TLK-Thermo GmbH

ModelFitter

Getting started with the ModelFitter for Excel

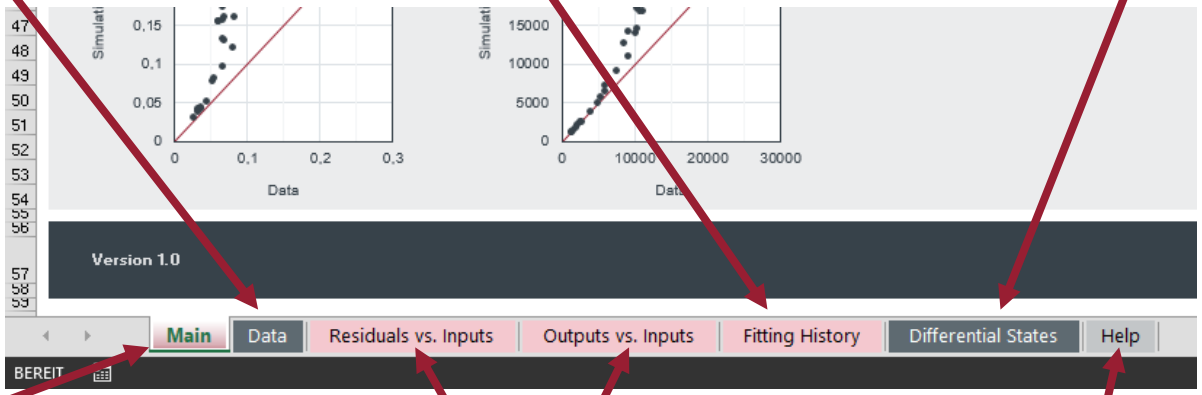
Working with examples

Overview Excel Tool

Data
- Database
- Simulation results

Fitting History
Backup of former values

Differential States
Important user input for Differential State Variables



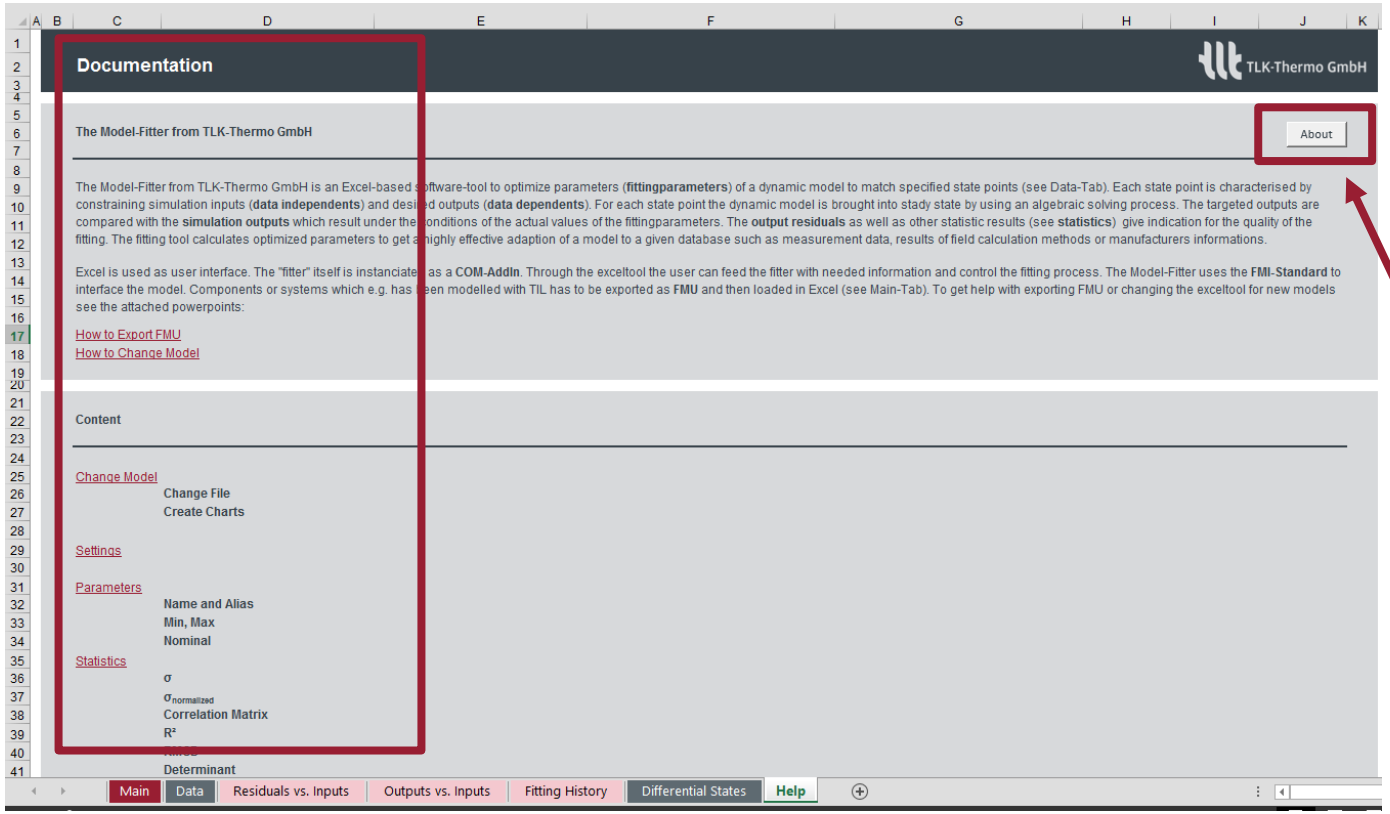
Main
- Settings
- Control Bar
- Parameters
- Statistics
- Main plots

Plots
Illustration of the results in different plot types

Help
Short explanations of all terms and functionalities

Help

The Help tab provides explanations of terms und functionalities which are used within the ModelFitter.



About
Information about software version and support

Data

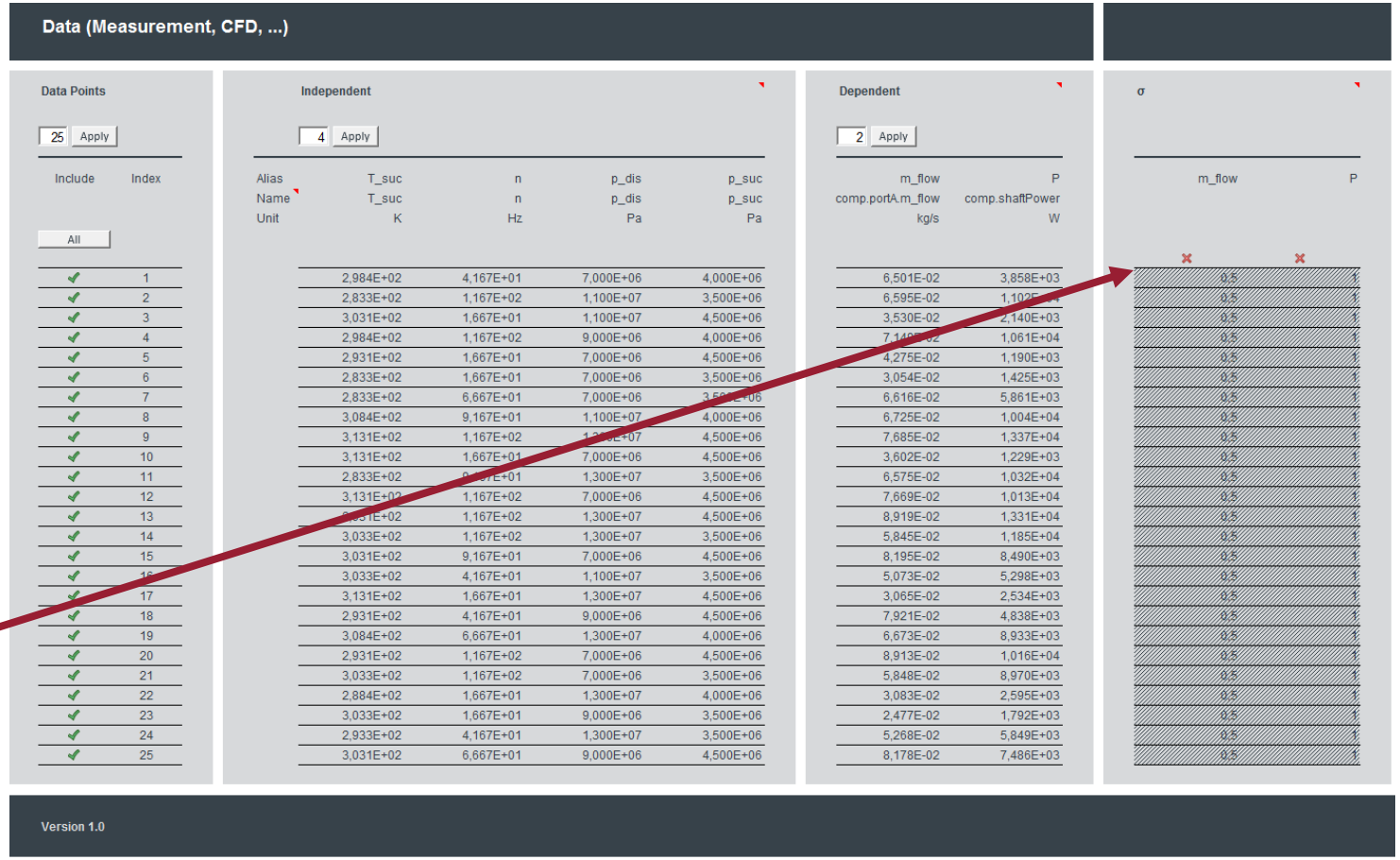
Database

The Database contains:

- **Data Points:** Static points
- **Independents**: Simulation inputs
- **Dependents**: Desired outputs
- **Sigma**: Standard Deviation

Simga is also used for weighting the dependents to each other.

Here, a global sigma for every dependent is entered on the Main tab.



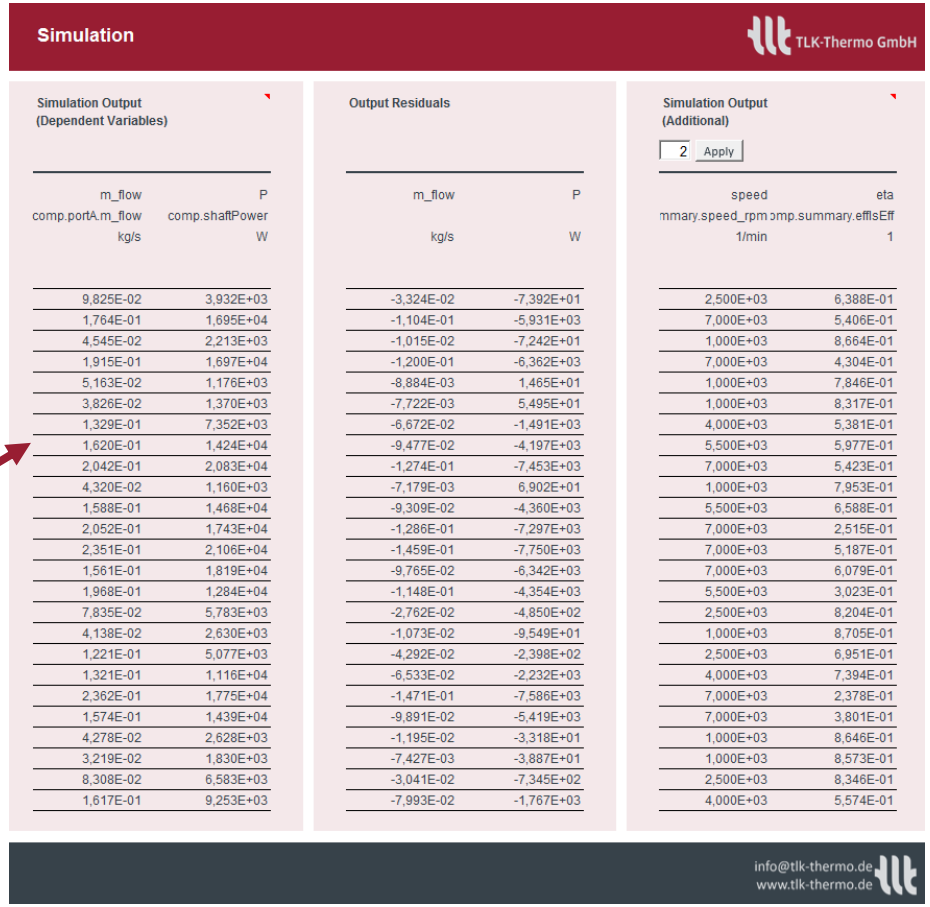
Data

Simulation results

Beside the Database simulation results are shown:

- **Simulation Output**
- **Output Residuals**: Calculated residuum between simulation output and dependents
- **Simulation Output (Additional)**: Possible additional outputs

Data Points



Simulation — TLK-Thermo GmbH

Simulation Output (Dependent Variables)

m_flow comp.portA.m_flow kg/s	P comp.shaftPower W
9,825E-02	3,932E+03
1,764E-01	1,695E+04
4,545E-02	2,213E+03
1,915E-01	1,697E+04
5,163E-02	1,176E+03
3,826E-02	1,370E+03
1,329E-01	7,352E+03
1,620E-01	1,424E+04
2,042E-01	2,083E+04
4,320E-02	1,160E+03
1,588E-01	1,468E+04
2,052E-01	1,743E+04
2,351E-01	2,106E+04
1,561E-01	1,819E+04
1,968E-01	1,284E+04
7,835E-02	5,783E+03
4,138E-02	2,630E+03
1,221E-01	5,077E+03
1,321E-01	1,116E+04
2,362E-01	1,775E+04
1,574E-01	1,439E+04
4,278E-02	2,628E+03
3,219E-02	1,830E+03
8,308E-02	6,583E+03
1,617E-01	9,253E+03

Output Residuals

m_flow kg/s	P W
-3,324E-02	-7,392E+01
-1,104E-01	-5,931E+03
-1,015E-02	-7,242E+01
-1,200E-01	-6,362E+03
-8,884E-03	1,465E+01
-7,722E-03	5,495E+01
-6,672E-02	-1,491E+03
-9,477E-02	-4,197E+03
-1,274E-01	-7,453E+03
-7,179E-03	6,902E+01
-9,309E-02	-4,360E+03
-1,286E-01	-7,297E+03
-1,459E-01	-7,750E+03
-9,765E-02	-6,342E+03
-1,148E-01	-4,354E+03
-2,762E-02	-4,850E+02
-1,073E-02	-9,549E+01
-4,292E-02	-2,398E+02
-6,533E-02	-2,232E+03
-1,471E-01	-7,586E+03
-9,891E-02	-5,419E+03
-1,195E-02	-3,318E+01
-7,427E-03	-3,887E+01
-3,041E-02	-7,345E+02
-7,993E-02	-1,767E+03

Simulation Output (Additional)

2 Apply

speed mmary.speed_rpm 1/min	eta omp.summary.effIsEff 1
2,500E+03	6,388E-01
7,000E+03	5,406E-01
1,000E+03	8,664E-01
7,000E+03	4,304E-01
1,000E+03	7,846E-01
1,000E+03	8,317E-01
4,000E+03	5,381E-01
5,500E+03	5,977E-01
7,000E+03	5,423E-01
1,000E+03	7,953E-01
5,500E+03	6,588E-01
7,000E+03	2,515E-01
7,000E+03	5,187E-01
7,000E+03	6,079E-01
5,500E+03	3,023E-01
2,500E+03	8,204E-01
1,000E+03	8,705E-01
2,500E+03	6,951E-01
4,000E+03	7,394E-01
7,000E+03	2,378E-01
7,000E+03	3,801E-01
1,000E+03	8,646E-01
1,000E+03	8,573E-01
2,500E+03	8,346E-01
4,000E+03	5,574E-01

info@tlk-thermo.de
www.tlk-thermo.de

Main

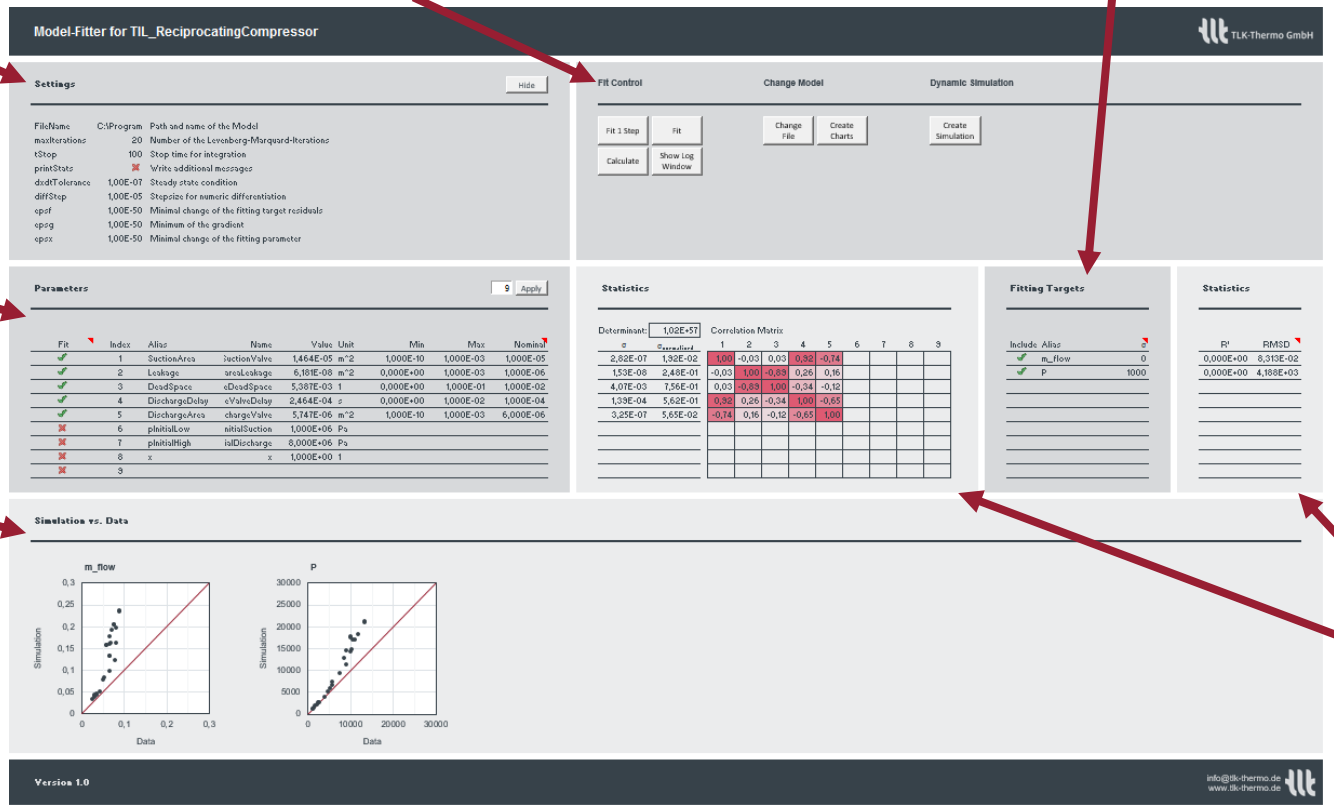
Settings
Settings for the fitting process

Control Bar
- Fit Control
- Change Model
- Dynamic Simulation

Fitting Targets

Parameters
Fitting Parameters

Simulation vs. Data
Main plots (Dependents)



Statistics

Main

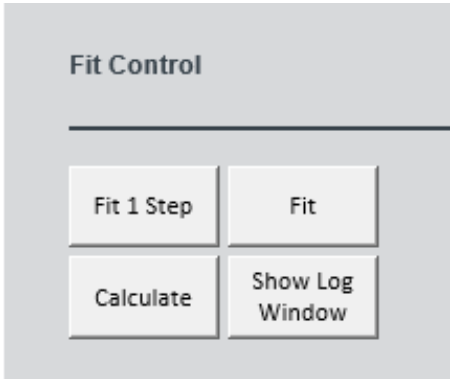
Control Bar – Fit Control

Fit 1 Step

- Only 1 step
- several times Fit1Step is not the same as a complete fit with several steps
- New fitting parameters
- See also fitting history

Fit

- Complete fit
- Number of steps: maxIterations
- New fitting parameters
- See also fitting history



Calculate

- Calculates the included static data points [s. Data Tab]
- Outputs are simulation results and some statistics
- No fitting

Show Log Window

- Shows messages from the ModelFitter
- Pops up automatically
- After closing, reopen with button „Show Log Window“

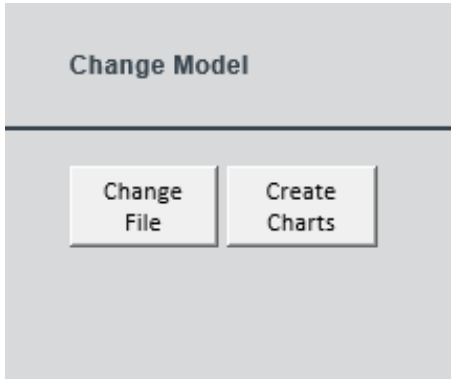
Main

Control Bar – Change Model

Change File
Change the input file (FMU)

Create Charts
- Re-draw all charts

See documentation of „How to Change Model“ for changing the Excel Tool to fit other models.



Main

Settings

Most important settings

- **printStats:**
  Additional information about the performance of the fitting process are written into the log window
- **maxIterations:**
  Maxmimum number of steps the ModelFitter does to improve the fitting parameters
- **dxdtTolerance:**
  Global tolerance for the change of differential state variables during steady state

Settings

FileName	C:\Program F	Path and name of the Model
printStats	✖	Write additional messages
maxIterations	20	Number of the Levenberg-Marquard-Iterations
dxdtTolerance	1,00E-07	Steady state condition
diffStep	1,00E-05	Stepsize for numeric differentiation
epsf	1,00E-50	Minimal change of the fitting target residuals
epsg	1,00E-50	Minimum of the gradient
epsx	1,00E-50	Minimal change of the fitting parameter
tStop	100	Stop time for integration

Please consider to adjust the settings only if problems occur.

Main

Parameters

Fitting parameters:

- Have to be marked → ✔
- The name of the full variable path is needed, e.g. „*comp.areaSuctionValve*“
- Start with meaningful values

Fixed parameters:

Parameters that are marked with a red cross ✘ are assigned as fixed parameters during simulation.

Parameters

9 Apply

Fit	Index	Alias	Name	Value	Unit	Min	Max	Nominal
✔	1	SuctionArea	SuctionValve	1,464E-05	m^2	1,000E-10	1,000E-03	1,000E-05
✔	2	Leakage	ıreaLeakage	6,181E-08	m^2	0,000E+00	1,000E-03	1,000E-06
✔	3	DeadSpace	ɜDeadSpace	5,387E-03	1	0,000E+00	1,000E-01	1,000E-02
✔	4	DischargeDelay	ıeValveDelay	2,464E-04	s	0,000E+00	1,000E-02	1,000E-04
✔	5	DischargeArea	ıchargeValve	5,747E-06	m^2	1,000E-10	1,000E-03	6,000E-06
✘	6	pInitialLow	InitialSuction	1,000E+06	Pa			
✘	7	pInitialHigh	ialDischarge	8,000E+06	Pa			
✘	8	x	x	1,000E+00	1			
✘	9							

Main

Statistics

Sigma:

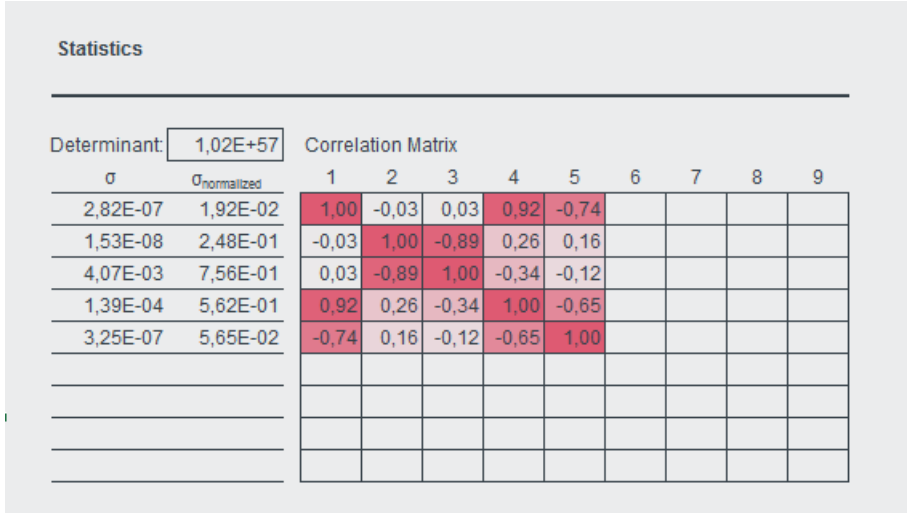
„How near are the current values of the fitting parameters to the optimum?“

Correlation Matrix:

„How does the fitting parameters influence each other?“

Determinant:

„How well does the database (e.g. measurement plan) fit to the model compared to other databases?“



Statistics

Determinant: 1,02E+57

Correlation Matrix

σ	$\sigma_{normalized}$	1	2	3	4	5	6	7	8	9
2,82E-07	1,92E-02	1,00	-0,03	0,03	0,92	-0,74				
1,53E-08	2,48E-01	-0,03	1,00	-0,89	0,26	0,16				
4,07E-03	7,56E-01	0,03	-0,89	1,00	-0,34	-0,12				
1,39E-04	5,62E-01	0,92	0,26	-0,34	1,00	-0,65				
3,25E-07	5,65E-02	-0,74	0,16	-0,12	-0,65	1,00				

Main

Statistics

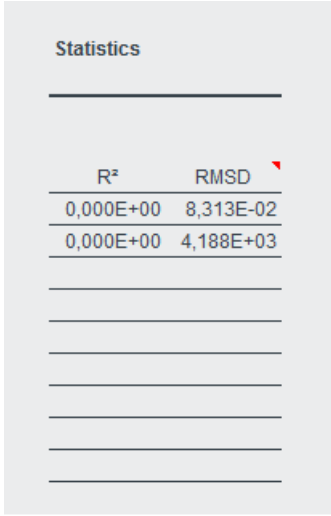
R^2:

„How well does the fitting parameters hit the database?“

RMSD:

„How big is the variation of the residuals?“

(residuals = dependent – simulation output)


Statistics

R^2	RMSD
0,000E+00	8,313E-02
0,000E+00	4,188E+03

Differential State Variables

The steady state definition is mainly influenced by the values given here.

Cumulating and ineffectual differential state variables are marked with a red cross.

Differential State Variables TLK-Thermo GmbH

Differential State Variables Autodetect Reset

Of some specific differential state variables the differentiation cannot be brought to zero ("**cumulating Variables**"). In this case, those variables has to be marked for being ignored while the fitter tries to bring the rest of the differential states to zero. Otherwise the fitter could not come to stady state.
Autodetect is a function to detect recommended nominal values of the differential state variables. Additionally, the exclusion of the state variables that should be ignored is automatically executed.

Use as State Variable	Name	Unit	Min	Max	Nominal
✓	comp.suctionChamberVLEFluid.p		0,00E+00	1,00E+300	1,00E+06
✓	comp.dischargeChamberVLEFluid.p		0,00E+00	1,00E+300	7,99E+06
✓	comp.portA.h_outflow		-1,00E+300	1,00E+300	3,50E+05
✓	comp.portB.h_outflow		-1,00E+300	1,00E+300	3,50E+05
✗	comp.getInputsRotary.rotatoryFlange.phi		-1,00E+300	1,00E+300	1,00E-03

Version 1.0 info@tlk-thermo.de www.tlk-thermo.de

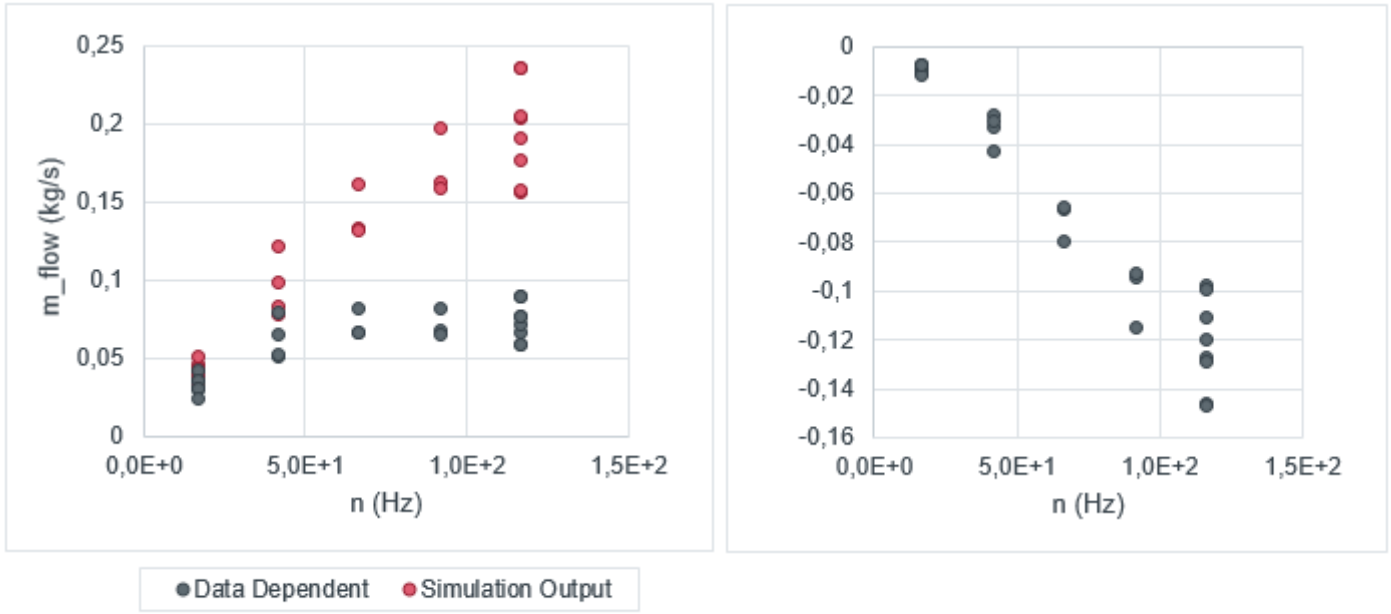
Plots

Outputs vs. Inputs:

Here the mass flow rate in the simulation rises too high compared with the dependent with respect to the speed (independent).

Residuals vs. Inputs:

Same conclusion. Residual between simulation output and dependent grows with higher speed.



History

In case of a Fit, a Fit1Step or essential changes of the differential state variables, information are saved in the fitting history.

History of Fitting Parameter

Clear All

Fit One Step

Time Stamp	Fit	Index	Alias	Name	Start Value	Fitted Value	Unit	$\sigma_{normalized}$	Dependents	R^2	RMSD	Target
15.06.2016 13:46:23	1	1	SuctionArea	SuctionValve	1,464E-05	7,744E-06	m^2	1,92E-02	m_flow	0,000E+00	8,313E-02	1
	1	2	Leakage	ıreaLeakage	6,181E-08	2,383E-07	m^2	2,48E-01	P	0,000E+00	4,188E+03	1
	1	3	DeadSpace	eDeadSpace	5,387E-03	1,241E-02	1	7,56E-01				
	1	4	DischargeDelay	ıeValveDelay	2,464E-04	2,449E-04	s	5,62E-01				
	1	5	DischargeArea	ıchargeValve	5,747E-06	5,306E-06	m^2	5,65E-02				
	0	6	pInitialLow	InitialSuction	1,000E+06	1,000E+06	Pa					
	0	7	pInitialHigh	ialDischarge	8,000E+06	8,000E+06	Pa					
	0	8	x	x	1,000E+00	1,000E+00	1					

Thank you

TLK-Thermo GmbH

If you have any questions,
please don’t hesitate to contact us at
modelfitter@tlk-thermo.com

Or your contact person
Jonathan Kistner
j.kistner@tlk-thermo.com

TLK-Thermo GmbH
Rebenring 31
38106 Braunschweig
www.tlk-thermo.com

Tel.: +49/531/390 76 - 250
Fax: +49/531/390 76 - 29