Power Plant Simulator & Designer

With the engineering tool Power Plant Simulator & Designer a Power Plant can be sketched and calculated.

Data with Drag & Drop on the IDE

Cavity

Cyclone for no ash in recirculation flue gas

Splitting the flue gas

Support tubes

Control

Municipal solid waste incinerator with flue gas recirculation

Tube bundle
User list of Power Plant Simulator & Designer
not all customers are listed

1. RWE Energie AG, Essen (Biggest Power Supplier in Germany) Germany
2. Nooter Eriksen; St. Louis Mo; USA
3. Florida Power & Light; West Palm Beach; Florida USA
4. Babcock Kraftwerkstechnik GmbH, Oberhausen; Germany
5. Siemens AG; PG; Erlangen
6. Alstom Power AG, Baden, Switzerland
7. BASF Ludwigshafen, Germany
8. NEM; Leiden; Netherlands
9. Siemens Westinghouse, Orlando, USA
10.KOLON Engineering Inc. Soul, Korea
11.mg engineering Lurgi Envirotetherm, Frankfurt; Germany
12.MITSUBISHI KAKOKI KAISHA LTD, Japan
13.Standard- Fasel- Lentjes-, Uetrecht, Netherlands
14.Vogt-Nem Inc. Louisville; USA
15. Babcock & Wilcox Volund; Denmark
16.Lentjes Industrieanlagen- Service GmbH; Duisburg; Germany
17.Sehgers Better Tecnology, Willebroeck, Belgium
18. Balcke Dürr, Vienna, Austria
19. Hocon Ketelbouw B.V., Venlo, Netherlands
20. Kraftanlagen Engergie- und Umwelttechnik GmbH, Krefeld; Germany
21.BHEL, Thiruchirapalli, India
22.Josef Bertsch Ges. m. b. H. Bludenz; Austria
23.Descon, Lahore, Pakistan
24.Standardkessel-Gesellschaft Lentjes-Fasel GmbH & Co KG, Duisburg
25.Thermax, Pune, India
27.Eisenwerke Baumgarte Kessel- und Apparatebau GmbH
28.Babcock Omnical Industriekessel GmbH, Dietzhölztal
29.TÜV Süddeutschland, Filderstadt
30.Dampfkesselbau Hohenthal GmbH, Hohenthal
31. Linde AG, Höllriegelskreuth (near Munich)
32. TÜV Süddeutschland, Munich

Please ask for other users.
**PowerPlantSimulator&Designer**

Program PowerPlantSimulator&Designer is designed for engineering complex heat exchangers e.g. steam boilers, power stations... etc.

The PowerPlantSimulator&Designer allows the user to build quickly a graphical schematic representation for a plant in a graphical user interface (GUI) by selecting from a library of predefined power plant elements to simulate their operation. Element connections for fluid-flow paths, mechanical couples, or signal/logic flow paths are based on connectivity rules, defined for each element. The connection of elements is intuitively implemented with mouse operations allowing only valid connections.

Some elements are hierarchical and can hold nested groups. Such an organization helps to make schemes of complicated objects with no limitations on element quantity.

**Different boiler types:**

1. Natural circulation boiler
2. Forced circulation
3. Force flow boiler (once through boiler)
4. Benson-boiler (supercritical)
5. Municipal waste incinerator
6. Fire tube boilers
7. Hot water boiler
8. Fluidized bed combustion
9. Other heat exchangers

**Heat transfer medium**

1. gases with real properties (Joule- Thomson- effect) (more than 20 different gases)
2. all fluids (user defined)
3. water with two phase flow
4. dust and slag with infrared radiation
Technical features

- complete thermal calculation
- calculation of the pressure drop
- efficiency calculation
- all kind of recirculations
- A heat exchanger can be divided into zones to consider different temperatures and mass flows
- approx. 60 different elements (heat exchanger, spray cooler and so on) are available
- almost any combinations of heaters, coolers, combustion chambers are possible
- performance range from 100 kW to 1500MW
- hot water boiler (shell tube, water tube and waste heat boiler)
- nominal load calculation i.e. presetting of steam weight flow: The temperatures, pressures and fuel consumption are calculated.
- easily part load calculation
- correct calculation of the vaporization in economizer
- combustion calculation and post-combustion
- high pressure flue gas possible
- heat exchange with real gases like CH4, H2 etc.
- working in the network
- graphical surface with icons and pull down menus
- user-definable fields for input and output
- C++ programming language
- executable with MS Windows 95/98/NT/ME/XP/2000

Service

- user manual
- documentation of calculation method (not everything because of conflict with copyrights)
- training
- one year charge free service (e-mail support etc.)
Other remarkable features

• Gas- Turbine exhaust gas can also be introduced into the combustion chamber. The turbine exhaust can be considered as oxygen carriers for the combustion calculation.
• the temperature at the end of the combustion chamber and fire tube can be entered.
• radiation from the combustion chamber can be transmitted onto the superheater bundles.
• turbine exhaust gas can be entered into Nm³/s or kg/s and/or the gas composition in Vol% or kg/kg.
• the thermal conductivity of the tubes is computed in dependence of tube material and the temperature.
• feed water pressure and the drum level are controlled automatically
• spray coolers and cooler in the drum are controlled by the temperature after the next heating surface.
• the fuel flow can be controlled in dependence of the desired steam production, independent of the steam temperature.
• several fuels can be mixed and burned
• calculation of efficiency (heat balance) in dependence of the exhaust flue gas temperature and composition, boiler surface conduction & radiation, loss in combustion chamber (unburned fuel), losses through ash and chemical not fully burned fuel (CO).
• design calculation of heater surfaces
• in almost every place of the flue gas draft can be taken recirculation flue gas and injected again not only in the furnace.
• flue gas flows and steam/water flows an be divided up and be combined again.
• statistical combustion calculation and net calorific value determination

Fluidized bed boiler

• Control of the ash flow parts to nearly all test points in the boiler
• Desulphuration with limestones
• Incomplete combustion and additional complete combustion
• Heat transfer for fluidized bed boilers and fluid bed heat exchangers

Usually for such number of calculations are used several programs and the results of the one program must be inserted manually into another program as initial data. That is one reason why the usage of the PowerPlantSimulator & Designer program gives such advantages:
• Fast calculation of the different boiler designs and as the result – helps to choose the best choice for projecting or reconstruction;
• Calculation of the transient stages on the projecting stage;
• Combine calculation of the heat scheme of the power plant with exact boiler calculation;
• Analyze static modes with different working conditions (fuel contents, dust presence on heat surfaces, feed water temperature difference…) and possible construction changes;
• Calculate natural circulation in drum-type boiler in current working mode and find minimum possible load by circulation condition;
• Analyze transient stages of the boiler (warm-ups, load changes…) in order to improve operational instructions of the boiler and future perfection of the startup devices;
• Unified elements and Graphic User Interface (GUI) minimizes time spending for the creation of the adequate mathematical model of the equipment. Qualified specialist in boiler construction can easily work with program, make and improve calculation models without any knowledge in programming;
• Comfortable data representation in Integrated Development Environment in different cases (data tables, tree views and graphs);
• Ability of bi-directional data transfer between calculation program and Microsoft Excel for future data analysis and data representation.

Mathematical model is adequate to real equipment because of:
• Application of the widely used calculation methods;
• Improved calculation method of heat exchange calculation, with division of the surface into small zones;
• Improved equations of the heat exchange considering the radiation, which was derived from the differential heat exchange equation, formulated according to physical processes specialties;
• Usage of the big database of the physical medium properties, which can be easily extended by user;
• Usage of the all-modes dynamic boiler model allows to calculate different stages with any combination of the disturbing influences with high static and dynamic precision;
• Usage of the special parameters, which characterize real state of the each heating surface, allows adapting mathematical model to the real equipment.

Operational experience of the program usage confirms it's highest efficiency and accuracy.

Program is shipped on the CD-ROM disk with user's guide and samples. Program price depends on the completeness. Training and other consultant services are also available.
POWER- PLANT SIMULATOR & DESIGNER

Some examples for the usage:

Static modules:
- Estimation
- Tendering and proposals
- Scrutinizing existing plants for e.g. fouling, different fuels, changing the heat exchangers

Dynamic modules:
- Dynamic behavior of the boiler e.g. start up, load changes, shut down
- Basic control design
- Simplified training simulator

Input output with Excel
The Excel sheets can be linked with e.g. price calculation codes etc.

These sheets are created automatically
Several control opportunities

- Temperature
- Mass flow
- Pressure

Superheater control

Pressure control

controled

- Temperature
- Mass flow
- Pressure
Insert different behavior for dynamic usage or for different load

Change of units (e.g. in SI- Units)
Change the language

Insert user defined bitmaps
Temeratures after a load change
Input and Output of Power Plant Simulator & Designer

Generally:
The input and output data are in every element. With a double click you have access to it (The Dimensions can be in mm, inch etc. they are user predefined)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>net-thub</td>
<td>bank of inline tubes</td>
<td>-</td>
<td>0 - bank of inline tubes, 1 - bank of staggered tubes</td>
</tr>
<tr>
<td>net-thub</td>
<td>staggered</td>
<td>-</td>
<td>0 - bank of inline tubes, 1 - bank of staggered tubes</td>
</tr>
<tr>
<td>net-thub</td>
<td>parallel flow</td>
<td>-</td>
<td>0 - parallel flow, 1 - counter flow, 2 - cross flow, 3 - pure parallel flow, 4 - pure counter flow</td>
</tr>
<tr>
<td>Dtube</td>
<td>38.0 mm</td>
<td>Tube outside diameter</td>
<td></td>
</tr>
<tr>
<td>Ptube</td>
<td>3.3 mm</td>
<td>Tube wall thickness</td>
<td></td>
</tr>
<tr>
<td>pitch axial</td>
<td>100.0 mm</td>
<td>Axial pitch</td>
<td></td>
</tr>
<tr>
<td>pitch axial</td>
<td>96.0 mm</td>
<td>Longitudinal tube pitch</td>
<td></td>
</tr>
<tr>
<td>wall bluff</td>
<td>10000.0 mm</td>
<td>Width bluff region</td>
<td></td>
</tr>
<tr>
<td>height bluff</td>
<td>20000.0 mm</td>
<td>Height bluff region</td>
<td></td>
</tr>
<tr>
<td>NumTubePerRow</td>
<td>100.000</td>
<td>Number of tubes per row</td>
<td></td>
</tr>
<tr>
<td>NumRows</td>
<td>12.000</td>
<td>Number of rows in gas flow direction</td>
<td></td>
</tr>
<tr>
<td>NumTubePerRow</td>
<td>1.000</td>
<td>Number of tubes parallel on steam/water side</td>
<td></td>
</tr>
<tr>
<td>Uf</td>
<td>1.000</td>
<td>Usage factor</td>
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</tr>
<tr>
<td>Meltube</td>
<td>S355J2</td>
<td>Tube material, P235GR = Austenit</td>
<td></td>
</tr>
<tr>
<td>RCond</td>
<td>0.0000 m²K/W</td>
<td>Thermal resistance of finned tubes</td>
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</tr>
<tr>
<td>angle tube</td>
<td>0.00</td>
<td>Gas flowing angle (between gas flow direction and tube axis)</td>
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</tr>
<tr>
<td>pitch fin</td>
<td>0.0 mm</td>
<td>Pitch for calculating pressure difference</td>
<td></td>
</tr>
<tr>
<td>length tube</td>
<td>0.0 mm</td>
<td>Length of volume of gas after (upstream) bank of tubes</td>
<td></td>
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<tr>
<td>wall bluff</td>
<td>yes</td>
<td>Switch for surface calculation, 0 = no, 1 = yes</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>17543.2 m²</td>
<td>Area of heating surface</td>
<td></td>
</tr>
<tr>
<td>length tube</td>
<td>24000.0 mm</td>
<td>Tube length</td>
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<tr>
<td>pitch fin</td>
<td>Semireg.</td>
<td>Fit type, Diamond, Circle, Circle, Square, Semi</td>
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</tr>
<tr>
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<td>Fin height</td>
<td></td>
</tr>
<tr>
<td>Prof</td>
<td>1.0 mm</td>
<td>Fin thickness</td>
<td></td>
</tr>
<tr>
<td>wall bluff</td>
<td>4.5 mm</td>
<td>Segment width</td>
<td></td>
</tr>
<tr>
<td>4th region</td>
<td>5.1 mm</td>
<td>Distance fin segment from tube (5.68mm-HF, 2mm-SFI)</td>
<td></td>
</tr>
</tbody>
</table>
## Input and Output with Excel Sheets

### Table 1: Input Data

<table>
<thead>
<tr>
<th>Model</th>
<th>C</th>
<th>O</th>
<th>T</th>
<th>d</th>
</tr>
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<tbody>
<tr>
<td>IPECO</td>
<td>39.1</td>
<td>2.9</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>IPESVAP</td>
<td>44.5</td>
<td>2.9</td>
<td>90</td>
<td>60</td>
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<tr>
<td>IPSE</td>
<td>40.2</td>
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<td>90</td>
<td>60</td>
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<tr>
<td>RHSH1</td>
<td>31.8</td>
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<td>90</td>
<td>80</td>
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<tr>
<td>RHSH2</td>
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<td>3.2</td>
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<td>4.0</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>MHPCO2</td>
<td>39.1</td>
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<td>90</td>
<td>80</td>
</tr>
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<td>90</td>
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<td>HPESH1</td>
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<td>3.2</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>HPESH2</td>
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<td>4.5</td>
<td>90</td>
<td>80</td>
</tr>
<tr>
<td>HPESH3</td>
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### Table 2: Output Data

<table>
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<th>Model</th>
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<th>T</th>
<th>K</th>
<th>MBL</th>
<th>A</th>
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<tr>
<td>GTS</td>
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<tr>
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<tr>
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<td>546</td>
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<tr>
<td>Gas-Turbine</td>
<td>575</td>
<td>412</td>
<td>206</td>
<td>652</td>
<td></td>
</tr>
</tbody>
</table>
Input and Output in the Graphical user interface (GUI)
A Philosophy of Excellence

Our success has been derived from a philosophy of technical excellence in all aspects of its products, services and people. Our philosophy of excellence is firmly rooted in our people. All of our engineers who do any programming on our models hold Master or Ph.D. degrees in Mechanical Engineering or Programming.

Philosophy of Quality

All our software is checked extremely on quality.

Our philosophy of quality:

- Highly educated staff members
- Built in quality checks, plain text comments variables etc.
- Using the latest programming tools. We are members of Microsoft Developer Network (MSDN).
- Project management tools for perfect quality
- Tests in a test-center. The tester are not related with the programmers
Example of a 3 Pressure HRSG

Q-T Diagram
Example of a municipal waste boiler

Gas path

Steam – Water Path
Natural Circulation

High temperature corrosion diagram
Residence time according 17. BImSchV
Power Plant Simulator & Designer

Basic- Module
- thermal calculation
- pressure drop calculation water / steam / flue gas etc.
- design calculation

Circulation- Module
- Natural circulation calculation
- forced through calculation

Regeneration- Module
- Regeneration calculation (low and high pressure preheating with turbine steam)

Dynamic- Module
- dynamic calculation (turbine trip normal or emergency shut-downs, warm and cold start-up etc.)

Other- Module
- Tube bundle vibration calculation
- critical run through calculation