



Getting started with the ModelFitter for Excel

Working with the example



Guideline

1. Overview Excel Tool
2. Help
3. Main Tab
 - Control Bar
 - Settings
 - Parameters
 - Statistics
4. Data Tab
 - Database
 - Simulation results
5. Differential State Variables
6. Plot Tabs
7. History

Overview Excel Tool

Data

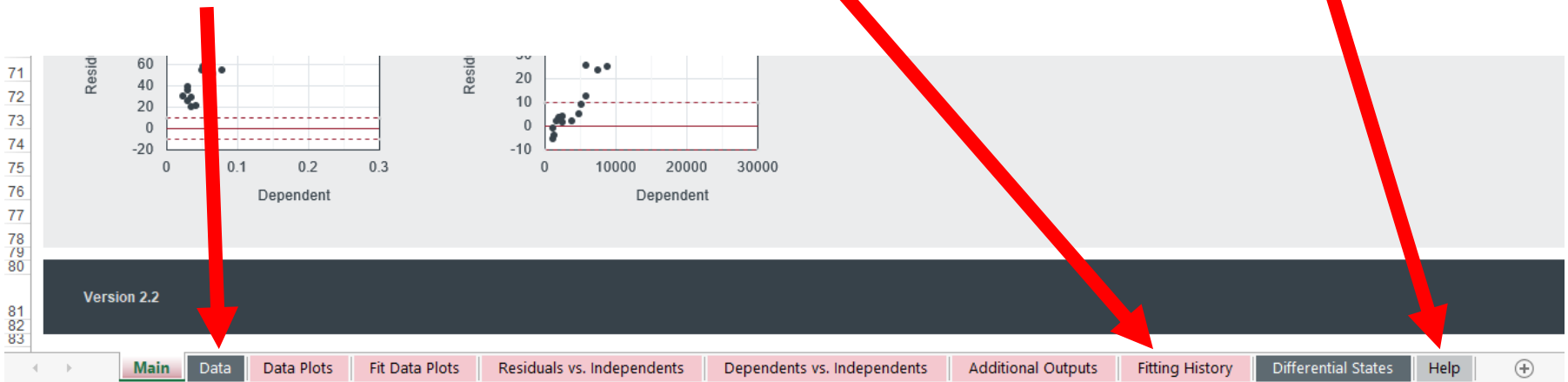
- Database
- Simulation results

History

Backup of former values

Help

Short explanations of all terms and functionalities



Main

- Fit Control
- Parameters
- Statistics
- Main plots

Plots

Differential States

Important user input for Differential State Variables

User defined Tabs can be added.

Help

On the Help Tab a lot of terms are explained

[s. Help Tab]

Some terms also can be easily looked up on the internet (e.g. Wikipedia, etc.)

The screenshot shows the 'Help' tab in the Model-Fitter software. The 'Documentation' section is highlighted with a red box and contains the following text:

The Model-Fitter from TLK-Thermo GmbH

The Model-Fitter from TLK-Thermo GmbH is an Excel-based software-tool to optimize parameters (**fitting parameters**) of a dynamic model to match specified state points (see Data-Tab). Each state point is characterized by constraining simulation inputs (**data independents**) and desired outputs (**data dependents**). For each state point the dynamic model is brought into steady state by using an algebraic solving process. The targeted outputs are compared with the **simulation outputs** which result under the conditions of the actual values of the fitting parameters. The **output residuals** as well as other statistic results (see **statistics**) give indication for the quality of the fitting. The fitting tool calculates optimized parameters to get a highly effective adaption of a model to a given database such as measurement data, results of field calculation methods or manufacturers informations.

Excel is used as user interface. The "fitter" itself is instantiated as a **COM-Addin**. Through the exceltool the user can feed the fitter with needed information and control the fitting process. The Model-Fitter uses the **FMI-Standard** to interface the model. Components or systems which e.g. has been modelled with TIL has to be exported as **FMU** and then loaded in Excel (see Main-Tab). To get help with exporting FMU or changing the exceltool for new models see the attached powerpoints:

[How to Export FMU](#)
[How to Change Model](#)

Content

- Change Model**
 - Change File
 - Create Charts
- Settings**
- Parameters**
 - Name and Alias
 - Min, Max
 - Nominal
- Statistics**
 - σ
 - $\sigma_{\text{normalized}}$
 - Correlation Matrix
 - R^2
 - RMSE
 - Determinant

The 'About' button is circled in red. A red arrow points from the text 'Information about software version and support' to the 'About' button.

Information about software version and support
[s. Help Tab]

Main Tab

Settings for the fitting process

Control Bar

Fitting Targets

Fitting Parameters

Main plots (Dependents)

ModelFitter for TIL3110_ReciprocatingCompressor

Settings

File Name: ..\examples\ Path and name of the Model
 method: 0 Integer that represents a combination of solver settings
 multiStarts: 30 Number of the Levenberg-Marquardt iterations
 distTolerance: 1.00E-10 Steady state condition

Parameters

Fit	Index	Alias	Name	Value	Unit	Min	Max	Nominal
✓	1	SurfaceArea	inletArea	1.464E-05	m ²	1.000E-10	1.000E-03	1.000E-05
✓	2	Leakage	areaLeakage	6.18E-08	m ²	0.000E+00	1.000E-03	1.000E-06
✓	3	DeadSpace	sDeadSpace	5.38E-03	1	0.000E+00	1.000E-01	1.000E-02
✓	4	DischargeDelay	sValveDelay	2.444E-04	s	0.000E+00	1.000E-02	1.000E-04
✓	5	DischargeArea	chargeArea	5.74E-06	m ²	1.000E-10	1.000E-03	6.000E-06
✗	6	Displacement	flapDisplacement	2.800E-05	m ³			
✗	7	rodDisplacement	s	1.000E+00	1			
✗	8							

Parameters Statistics

Determinant: 1.67E-05

Parameter	1	2	3	4	5	6	7	8
1	1.00	0.43	-0.23	0.65	-0.43			
2	0.43	1.00	-0.63	0.65	0.10			
3	-0.23	-0.63	1.00	-0.80	-0.39			
4	0.65	0.65	-0.80	1.00	-0.23			
5	-0.43	0.10	-0.39	-0.23	1.00			

Fitting Targets

Includes	Alias	p1	RMSE
✓	m_flow	0	0.000E+00
✓	p	100	0.000E+00

Fitting Statistics

p1: 0.000E+00
 RMSE: 8.331E-02
 0.000E+00
 4.183E-03

Simulation Outputs vs. Dependents

m_flow

p

Residuals vs. Dependents

m_flow

p

Version: 2.2

info@tk-thermo.de
 www.tk-thermo.de

Statistics

Main Tab

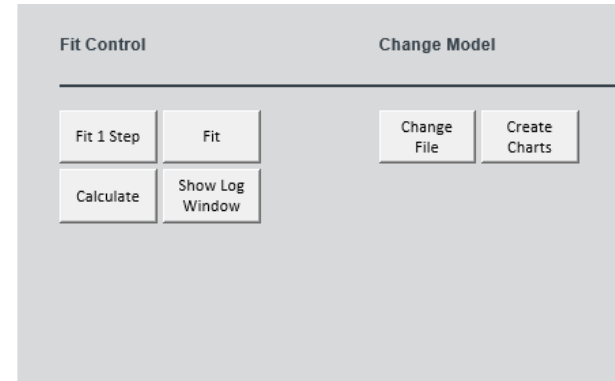
Control Bar

Calculate

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

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 [s. Settings]
- New fitting parameters
- See also fitting history

Main Tab

Control Bar

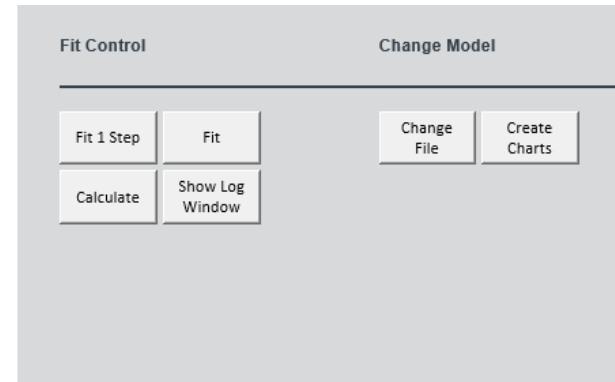
Log Window

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

Change Model

See documentation of „How to Change Model“ for changing the Exceltool to fit other models

[s. Help Tab]



Main Tab

Settings

Most important settings

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

Only if problems occur consider to adjust the settings

[s. Help Tab]

Settings		
FileName	C:\Program F	Path and name of the Model
printStats	<input checked="" type="checkbox"/>	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

Main Tab

Parameters

Fitting parameters [s. Main Tab]

- Have to be marked as such
- As name the full variable path is needed, e.g. „comp.areaSuctionValve“
- Start with meaningful values

Fixed parameters [s. Main Tab]

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

Parameters								
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	areaLeakage	6,181E-08 m ²	0,000E+00	1,000E-03	1,000E-06	
✓	3	DeadSpace	DeadSpace	5,387E-03 1	0,000E+00	1,000E-01	1,000E-02	
✓	4	DischargeDelay	DischargeValveDelay	2,464E-04 s	0,000E+00	1,000E-02	1,000E-04	
✓	5	DischargeArea	DischargeValve	5,747E-06 m ²	1,000E-10	1,000E-03	6,000E-06	
✗	6	pInitialLow	InitialSuction	1,000E+06 Pa				
✗	7	pInitialHigh	InitialDischarge	8,000E+06 Pa				
✗	8	x	x	1,000E+00 1				
✗	9							

Main Tab

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?“

Statistics

Determinant: Correlation Matrix

σ	$\sigma_{\text{normalized}}$	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				

Determinant

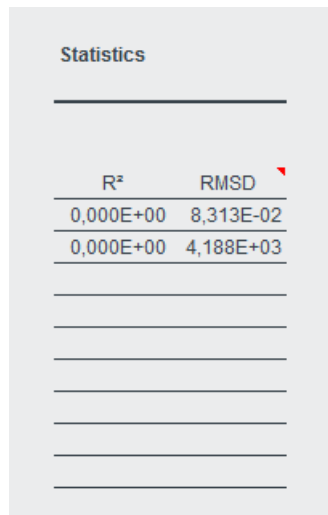
„How well does the database (e.g. measurement plan) fit to the model compared to other databases?“

Main Tab

Statistics

R²

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



The screenshot shows a table titled "Statistics" with two columns: R² and RMSD. The first row shows R² as 0,000E+00 and RMSD as 8,313E-02. The second row shows R² as 0,000E+00 and RMSD as 4,188E+03. There is a small red triangle next to the RMSD value in the second row.

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

RMSD

„How big is the variation of the residuals?“

(residuals = dependent – simulation output)

Data Tab Database

The Database contains [s. Data on Data Tab]

- Static points (Data Points) of
- Simulation inputs (Independents),
- Desired outputs (Dependents) and
- Standard Deviation (sigma)

Sigma is also used for weighting the dependents to each other

Here a global sigma for every dependent is entered on the Main Tab

[s. Targets on Main Tab]

Data (Measurement, CFD, ...)

Data Points		Independent					Dependent			σ	
25	Apply	Alias	T_suc	n	p_dis	p_suc	m_flow	P	m_flow	P	
		Name	T_suc	n	p_dis	p_suc	comp.portA,m_flow	comp.shaftPower			
		Unit	K	Hz	Pa	Pa	kg/s	W			
All											
✓	1		2,984E+02	4,167E+01	7,000E+06	4,000E+06	6,501E-02	3,859E+03	0.5	1	
✓	2		2,833E+02	1,167E+02	1,100E+07	3,500E+06	6,595E-02	1,100E+03	0.5	1	
✓	3		3,031E-02	1,667E+01	1,100E+07	4,500E+06	3,530E-02	1,100E+03	0.5	1	
✓	4		2,984E-02	1,167E+02	9,000E+06	4,000E+06	7,110E-02	1,061E+04	0.5	1	
✓	5		2,931E+02	1,667E+01	7,000E+06	4,500E+06	6,175E-02	1,190E+03	0.5	1	
✓	6		2,833E+02	1,667E+01	7,000E+06	3,500E+06	3,054E-02	1,425E+03	0.5	1	
✓	7		2,833E+02	6,667E+01	7,000E+06	3,500E+06	6,816E-02	5,861E+03	0.5	1	
✓	8		3,084E+02	9,167E+01	1,100E+07	4,000E+06	6,725E-02	1,004E+04	0.5	1	
✓	9		3,131E-02	1,167E+02	1,300E+07	4,500E+06	7,685E-02	1,337E+04	0.5	1	
✓	10		3,131E-02	1,667E+01	1,300E+07	4,500E+06	3,602E-02	1,229E+03	0.5	1	
✓	11		2,833E+02	9,167E+01	1,300E+07	3,500E+06	6,575E-02	1,032E+04	0.5	1	
✓	12		3,131E+02	1,167E+02	7,000E+06	4,500E+06	7,689E-02	1,013E+04	0.5	1	
✓	13		2,931E+02	1,167E+02	1,300E+07	4,500E+06	8,919E-02	1,331E+04	0.5	1	
✓	14		2,931E+02	1,167E+02	1,300E+07	3,500E+06	5,845E-02	1,185E+04	0.5	1	
✓	15		3,031E+02	9,167E+01	7,000E+06	4,500E+06	8,195E-02	8,490E+03	0.5	1	
✓	16		3,033E-02	4,167E+01	1,100E+07	3,500E+06	5,073E-02	5,298E+03	0.5	1	
✓	17		3,131E-02	1,667E+01	1,300E+07	4,500E+06	3,085E-02	2,534E+03	0.5	1	
✓	18		2,931E-02	4,167E+01	9,000E+06	4,500E+06	7,921E-02	4,838E+03	0.5	1	
✓	19		3,084E+02	6,667E+01	1,300E+07	4,000E+06	6,673E-02	8,933E+03	0.5	1	
✓	20		2,931E+02	1,167E+02	7,000E+06	4,500E+06	8,913E-02	1,016E+04	0.5	1	
✓	21		3,033E-02	1,167E+02	7,000E+06	3,500E+06	5,848E-02	8,970E+03	0.5	1	
✓	22		2,884E+02	1,667E+01	1,300E+07	4,000E+06	3,083E-02	2,595E+03	0.5	1	
✓	23		3,033E-02	1,667E+01	9,000E+06	3,500E+06	2,477E-02	1,792E+03	0.5	1	
✓	24		2,933E+02	4,167E+01	1,300E+07	3,500E+06	5,268E-02	5,849E+03	0.5	1	
✓	25		3,031E+02	6,667E+01	9,000E+06	4,500E+06	8,178E-02	7,486E+03	0.5	1	

Version 1.0

Data Tab

Simulation results

Beside the Database simulation results are shown

[s. Simulation on Data Tab]

- Simulation output
- Calculated residuum between simulation output and dependents
- Possible additional outputs

Data Points

[s. Database]



Simulation

Simulation Output (Dependent Variables)

m_flow	P
comp.portA.m_flow	comp.shaftPower
kg/s	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	P
kg/s	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)

speed	eta
mmary.speed_rpm	comp.summary.effsEff
1/min	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

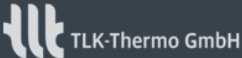
Differential State Variables

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

Cumulating and effectless differential state variables are marked with a cross

[s. Differential State Tab]

Differential State Variables




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 steady 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 

Plot Tabs

Dependents vs. Independents

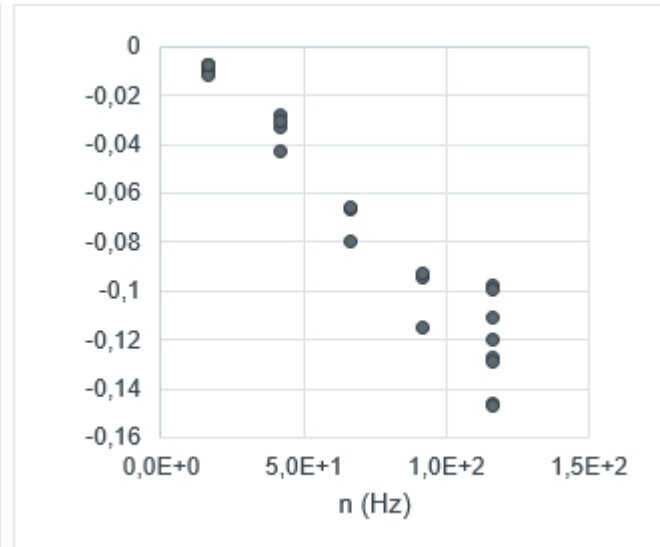
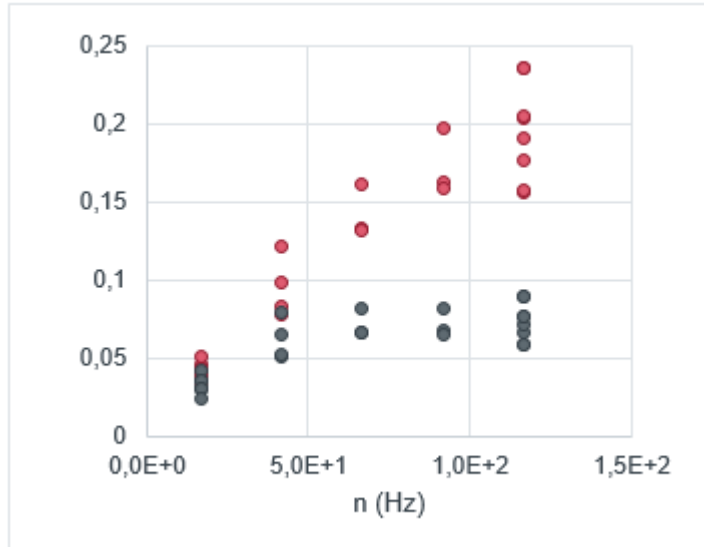
Here the mass flow rate in the simulation rises too high compared with the dependent with respect to the speed (independent)

[s. Outputs vs. Inputs Tab]

Residuals vs. Independents

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

[s. Residuals vs. Inputs Tab]

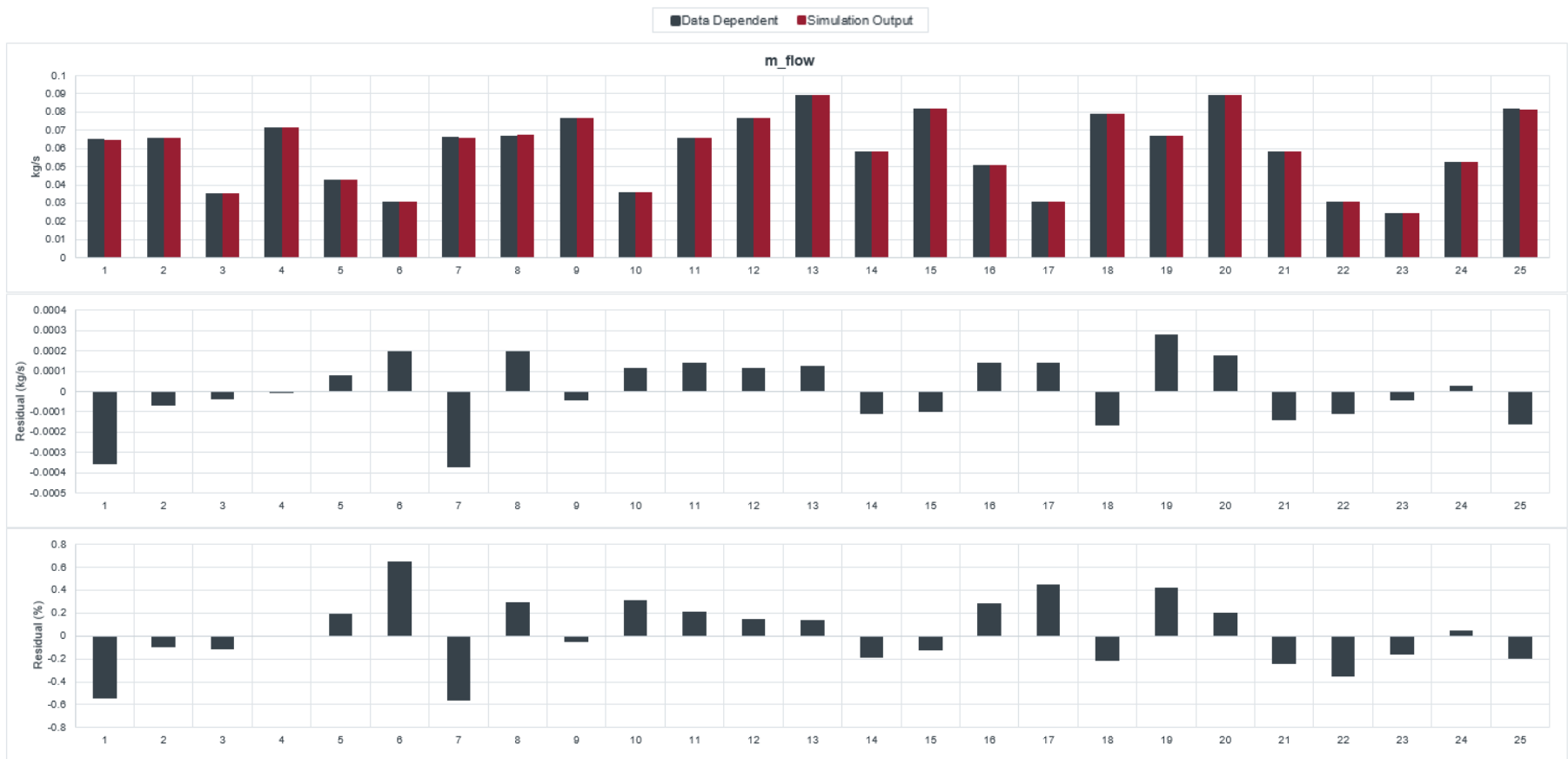


● Data Dependent ● Simulation Output

Plot Tabs

Via bar charts, particular data points can easily be localized.

[s. Tabs of Data Plots, Fit Data Plots, Additional Outputs]



History

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

[s. Fitting History Tab]

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	areaLeakage	6,181E-08	2,383E-07	m ²	2,48E-01	P	0,000E+00	4,188E+03	1
	1	3	DeadSpace	DeadSpace	5,387E-03	1,241E-02	l	7,56E-01				
	1	4	DischargeDelay	DischargeValveDelay	2,464E-04	2,449E-04	s	5,62E-01				
	1	5	DischargeArea	DischargeValve	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	InitialDischarge	8,000E+06	8,000E+06	Pa					
	0	8	x		x	1,000E+00	1,000E+00	1				



ModelFitter



TLK-Thermo GmbH
Hans-Sommer-Straße 5
38106 Braunschweig / Germany

Phone: +49/531/390 76 - 28

Fax: +49/531/390 76 – 29

E-Mail: software@tlk-thermo.de

www.tlk-thermo.com