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Performance Characteristics in Draft Tube - A Review

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Abstract

The draft tube elbow was modelled using the fundamental geometry of GAMM Francis turbine. Its purpose was to design a draft tube with improved hydrodynamic performance This was accomplished by integrating unfasten resource and commercialized technologies to optimize and update the shape and CFD grid, and analyzing pressure retrieval and mechanical power wounded next to draft tube intend through Computational Fluid Dynamics (CFD). A technique was used to evaluate the functioning of an elbow draft tube. According to CFD, an 18.8° inclined angle has been the best way in blocking the production of physically powerful swirl stream and resulting in reducing the amplitude of pressure fluctuation. The blade passing frequency dominates the draft tube entrance, influencing local pressure recovery; however, the low-frequency core instability quickly diffuses and taps it.
Keywords: *Processing vortex rope, Solidity, Draft tube, CFD, Francis Turbine.*

1. INTRODUCTION

Conventional sources of energy like water energy, in which hydroelectric power is very common, which require no fuel and therefore it remains a good source of electricity generation globally. They produce no pollution and are more cost-effective than a thermoelectric plant. The most useful component in a reaction turbine is a draft tube, whose main function is to convert the running kinetic energy of the dam's head to pressure energy which raises the energy difference between the rotor outlet and main outlet which in turn increases available head and hence cavitation phenomenon could also be reduced. It also helps in calculating turbine characteristics.

The geometry of the draft tube design must be carefully considered to achieve the best possible balance of hydraulic efficiency and construction costs. As a result, there are a plethora of design parameters. The Francis turbine which works in low to medium head, in that major portion of energy present is in a kinetic way, and factors such as decrease in acceleration flow have viscosity and there is the possibility of separations which could reduce its efficiency and to make it small and to reduce the cost a ninety-degree bend is provided in a tube.

The design in the draft tube should be done in a very delicate way since there are a lot of chances in which a small change in design could cost efficiency and it will increase cost also. The pathway through which water flow has both stationary as well as moving blades whose improper design would have a major effect on results each part of turbine such as blades, casing are designed and manufactured separately, such that their efficiency is improved which in turn will increase overall efficiency. As a result, extensive flow information is required for the effective design of both the runner blade and the draft tube. The energy transfer that occurs in the runner, impacts the runner life and efficiency and it affects draft tube effectiveness also.

2. STUDY OF DRAFT TUBE

Arispe et al. [1] compared, the (GAMM) Gesellschaftfür Angewandte Mathematik und Mechanik/Society of Applied Mathematics and Mechanics) Francis turbine with the small size of the model and then model characteristics results was analyzed with the results. Three criteria for elbow curves were used to generate four types of draft tube geometries which are criteria of curve in circular arc, logarithmic and hyperbolic spiral geometry. Geng et al. [2] analyzed that, DMD(dynamic mode decomposition) is giving very good streamlines inflow and its structure also shows flow at different positions in the draft tube. The operations show that cavitation has improved in vortex rope for elbow type and conical draft tube near the mouth of tube.

Daniels et al. [3] validated, the study of base design Hölleforsen-Kaplan draft tube, in which calculations were done and numerically it was analyzed. As a result, the steady-state assumption was found to be well supported by the analogous experimental observations.Su et al. [4] focused their study on the runner hub and gave calculation numerically and experimentally which showed draft tube is unstable, there were four good design, and vortex dynamics and pressure field which is interlinked with dynamics is also analyzed.

McNabb et al. [5] analyzed that the three-dimensional effects of viscosity, like boundary layer separation, affect draft tube performance and flow in a swirl manner is affected since every part went with fluent analysis with three-dimensional meshing and analysis of Navier Stokes equation. The conversion of kinetic head to pressure head is done by the above analysis. Zhou et al. [6] validated that an inclined diffuser that is conical in shape with draft tube design improvement reduces the instability in flow and it also the formation of strong whirling flow is prevented. Kubota [7] analyzed the specific speed characteristics and in both model of turbines its characteristics is the same and the water energy of the draft tube is compared with the characteristics. Khare et al. [8] discussed how the computational fluid dynamics with the help of fluent was simulated in Francis turbine which is mixed flow, the losses in draft tube and energy recovery and different patterns in flow in Francis turbine with different operating characteristics was performed. Muhirwa [9] analyzed the frequency spectrum of the feedback instability at the entrance in a draft tube which results in smashing the wall of the tube which enhanced instabilities locally and component which has a frequency which is low can alter spiral casing flow instability during highly turbulent flows. Galván et al. [10] analyzed, the findings to show that at the inlet of the draft tube having good flow distribution would give excellent effectiveness at different points of system performance. As a result, the runner-draft tube coupling must be adjusted to reduce losses caused by the inlet flow distribution. Sergio et al. [11] validated, that the draft tube parameters such as inlet velocity have sensitiveness towards the performance, and the results showed that, despite the numerical differences there is the similarity in performance results. Kharea et al. [12] studied that simulations by computational fluid dynamics improve optimization in designing draft tube and loss and efficiency parameters are checked for best effectiveness. The loss and efficiency in draft tube have parabolic relationship and as solidity is decreased, speed factor and efficiency change. Bergström [13] analyzedthe boundary conditions, grid quality, numerical error, analysis of the resulting flow field, and comparison to experimental data. Mulu et al. [14] investigated that at the draft tube cone inlet, the velocity which is tangential to the blade changes at the pressure and suction side of the runner. The isentropic flow is shown and shear stress by Reynold's came to zero, leaving below the runner cone. The cone in the hub revolving created a forced vortex that was encircled by a free vortex. Jonsson et al. [15] studied that draft tube's performance was low because of rotating vortex rope (RVR), the velocities which is axial and are maximum was measured very near to cone draft tube and is not changed by the area which cross-sectional along the length of draft tube cone.

3. CONCLUSION

As a result, from the literature review discussed above the different areas that will be covered in this study are as follows.

- The numerical discretization has the limitation that grid convergence is apparent so that is increased with length of the draft tube when calculating pressure which is recovered by averaging arithmetically diagonally the faces.
- The local area cross-sectional in tube which has grid convergence that is apparent it changes frequently while calculating recovery pressure by weighted area and average them which lowers the uncertainty.
- The optimal draft tube flow manipulates the backward flow of propagation that is influencing travel.
- The programming language is used for an iterative process to get different angles, curves and constants to develop geometry and mesh in analysis in fluent.
- The pressure is regained in the cone which is draft tube cone and it was very near to the ideal value which shows better functioning without any parting in conical diffuser.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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