



GUJARAT TECHNOLOGICAL UNIVERSITY

(Established by Government of Gujarat under Gujarat Act No. : 20 of 2007)

ગુજરાત ટેકનોલોજીકલ યુનિવર્સિટી

(ગુજરાત સરકારના ગુજરાત અધિનિયમ ક્રમાંક : ૨૦/૨૦૦૭ દ્વારા સ્થાપિત)

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Faculty: **Engineering**

Discipline/Branch: **Mechanical**

Title of the Thesis: **"Design, Development and Experimental Studies on Micro Hydro Pelton Turbine"**

Abstract of the Thesis

Micro-hydro power represents one form of renewable energy generation that can be considered to be one of the most dependable and environmentally responsible methods of producing renewable energy as they are ideally suited for sites with a high hydraulic head and low discharge rates having hydraulic head heights of up to 1800m. The turbine technologies available for these conditions, Pelton impulse turbines have historically exhibited greater operational efficiency and better structural integrity than other types of water turbines. The component that comprises the heart of a Pelton turbine is the runner bucket and the maximization of hydraulic performance (i.e., hydraulic efficiency) can be attributed to the careful optimization of specific critical design characteristics such as the speed ratio, exit angle of the bucket, and overall bucket geometry; furthermore, overall hydraulic performance depends directly and solely upon the suppliers of Pelton turbine technology and on the Pelton turbine designer being able to provide these components, which will produce maximum hydraulic performance within the operation of the Pelton turbine. The research Work described here with attempt to fully analyze this problem by utilizing an integrated multi-physics methodology to analyze hydraulic parametric design, perform structural static and modal analysis with finite element modeling using ANSYS Mechanical APDL, conduct steady-state and transient computational fluid dynamics analysis using ANSYS Fluent, fabricate an optimized runner through sand-casting, and perform controlled experimental testing. A thorough parametric analysis across both speed ratio and bucket exit angle range

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has been conducted, validating a peak theoretical hydraulic efficiency of 94.29 percent at the optimum configuration. An F.E.A on four materials, under six combined loading conditions, has determined structural safety in all cases; hence, stainless steel 314 was the material of choice for the bucket based on its superior yield strength, corrosion resistance, and wear properties. A CFD simulation demonstrated clear trends for pressure distribution, flow, and turbulent kinetic energy in the bucket, with agreement to published experimental results. The enhanced runner constructed from sand-casting patterns offered a maximum hydraulic efficiency of 90.92 percent and maximum thrust power of 2018.97 W, greater than that of the conventional modeled runner by 2.05 percentage points in efficiency and 4.37 percent greater thrust power.

This PhD thesis will be useful for researchers, hydropower engineers, turbine manufacturers, and organizations involved in micro-hydropower plant development. It also supports rural electrification, efficient utilization of water resources.

List of Publication(s):

1. A.H. Chaudhari, G. C. Chaudhari, and O. S. Bharti, "Performance of Pelton turbine using ANSYS mechanical APDL: Modal analysis," Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering, 2025. doi: 10.1177/0954408925133418.
2. Anupkumar Chaudhari and Gaurang C. Chaudhari, "Optimization of Bucket Outlet Angle and Speed Ratio to Enhance the Efficiency of a Micro-Hydropower Plant," International Journal of Mechanical Engineering and Technology (IJMET), vol. 17, no. pp. 71–78, Jan.–Feb. 2026. doi: 10.34218/IJMET_17_01_005
3. A.H. Chaudhari, G. C. Chaudhari, and O. S. Bharti, "Design Optimization of Micro-Hydro Pelton Turbine: Integration of Static and Modal Analysis Using ANSYS APDL," IOP Conference Series: Earth and Environmental Science, vol. 1533, no.1, p. 012001, 2025. doi: 10.1088/1755-1315/1533/1/012001.
4. Anupkumar Chaudhari and Gaurang C. Chaudhari, "Review on Micro Hydro Power Plant," in Recent Advances in Fluid Dynamics, J. Banerjee et al., Eds., Lecture Notes in Mechanical Engineering. Singapore: Springer, 2023, pp. 401–409. doi: 10.1007/978-981-19-3379-0_34.

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