International Journal of Research in Advent Technology, Vol.4, No.3, March 2016
E-ISSN: 2321-9637
Available online at www.ijrat.org

Maintenance and Investigation of the Kaplan Turbine to Obtain the Best Turbine Efficiency

Mr. Shakti Prasanna Khadanga[1], Bikash Chandra Nanda[2], Gunpreet Taggar[3], Swastik S Sahu[4]
*Department of mechanical Engineering[1, 2, 3, 4], GIET,Gunupur,**BPUT, Odisha**[1, 2, 3, 4]*
Email: shaktiprasanna@gmail.com[1] ,
bikashnanda1234@gmail.com[2],taggartaggar94@gmail.com[3],swastik.dgh@gmail.com

Abstract- In today's world different types of hydraulic Kaplan turbine are used in various working environment. This project depicts the sediment erosion types of the hydraulic turbines and thin components based upon the completely experimental review on our Kaplan turbine test rig. To know the exact behavior of the hydraulic turbine at some varying operating conditions. We conducted some necessary test on Kaplan turbine in fluid power laboratory. The possible problems and errors which can appear during the numerical analysis of the low head Kaplan turbine with a view of runner draft tube interaction. We have also focused on turbine flows for which both experimental and numerical analysis have been discussed clearly and also concentrate on blade operation. This project gives report on unsteady pressure measurement on runner blade of Kaplan turbine model as well as torque and radial load bearing measurement on corresponding prototype at several operating point to investigate the source of the periodic load exerted on runner when operated at best efficiency.

Index Terms- Kaplan Turbine, Bearing Bush, Erosion, Cavitation, Efficiency

1. INTRODUCTION

Hydropower is a renewable, non-polluting and environment friendly source of energy for conversion of mechanical energy into electrical energy .The Kaplan's blades are adjustable for pitch and will handle a great variation of flow very efficiently.

Hydro power plants generate one fifth of the total electrical power produced in world. Even a small improvement of the hydrodynamic design and efficiency can contribute a great deal to the supply of the electric power. The efficiency of a hydropower plant depends on a number of parameters, such as: Turbine efficiency, Draft tube efficiency and Generator efficiency. Most of the past studies have focused on the generator efficiency[7] for increasing the efficiency of the plant, but a good generator design is not enough. Recent studies have shown that the efficiency improvement can also be realized by minor modification on the older design in the rest of the waterway i.e., in the draft tube, runner blades and spiral casing.

However, operating life of a Kaplan turbine can be drastically curtailed by improper start up and shut down practices. So properly planed executed maintenance schedule is in dispensable for very power plant having hydraulic turbine on their main equipment in their process plant. The case study deals with the failure analysis of failure and design is checked and then proper solutions are given to improve the effectiveness of turbine.

2. KAPLAN TURBINE

The modern Kaplan turbine which is taken for the investigation and maintenance is situated in the Hydraulic Machine laboratory in mechanical Engineering branch. The Kaplan turbine is designed and developed for "Incidental Power Generation" from flow of Water.

TABLE 1, KAPLAN TURBINE SPECIFICATION

SIZE	250MM	TYPE	162
HEAD	5MM	DISCHARGE	16000LPM
POWER	3.75KW	SPEED	1500RPM

TABLE 2, KAPLAN SUPPLY PUMP SPECIFICATION

SIZE	250MM	TYPE	MF
HEAD	8.5M	DISCHARGE	6000LPM
POWER	15KW	SPEED	1440RPM

TABLE 3, INDUCTION MOTOR SPECIFICATION

VOLT,PHASE AND CYCLE	400,3,50
KW,RPM	20/15,1440
TYPE	TEFC

3. COMPONENTS OF KAPLAN TURBINE

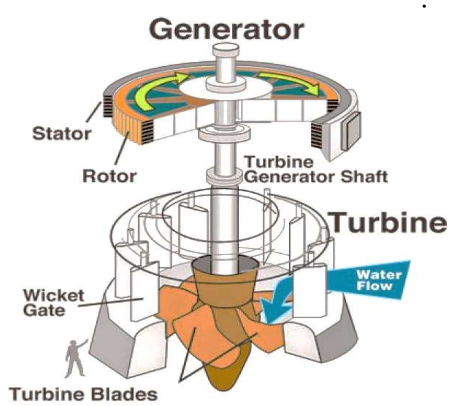

Fig.1: Common components of Kaplan Turbine.

(1) Spiral casing
(2) Distributor assembly
(3) Shaft and Coupling
(4) Runner and Blade regulating system
(5) Guide Blade
(6) Shaft Gland
(7) Draft Tube
(8) Mechanical over speed switch assembly.
(9) Electronic over speed rely.

4. PROBLEM IDENTIFICATION

4.1. *Venturimeter*

Since our turbine was in a non-working condition for a long period it got eroded and at the time of water flow some bubble formation occurs which causes major problem to the machinery [1] and reduces the efficiency of the turbine. Also due to the unsteady flow of the water, unsteady pressure generates which causes major problem.

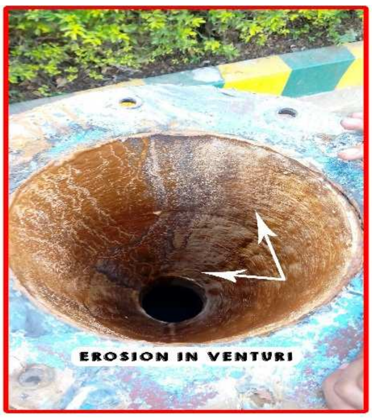

Fig.2: Erosion in Venturi

4.2. *Butterfly Valve.* (1)

Due to improper maintenance of the turbine we found a lot of complications in it due to which it was not working properly causing a discontinued flow of water due to numbers of leakage in joints.

Fig.3: Erosion in Butterfly Valve

4.3. *Casing.*

Due the improper working of the butterfly valve and due to surface roughness and development of the scales on the surface of the interior part of the turbine causes the improper flow of the water inside the casing which causes the leakages [4] and due to which efficiency gets reduced.

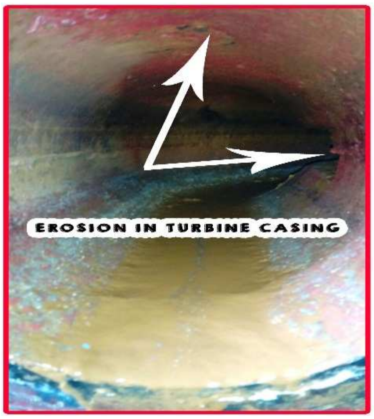

Fig.4: Erosion in the Turbine Casing

4.4. *Vane blades and wicket gate.*

The main problem with the blades is hydrodynamic loads on it due to improper striking of the water and the water quality. Due to the hydrodynamic [9] load unwanted stress on the blade occurs and it gets eroded.

Fig.5: Erosion in the gate

4.5. *Draft Tube*

Due to surface roughness and improper flow of the water the local absolute pressure falls below the saturated vapour pressure of the water at that temperature. [5] The height of the draft tube is a major parameter to avoid the cavitation and due to surface roughness and the scarp on the machine part surface it reduces and causes the decreasing the efficiency of the turbine.

4.6. *Bearing Bush*

Due to the improper movement of the shaft the gap between the bearing bush and the shaft decreases which causes unwanted noise and a decrease in the efficiency of the turbine.[8]

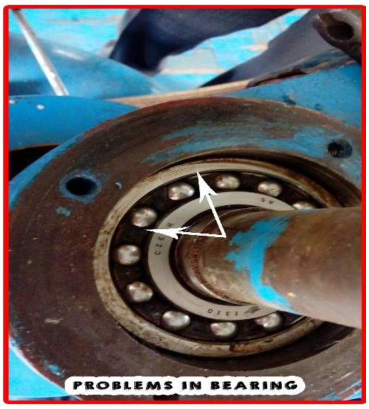

Fig.6: Wear in the Bearing

5. REMEDIES

5.1. *Replace the Seals with Self Lubricating Seals*

Replace the seals using self-lubricating seals the chance of failure is less, with the increase in the life-time of the bearing, cost are eliminated related to machining of worn parts, grease and oil used in the distributor mechanism. [2] Self-lubricating material has an advantage of longer lifetime and its higher load capacity when compared with PTFE foils.

5.2. *Design of Blades*

In order to decrease the maximal stress value it is necessary to reduce the hydrodynamic loads on the blade which is possible by increase in number of blades. [6] The efficiency is obtained at different runner blades and guide vanes opening, for the different head values.

5.3. *Fatigue Analysis of Bearing Bush*

The fatigue analysis can be made which validates the bearing bush for usage in turbine which can bear high load capacity and can sustains high temperature so that the lifetime of bearing is increased. [3]

6. CONCLUSION

From the above it can be concluded that:

1. Investigation of the problems associated with the operation of Kaplan Turbine has been identified; the losses and cause for such losses has been described. The remedy to such problem has been compared with the Current technology introduced.
2. To facilitate the task of enhancing efficiency, Methodology [10] is prepared which follows through all the important losses which occur in turbine. Approximation of possible increase in efficiency is included for each separate part.
3. To speed up the estimation and improvement of efficiencies the Optimum area of project has been discussed.
4. Among the suggested area for project, the bearing bush has been found to be feasible which can be done by fatigue analysis with other material and suggesting the optimum bearing bush.

□

(A.1)

7. References

[1] R.K. RAJPUT "Fluid mechanics and hydraulic machine", Laxmi publication (P), Ltd, New Delhi (India).
[2] A.K. Jain, Fluid mechanics, "Khanna Publication".
[3] A.K. Mohanty, "Fluid Mechanics", Prentice Hall Publication.
[4] R.K. Bansal, "Fluid Mechanics and Hydraulic Machine" Laxmi Publication (p) New Delhi (India).
[5] D.S. Kumar, "Fluid Mechanics and Hydraulic machine", Laxmi Publication (P) New Delhi (India).
[6] Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics Fundamentals and Applications", McGraw-Hill.
[7] D.S Kumar, "Fluid Power Engineering", S.K. Kataria Publication.
[8] C.P.kothandaraman and R.Rudramoorthy, "Basic Fluid Mechanics", New Age Publication.
[9] J.F.Douglas, J.M.Gasiorek & J.A. Swaffieid,"Fluid Mechanics", ELBS Publications.
[10] Bhoumika Sahu1, Kalpit P. Kaurase2, Alok Verma3"Enhancing Efficiency of Kaplan Turbine by Implementing Advance Features: A Review" International Journal of Emerging Technology and Advanced Engineering.