flow mechanical device at preliminary level and need parameters may be checked at initial level thus more improvement may be created at primary level before begin an in depth design.

The mean line prediction method because it is performed nowadays may be a terribly fast and reliable technique for mechanical device preliminary style generally, the results of the preliminary method square measure obtained by time intense manual parameter studies supported engineering intuition or expertise. the ultimate one dimensional answer is employed as Associate in Nursing initial guess for the following style method, e.g. for through flow calculations [4].

These calculations additionally embody natural philosophy properties of the operating fluid, stage potency, and variety of rotor and stator coil blades, tip and hub diameters, chord, length and area of blade for rotor and stator coil, ratio, flow and blade angles. A recurrent stage calculation is created to calculate the on top of parameters on mechanical device stages. the standard approach to axial-flow mechanical device mechanics style was to use varied families of airfoils because the basis for blade style. yank follow was supported varied families designed by the National informative

Committee for physics (NACA),the most common being the 65-series family[5] .NACA 65410[6] device is employed here to come up with blade coordinates. within the 1954,Donald M. Sandercock, kovach Associate in Nursingd queen Lieblein designed a 5 stage axial mechanical device and administered an experimental investigation with all rotor rows in operation with sonic relative recess Mach numbers designed as analysis unit to check the potentialities and issues arising from the combination of sonic stages.

II. DESIGN PROCESS

The steps involved in design of axial flow compressor is Shown in figure 1. Suitable design point under sea level static conditions [5], given pressure ratio is 4.75 and Air mass flow rate is 30 kg/sec. Also, Axial velocity Ca= 160 m/s and blade speed is 270m/s is considered.

III. ANNULUS DIMENSIONS

Stagnation and static properties can be found by simple thermodynamic equations and the Enthalpy-Entropy diagram which is shown in fig.2 Once P_0, T_0 and P, T at entry and exit have been found.

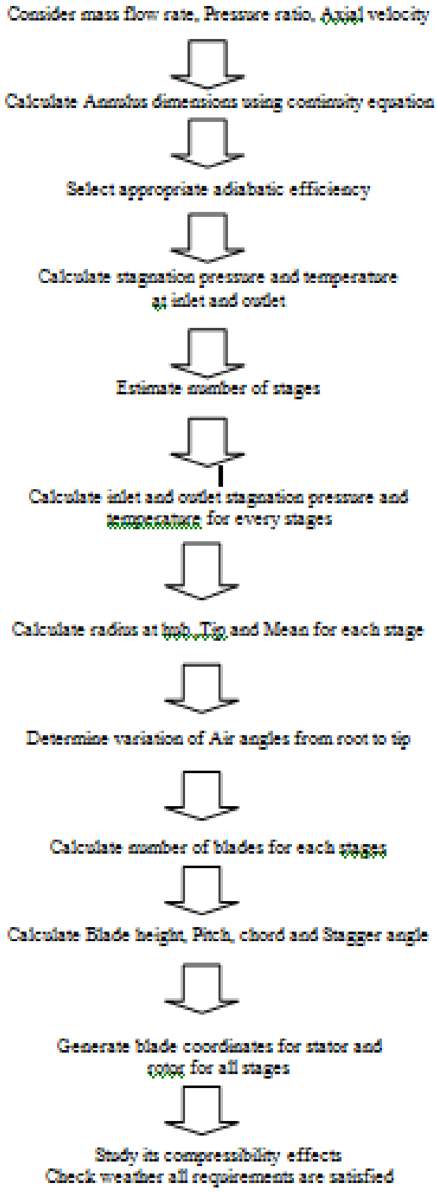

Fig 1 Aerodynamic Design input and Steps

IV. ESTIMATION NUMBER OF STAGES

The number of stages is found by dividing total temperature rise in all stages by Temperature rise per stage.

$$\text{Where}, \Delta T_{0s} = \frac{\lambda . U . C_a . (C_{w2} - C_{w1})}{C_p}.$$

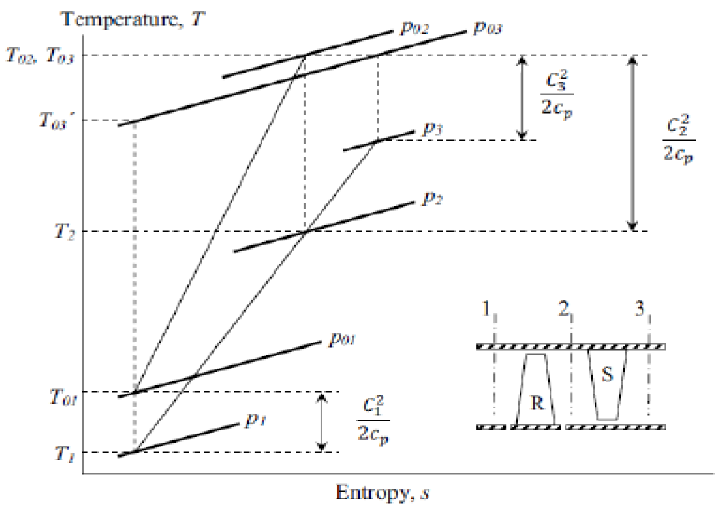

Fig 2 Enthalpy-Entropy diagram

V. STAGE BY STAGE DESIGN

The rotor and stator of a stage are shown in figure2 Note that all angles are referred to the axial velocity vector Ca. Air exits from the previous row of stator blades at angle of α1with absolute velocity C1.The rotor rows has tangential velocity, and combining the two velocity vectors gives the relative inlet velocity vector W1 at angle β1.At rotor row outlet the velocity triangles are similar to those draw for the axial flow pump, and absolute velocity vector C2 moves into the stator row where the flow direction is changed to C3 with the absolute velocity C3The diagram have been drawn showing a large gap between the rotor and stator blades. In practice, the clearance between the rotor and stator is very small. If the following stage is the same as the preceding one the stage is said to be normal. For a normal stage C1=C3 and α1 = α3. V2 is less than V1, showing that diffusion of relative velocity has taken place with some static pressure rise across the rotor blades. The air is turned towards the axial direction by the blade camber and the effective flow area is increased from inlet to outlet, thus causing diffusion to take place. Similar diffusion of the absolute velocity takes place in the stator where the absolute velocity vector is again turned towards the axial direction and further pressure rise occurs.

VI. CONCLUSION

With available data i.e. Mass flow rate, Pressure ratio and Pressure at given Altitude. The Blade profile has been generated for both Rotor and Stator analytically. The other possibility of flow separation is also checked with Mach

number and Pressure co efficient. The calculation spread sheet is made so by input the values one can get the required parameters to generate the blade coordinates.While comparing theoretical design results with analytical results, it is observed that the CFD analysis results are in agreement within acceptable range of theoretical results.

REFERENCES

[1] Saravanamutto,HIH,Rogers,GFC och Cohen,H.Gas Turbine Theory fifth Edition,Pearson Prentice Hall,2001.

[2] Nicallas Falck,'Axial Flow Compressor Mean Line Design',Master thesis.Lund University,Sweden,Feb.2008

[3] Hill,P.,& Peterson,C(1992),Mechanics and Thermo dynamics of Propulsion(2nd ed.).Addison Wesley.

[4] Akin Keskin,"Process Integration and Automated Multi- Objective Optimization Supporting Aerodynamic Compressor Design".P.hd Thesis,Brandenburg Technical University Cottbus,2007

[5] Ronald H. Aungier,"Axial Flow Compressor",2nd edition,2003.

[6] UIUC Airfoil Coordinates Database Source dat file,'Compressor'http://airfoiltools.com/airfoil/details?airfoil=naca65410-il'(accessed 10th Nov.2012)

[7] Robin Richard Rajan,Saravanan. T,Rajesh Kumar K.,'Aircraft Design Project1'B.E Thesis,Hindustan College of Engineerng,Anna University,2010.

[8] Meherwan P. Boyce,"Gas turbine Engineering handbook",2nd Addition,Gulf Professional publication,2001

[9] McKenzie, A.B. Axial Flow Fans and Compressors, Ashgate Publishing Limited,1997.

[10] Rizwan r. Ramakdawala, "Preliminary Design Code for an Axial Stage Compressor", M.Sc. Thesis, .S.,University of Maryland ,College Park,1994.

[11] Mattingly, J. D., Heiser W. H., Daley, D. H., Aircraft Engine Design, AIAA,NewYork, 1987.

[12] Cumpsty, N.A. Compressor Aerodynamics, Krieger Publishing Company, 2

[13] S.L. Dixon, B.Eng., PH.D. Senior Fellow at the University of Liverpool, "Fluid Mechanics, Thermodynamics of Turbo machinery, FOURTH EDITION 1998

[14] V Ganesan,Gas Turbines,3rd Edition,Tata McGraw Hill,New Delhi,2010.

[15] Boyle, R. J., "Navier-Stokes Analysis of Turbine Blade Heat Transfer," ASME Paper 90-GT-42, June 1990

[16] G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*

[17] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[18] I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[19] K. Elissa, “Title of paper if known,” unpublished.

[20] R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.

[21] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[22] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[23]. E. Elangovan. "IDENTIFICATION AND PREVENTION OF MULTIPLE ACCOUNT IN SOCIAL MEDIA." *International Journal of Advanced Technology in Engineering and Science* 3.Special Issue No. 01 (2015): 80-88.