Anthony Ball

Group: Bladeless Turbine

Research Question: What models exist to investigate the performance of Tesla Turbines, specifically in the context of an expander in a solar Rankine cycle?

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|  | **Source #1** | **Source #2** | **Source #3** | **Source #4** | **Source #5** |
| **Purpose** | * To investigate the parametric trends in Tesla turbine efficiencies using an analytical model of the turbine performance.
* To use experimental data to evaluate the accuracy of trends predicted by the analytical model.
* To use these results to optimize the design.
 | * To develop a 1D model analysis for flow and momentum transport in Tesla turbines that can be solved to obtain closed form relations among dimensionless performance parameters.
* To apply this model to evaluate a Tesla turbine operating in a solar Rankine combined heat and power system.
 | * To review the principles of Tesla-type turbomachinery
* To discuss the problems with nozzles and diffusers
 | * To design and build a Tesla turbine
* To design and build a flexible test rig for the Tesla turbine
* To systematically study the performance of Tesla turbines
 | * To design a system that utilizes solar hot water collectors and a tesla turbine to generate heat and power in a Rankine cycle
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| **Justification** | * Tesla turbines are reliable and inexpensive, however they are not yet able to achieve the efficiency required to make distributed Rankine cycle systems commercially viable.
 | * Tesla turbines are reliable and inexpensive making them an attractive option for solar Rankine combined heat and power systems if an efficient design can be realized.
 | * Belief that Tesla turbines will find applications in the future
 | * The construction of Tesla turbines is easy, and they can be built in a simple workshop.
 | * This system has a greater efficiency than PV systems
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| **Methods** |  |  | * Literature review
 | * Several methods of torque and power measurement are implemented and cross-checked
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| **Results** | * The efficiency increases at lower torque and higher speed
* Low Reynolds numbers are desirable
* The rotor tip Mach number should be as high as possible
 | * The model predictions agree well with the given data.
 | * Nozzles are long and inefficient
 | * The flow at the exhaust is complex
* It is difficult to accurately measure the temperature and the pressure at the outlet
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| **Discussion/ Conclusion** | * The analytical model accurately predicts performance and design changes for a variety of operating conditions and turbine designs
* The performance predicted by the model improves along with: decreasing torque on the rotor, increasing number of disks, and decreased spacing between disks.
 | * This model analysis provides a framework for determining how to best design a Tesla turbine to function as an expander in a Rankine cycle for small-scale solar thermal combined heat and power systems
 | * Tesla-type turbomachinery should be considered for use in applications in which conventional turbines are inadequate, such as when very viscous or non-Newtonian fluids are the working fluid.
 | * Because of the low torque at high rpms the torque and power are difficult to measure
* The output flow is complex
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| **How can this help my senior project:** | * A summary of the desired ranges of dimensionless variables for turbines operating at both near choked, and sonically choked flow conditions are provided
* Experimental data from several studies was provided
 | * Provides a framework that can be used to design a more efficient disk turbine for like applications
 | * Numerous experimental results are provided in the references.
 | * An eddy-current brake was found to be the best method for measuring the torque under steady state conditions
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**References:**

[1] V. Romanin, V. P. Carey, and Z. Norwood, "Strategies for performance enhancement of Tesla turbines for Combined Heat and Power applications," in *ASME 2010 4th International Conference on Energy Sustainability, ES 2010, May 17, 2010 - May 22, 2010*, Phoenix, AZ, United states, 2010, pp. 57-64.

[2] V. P. Carey, "Assessment of Tesla Turbine Performance for Small Scale Rankine Combined Heat and Power Systems," *Journal of Engineering for Gas Turbines and Power,* vol. 132, p. 122301 (8 pp.), 12/ 2010.

[3] W. Rice, "Tesla turbomachinery," in *Handbook of Turbomachinery*, ed: Marcel Dekker Inc, 1994, pp. 57-57.

[4] G. P. Hoya and A. Guha, "The design of a test rig and study of the performance and efficiency of a Tesla disc turbine," *Proceedings of the Institution of Mechanical Engineers, Part A (Journal of Power and Energy),* vol. 223, pp. 451-65, 06/ 2009.

[5] R. Crowell, "Generation of electricity utilizing solar hot water collectors and a tesla turbine," in *ASME 3rd International Conference on Energy Sustainability, ES2009, July 19, 2009 - July 23, 2009*, San Francisco, CA, United states, 2009, pp. 613-620.