CFD Capabilities in AES
CFD ANALYSIS SOFTWARE & AREA OF EXPERTISE IN AES

Modeling Software
- PRO E
- UNIGRAPHICS
- MECHANICAL DESKTOP

Meshing Software
- ICEM HEXA
- ICEM TETRA
- GABMIT

CFD Analysis Software
- CFX
- FLUENT

Hardware
- Parallel Intel 64 bit processors
- Parallel Quad core Xeon 64 bit Processors

Area of Expertise
- Gas Turbine Engine & Components
- Steam Turbine & Components
- Micro Turbine
- Automotive Application
- Industrial Application
- Pumps

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COMPUTATIONAL FLUID DYNAMICS-TECHNICAL CAPABILITIES

- CFD Modeling
- Meshing: Hexa, Tetra & Hybrid Mesh Capabilities
  - Unstructured meshes (hexahedral, tetrahedral)
  - Tetrahedral meshes with prism layer extrusion
  - Discontinuous/hybrid meshing
  - Local mesh refinement
- Pre-processing
  - Definition of thermodynamics models, properties and boundary conditions
- CFD Analysis
- Post Processing
  - Display of vectors, contours & etc
  - Particle tracking
  - Animation
  - Data conversion for structural analysis
  - Data manipulation functions
- Parallel Computing
CFD- PHYSICAL MODELING CAPABILITIES

- Steady & Transient Flows
- Flow Distribution (Laminar & Turbulent) using Different Turbulent Methods.
- Incompressible and Compressible Flow
- Newtonian & Non-Newtonian Fluids
- Swirling & Rotating Flows
- Conjugate Thermal Analysis
- Forced & Natural Convection Heat Transfer
- Flow Through Porous Media
- Rotating Frames of Reference
- Multiple Frames of Reference
- Multiple Species Transport
- Free Surfaces by VOF Method
- Deformable Meshes
- Lagrangian Particle Tracking
- Thermal and Solar Radiation
- Multi-component & Multi Phase Flow- Mixing, Flashing, Evaporation
- Reacting and Combusting Species
- Fluid Structure Interaction (Including Deforming Grid)
- Cavitation
1. Gas Turbine
2. Steam Turbine
3. Micro Turbine
4. Compressor
5. Pumps
6. Turbomachinery components for Different Industries i.e Automotives, Aerospace
AES is capable of providing a wide range of CFD solutions in Turbomachinery:
- Flow conditions ranging from subsonic to supersonic
- To solve the wide range of specialized problems encountered in the turbo-machinery industry.
- Provide the accuracy, turnaround time, and unique capabilities to improve the productivity of the design process.

Major Areas
- Gas Turbine
- Steam Turbine
- Micro Turbine
- Compressor
- Pumps
- Rotating components for Different Industries i.e. Automotives, Aerospace
- Fans & Blower

Key Applications
- External Aerodynamics
- Internal Flows
- Thermal Management
- Tank Sloshing
- VOF
- Multi-phase & Species
- Heat Exchangers
- Fluid Structure Interaction (FSI)
- Combustion
- Erosion Modeling
- Mixing
CFD Analysis: Gas Turbine Components

- Fan
- Compressor
- Secondary Flow System
- Turbine
- Exhaust System
- Conjugate Heat Transfer Analysis
- Inlet System
- Diffuser
- Combustion Chamber
- After Burner
AES is capable of provide a wide range of CFD solutions in Gas Turbine:
- Flow conditions ranging from subsonic to supersonic
- To solve the wide range of specialized problems encountered in different altitude operating condition.

**Major Areas**
- Air Intake System
- Fans
- Compressor
- Anti Icing System
- Fuel System
- Diffuser
- Combustion Chamber
- Turbine
- Thrust Reverser
- After Burner
- Secondary Air Flow
- Exhaust System

**Key Applications**
- CFD Fluid Modeling
- Internal & External Flows
- Fluid & Thermal Management of the Components
- Single Stage & Multistage Analysis
- Combustion with Multi-Species Analysis
- Conjugate Heat Transfer Analysis
- Fluid Structure Interaction (FSI)
- Secondary flow & Cavity system
- Aero thermo design Support
Gas Turbine Capabilities – Inlet System

Gas Turbine Inlet & Intake System for Industrial as well as the aircraft engines

- To validate the pressure and temperature at the inlet system with experimental data
- To compare the pressure loss at different stages of inlet system with variation in the geometrical configurations
- Validate the Fluid parameters distribution i.e Flow distribution, Temperature & pressure distribution
- High jet mixing flow analysis.
- Porous media modeling for Industrial Gas Turbine.
- Optimisation of Flow path and design of Inlet System.
- Fan CFD Analysis
Gas Turbine Capabilities – Compressor

- Steady & Unsteady Performance Prediction
- Validation of the performance of compressor with experimental data.
- Analysis Compressor Inlet Plenums
- Axial and Centrifugal Compressor Stator & Rotor Analysis
- Single/Multi Stage Axial/Centrifugal Compressor.
- Prediction of blade loading, flow angle, efficiency, etc.
- Combined Return Channel & Impeller model using MFR
- Design and Analysis of compressor Discharge Volute
- Radial diffuser and axial diffuser analysis of Centrifugal Compressor
- Rotor Blade Tip Clearance
- Frozen Rotor interface (between stator & rotor)
- Prediction Fan/Compressor Performance curves, the effect of inlet or exit geometry and off design conditions.

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Gas Turbine Capabilities – Combustion Chamber

Gas Turbine Combustion Chamber Analysis:

- CFD analysis of Annular & Reverse flow combustion chamber
- Hexahedral / Tetrahedral meshing depending on the complexity of model
- Includes swirl inlet condition
- Reacting flow with Turbulent Eddy break up model, Two-step reaction mode
- Dispersed Multiphase flow modeling
- Liquid fuel spray with droplet distribution
- Oxygen mass, velocity, pressure and temperature distribution
- Wide range of physical models for turbulence, sprays, combustion and combustion interaction.
- Combustion modeling of turbulent diffusion flames
- Prediction of exit temperature profile for inlet to Turbine
- Optimisation of Combustor.
- Soot formation & NOx emission
Gas Turbine Capabilities – Turbine

Gas Turbine - Axial and Radial Turbine Analysis
- Validation of the performance of turbine with experimental data.
- Axial and Radial Stator & Rotor Analysis
- Performance Prediction.
- Single/ Multi Stage Turbine.
- Prediction of blade loading & efficiency
- Rotor Blade Tip Clearance
- Frozen Rotor interface (between stator & rotor)
- Conjugate heat transfer considering blade model
- Prediction of high temperatures as well as radial, circumferential and axial variations in flow quantities on the turbine blade life.
- Blade Cooling: simultaneous computation of gas and solid by conjugate heat transfer method.
- Prediction of blade temperature and heat transfer co-efficients.
Gas Turbine Capabilities – Exhaust System

- Gas Turbine Exhaust System for Industrial as well as the aircraft engines
- To validate the pressure and temperature at the exhaust system with experimental data.
- To compare the Flow distribution, Temperature & pressure distribution with variation in the geometrical configurations.
- Use of modular approach for time effective meshing with minimum number of cells.
- Pressure recovery and losses.
- Predication of Heat Transfer Co efficient
Gas Turbine Capabilities – Secondary Flow System, Heat Transfer, Other Components Analysis

- Gas Turbine Nozzle
- Cavities
- Ducts
- Nacelles
- Thrust Reverser
- Secondary Flow \& Heat Transfer Analysis
- Gas Turbine secondary flow system, cavity flow, leakage path \& heat transfer analysis
- Secondary flow \& Heat transfer Analysis.
- Prediction of fluid parameters i.e. Mass Flow, Temperature \& pressure distribution
- To predict the Heat Transfer coefficient on the surface \& windage temperature rise.
- Turbine Casing Temperature Prediction
- Conjugate Heat Transfer Modeling
AES Capabilities in Aerospace

- CFD Analysis of ventilation system
- External aerodynamics
- Internal Flow CFD Analysis
- Thermal Analysis
- Thermal analysis of electronic system
- Aircraft engine different component CFD analysis
- CFD analysis for different altitude conditions
- Hydraulic system CFD analysis
- Airport Ventilation and flow analysis
- Anti-Icing System
- Electronic Cooling System Analysis
- Environmental analysis
- Fuel tanks and fuel pump CFD analysis
- Nozzle CFD analysis
- Thrust Reverser CFD Analysis
- Inlet system and diffuser CFD Analysis
- ATEX for explosive atmosphere of Gas Turbine Ventilation
- Multistage Analysis
AES is capable of providing a wide range of CFD solutions in Steam Turbine:

- Flow conditions ranging from subsonic to supersonic
- To solve the wide range of specialized multi-physics problems encountered in the steam turbine.

### Major Areas

- HP Inlet System
- HP Turbine
- LP Turbine
- HP Outlet System
- Bleed Pipe
- IP Inlet & IP Outlet System
- Nozzle System
- Secondary Air Flow
- Exhaust Hood System

### Key Applications

- Internal Flows
- Thermal Management
- Fluid Structure Interaction (FSI)
- Aerodynamics & Aerothermodynamics
- Heat Transfer
- Multidisciplinary Design & Optimization
AES is capable of provide a wide range of CFD solutions in Multiphase:

- To solve the wide range of specialized problems encountered.
- Provide the accuracy, turnaround time, and unique capabilities to improve the productivity of the design process.
- Multiphase flow is simultaneous flow of:
  - Materials with different states or phases (i.e. gas, liquid or solid).
  - Materials with different chemical properties but in the same state or phase (i.e. liquid-liquid systems such as oil droplets in water).
- The primary and secondary phases:
  - One of the phases is continuous (primary) while the other(s) (secondary) are dispersed within the continuous phase.
  - A diameter has to be assigned for each secondary phase to calculate its interaction (drag) with the primary phase.
  - A secondary phase with a particle size distribution is modeled by assigning a separate phase for each particle diameter.
AES Capabilities in Electronic/Semiconductor

- CFD Analysis of Numerical Study of Forced Convection over the heat sources.
- Optimisation of flow path over Power Supply, Heat Sinks of a Electronics System
- Thermal Optimization of Electronic Systems
- System-level Thermal Simulation
- Three dimensional conjugate heat transfer in an Electronic package.
- Enhanced Electronic System Reliability
- Natural Convection
- Thermal Performance of Air-cooled with Natural convection and low velocity Electronic cooling system.
- Forced Convection air flows.
- Electronic equipment with Natural convection & radiation.
- Thermal analysis of the electronic enclosure in a harsh working condition.
Thank you