PROOSIS

Propulsion Object Oriented Simulation Software

PROOSIS is a stand-alone, flexible and extendible object-oriented simulation environment for modelling industrial gas turbines in detail, power plants and other systems (control, electrical, thermal, hydraulic, mechanical, etc.). It was originally developed by Empresarios Agrupados Internacional S. A. – a Power Plant Engineering Company- and an aeronautics consortium of European universities, research institutes and corporate companies.

It is based on EcosimPro, the European Space Agency's preferred tool for designing rocket propulsion, environmental control and life support systems, among others.

PROOSIS has an advanced Graphical User Interface and uses a high-level, "engineer-friendly" object-oriented language (EL) for modelling engine systems and state-of-the-art technologies in areas such as numerical solvers, non-causal modelling of reusable libraries, XML file formats, map handling etc.

Any gas turbine engine and/or power plant configuration or system can be constructed graphically by 'dragging and dropping' the required component symbols from the included libraries to a schematic window. Using EL, users can also create new components and libraries, or extend the existing ones.

PROOSIS is capable of steady-state and transient simulations as well as customer deck generation (dll, exe, ARP4868, AS4191). Different calculation types can be performed (design, off-design, test analysis, sensitivity, parametric and optimisation studies, diagnostics, control system design and test, etc).

It is also capable of performing multi-fidelity, multi-disciplinary and distributed simulations. These are greatly facilitated by its open architecture, which allows it to connect to external commercial (Excel, Matlab, COM) or in-house tools and link with codes written in C, C++ and FORTRAN.

These features make PROOSIS a useful tool for all sorts of analyses of the GT life cycle and Power Plants such as Fossil (Combined gas Cycle and Coal), Nuclear (only for secondary side), Thermo-solar & Hybrid, and Advanced Generation (Coal Oxy-combustion).

It also acts as a common framework in multi-partner collaborative engine projects providing common standards and methodologies.

EA Internacional S.A.
Magallanes, 3 Madrid
28015 Spain
URL: http://www.proosis.com
E-mail: info@ecosimpro.com
Phone: +34 91 309 81 42
Fax: +34 91 591 26 55

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PROOSIS
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Power Plant Applications

A first class simulation tool for modelling gas turbines and power plant systems

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Gas Turbines

PROOSIS's modelling flexibility, multi-disciplinary nature and extensive customer deck generation capabilities make it an ideal tool for the entire value chain of stationary gas turbines.

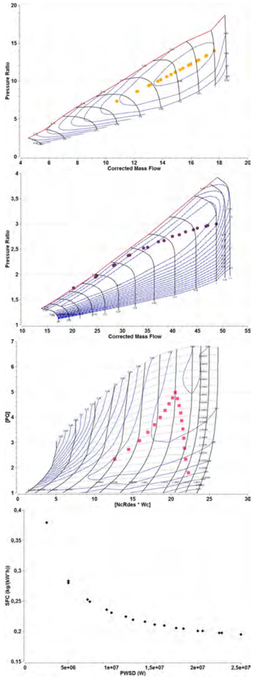
Using the existing component and engine libraries (TURBO & GTE_TURBOSHAFT), OEMs, R&D institutes and service providers can quickly define and assess alternative engine concepts (including new or advanced cycles) at the preliminary engine design phase allowing for reduced lead time of new designs. PROOSIS calculations can include design optimization, steady state and transient analyses, water/steam injection and techno-economic studies.

During the detailed design phase, multi-physics computational models of higher-fidelity can be integrated or interact with the engine performance model to refine the design of the selected concept. Collaboration is greatly facilitated and enhanced through PROOSIS's distributed simulation and model encryption capabilities. Detailed studies on gas turbine operations such as control system design and testing or secondary air system modelling can be performed with the help of existing or custom developed libraries.

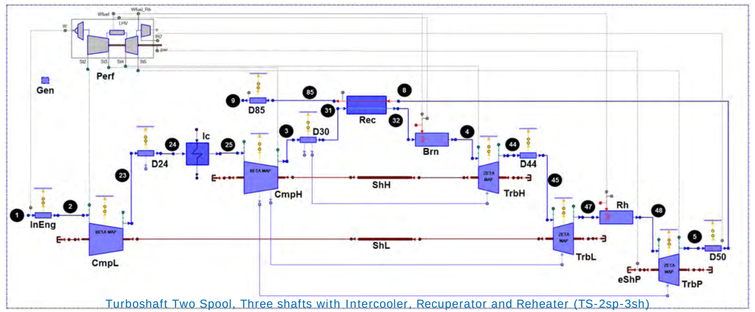
Service providers, technology consultancies, power generation and oil and gas companies can use PROOSIS engine decks for engine condition monitoring and perform diagnostic and prognostic simulations, optimize plant operation or assess operation with different fuels.

The GTE_TURBOSHAFT library in PROOSIS contains several gas turbine turboshaft engine configurations typically used in industrial applications (e.g. for power generation or mechanical drive) and for marine vessel propulsion. These engine configurations are based on TURBO library components. The user can perform both design point and off design calculations.

Please refer to the PROOSIS, TURBO and Aircraft Systems brochures for a detailed description of PROOSIS's capabilities, TURBO's library for gas turbine modelling and about the modelling capabilities for other gas turbine related systems.



TS-2sp-3sh Operating line (High and Low Pressure compressors, Power turbine) and Specific Fuel Consumption vs Delivered Power



Turboshaft Two Spool, Three shafts with Intercooler, Recuperator and Reheater (TS-2sp-3sh)

Power Plant Transients

PROOSIS has a set of off-the-shelf libraries, PPTS (Power Plant Transient Simulation), that provide modelling components to represent the typical hardware and controls of a Power Plant, currently available for: FOSSIL (Combined Gas Cycle and Coal), NUCLEAR (secondary side), THERMOSOLAR & HYBRID, and ADVANCED GENERATION (Coal Oxy-combustion). PROOSIS models can be used throughout the project development process for supporting different design activities. The models can be used either directly in its development & simulation environment or can be easily connected to a Human Machine Interface (HMI) application to develop an engineering and/or partial training simulator. These libraries have been used in several succesful application cases:

Solar-Thermal Power Plant Simulator

A simulator has been developed for a solar-thermal power plant with parabolic collectors in order to study the typical transients of this type of power plants: startup, shutdown passing clouds, a trip in some equipment, etc.

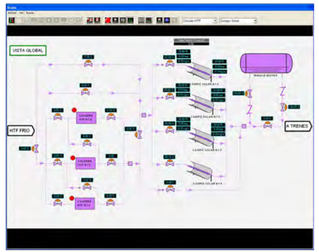
The simulation model represents the transient behaviour of the following parts of the solar-thermal plant using parabolic collectors:

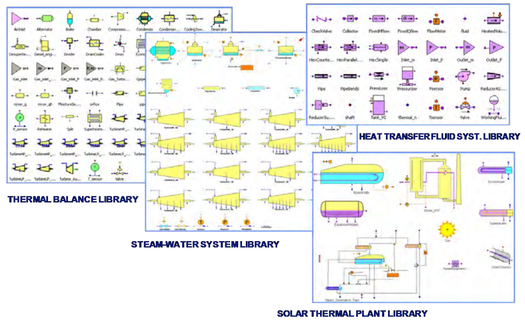
- Solar field Heat Transfer Fluid (HTF)
- Circuit Steam generation units
- Steam cycle and circulating water system
- Control sequences and loops and plant operating modes

The model also includes simulating the weather conditions: intensity of direct sunlight, wind speed, etc.

One of its main applications is the training of operators and engineers in operating the plant, the support in developing the engineering of the plant and checking the logics and control sequences before startup (virtual commissioning).

The simulation model was used to generate an OPC server (Object Linking and Embedding for Process Control) that was then connected to one of the plant's SCADA systems.



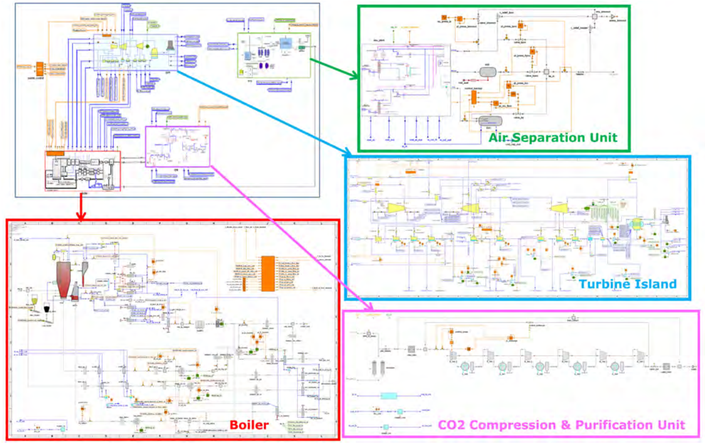


Coal Oxycombustion Power Plant Simulator

An integrated dynamic model of a power plant with CO_2 capture based on a supercritical coal-fed circulated fluidized bed boiler. It includes:

- The Air Separation Unit (ASU)
- The CO_2 Compression and Purification Unit (CPU)
- Detailed models for the boiler and the cycle
- Thermal interaction between ASU/CPU and cycle
- Detailed modelling of the interfaces with the boiler

The simulator can simulate a wide range of transient scenarios such as transitions between different operating modes, load changes, steam turbine trips, ASU/CPU trips, variation of the purity of O2 in the oxygen stream, etc.



Thermal Balance

The library has all the components you need to carry out the thermal balance (total or partial) of the plant cycle and operational studies. It constitutes a very powerful tool for modeling steady-state and thermal balance studies for any type of power plant: Coal, Combined Cycle, Nuclear, Cogeneration, Thermo-solar, etc.

Component formulation is according to accepted codes (ASME, HEI, etc), including steady-state and some dynamic behavior and controls, while existing formulations and new components can be modified/developed by advanced users.
The library is prepared to work not only with water, but also with air, oxygen, carbon dioxide, carbon monoxide, helium, argon, methane, propane, butane and sulphur dioxide. Users will also find it easy to add new fluids.