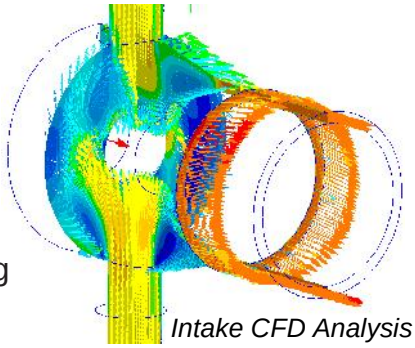
Case Study

Contra-Rotating Turbine Rotor Design

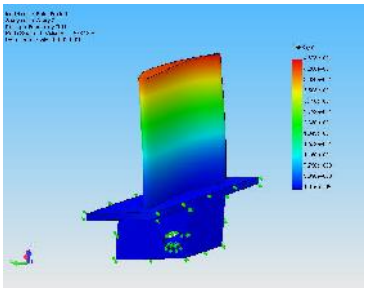
Description

3D CAD blade aerodynamic profiles were initially provided as parasolids and converted into blade designs for the inlet guide vane and four rotor stages.

To achieve this, the design of a root & tip was required for each blade row, including the design of the root fixing method and outer/inner tip clearance seal.



Intake CFD Analysis



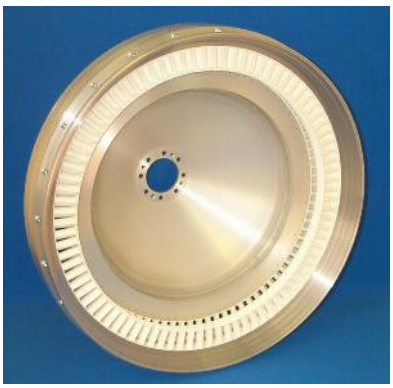
Turbine Rotor Blade IF Mode

Axial and radial clearances were calculated to ensure acceptable running clearances under worst case CF/thermal conditions and tolerance build-ups, axial adjustment being provided during build by the use of machined rotor spacers. Blades were resin injection moulded using a high temperature polyester/PU material and the main rotors produced from aluminium, with steel shafts and rigid bearing supports, to provide acceptable first critical speed, rotordynamic characteristics.

Rotor 1 & 3 stages were connected and drove on their inner annulus, whilst rotor 2 & 4 stages were connected on their outer annulus, with the output drive passing through the rotor 4 blades.

Each blade underwent 3D FE stress analysis, looking at the effect of CF & pressure loadings. FE vibration analysis was carried out to calculate modes and frequencies, to produce a “Campbell” diagram to ensure there were no blade resonance issues.

To ensure an acceptable, minimum distortion inlet flow, CFD was used to investigate multiple different intake geometries, including size, number of inlets, diffusion passages etc, as well as the use of honeycombs and inlet meshes. Finally, the instrumentation was designed to investigate actual pressure and temperature changes through the turbine.



Rotor 2 & 4 Assembly

Rotor 1 & 3 Assembly

Disciplines Used

- Conceptual & mechanical Design, computational fluid dynamics, rotordynamics analysis, stress & vibration analysis.