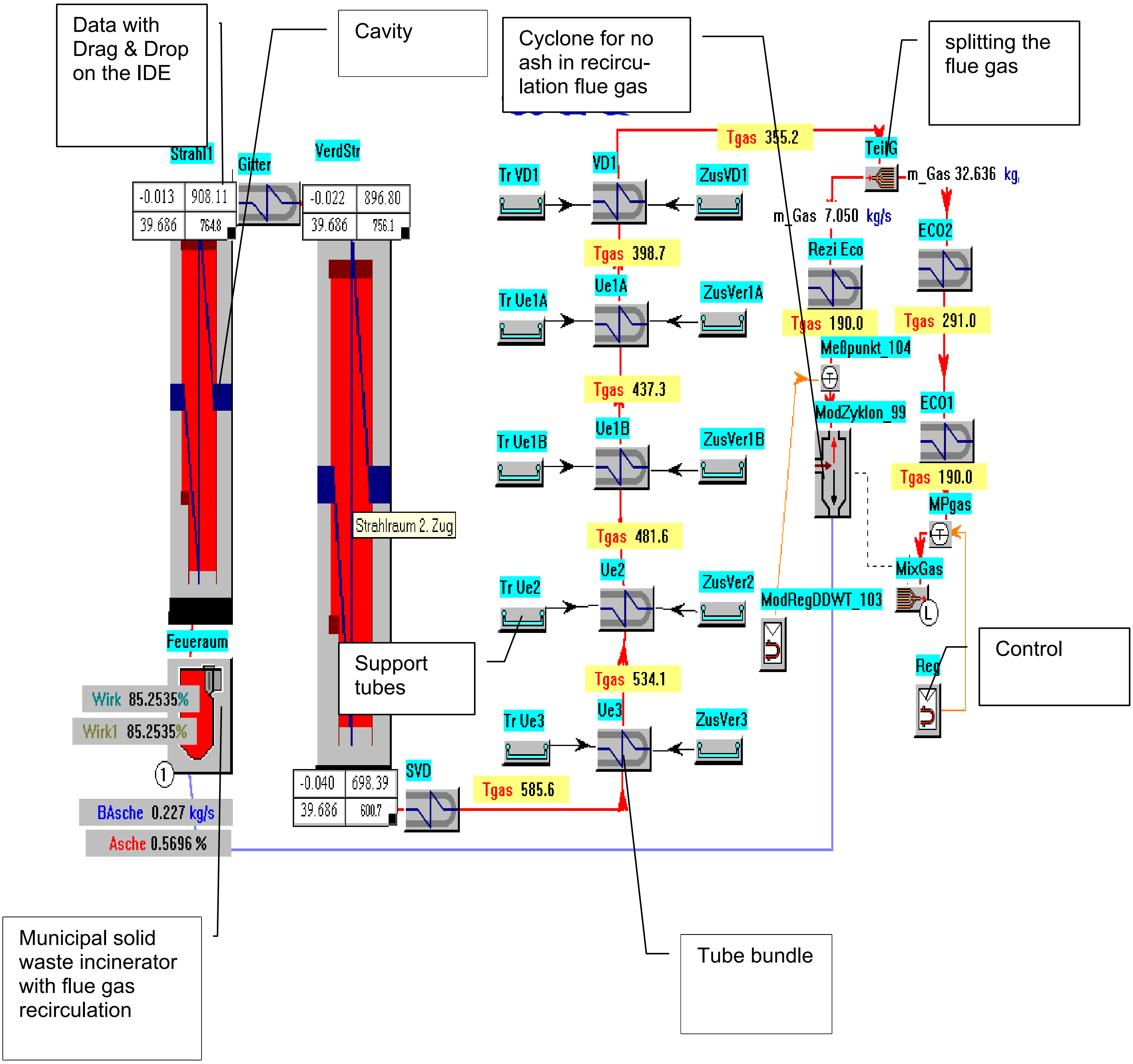
Power Plant Simulator & Designer

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 recircu-lation 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 Envirotherm, 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
26. Viessmann Werke GmbH & Co, Allendorf/Eder
27. Eisenwerke Baumgarte Kessel- und Apparatebau GmbH
28. Babcock Omnical Industriekessel GmbH, Dietzhölztal
29. TÜV Süddeutschland, Filderstadt
30. Dampfkesselbau Hohenthurm GmbH, Hohenthurm
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:

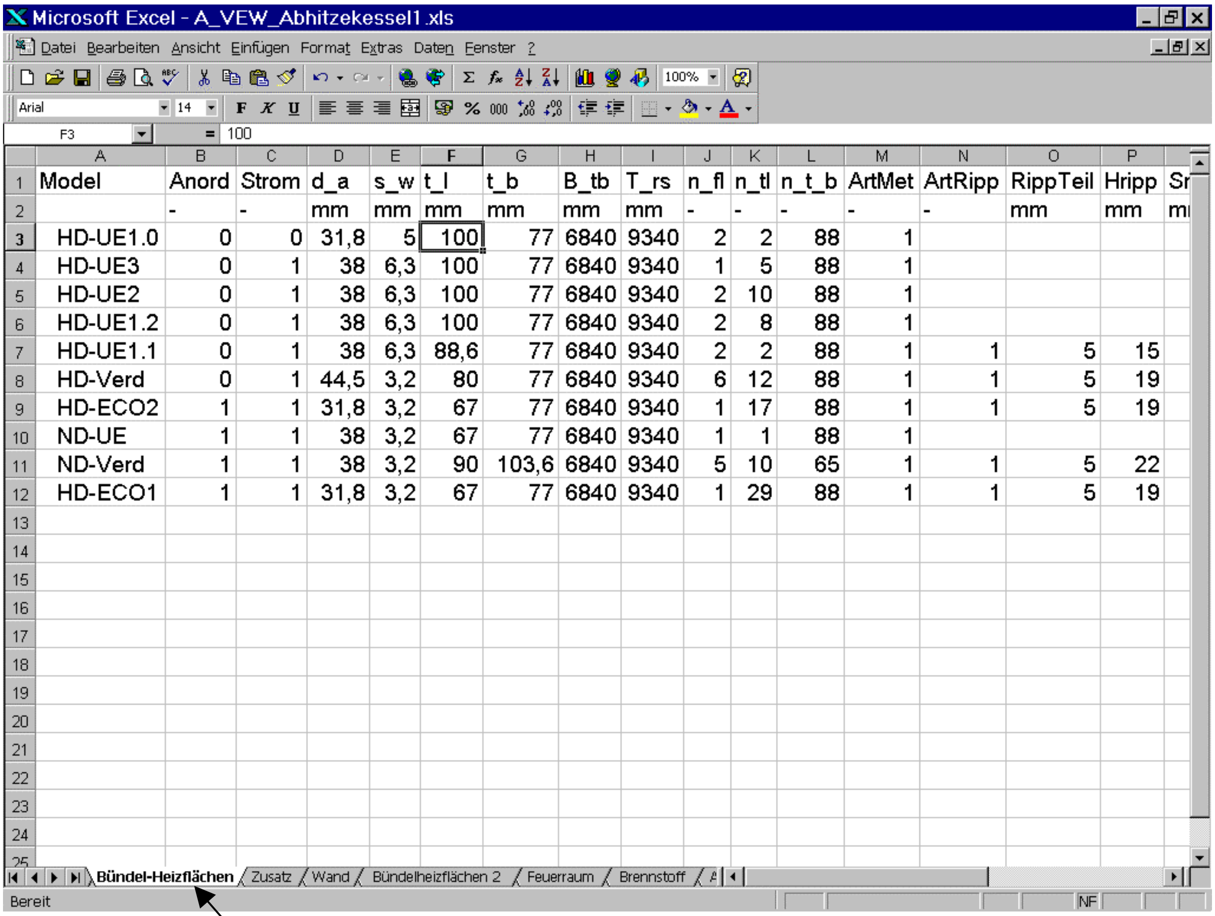
- Estimation
- Tendering and proposals
- Scrutinizing existing plants for e.g. fouling, different fuels, changing the heat exchangers

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

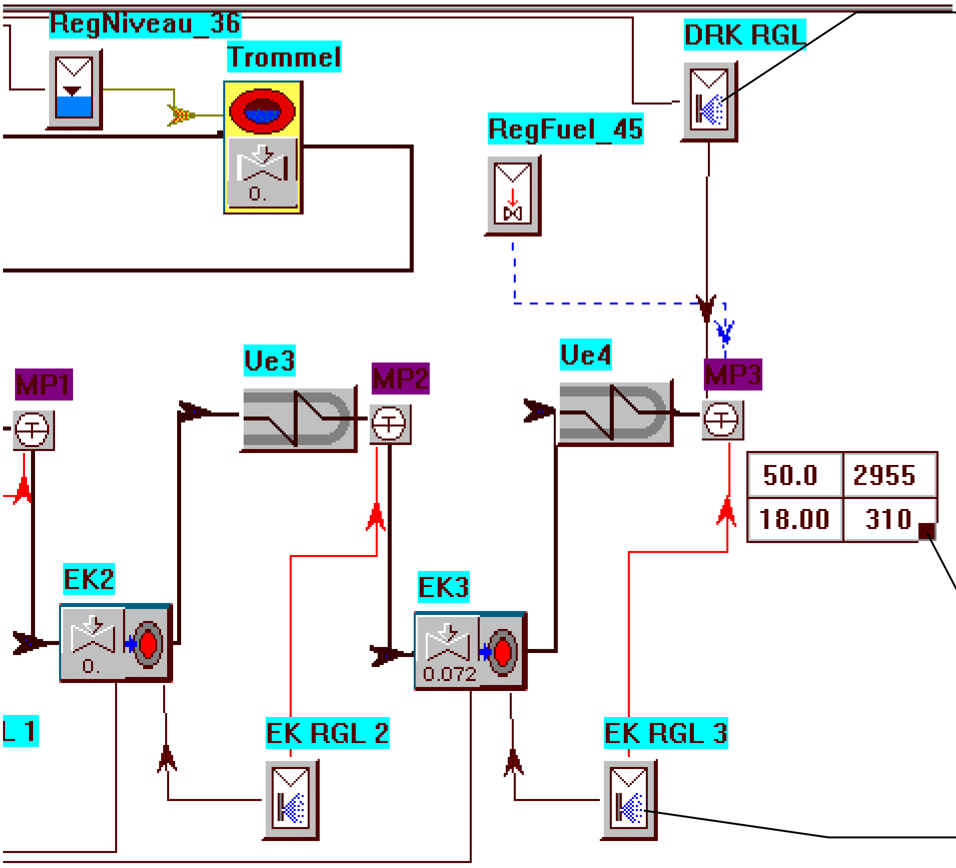
The Excel sheets can be linked with e.g. price calculation codes etc.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
1	Model	Anord	Strom	d_a	s_w	t_l	t_b	B_tb	T_rs	n_fl	n_tl	n_t_b	ArtMet	ArtRipp	RippTeil	Hripp	Sr
2		-	-	mm	mm	mm	mm	mm	mm	-	-	-	-	-	mm	mm	m
3	HD-UE1.0	0	0	31,8	5	100	77	6840	9340	2	2	88	1				
4	HD-UE3	0	1	38	6,3	100	77	6840	9340	1	5	88	1				
5	HD-UE2	0	1	38	6,3	100	77	6840	9340	2	10	88	1				
6	HD-UE1.2	0	1	38	6,3	100	77	6840	9340	2	8	88	1				
7	HD-UE1.1	0	1	38	6,3	88,6	77	6840	9340	2	2	88	1	1	5	15	
8	HD-Verd	0	1	44,5	3,2	80	77	6840	9340	6	12	88	1	1	5	19	
9	HD-ECO2	1	1	31,8	3,2	67	77	6840	9340	1	17	88	1	1	5	19	
10	ND-UE	1	1	38	3,2	67	77	6840	9340	1	1	88	1				
11	ND-Verd	1	1	38	3,2	90	103,6	6840	9340	5	10	65	1	1	5	22	
12	HD-ECO1	1	1	31,8	3,2	67	77	6840	9340	1	29	88	1	1	5	19	

These sheets are created automatically

Several control opportunities

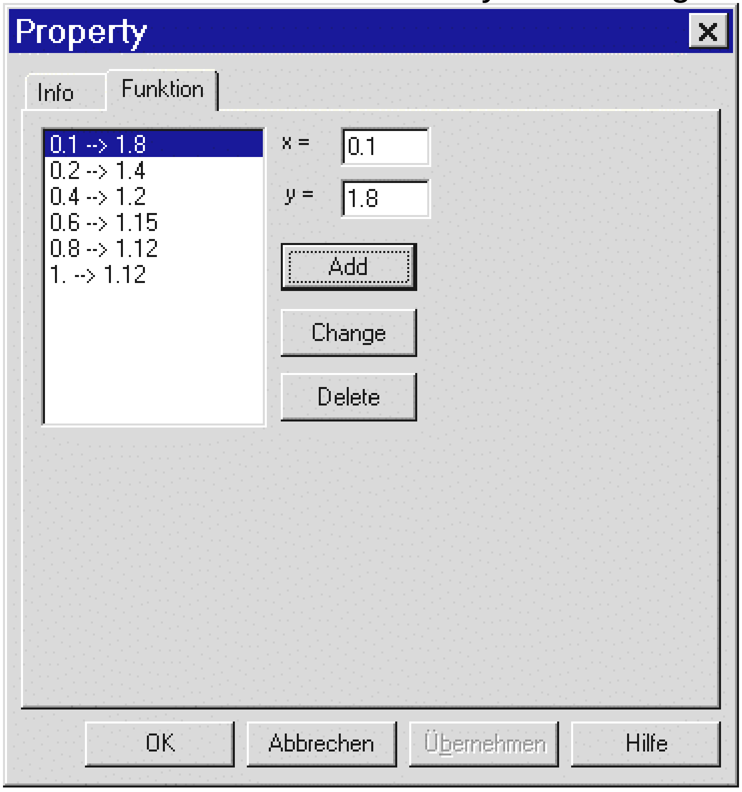


Pressure control

controled
-Temperature
-Mass flow
-Pressure

Superheater control

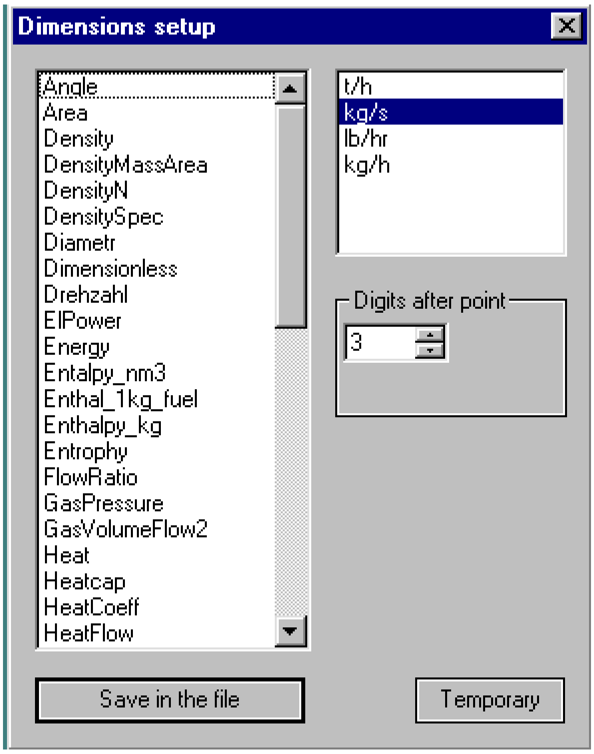
Insert different behavior for dynamic usage or for different load



0.1 --> 1.8
0.2 --> 1.4
0.4 --> 1.2
0.6 --> 1.15
0.8 --> 1.12
1. --> 1.12

x = 0.1
y = 1.8

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



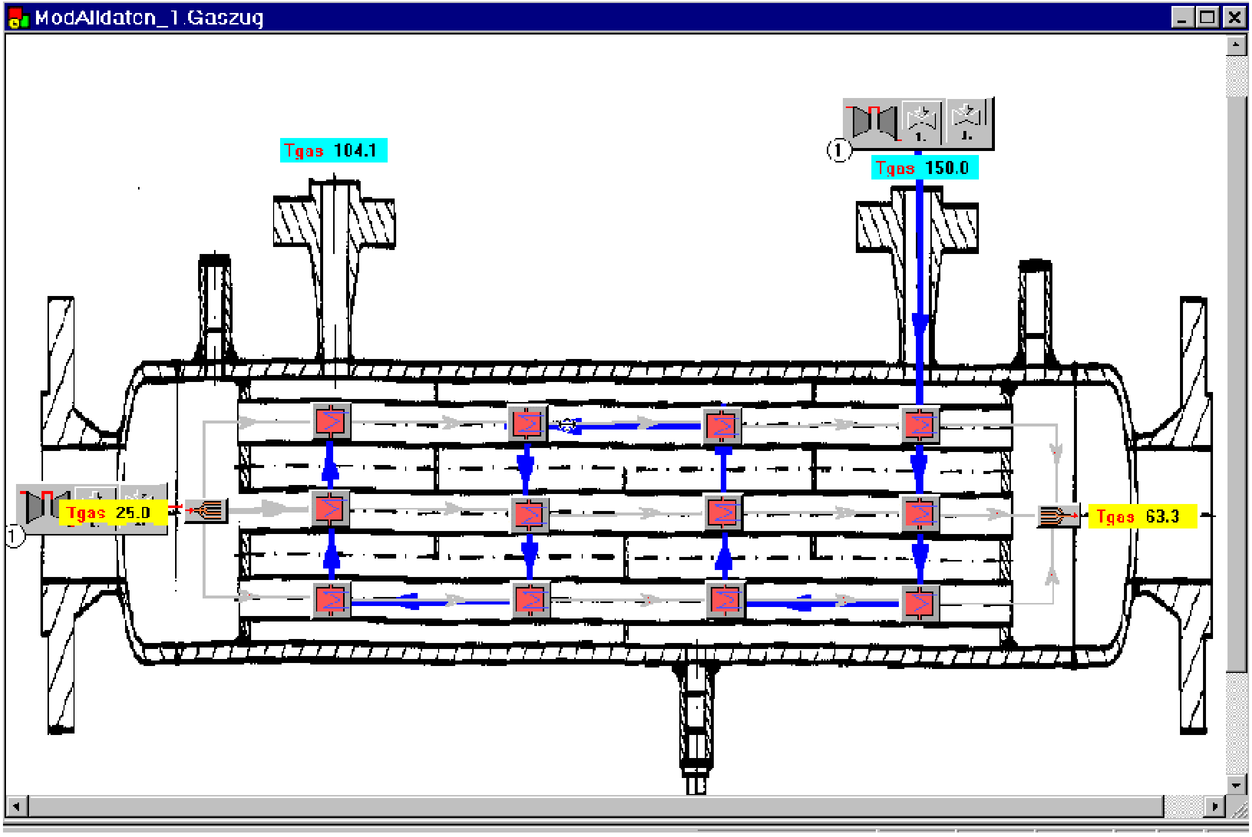
Angle
Area
Density
DensityMassArea
DensityN
DensitySpec
Diametr
Dimensionless
Drehzahl
ElPower
Energy
Entalpy_nm3
Enthal_1kg_fuel
Enthalpy_kg
Entrophy
FlowRatio
GasPressure
GasVolumeFlow2
Heat
Heatcap
HeatCoeff
HeatFlow

t/h
kg/s
lb/hr
kg/h

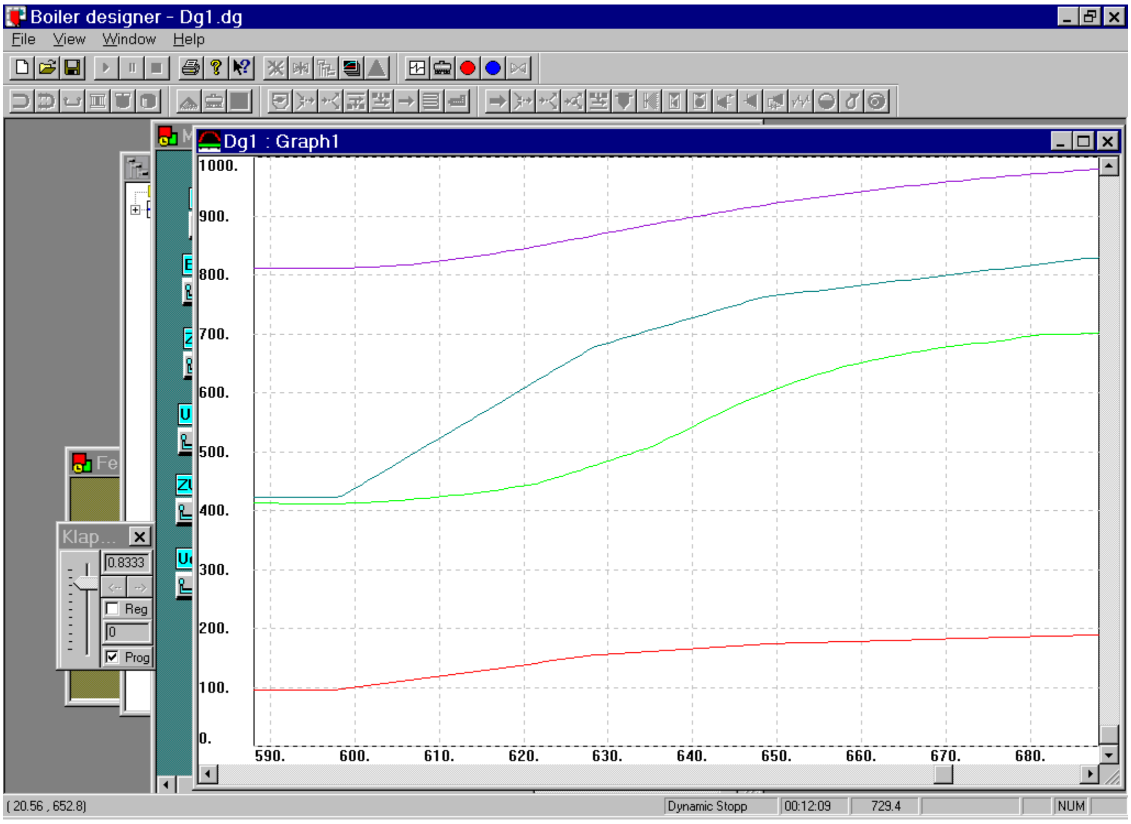
Digits after point: 3

Change the language

Insert user defined bitmaps



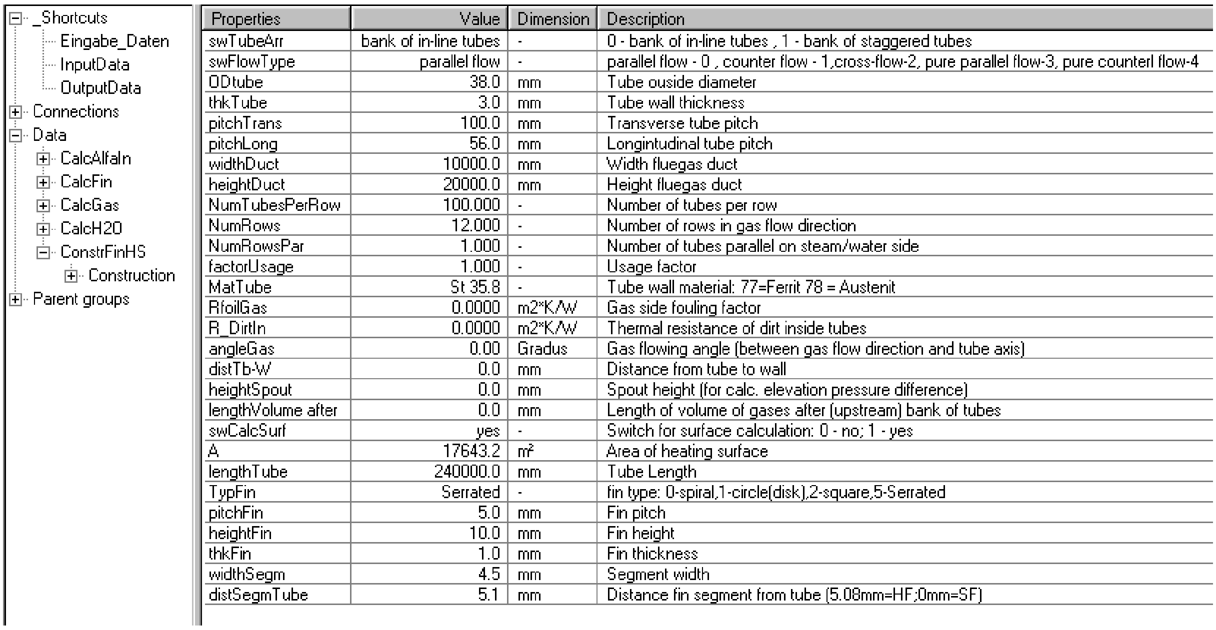
Temeratures after a load change



0.8333
☐ Reg
0
☑ Prog

Input and Output of Power Plant Simulator & Designer

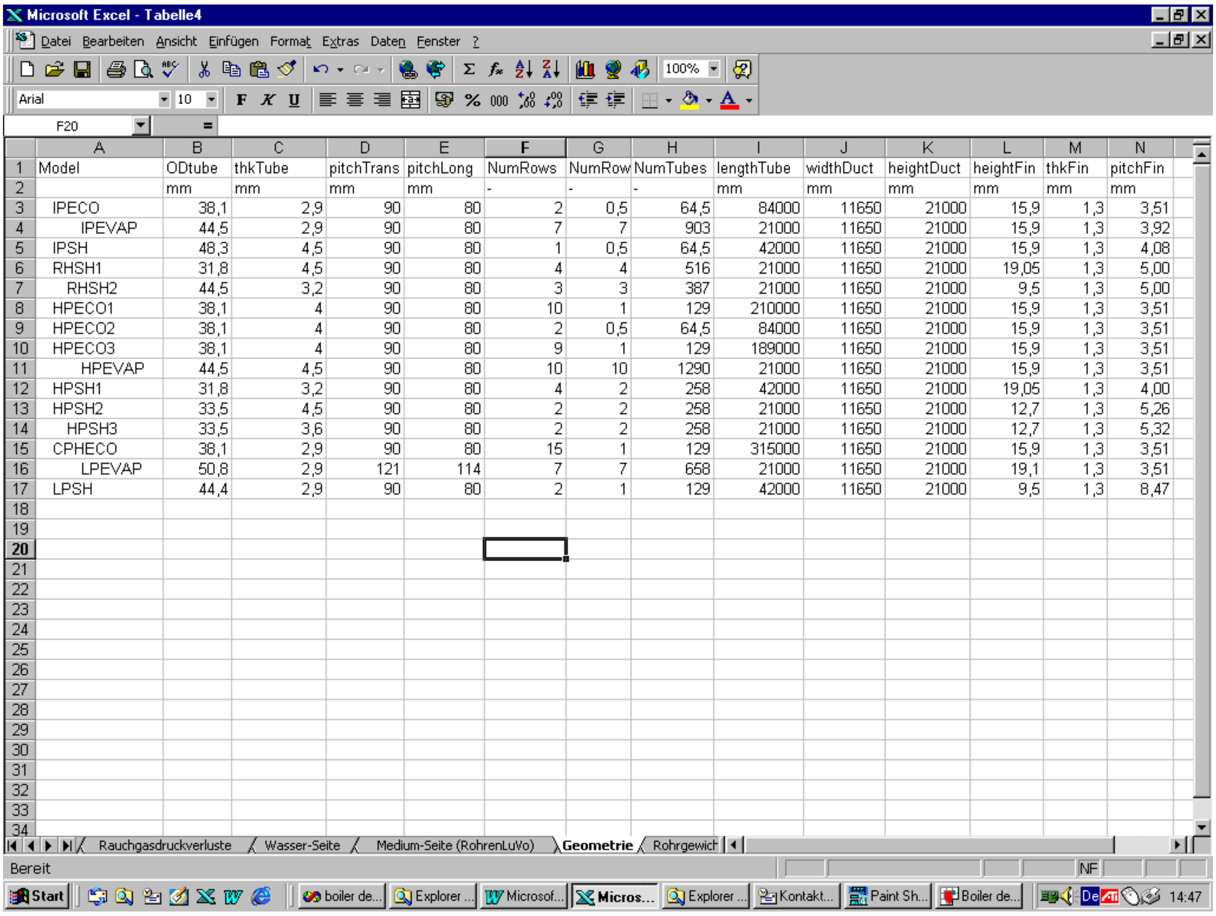
Generally :
The input and output- datas are in every element. With a double click you have access to it (The Dimensions can be in mm, inch etc. they are user predefined)



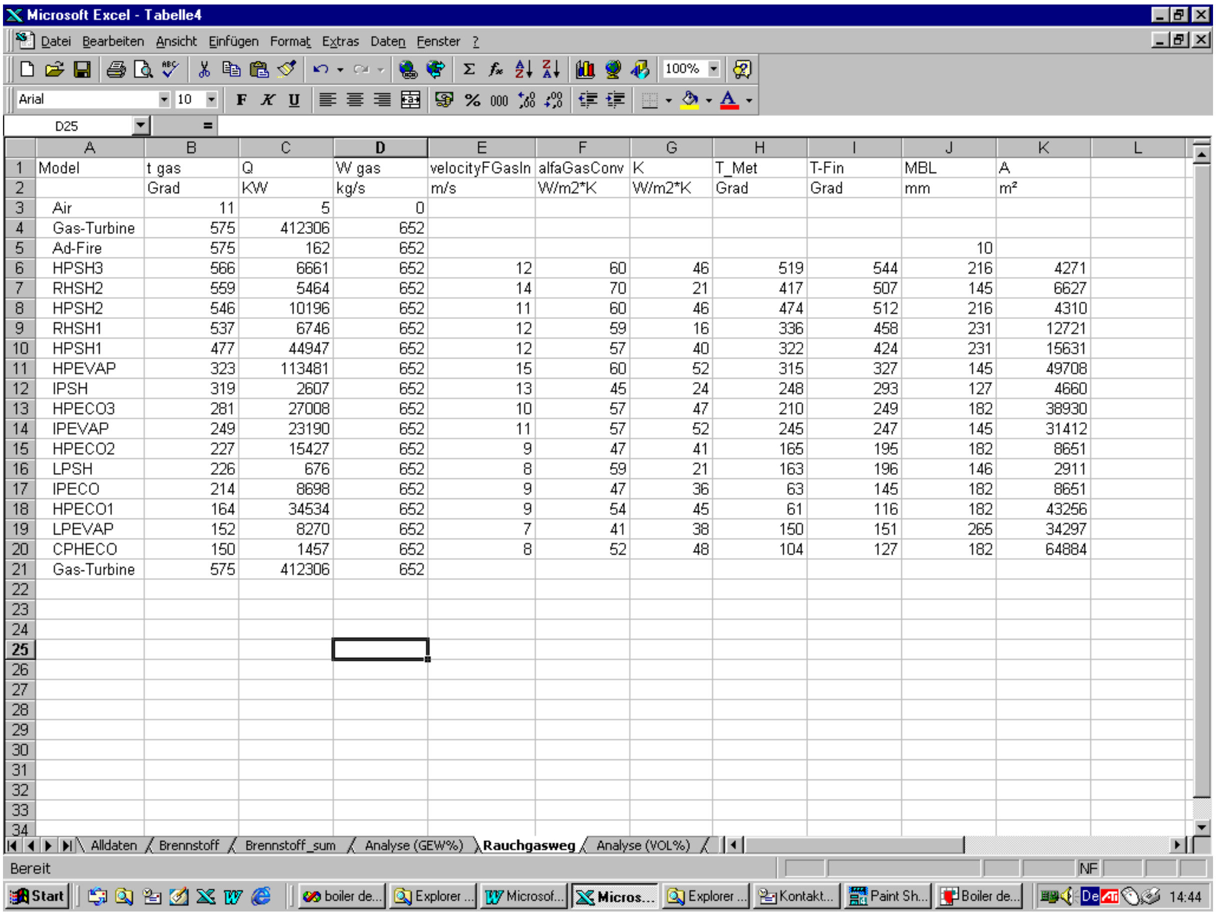
- _Shortcuts
  - Eingabe_Daten
  - InputData
  - OutputData
- Connections
- Data
  - CalcAlfaIn
  - CalcFin
  - CalcGas
  - CalcH2O
  - ConstrFinHS
    - Construction
- Parent groups

Properties	Value	Dimension	Description
swTubeArr	bank of in-line tubes	-	0 - bank of in-line tubes , 1 - bank of staggered tubes
swFlowType	parallel flow	-	parallel flow - 0 , counter flow - 1,cross-flow-2, pure parallel flow-3, pure counterl flow-4
ODtube	38.0	mm	Tube ouside diameter
thkTube	3.0	mm	Tube wall thickness
pitchTrans	100.0	mm	Transverse tube pitch
pitchLong	56.0	mm	Longintudinal tube pitch
widthDuct	10000.0	mm	Width fluegas duct
heightDuct	20000.0	mm	Height fluegas duct
NumTubesPerRow	100.000	-	Number of tubes per row
NumRows	12.000	-	Number of rows in gas flow direction
NumRowsPar	1.000	-	Number of tubes parallel on steam/water side
factorUsage	1.000	-	Usage factor
MatTube	St 35.8	-	Tube wall material: 77=Ferrit 78 = Austenit
RfoilGas	0.0000	m2*K/W	Gas side fouling factor
R_DirtIn	0.0000	m2*K/W	Thermal resistance of dirt inside tubes
angleGas	0.00	Gradus	Gas flowing angle (between gas flow direction and tube axis)
distTb-W	0.0	mm	Distance from tube to wall
heightSpout	0.0	mm	Spout height (for calc. elevation pressure difference)
lengthVolume after	0.0	mm	Length of volume of gases after (upstream) bank of tubes
swCalcSurf	yes	-	Switch for surface calculation: 0 - no; 1 - yes
A	17643.2	m^2	Area of heating surface
lengthTube	240000.0	mm	Tube Length
TypFin	Serrated	-	fin type: 0-spiral,1-circle(disk),2-square,5-Serrated
pitchFin	5.0	mm	Fin pitch
heightFin	10.0	mm	Fin height
thkFin	1.0	mm	Fin thickness
widthSegm	4.5	mm	Segment width
distSegmTube	5.1	mm	Distance fin segment from tube (5.08mm=HF;0mm=SF)

Input and Output with Excel Sheets

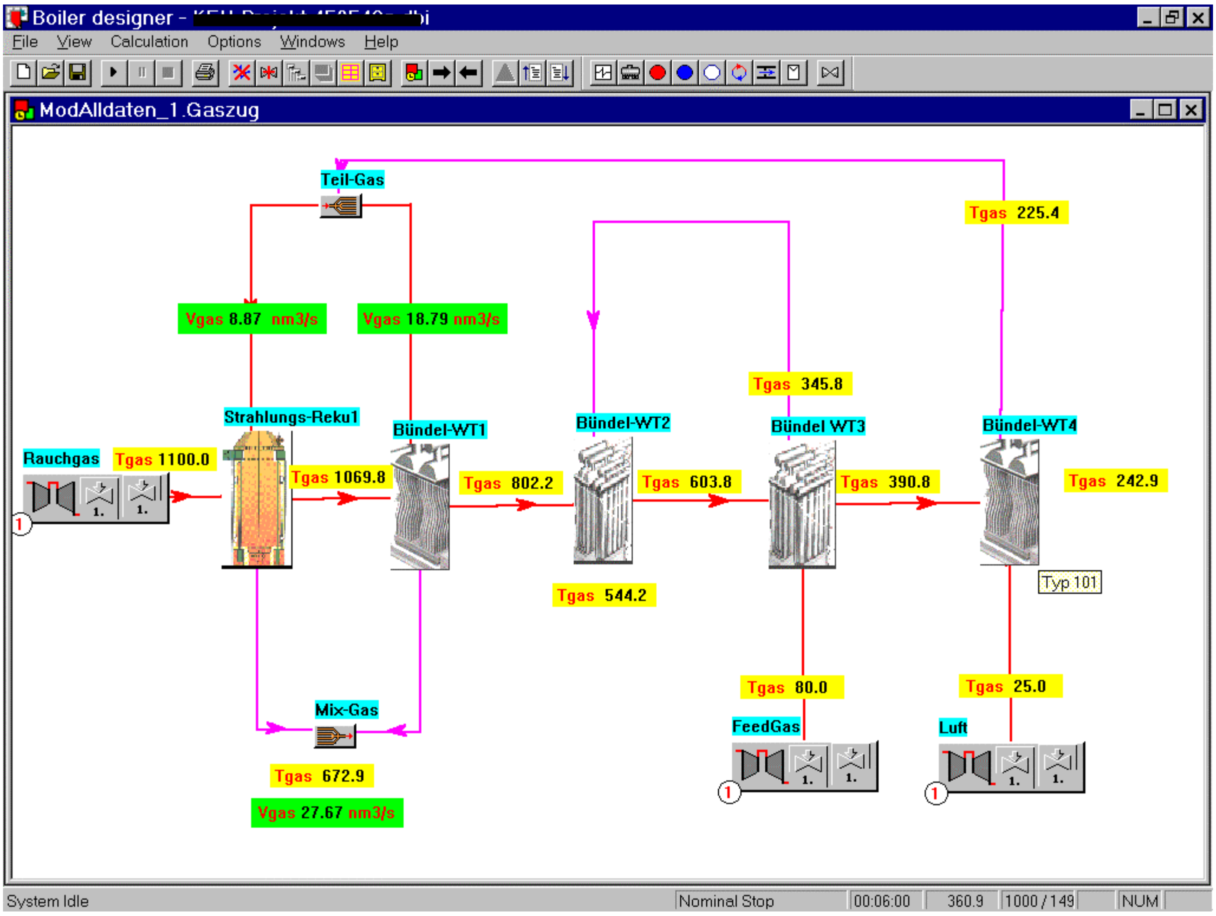


	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Model	ODtube	thkTube	pitchTrans	pitchLong	NumRows	NumRow	NumTubes	lengthTube	widthDuct	heightDuct	heightFin	thkFin	pitchFin
2		mm	mm	mm	mm	-	-	-	mm	mm	mm	mm	mm	mm
3	IPECO	38,1	2,9	90	80	2	0,5	64,5	84000	11650	21000	15,9	1,3	3,51
4	IPEVAP	44,5	2,9	90	80	7	7	903	21000	11650	21000	15,9	1,3	3,92
5	IPSH	48,3	4,5	90	80	1	0,5	64,5	42000	11650	21000	15,9	1,3	4,08
6	RHSH1	31,8	4,5	90	80	4	4	516	21000	11650	21000	19,05	1,3	5,00
7	RHSH2	44,5	3,2	90	80	3	3	387	21000	11650	21000	9,5	1,3	5,00
8	HPECO1	38,1	4	90	80	10	1	129	210000	11650	21000	15,9	1,3	3,51
9	HPECO2	38,1	4	90	80	2	0,5	64,5	84000	11650	21000	15,9	1,3	3,51
10	HPECO3	38,1	4	90	80	9	1	129	189000	11650	21000	15,9	1,3	3,51
11	HPEVAP	44,5	4,5	90	80	10	10	1290	21000	11650	21000	15,9	1,3	3,51
12	HPSH1	31,8	3,2	90	80	4	2	258	42000	11650	21000	19,05	1,3	4,00
13	HPSH2	33,5	4,5	90	80	2	2	258	21000	11650	21000	12,7	1,3	5,26
14	HPSH3	33,5	3,6	90	80	2	2	258	21000	11650	21000	12,7	1,3	5,32
15	CPHECO	38,1	2,9	90	80	15	1	129	315000	11650	21000	15,9	1,3	3,51
16	LPEVAP	50,8	2,9	121	114	7	7	658	21000	11650	21000	19,1	1,3	3,51
17	LPSH	44,4	2,9	90	80	2	1	129	42000	11650	21000	9,5	1,3	8,47



	A	B	C	D	E	F	G	H	I	J	K	L
1	Model	t gas	Q	W gas	velocityFGasIn	alfaGasConv	K	T_Met	T-Fin	MBL	A	
2		Grad	KW	kg/s	m/s	W/m2*K	W/m2*K	Grad	Grad	mm	m²	
3	Air	11	5	0								
4	Gas-Turbine	575	412306	652								
5	Ad-Fire	575	162	652						10		
6	HPSH3	566	6661	652	12	60	46	519	544	216	4271	
7	RHSH2	559	5464	652	14	70	21	417	507	145	6627	
8	HPSH2	546	10196	652	11	60	46	474	512	216	4310	
9	RHSH1	537	6746	652	12	59	16	336	458	231	12721	
10	HPSH1	477	44947	652	12	57	40	322	424	231	15631	
11	HPEVAP	323	113481	652	15	60	52	315	327	145	49708	
12	IPSH	319	2607	652	13	45	24	248	293	127	4660	
13	HPECO3	281	27008	652	10	57	47	210	249	182	38930	
14	IPEVAP	249	23190	652	11	57	52	245	247	145	31412	
15	HPECO2	227	15427	652	9	47	41	165	195	182	8651	
16	LPSH	226	676	652	8	59	21	163	196	146	2911	
17	IPECO	214	8698	652	9	47	36	63	145	182	8651	
18	HPECO1	164	34534	652	9	54	45	61	116	182	43256	
19	LPEVAP	152	8270	652	7	41	38	150	151	265	34297	
20	CPHECO	150	1457	652	8	52	48	104	127	182	64884	
21	Gas-Turbine	575	412306	652								

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.

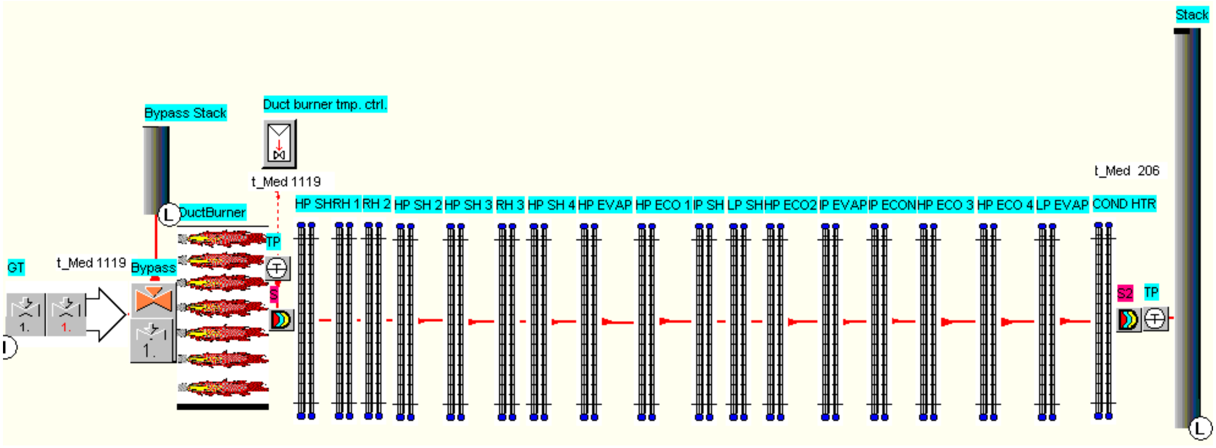
Philosophy of Quality

All our software is checked extremely on quality.

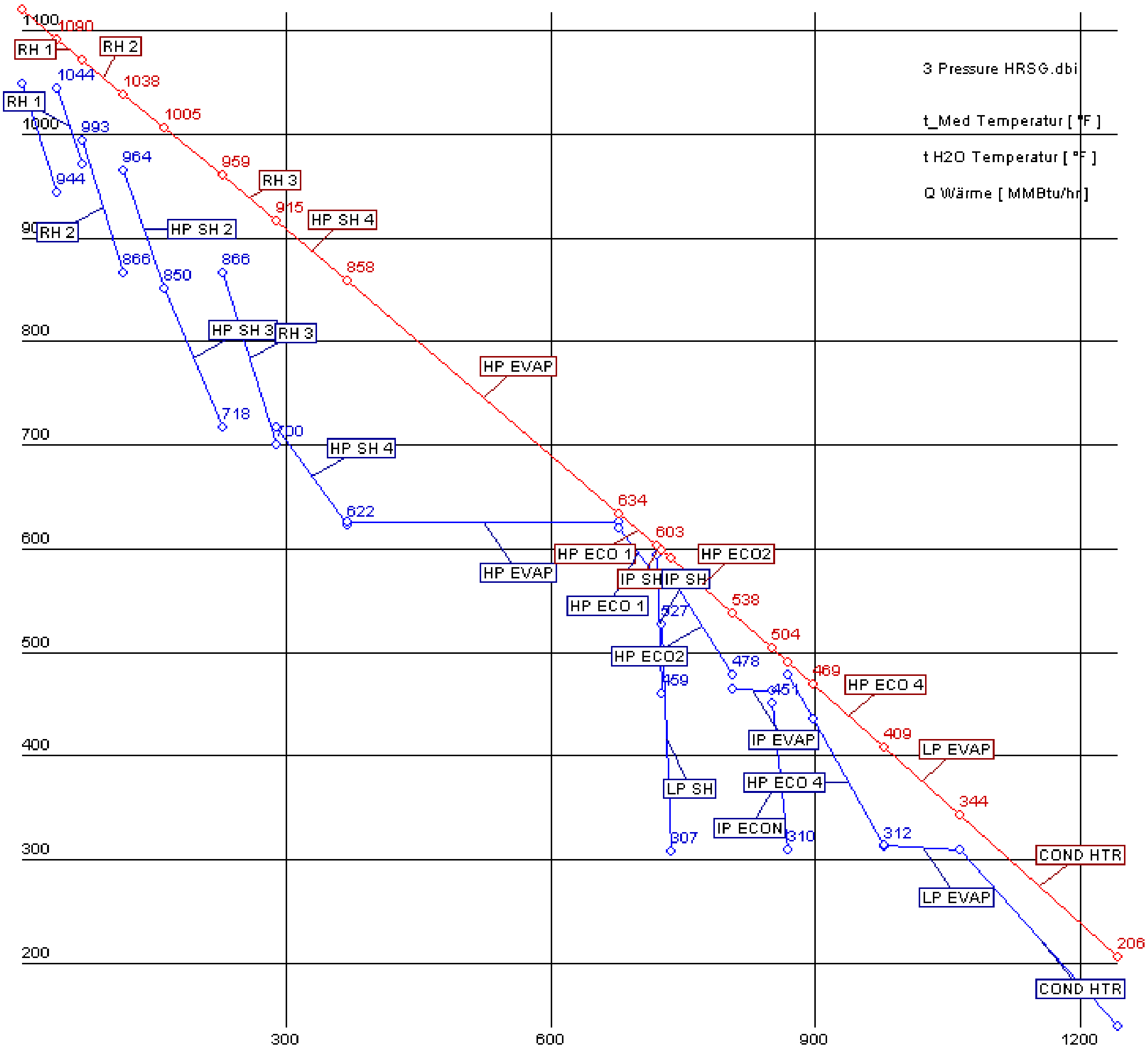
Our philosophy of quality :

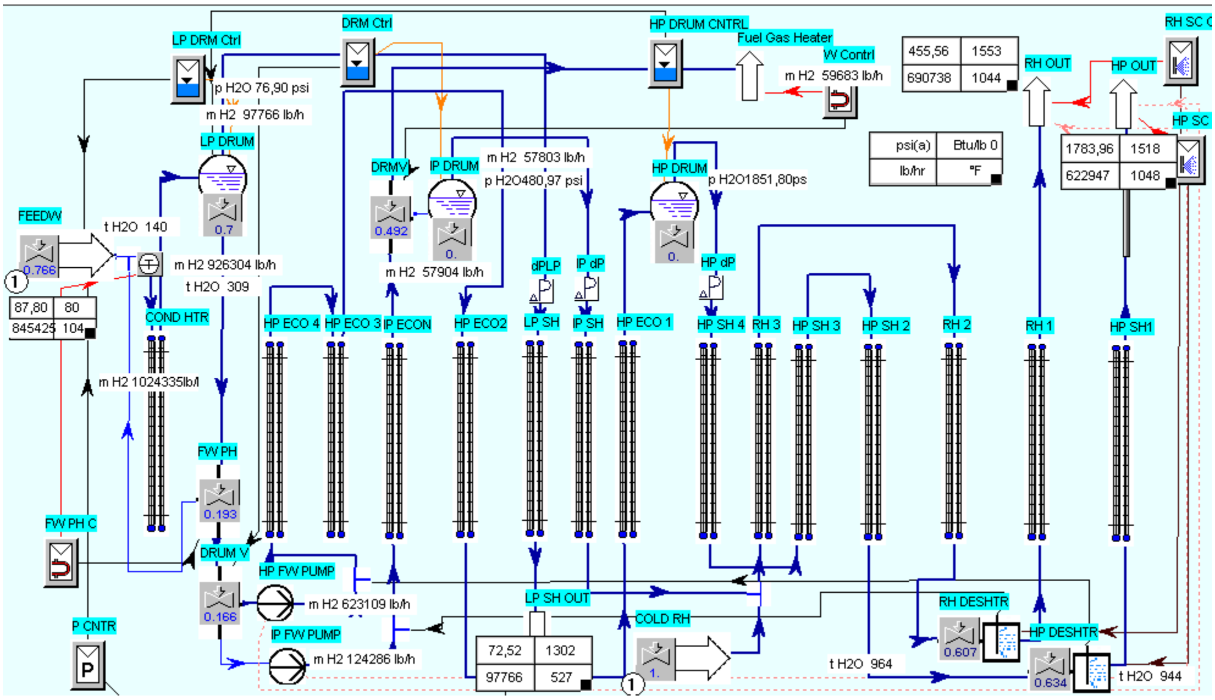
- Highly educated staff members
- Built in quality checks, plain text comments variables etc.
- Using the latest programming tools. We are members of Microsoft Developer Network (MSDN).
- Project management tools for perfect quality
- Tests in a test-center. The tester are not related with the programmers

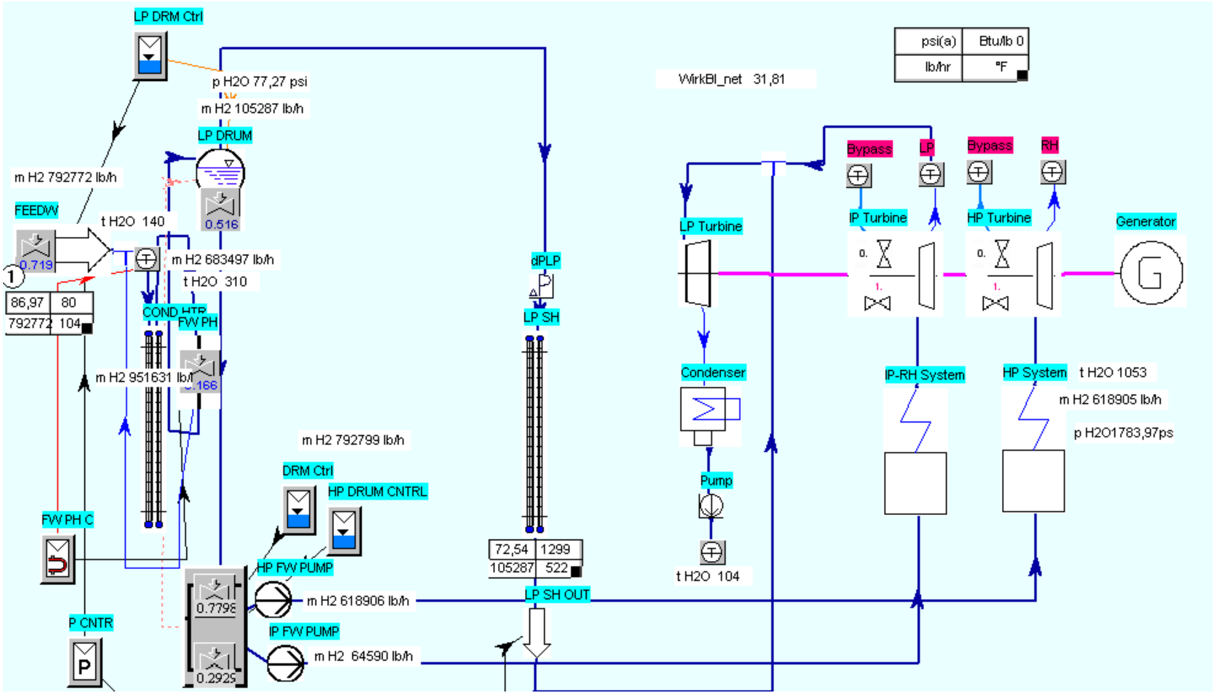
Example of a 3 Pressure HRSG



Q-T Diagram

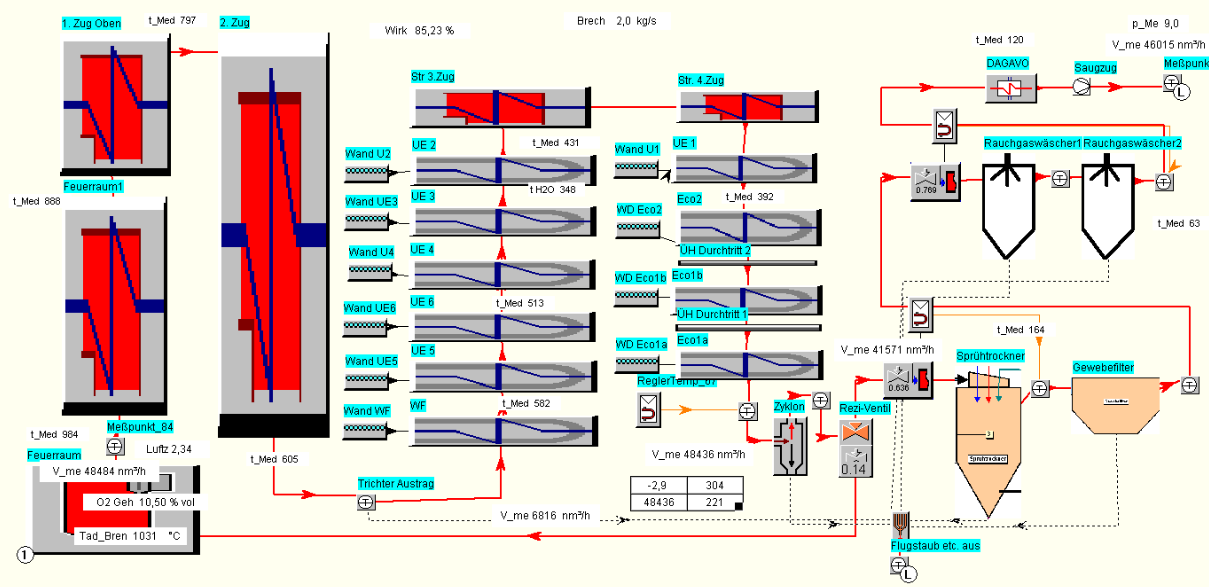



LP DRM Ctrl
DRM Ctrl
HP DRUM CNTRL
Fuel Gas Heater
W Contrl
m H2 59683 lb/h
455,56 1553
690738 1044
RH OUT
HP OUT
RH SC
HP SC
p H2O 76,90 psi
m H2 97766 lb/h
LP DRUM
DRMV
IP DRUM
m H2 57803 lb/h
p H2O480,97 psi
HP DRUM
p H2O1851,80ps
psi(a) Btu/lb 0
lb/hr °F
1783,96 1518
622947 1048
FEEDW
0.766
t H2O 140
0.7
0.492
0.
0.
m H2 926304 lb/h
t H2O 309
m H2 57904 lb/h
dPLP
IP dP
HP dP
87,80 80
845425 104
COND HTR
HP ECO 4
HP ECO 3
IP ECON
HP ECO2
LP SH
IP SH
HP ECO 1
HP SH 4
RH 3
HP SH 3
HP SH 2
RH 2
RH 1
HP SH1
m H2 1024335lb/l
FW PH
0.193
FW PH C
DRUM V
HP FW PUMP
0.166
m H2 623109 lb/h
LP SH OUT
COLD RH
RH DESHTR
HP DESHTR
0.607
0.634
P CNTR
IP FW PUMP
m H2 124286 lb/h
72,52 1302
97766 527
1.
t H2O 964
t H2O 944

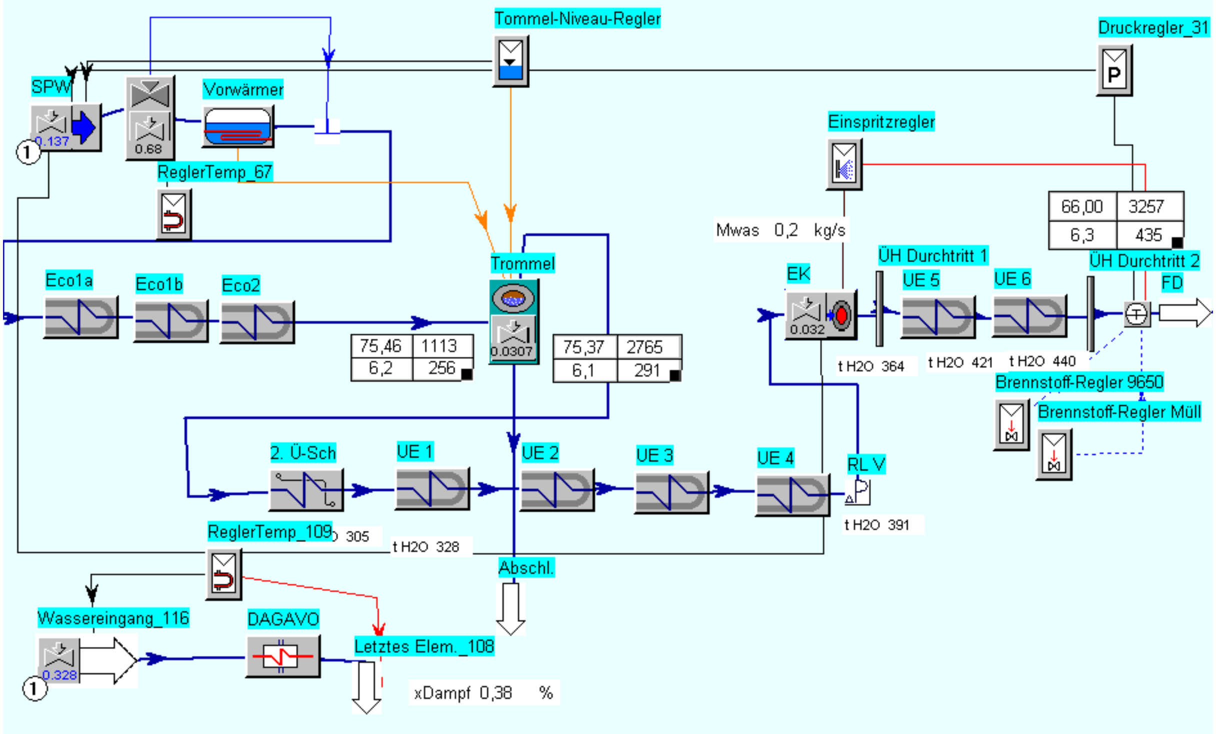

LP DRM Ctrl
p H2O 77,27 psi
m H2 105287 lb/h
LP DRUM
0.516
WirkBl_net 31,81
psi(a) Btu/lb 0
lb/hr °F
m H2 792772 lb/h
FEEDW
0.719
t H2O 140
m H2 683497 lb/h
t H2O 310
86,97 80
792772 104
COND HTR
FW PH
0.166
m H2 951631 lb/h
dPLP
LP SH
Bypass
LP
Bypass
RH
LP Turbine
IP Turbine
HP Turbine
Generator
0.
1.
0.
1.
Condenser
IP-RH System
HP System
t H2O 1053
m H2 618905 lb/h
p H2O1783,97ps
m H2 792799 lb/h
DRM Ctrl
HP DRUM CNTRL
Pump
FW PH C
72,54 1299
105287 522
t H2O 104
HP FW PUMP
0.7798
m H2 618906 lb/h
LP SH OUT
P CNTR
IP FW PUMP
0.2929
m H2 64590 lb/h

Example of a municipal waste boiler

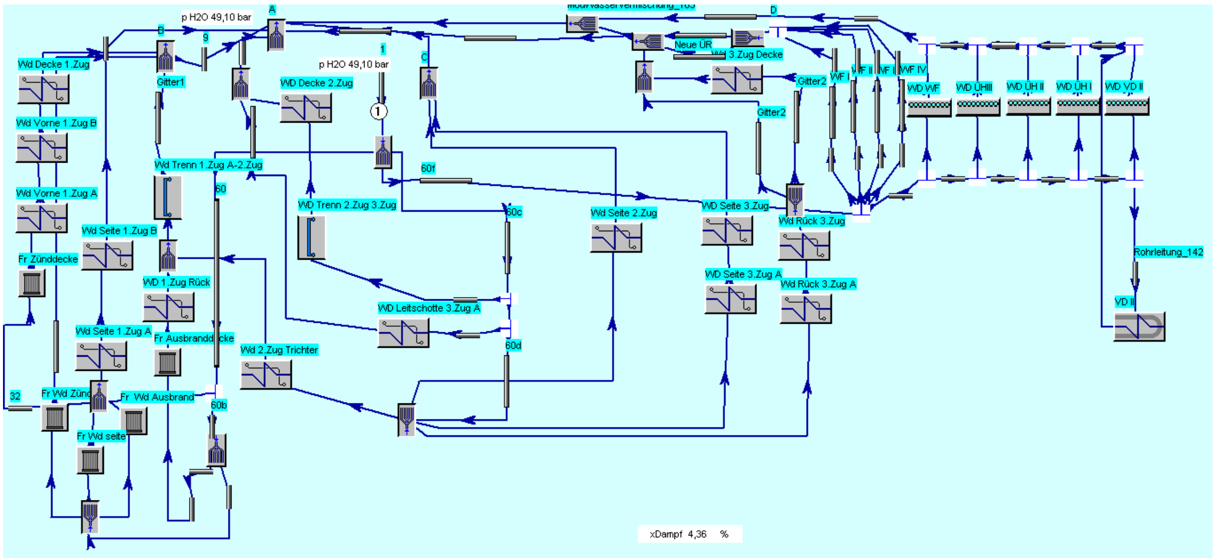
Gas path



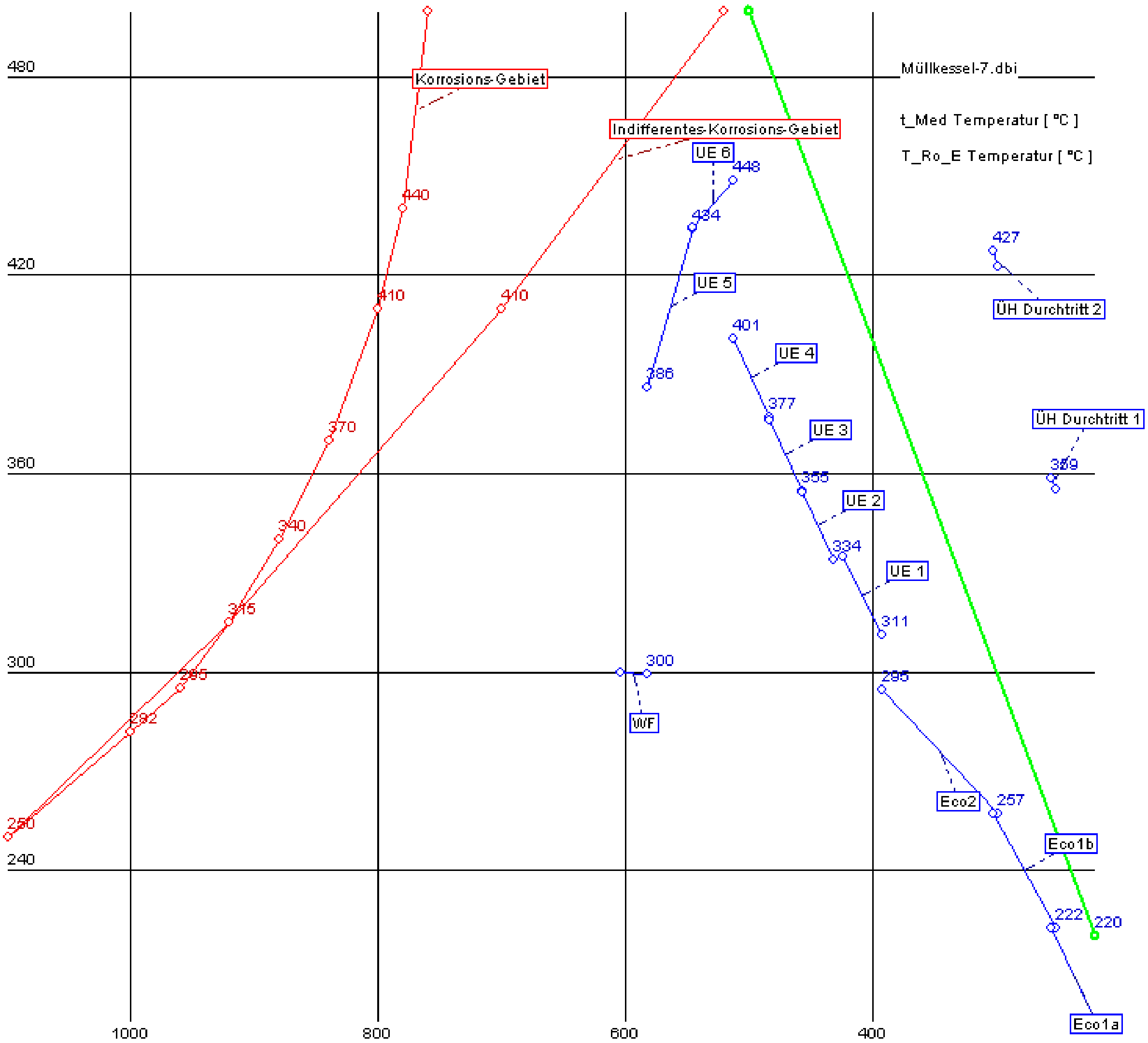
Steam – Water Path



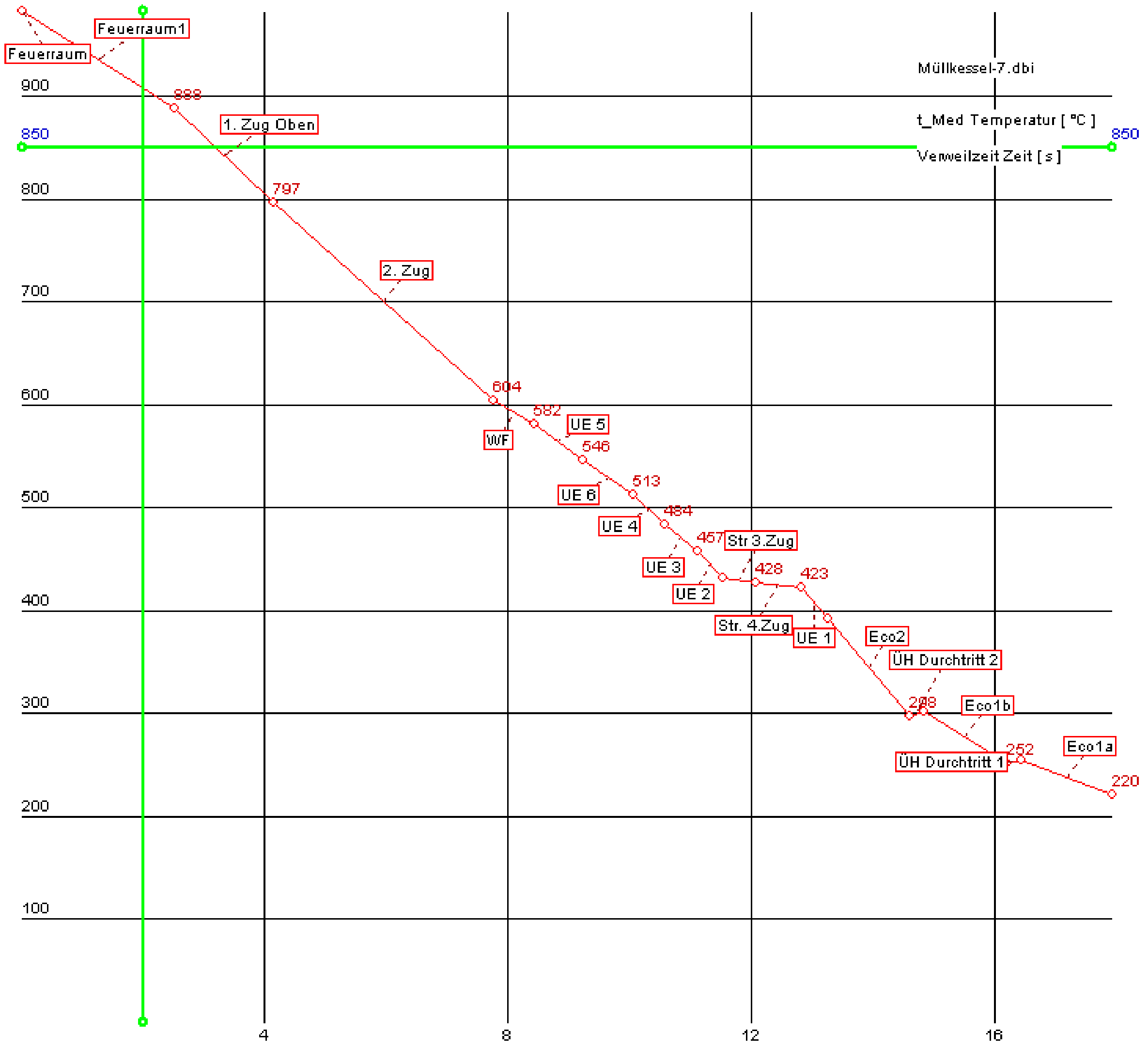
Natural Circulation



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