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GRAPH APPLICATIONS TO HYDRAULIC TURBINES

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ABSTRACT

The writing of the paper entitled 'Graph Applications to Fluid Mechanics was prompted by a desire to meet the requirements of Mechanical Engineering students. Usually students face difficulty understanding clearly the basic principles. To meet this basic requirement some fundamental concepts and its Graph Applications were given. This paper concerns the graph applications of hydraulic turbines which are the characteristic curves. The turbines are usually designed for particular values of H, Q, P, n which are known as designed values under given conditions. But it is not possible for a turbine to run at design conditions. Hence it is necessary to have knowledge how these conditions vary with respect to one another .Relations between any two of the parameters are characteristic curves. It is therefore customary to study the variation of all the quantities with respect to variation of any one of the independent quantities. Performance curves is an important topic which has been given equal weight age in Mechanical, civil, Chemical Engineering curriculum. This paper designed to explain the fundamentals of turbines and its applications to graphs. principles and concepts of turbines presented in simple and clear terms. The paper has an easy to read style and is going to benefit the readers. Important findings are

1. characteristic curves helps in selecting given situation or predicting its behavior at different places where head and discharge may be different.

2Trend of unit power and overall efficiency is same for all turbines increase in their value with increasing in their gate value

Keywords:. Introduction, properties of turbine, introduction, importance,, Graphical representations

INTRODUCTION:

Charactaristic curves of hydraulic turbines are the curves with the help of which the exact behavior and performance of the turbine under different working conditions can be known. These curves are plotted from the results of the tests performed on the turbine under different working conditions.

The important parameters under which are varying during tests of turbine are

1.speed, 2.Head 3.Discharge 4.Power 5.Overall efficiency 6.Gate opening.

Out of these parameters speed n ,Discharge Q, Head H are independent parameters

Out of these independent parameters one of the parameter kept constant and the variation of other four parameters with respect to any one of the two independent variables are plotted and various curves obtained are called Characteristic curves

Main Characteristic curves :These are obtained by maintaining constant head and constant Gate opening on the turbine. The speed of the turbine is changed by changing load on the turbine

Operating Characteristic curves ; In this case speed of the turbine is constant .In this head generally constant the variation of power and efficiency with respect to discharge Q are plotted
Constant efficiency curves or Muschel curves: These versus efficiency ,speed versus discharge curves

Importance: In actual practice of operation the turbines may often be required to work at conditions different from those for which they have been designed. Hence it is necessary to have the knowledge between these quantities. Hence test results will be graphically plotted between the unit quantities. Human operated, hydraulic actuated machines are widely used in many high-power applications. Improving productivity, safety and task quality has been the focus of past research.

WHY Graph Application needed: Turbines are often required to work under varying conditions of head, speed, output and gate opening. As such in order to predict their behavior it is necessary to study the performance of turbines under varying conditions and by carrying out tests either on the actual turbine or on their small scale models..The results of these tests are graphically represented and the resulting curves are known as characteristic curves. For the sake of convenience curves are plotted in terms of unit quantities.

Thus for a given unit discharge the vertical line touches the curve of maximum efficiency at only one point .If the peak points of various efficiency curves are joined together by a smooth curve then we obtain a best performance curve for the turbine.

Advantages

1.To have an idea about the performance of actual turbine.
2.To predict the performance of actual turbine.
3.To obtain a perfect design of actual turbine
4.In the development of new types of turbines with higher specific speed and better efficiency.

REVIEW OF PAST RESULT

In 1992 James L. Gordon, a hydropower consultant residing in Quebec, devised a mathematical methodfor approximating hydraulic turbine efficiecy curves for several types of turbinesThis mathematicalapproach was created to be especially useful for approximating gains through rerunnering, updating anexisting performance curve, and creating a performance curve for a turbine that lacks a performance
curveThe method outlined by Gordon (2001) is a generic procedure, with calibration factors for differentstyles of turbines including the Francis, axial flow, and impulse turbinesThe use of hydraulic turbines for the generation of power *W*, *w* relative velocity (m/s) has a very

strong historical traditionThe first truly *Z* axial direction/axis of rotation effective inward flow reaction turbine was developed andtested by Francis and his collaborators around 1850 in a absolute flow angle (degrees) Lowell, Pelton turbine with a double elliptic bucket*revision for publication on 27 July 1998. Sulzer Hydro AG, Hardstrasse 319/Postfach,* including a notch for the jet and a needle control for the*CH-8023 Zu¨rich, Switzerland.* nozzle was first used around 1900The axial flow turbineC01898 © IMechE 1999 Proc Instn Mech Engrs Vol 213 Part C86 P DRTINA AND M SALLABERGER with adjustable runner blades was developed by the 2 BASIC FLUID MECHANICS OF HYDRAULIC Austrian engineer Kaplan in the period from 1910 to 1924

Performance characteristics of the turbine under variable head

It has been cleared that the simplified low head cross-flow turbine has good performance at a constant head . In order to apply the turbine to variable head micro-hydropower, it is necessary to reveal the performance characteristics of the turbine under variable head.As mentioned before, the performance of the turbine is strongly influenced by the air pressure of the runner inside. , and the optimal air pressure decreases with the increase of the head, while the best turbine efficiency keeps a constant value From the above results, it is clearly revealed that the unit rotational speed ($nd/H1/2$) of the turbine should be set to the optimal value despite the variation of the operating head, then the turbine can always be operated under the optimal condition.

Analysis of a Hydraulic Turbine

performance testing of hydraulic turbines is undertaken to define the head-power-discharge relationship, which identify the turbine's peak operating point. This relationship is essential for the efficient operation of a hydraulic turbine Gordon (2001) proposed a method of mathematically simulating the performance curve for several types of turbines In this study, performance curves developed by the mathematical model are compared and modified to model performance curves developed by prototype testing The role of the hydroelectric power plant is increasing in importance because water power is a clean energy source amply available in nature furthermore, requirements for hydroelectric generation have been raised as a means of generating energy quickly in response to demands of electricity systems. It is very important to utilize existing old hydroelectric power plants effectively and efficiently, as well as to build new hydro electric power plants. In this study, performance curves developed by the mathematical model are compared and modified to model performance curves developed by prototype testing The present paper discusses the basic principles of hydraulic turbines, with special emphasis
on the use of computational fluid dynamics (CFD) as a tool which is being increasingly applied to gain insight into the complex three-dimensional (3D) phenomena occurring in these types of fluid machinery.

Much effort is being made to develop efficient and cost-effective renewable energy solutions . In conventional hydropower, as well as in the more recent quest to harness the energy from waves and tides, well designed turbo machinery is essential. We feature the analysis of a new **Hydraulic** turbine design to power a generator providing between 1.0 and 1.2 kW for remote dwellings not connected to an electrical supply grid. In the analysis, the turbine was modeled to determine its Characteristic curves of torque and power vs. rotational speed. The figures are provided to give an idea of the general trend of the results, but do not include numerical data due to client confidentiality requirements. The movie above shows the calculated flow through the rotating turbine.

Figure 1 shows the geometry of the turbine. The finite element mesh used is shown in Figures 2 and 3.

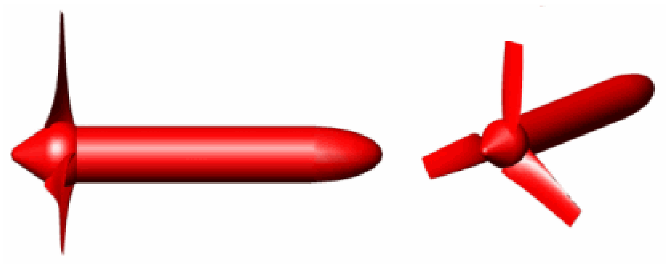

Figure 1 Schematic of the turbine, two views

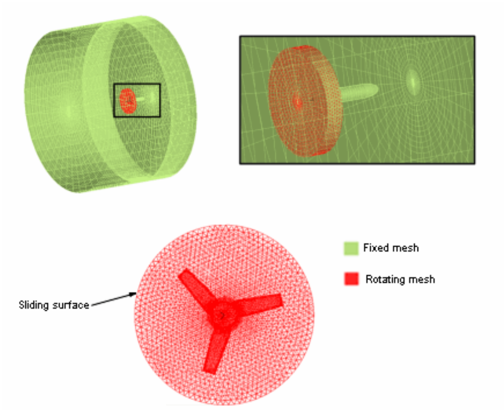

Figure 2 Finite element model used: fixed and rotating fluid mesh

In the fluid model, a rotating mesh (shown in red in Figure 2) attached to the blades was defined and a separate fixed mesh (green in Figure 2) was also defined, with a sliding surface between these two meshes. The rotating turbine is shown in the movie above.

To investigate the effect of river flow turbulence on the results, different values of free flow turbulence intensity (It) were considered. The numerical results were obtained modeling the flow with two different turbulence models

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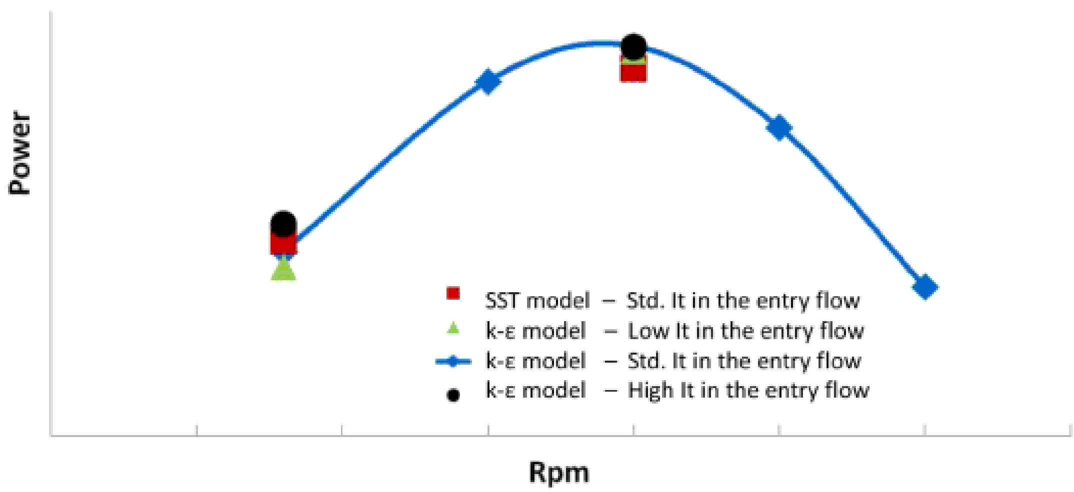

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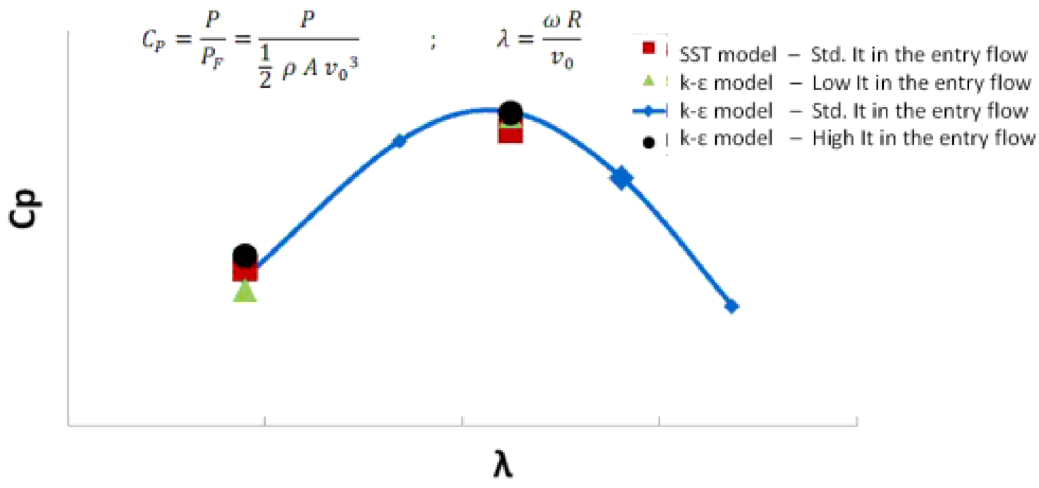

General Layout:_Hydraulic Turbine which convert hydraulic energy in to mechanical energy can be used in running electric generators.Thus mechanical energy can be converted in to electrical energyThe electric power obtained from hydraulic energy is known as hydro electric power.At present the generation of hydro electric power is the cheapest as compared by other sources such as oil,coal etc.To know the exact behavior of hydraulic turbines characteristic curves can be applied

Importance: Energy is the primary input to every activity of development.The present paper deals with the hydraulic turbines and their performance curve because of their importance and wide applications in Engineering practice. Hydraulic Turbines coupled with hydro generators which are widely used now a days for generating electric power. Hydro power generators constitute the largest and cheapest source of renewable supply of energy. Hydraulic Turbines utilize the energy of water and convert in to mechanical energy of rotating shaft. In actual practice turbines may often be required to work at conditions different from those for which they have designed. To determine the behavior of machine under varying conditions tests are conducted and the results are graphically plotted and using these graphs the behavior of turbine was determined

CONCLUSION Charactaristic curves of hydraulic turbines are curves with help of which the exact behavior and performance of turbine with different working conditions can be determined.In constant speed curves the power and efficiency curves will be slightly away from the origin. On the X-axis as to overcome certain amount of discharge will be required. For plotting iso efficiency curves the horizontal lines representing the same efficiency drawn on the speed curve.These curves are helpful in determining the Zone of constant efficiency and for predications the performance of turbine at various efficiencies is required

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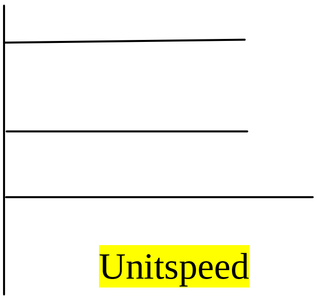
BASIC SHAPES

Unit discharge



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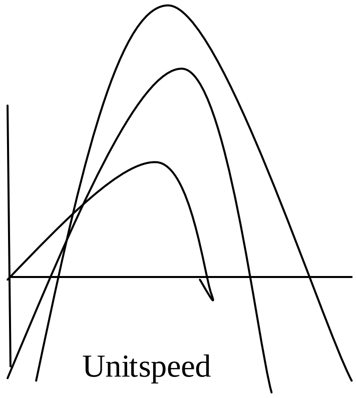
Unit discharge



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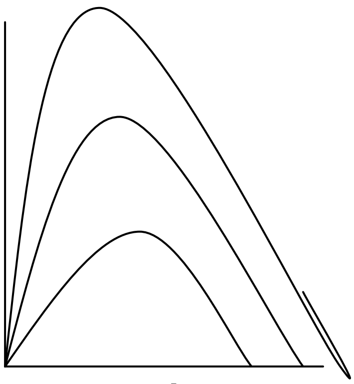

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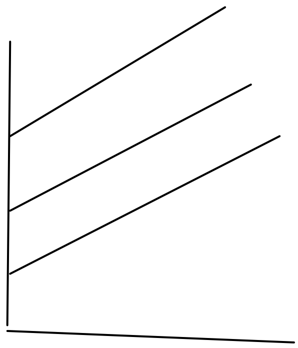

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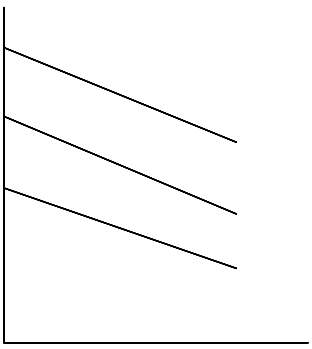

Unit speed

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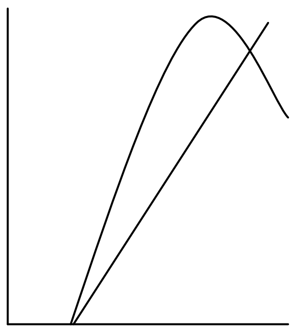

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