Article Title: Mean Line Design of Radial Inflow Turbine for Sco_2 Power Systems
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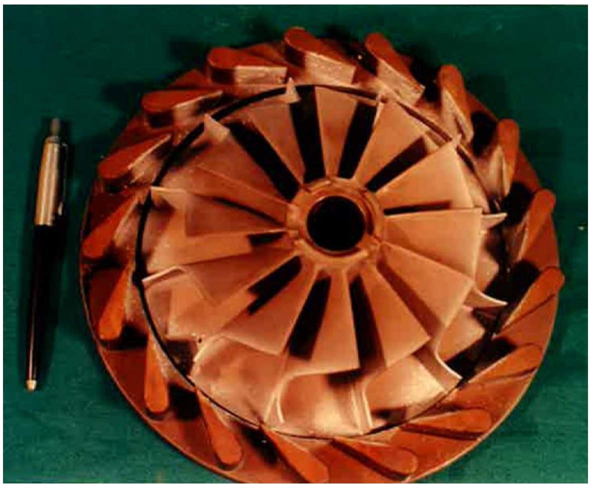
Abstract: Closed Loop Brayton cycle power plants using supercritical Carbon dioxide (sCO_2) have drawn the attention of many researchers in recent times. In this power plant (using heat source from either solar or nuclear), one of the main challenges is the design of the prime mover, namely the turbine. Radial Inflow Turbine (RIT) is found to be a suitable candidate as it has many advantages over Axial Flow Turbines. RIT offers robust configuration, ruggedness, manufacturing ease, good maintainability and absolute reliability superior to that of axial stage. It allows little or no swirl at the exit. Considering these advantages, it is found to be most suitable for sCO_2 power systems. Accounting for the aforesaid advantages, an attempt is made in this paper, to develop a procedure for the mean line design of RIT that will have reasonably good efficiency. This design forms a basis for 2D and 3D design of the turbine leading to hardware configuration.

Technologies used for the design of RIT for air Brayton cycle are well established. However, the problems faced in the design of RIT suitable for sCO_2 application are extreme variations in the physical property of the fluid, high working pressures and high speeds of the machine. These parameters pose problems in obtaining proper specific speed and thus the physical dimension of the turbine stage. In this paper, these issues are taken into consideration for the design methodology. With the input parameters for the design obtained from the sCO_2 Brayton cycle (turbine inlet pressure and temperature, outlet pressure), the speed of the turbine can be chosen appropriately to get the proper specific speed. Using a few control parameters, a methodology of the design of the turbine geometry is given in the paper. The design procedure described in this article can result in estimating the efficiency in addition to the geometry of the turbine. The geometry obtained by this 1-D code can be used for further to form the input for optimizing the flow path of RIT using Computational Fluid Dynamics (CFD) codes. The method is written in MATLAB so that a parametric analysis can be done. A case study is also included.



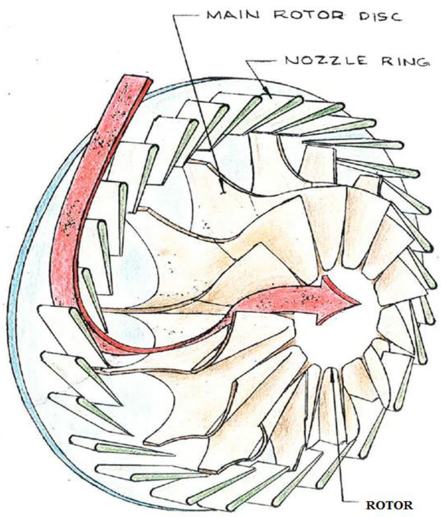


Figure 1: A view of radial inflow turbine hardware and diagram indicating the fluid flow