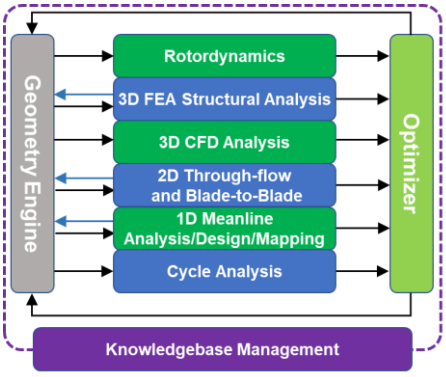
TurboTides

Turbomachinery Integrated Design System

TurboTides is a specialized tool tailored specifically for turbomachinery design, based on systems engineering principles, offering turbomachinery industry users an integrated, intelligent, and customizable CAE design solution.



TurboTides Integrated Design System

With support from its proprietary database, TurboTides integrates various functional modules centered around geometric modeling. These include system cycle analysis, one-dimensional mean-line design analysis, two-dimensional passage flow calculations, three-dimensional CFD calculations, three-dimensional FEA calculations. Data seamlessly transfers between these modules, and they can all connect to the optimizer for automated design optimization.

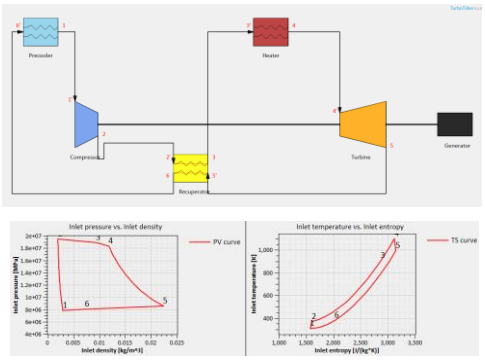
Integrated Specialized Intelligent Customizable

MAIN FUNCTIONS

Cycle Modeling and Analysis

TurboTides cycle analysis supports the design and analysis of thermodynamic cycles in various layout forms.

- ✓ Rankine cycle& Organic Rankine Cycle (ORC))
- ✓ Gas turbine cycle
- ✓ supports power turbine model and turbojet engine modell
- ✓ supports adding a secondary air system (SAS), modeling of turbine cooling and anti-surge flow path
- ✓ supercritical CO_2 cycle
- ✓ supports simulation of Printed Circuit Heat Exchangers (PCHE).
- ✓ Refrigeration Cycle
- ✓ Turbocharging Matching
- ✓ Multi-stage compression system design and analysis, including gear-type multi-stage compression (IGC).



1D Meanline& Anysis Module

Supports preliminary design and analysis of radial, mixed-flow, and axial forms of compressors, turbines.

- ✓ Rapid design of centrifugal, axial, and mixed-flow pumps, incorporating design experience from the pump industry.
- ✓ Supports the design and analysis of counter rotating axial flow compressors.
- ✓ Based on REFPROP10 and fast lookup tables.
- ✓ Capable of modeling of components such as airfoil diffusers and tandem diffusers.
- ✓ Functionality includes scaling, cutting, flow cut, and variabe geometry models.

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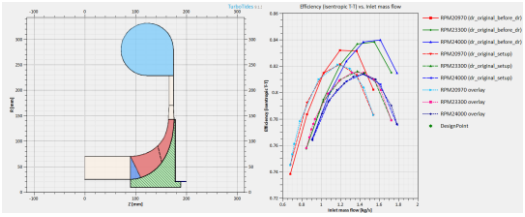
- ✓ Embedded optimizer with user-friendly operations supports optimization of parameters in the one-dimensional mean-line model.
- ✓ User Defined Functionality (UDF) allows users to change the default models and functionalities of the program.

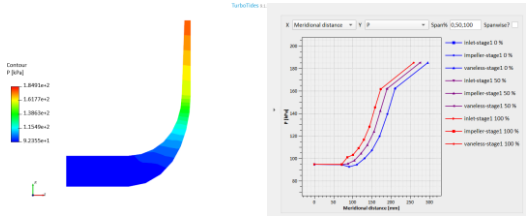
* The Data Reduction function can calibrate the one-dimensional model to match experimental/simulation data point by point across the entire performance map.After calibration, the model can accurately predict machine performance curves when replacing working fluids or modeling similar designs.



2D Through-Flow Analysis Module

Includes meridional through-flow (S2 surface) calculations and blade-to-blade (S1 surface) calculations.

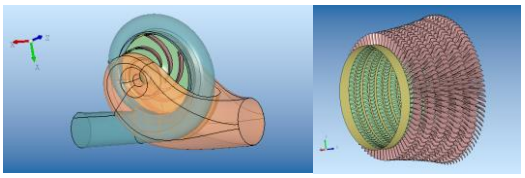
- ✓ Based on streamline curvature method.
- ✓ Generate grids automatically.
- ✓ Consider loss, deviation angle, blockage, and radial mixing models.
- ✓ Supports optimization with convenient operation.
- ✓ Multi-operating point analysis.
- ✓ Comparative design.
- ✓ Post-processing plotting.
- ✓



Geometric Modeling

The geometric modeling module comprehensively supports the generation of 3D parameterized geometric models.

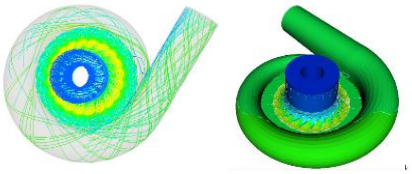
- ✓ Encompasses the geometric configurations of common components found in centrifugal or axial compressors, turbines, pumps, and fans.
- ✓ Real-time visualization and geometric editing features.
- ✓ Various methods for defining parameters.
- ✓ Various airfoil blade models, such as NACA, DCA, and MCA.
- ✓ Volute editing features.
- ✓ Parameterized modeling of different inlet chambers.
- ✓ Export three-dimensional models for solid/fluid domains.
- ✓ Import and parameterize of existing 3D CAD models.



3D CFD Flow Field Simulation Analysis Module

The 3D CFD module provides a full 3D pressure-based flow field simulation solver that supports structured, unstructured, or hybrid grids.

- ✓ Supports parallel computing.
- ✓ Generates grids automatically with improved quality.
- ✓ Imports inlet/outlet boundary conditions and fluid properties automatically.
- ✓ Calculates real-fluid properties and generates thermodynamic property tables.
- ✓ User-friendly post-processing features.
- ✓ Facilitates easy comparison between results from CFD from 1D.
- ✓ Provides an interface with the third-party software TurboGrid.



3D FEA Finite Element Module

Supports finite element analysis of impellers and volutes.

- ✓ Automatic grid generation, load and constraint settings.
- ✓ Supports one-way fluid-structure coupling.
- ✓ Supports linear and nonlinear materials.
- ✓ Static strength analysis, thermal analysis, and modal vibration analysis.
- ✓ Harmonic response analysis, transient dynamics analysis, transient heat transfer analysis, and stochastic vibration analysis.

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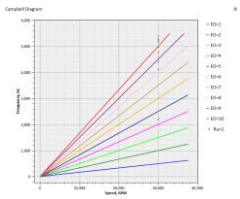
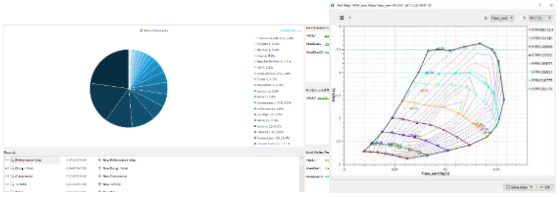
- ✓ Quickly calculates mass, moment of inertia, etc.
- ✓ User-friendly post-processing features.

Embedded Database

The embedded database is a deployable data storage center accessible over the network, equipped with permission control functionalities, seamlessly interconnected with the design modules.

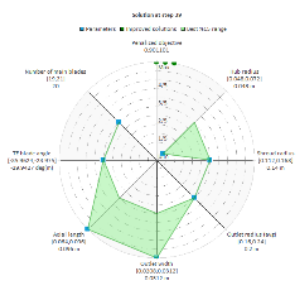
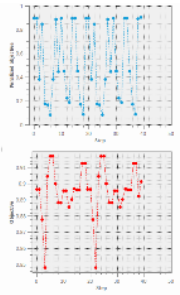
- ✓ Any object within TurboTides (components, machines, curves, fluid models, etc.) can be saved to the database and reloaded into the current design.
- ✓ The object-oriented database can input various complex data structures such as performance maps, components, machines, geometric models, and fluid models.
- ✓ Users can customize data record types and specify properties through scripts.
- ✓ All content stored in the database is searchable, recoverable, and reusable.
- ✓ Supports both local and remote online access to data.



Optimization Design

Both stage/machine level optimization and local component level optimization can be performed using TurboTides' built-in optimization functionality. By setting optimization parameters, defining objectives, selecting appropriate solvers, and optionally constraining input and output parameters, users can conduct automated optimization calculations. The software provides a visualization interface during the optimization process to display real-time iterations of the optimization.

- ✓ Supports Latin Hypercube Sampling, grid-adaptive search, Maximum Expected Improvement algorithm, and Genetic Algorithm optimization algorithms.
- ✓ Provides the fourth-generation OASIS optimization algorithm based on artificial intelligence and machine learning, effectively addressing optimization design problems with high variability, expensive constraints, multiple objectives, and black-box constraints.
- ✓ The optimizer can call solvers for cycle analysis, one-dimensional, two-dimensional passage flow, CFD, and FEA either separately or in combination.
- ✓ Through script writing, users can customize complex optimization processes, such as multidisciplinary optimization involving CFD and FEA to optimize flow fields and impeller structures.

Technical Advantages

1) Integrated and unified forward design system
2) Proprietary model calibration technology
3) Parametric full-flow-path import capability
4) Multi-disciplinary, multi-objective, and multi-scale integrated intelligent optimization design technology
5) Independently owned intellectual property, highly scalable, and secure & controllable

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