Effect of Draft Tube on Hydraulic Turbine

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***Abstract*— The draft tube is an important part of a hydraulic turbine which affect the hydraulic performance. The optimum performance of draft tube is an important aspect in the design of hydraulic turbine, which can be achieved by varying the shape and size of draft tube. Turbine need to have a minimum amount of water to propel them in order to produce enough energy without these tubes, the pressure could drop because of lack of water and in turn, the entire turbine could fail to work and power could be lost.**

***Index Terms*— Draft tube, conical, hydroelectric, pressure head, efficiency, swirl, tailrace, turbine.**

I. INTRODUCTION

Basically, draft tube is a diffuser pipe which connects the runner exit to the tailrace where the water is being finally discharged from the turbine. The draft tube used in reaction turbine has increased in cross sectional area from its inlet to outlet. The function of draft tube is to allow the installation of turbine above the tailrace level without any appreciable drop of available head. The recovery of kinetic energy leaving the runner determines the performance of draft tubes. Francis turbines are one of the most preferred hydraulic turbines. A hydraulic turbine always runs completely filled with the working fluid. The tube that connects the end of the runner to the tailrace is known as a draft tube and should completely to fill with the working fluid flowing through it. Water exits the turbine through the draft tube, which act as a diffuser and reduces the exit velocity of the flow to recover maximum energy from the flowing water. It acts as a diffuser since area of flow increases. Thus we have water coming from turbine at atmospheric pressure. The efficiency of each component of turbine affects the performance of hydro- power plant.

II. DRAFT TUBE

The draft tube is an integral part of reaction turbine, and it design criteria should be specified by the turbine manufacturer. The draft tube used in hydraulic reaction turbine has gradual increases in cross sectional area from its inlet to outlet it is one of the component of reaction turbine and connect to tailrace the main function of draft tube is to allow the installation of turbine above the tailrace level without the loss of head and to convert major part of kinetic energy coming out of runner into pressure energy in mixed flow reaction turbine, kinetic energy from runner is up to 15% where as in low head and high speed axial flow turbines, kinetic energy leaving the runner may go up to 50% of sectional area of the draft tube in the flow direction. The turbine efficiency is based on Net Head (H) on behalf of Gross Head (H_{gross}).

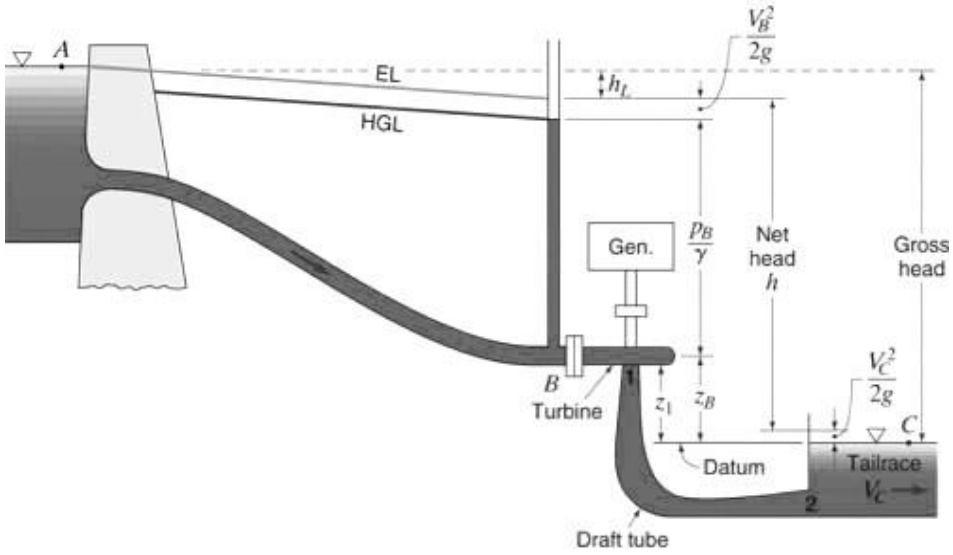

Fig 1: typical setup and terminology for a hydroelectric plant.

$$\eta_{turbine} = \frac{W_{shaft}}{W_{water\ horsepower}} = \frac{bhp}{\rho g H V}$$

Hence it is clear that the draft tube efficiency noticeably affects the turbine efficiency. To enable the turbine to be se above the tail water level without losing any head thereby. A reduced pressure produced at the upper end of the draft tube, which compensate for the height at which the turbine runner is set. Within limits the turbine can be set at a different elevation without altering the net head. By its use there is an unbroken steam of liquid from head water to tail water. The second function of the draft tube is to reduce the head loss at submerged discharge to thereby increase the net head available to the turbine runner. This is accomplished by using a gradually diverging tube whose cross-sectional area at discharge is considerably larger than the cross-sectional area at entrance to the tube.

III. DIFFERENT TYPES OF DRAFT TUBE

1) Conical diffuser or straight divergent tube – This type of draft tube conical diffuser half angle generally less than equal to 10° to prevent flow separation it is usually employed for low specific speed, vertically shaft hydraulic turbine. Efficiency of this type of draft tube is 90%. This draft tube has been eventually used for small and medium size vertical turbine. This will lead to the eddy formation bringing down the efficiency of the draft tube and it has excellent hydraulic characteristics. A draft tube at the end of the turbine increase the pressure of the existing fluid at the expense of its velocity. For maximum value of the cone angle it is seen that flowing body of water may not touch the sides of the draft tube.

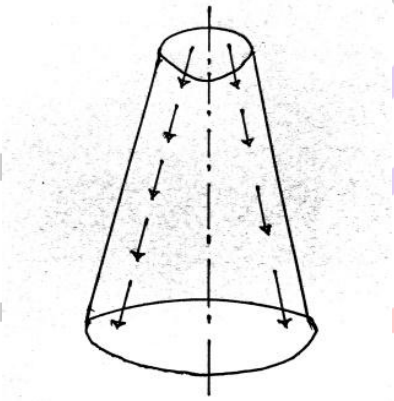

Fig 2: Conical diffuser draft tube

2) Simple Elbow Draft Tube – It consist of an extended elbow type tube. Generally, used when turbine has to be place close to the tail race. The simple and most efficient draft tube is the elbow shape draft tube. In order to turn the water, From the Horizontally discharging runner, into the vertically discharge cylinder, A 90 degree cast iron elbow was inserted at the discharge of runner. Such draft tube is near about 60% efficient. This is further improvement of Simple Elbow draft tube. The outlet of draft tube should be situated below the tail race.

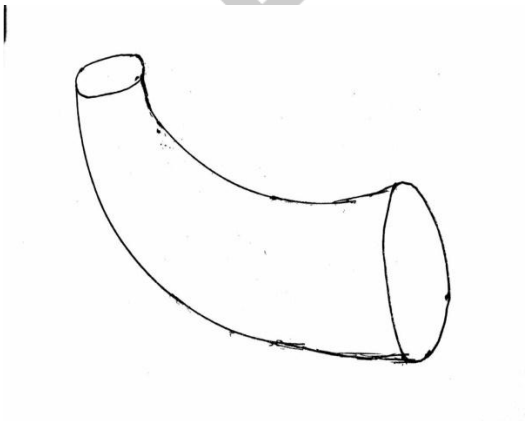

Fig 3: Simple elbow type draft tube

3) Elbow with varying cross section- This type of draft tube is similar to elbow draft tube but varying cross-section except the bent part is varying cross-section and with rectangular shape at outlet. The height of curved draft tube has great impact on the performance

and output of turbine. It has three parts like simple elbow draft tube namely cone, elbow, diffuser. The main difference between simple elbow draft tube and elbow draft tube with varying section is an diffuser that changes in shape, cross-sectional area. This draft tube helped to recover a maximum kinetic energy leaving the runner outlet at non-optical operating condition. That's why it can help to greater swirl and greater inlet-outlet area ratio. Height and length of draft tube has effect on performance and efficiency of elbow draft tube with varying cross-section

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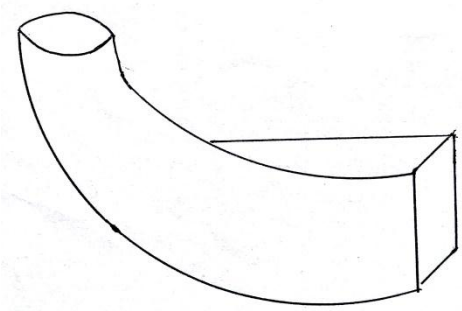

Fig 4: Elbow Draft Tube with Varying Cross Section

4) Moody Draft Tube or Hydra cone – Moody spreading draft tube is the special type of draft tube. It consists of vertical diverging pipe with a solid cone settling the lower part. The divergence rate is very high and takes place in slight depth. A special function of this tube is the effect of solid cone in destroying any swirl motion present in turbine discharge. It is appropriate particularly for helical flow, which occur when the water leaves the runner with whirl component. It is modification of conical diffuser and a solid conical cone is provided in the middle of the tube with a flare at the bottom end. The solid cone at the middle allows full flow and minimizing the eddy losses.

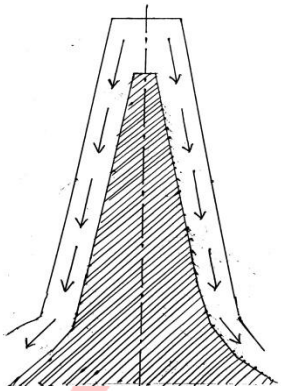

Fig 5: Moody draft tube or hydra cone

IV. CONCLUSION

In this research paper we have study various type of draft tube and it has significant effect on performance of hydroelectric power plant and efficiency of draft tube.

V. ACKNOWLEDGMENT

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REFERENCES

[1] Fluid Mechanics Fundamental and Applications, Second Edition, Yunus A. Cengel & John M. Cimbala, Tata Mc GrawHill Publication, Page 816.

[2] Dr. Ruchi Khare, Dr. Vishnu Prasad, Mitrasen Verma, "Design Optimization Of Conical Draft Tube Of Hydraulic Turbine", International Journal Of Advances In Engineering, Science And Technology (IJAEST), ISSN: 2249-913x, Vol. 2 No. 1 Mar-May 2012.

[3] Sumeet J. Wadibhasme, Shubham Peshne, Pravin Barapatre, Santosh Barde , Saurabh Dangore, Shubham Harde, Prof. Shailendra Daf, "Hydraulic Turbine Draft Tube : Literature Review", International Journal of Science, Engineering and Technology Research (IJSETR), Volume 5, Issue 3, March 2016

[4] Vishal Soni, Amit Roghelia, Jaymin Desai, Vishal Chavhan, "Design Development Of Optimum Draft Tube For High Head Francis Turbine Using CFD", Proceeding of the 37th International 4th National Conference on Fluid Mechanics and Fluid Power, FMFP 2010 ,December 16-18,2010,IIT Madras, Chennai, India

[5] https://www.quora.com/what-is-function-of-a-draft-tube-in-a-turbine- why-is-it-tappering-and-not-cylendrical/sai-sandeep

[6] https://www.slideshare.net/mobile/swargpatel283/draft-tube

[7] Hydraulic Machine, K Subramanya, Tata McGraw Hill Education Private Limited, Page 120

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