Gas Turbine Engine Design Competition

MEEN 646 2016 Final Project

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Introduction

Gas turbine engine is applied widely as jet engines and power plants power source. The engine concept is based on a thermodynamics cycle: Brayton Cycle.

Figure 1. Gas turbine engine application and Brayton cycle

Objective

The objective for this project is to design an axial gas turbine engine for a power plant application based on given thermodynamics properties at inlet and exit of each component. Main tasks includes aero-thermodynamics calculation for compressor and turbine; 3D model design and assemble of the engine based on previous calculation results.

Axial Compressor

A 16-stage axial compressor is designed to provide compressed air for the engine. The overall compression ratio at design operation condition is 9.23 at 4484 RPM, with isentropic efficiency equals to 0.92.

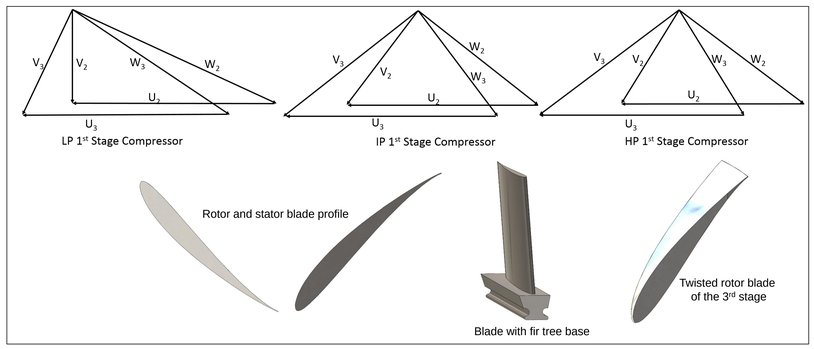

Figure 2. Compressor Blade Design

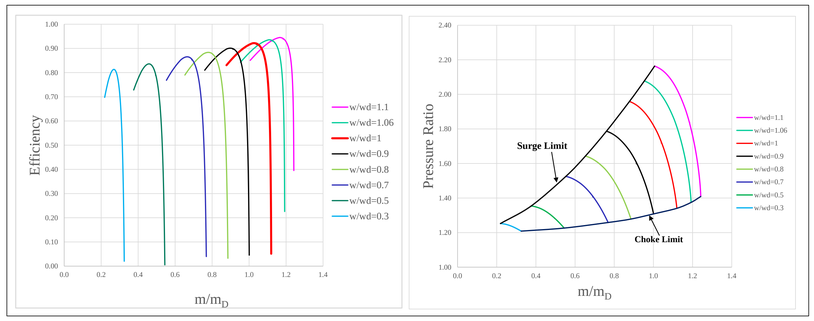

Figure 3. Performance map of a 3-stage LP compressor[1]

The compressor's total power consumption is 44.6 MW under design operation condition. Given the power generated from turbine, the net power output is 27.9 MW.

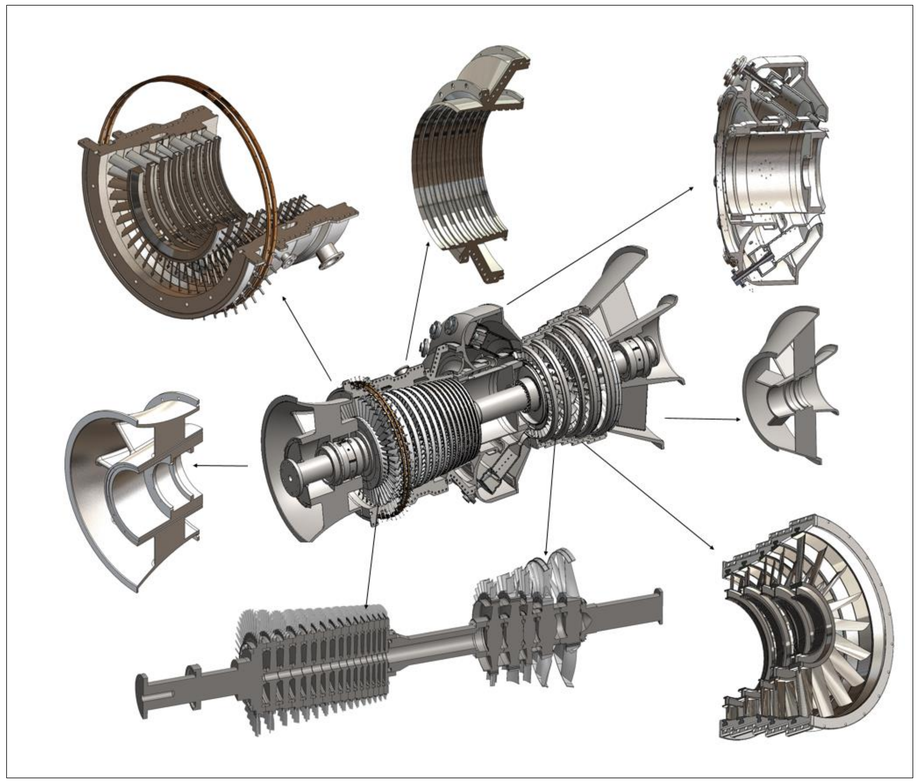

Figure 4. Fully assembly of designed gas turbine engine

Bearing Arrangement

A single rotor shaft is supported by spherical seat tilting journal bearings and a fix-arc thrust bearing. With a high-performance design from JohnCrane, these bearings are suitable for such a high speed application.

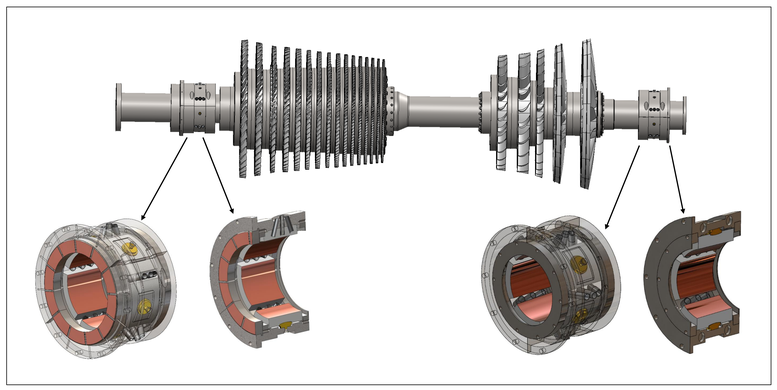

Figure 5. Bearing arrangement for both ends

Axial Turbine

A 5-stage axial turbine is designed to generate 72.5 MW power with isentropic efficiency 0.87 at design operation condition. The aero-thermodynamics calculation provides all the design parameters for 3D mechanical design in Solidworks.

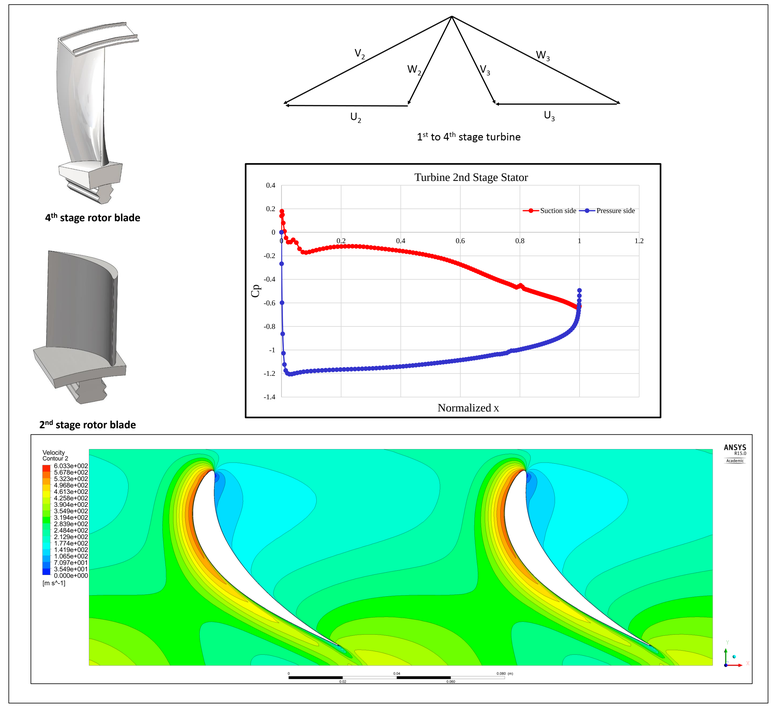

Figure 6. Turbine blade design and CFD study

Combustion Chamber

A tubular shaped combustion chamber are selected with reference to Siemens SGT-800. 16 combustion burner are installed in the chamber circumferentially.

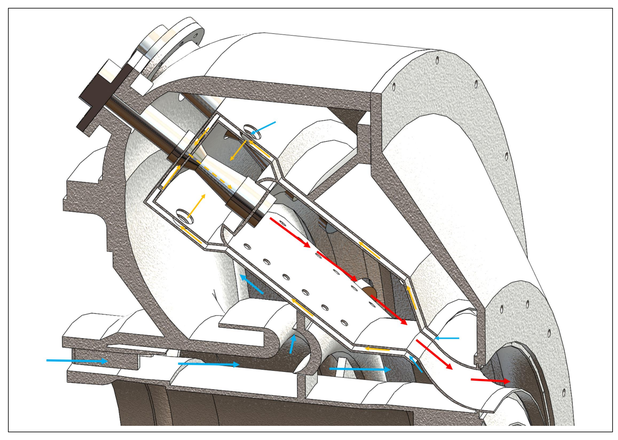

Figure 7. Combustion chamber air flow direction

Reference

[1]. M. T. Schobeiri, (2012). Turbomachinery Flow Physics and Dynamic Performance.