



TIL Suite

Software containing models for
thermal components and systems

Overview

- Physical models for thermal components and systems
- Well established system simulation using modelica
- Stationary and transient
- Based on technical experience with our test benches
- Used for modeling and simulation services
- Largely visible and expandable code



Overview

- TIL Add-ons for special applications
- Very fast and robust thermophysical properties from TILMedia
- Reference property data from REFPROP
- Supporting different simulation environments
- FMU, code export and real-time capable simulations



Content



TIL

Model library for thermal components and systems



TILMedia for MODELICA

Model library providing thermophysical properties



TILFileReader

Imports tabular data from files



TIL Add-On Libraries

Additional components and systems available to TIL

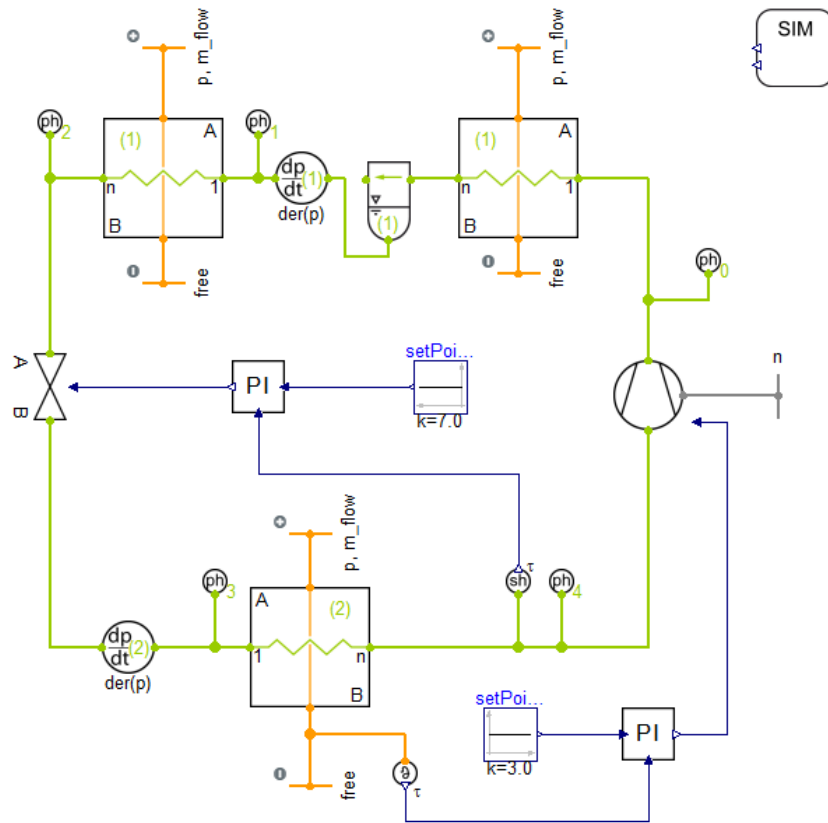


Training courses and Customers

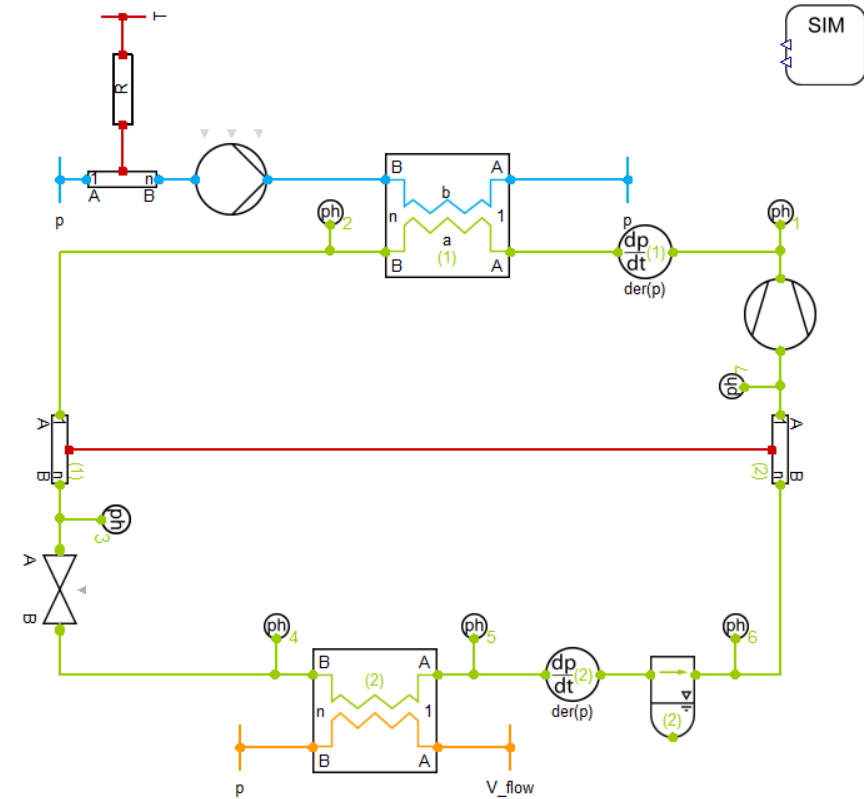
Modelica, TIL introduction and references

TIL – General Examples

R-1234yf Air Conditioning Cycle

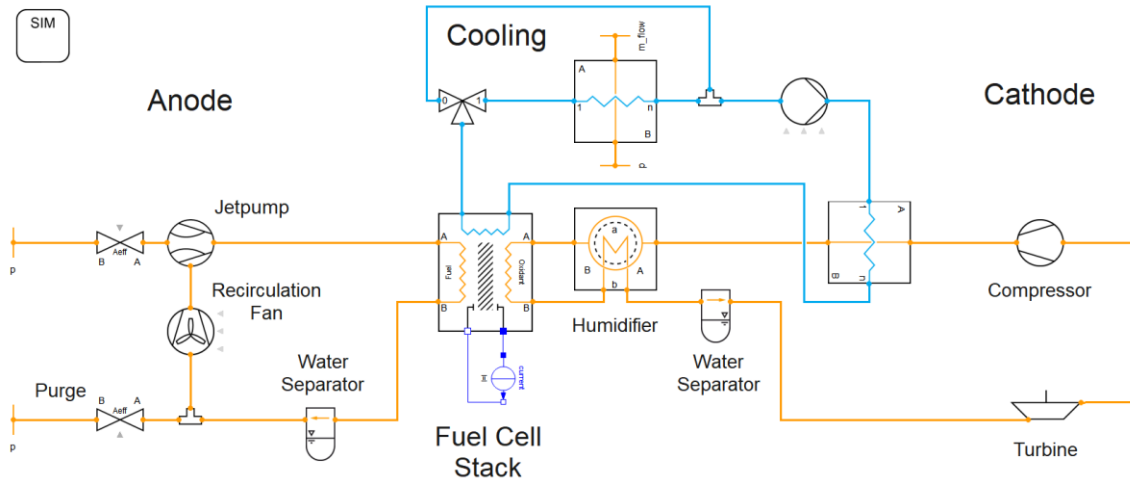


CO₂ Heat Pump System



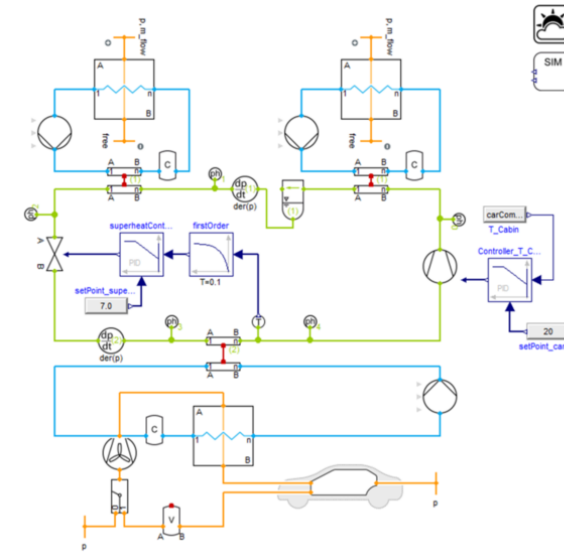
TIL – Automotive Applications

Fuel Cell Systems



© Volkswagen AG

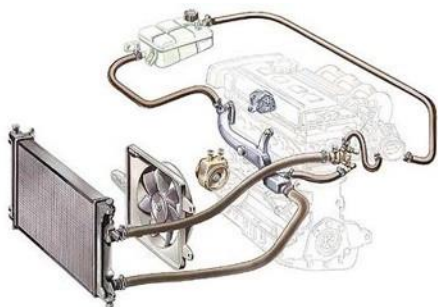
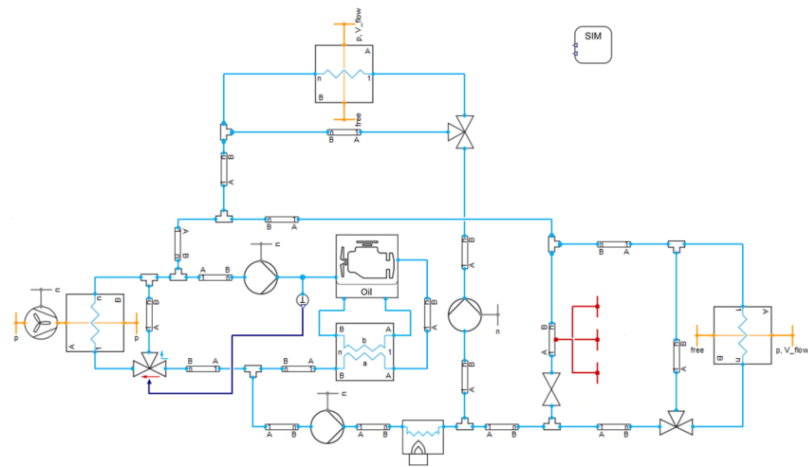
Advanced Thermal Management



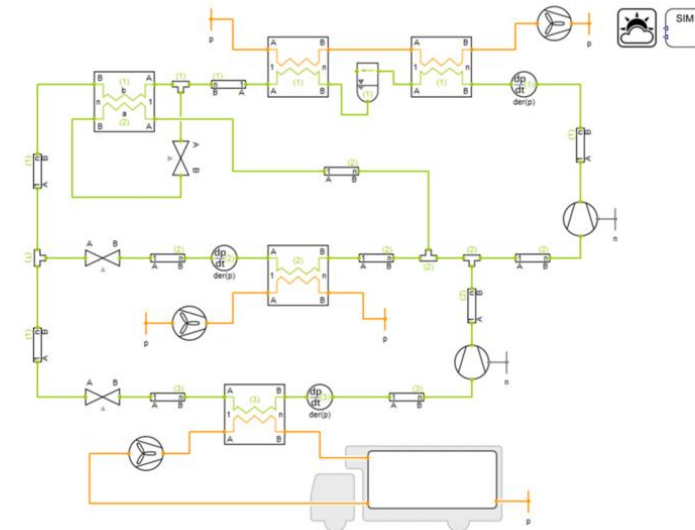
© Daimler AG

TIL – Automotive Applications

Cooling Systems



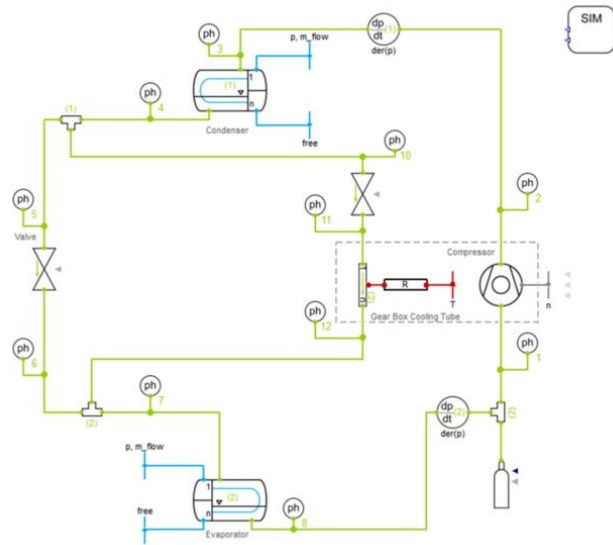
Transport Refrigeration



© Schmitz Cargobull AG

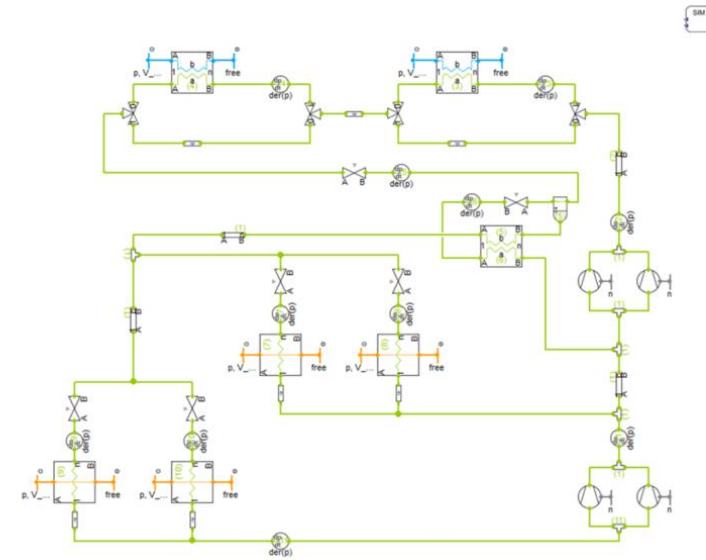
TIL – Industrial Applications

Industrial Refrigeration



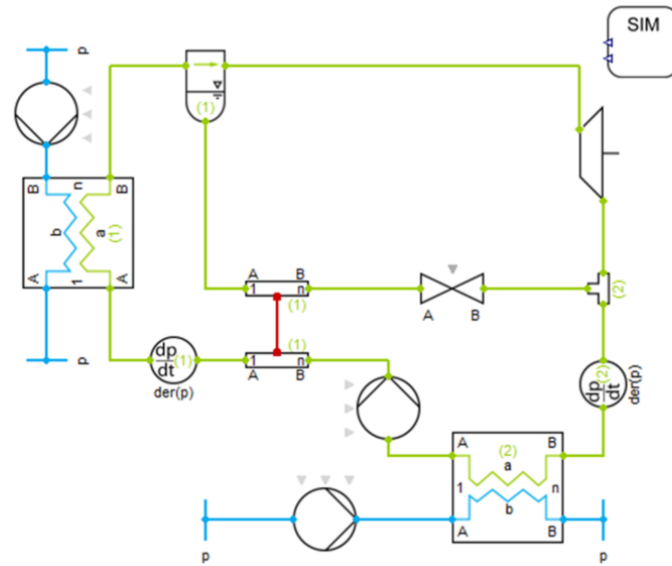
© Cofely Refrigeration GmbH

Supermarket Refrigeration



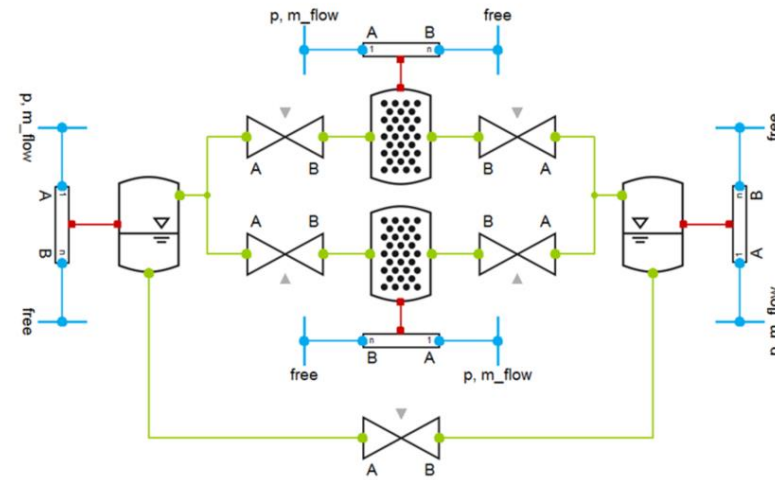
TIL – Industrial Applications

Kalina Cycle



© General Electric

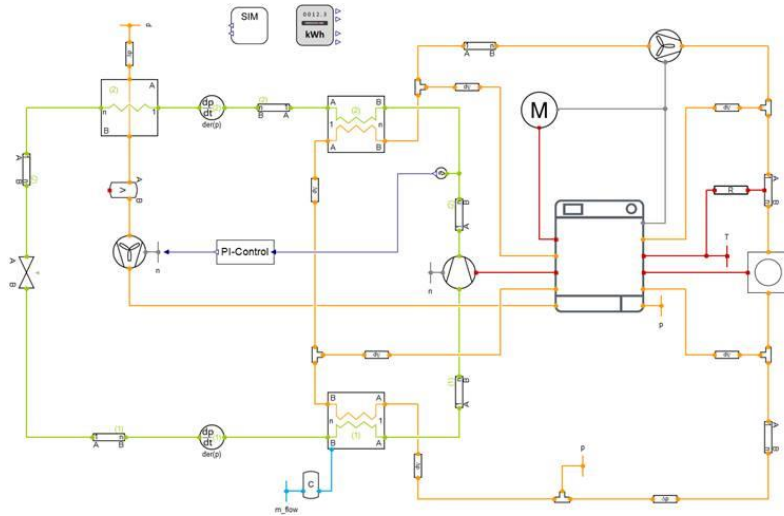
Sorption Refrigeration



© LTT RWTH Aachen

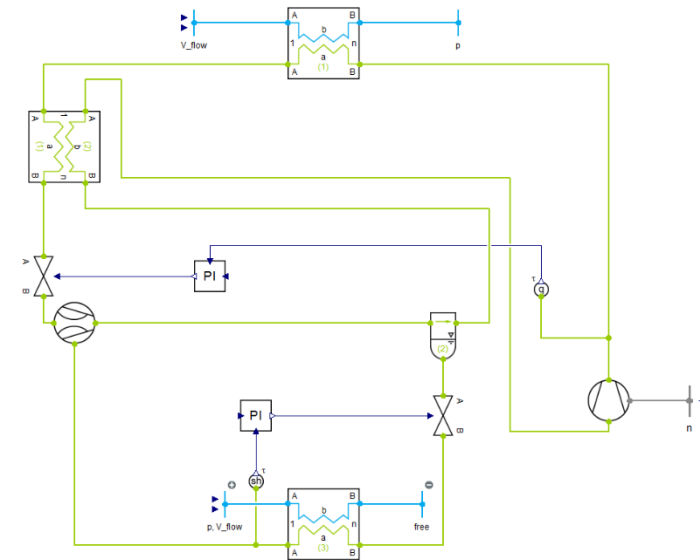
TIL – Heat Pump Systems

Tumble Dryer



© Miele & Cie. KG

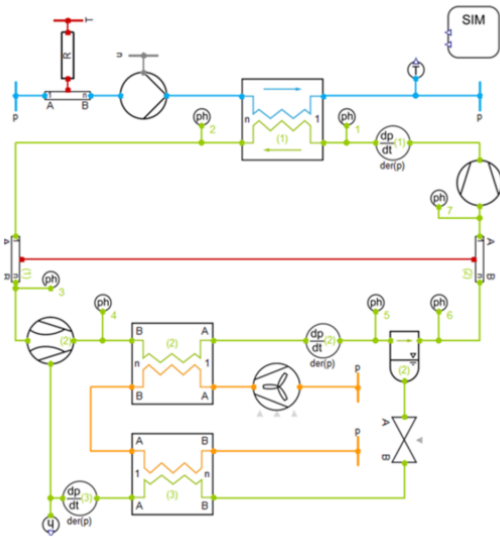
Domestic Heat Pump System



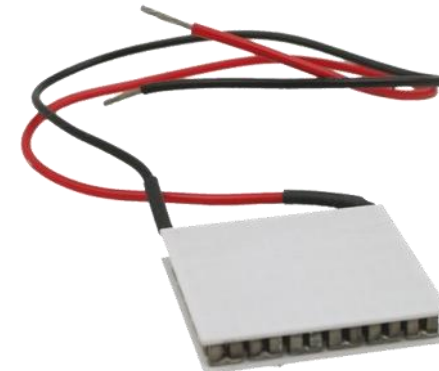
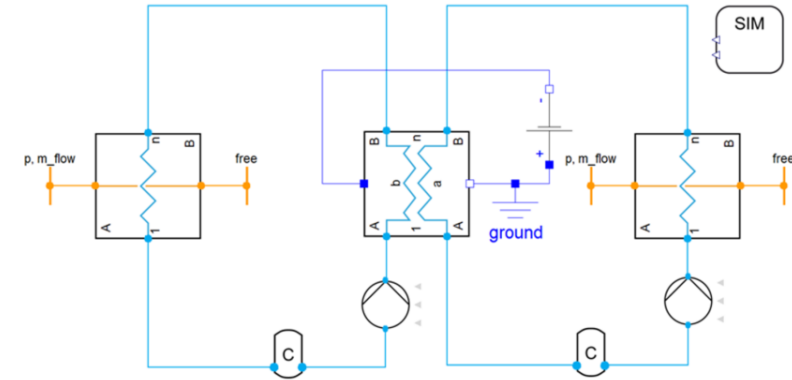
With kind permission of Stiebel Eltron Deutschland Vertriebs GmbH

TIL – Special Components

Ejector Systems

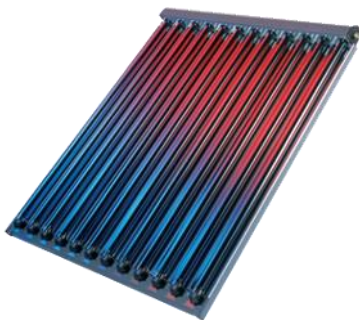
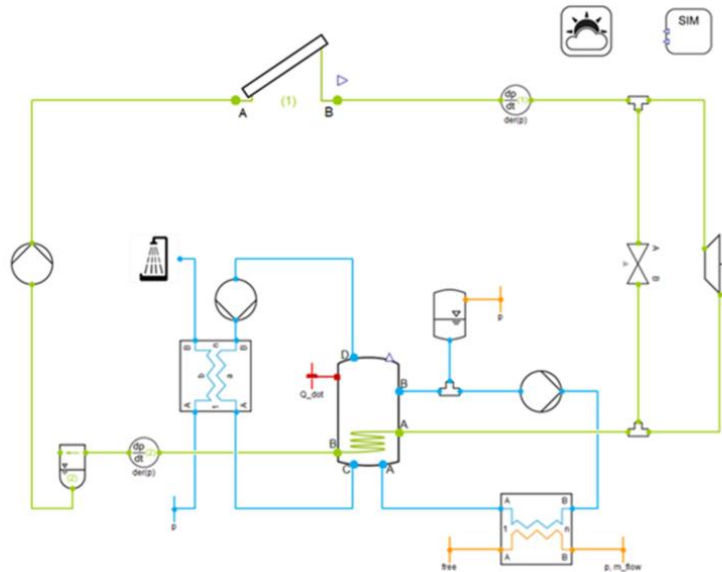


Thermoelectric Systems

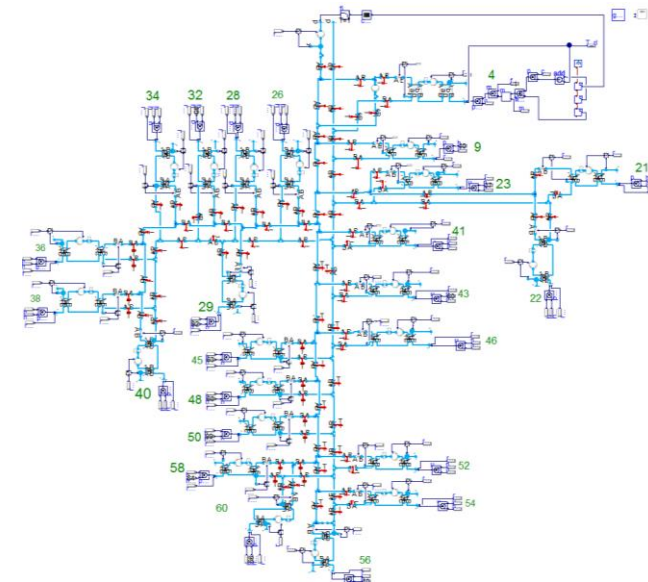


TIL – Special Scopes

Solar Organic Rankine

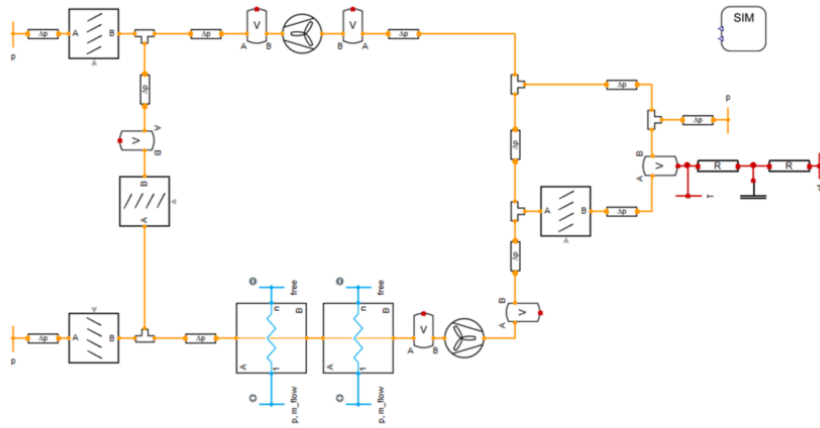


District Heating Grids

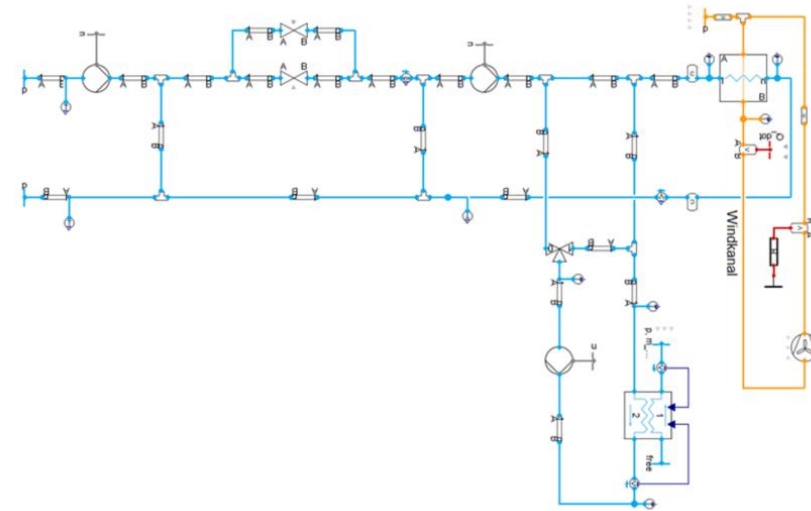


TIL – Special Scopes

Air Handling Unit



Climatic Wind Tunnel



TIL Standard Components

Heat Exchangers

Fin and Fin

Fin and Tube

Multi-Port Extruded Tubes

Tube and Tube Plate

Shell and Tube

All Heat Exchangers using finite volume approach (FV). Various Moving Boundary models available.

VLEFluid Components

m_flow	inl.Bound.	Compressor	Recipr.	Scroll	Ejector	Expander	Pump
Valve	3 W Valve	TXV	TXV-Block	CapillaryTube	Hyd. Resist.	Pr. State	
Separator	Tube	Volume	Junction	Sensor	StatePoint	Fill Station	Adapter

Gas Components

m_flow	Fan	Hyd. Resist.	Valve
Volume	Tube	Junction	Inductor
Sensor	StatePoint	Adapter	

Liquid Components

m_flow	inl.Bound.	Pump	Sensor	Inductor
Exp. Tank	Tube	Volume	Junction	Adapter
Valve	3 W. Valve	Hyd. Resist.	Bend	

Top Level

SIM
System Information Manager

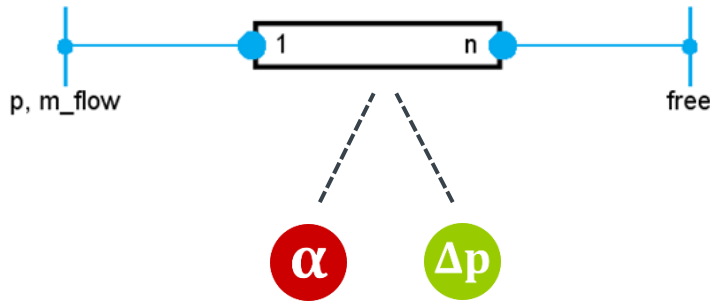
Various Examples

Other Components

Heat Bdy.	Heat Cap.	Heat Res.	Sensor	Controller
Mech. Bdy.	Sensor	StepSource	Smo.Step	Watchdog
TimeSwitch	Smo.Switch	Dis.Smooth.		

Exchangeability and

Pressure drop and heat transfer correlations can easily be selected and exchanged from drop down menus.



General		
tubeGeometry	Geometry record for a tube(...)	Geometry of tube
nCells	12	Discretization number of cells
TubeSideHeatTransferModel	Gnielinski Dittus Boelter	Tube side heat transfer model
PressureDropModel	Konakov correlation for smooth pipes	Pressure drop model
enableHeatPorts	false	true, if heat ports are enabled
Wall		
WallHeatConductionModel	Geometry based calculation for circular tubes	Wall heat transfer model
WallMaterial	TILMedia.Steel	Wall material

OK Info Cancel

Extensibility

Create your own models using inheritance to TIL.

- Component models e.g. compressor

α Heat transfer models

Δp Pressure drop models

```

model MyCompressor "Efficiency based compressor model" extends
  TIL.VLEFluidComponents.Compressors.BaseClasses.PartialEffCompressor;

parameter Real pi0 = 25;
parameter Real a= 0.9;
parameter Modelica.SIunits.Efficiency isentropicEfficiency = 0.7
  "|Compressor Efficiencies|Isentropic efficiency";
parameter Modelica.SIunits.Efficiency effectiveIsentropicEfficiency = 0.7
  "|Compressor Efficiencies|Effective isentropic efficiency";

Real pressureRatio;

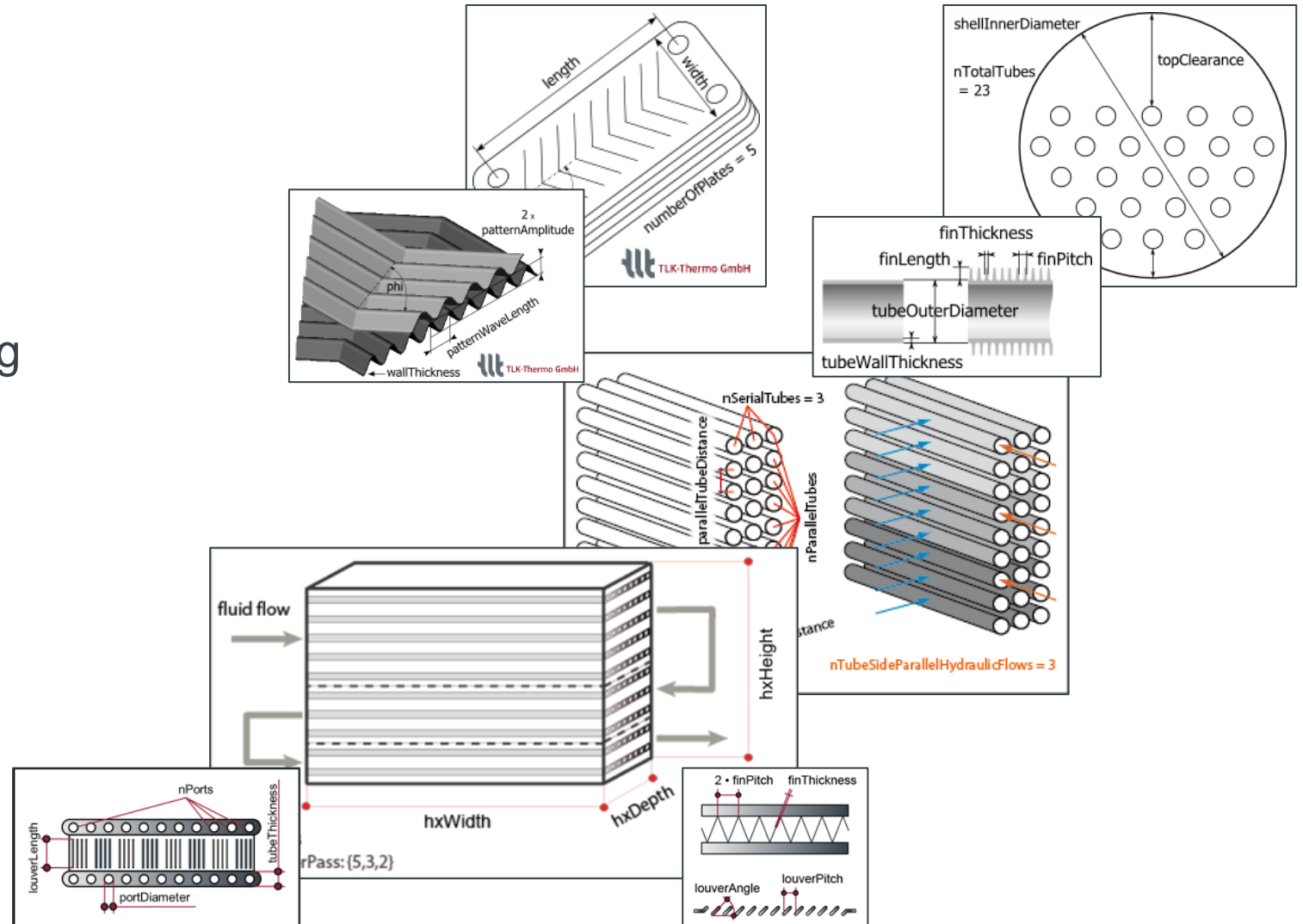
equation
  pressureRatio = portB.p/portA.p;
  volEff = ((pi0 - pressureRatio)/(pi0-1))^2*a;

  isEff = isentropicEfficiency;
  effIsEff = effectiveIsentropicEfficiency;
end MyCompressor;
  
```


Detailed Thermodynamic Models

TIL models use geometry based heat transfer and pressure drop correlations.

Advanced thermodynamic modeling concepts for both steady state and transient simulations are implemented e.g. Moist air: evaporation, condensation, dynamic water balance.



Content



TIL

Model library for thermal components and systems



TILMedia for MODELICA

Model library providing thermophysical properties



TILFileReader

Imports tabular data from files



TIL Add-On Libraries

Additional components and systems available to TIL



Training courses and Customers

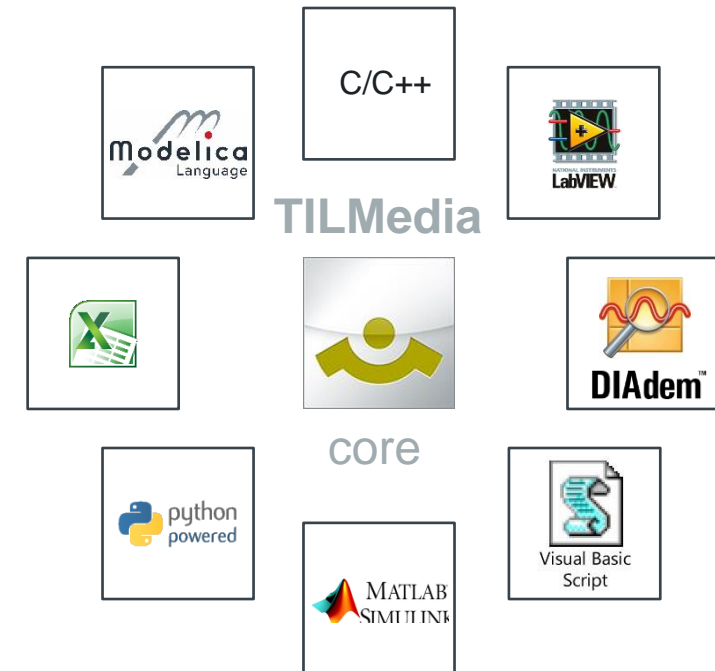
Modelica, TIL introduction and references



TILMedia

Substance properties optimized for stable and extremely fast dynamic simulations

- Calculation methods to express thermophysical properties of:
 - **L** Incompressible Liquids
 - **G** Ideal Gases
 - **VLE** Real Fluids (with vapor liquid equilibrium)
 - Mixtures
- Optimized mathematical equations with extremely high calculation speeds and high accuracies
- Several hundreds of substances available (external sources e.g. REFPROP, Multiflash, CoolProp)
- TILMedia Suite interfaces one property core for various software
- Code export



TILFileReader

Importing tabular data from files

- Convenient import of csv- and Dymola-result-files
- Intuitive GUI: one Modelica block for each variable
- Optional interpolation of variables

The screenshot shows the TILFileReader software interface. On the left is a Package Browser with a tree view containing 'TIL', 'TILMedia', 'TILFileReader', 'User's Guide', 'FileReader', 'Variables', 'Connectors', 'Internals', and 'Examples'. The 'Variables' folder is expanded, showing 'IntegerVariableIndex', 'IntegerVariableName', 'RealVariableIndex', and 'RealVariableName'. The 'TestHeatExchanger_FileReader' block is selected. The main diagram shows a flowchart with several blocks: 'm_dot_Air' (value -300/3600), 'T_Air_in' (value 273.15 - 10), 'V_dot_Liq' (value -100/3.6), and 'T_Liq_in' (value 273.15 + 90). These blocks are connected to ports labeled 'p, m_flow' and 'p, V_flow'. A parameter configuration window is open, showing the following details:

Model	TILFileReader.Variables.RealVariableName	
Path	TILFileReader.Variables.RealVariableName	
Comment	Block reading a single floating point value from a specified variable	
Parameters		
variableName	"T_Air_in"	Name of the variable in the file
interpolationMethod	polationMethods.LinearInterpolation	Method used for interpolating values
initialValue	<Remove modifier>	initialization (in target unit)
Unit conversion (value)	Linear interpolation	
offset	273.15	offset of value
factor	1	factor of value

Content



TIL

Model library for thermal components and systems



TILMedia for MODELICA

Model library providing thermophysical properties



TILFileReader

Imports tabular data from files



TIL Add-On Libraries

Additional components and systems available to TIL



Training courses and Customers

Modelica, TIL introduction and references

TIL Add-On Libraries

Hydrogen Energy Systems (Fuel Cells, PEM, SOFC, Electrolyzers, Refueling Stations, Liquefaction)

Automotive (Heating Ventilation Air Conditioning Systems HVAC, Driving Cycles) including...

Cabin (Car-, Coach-, Railway-, Transportation-Compartments)

Thermal Storages:

Hot Water Tank (Domestic Heat Storages)

PCM Storages (Phase Change Material)

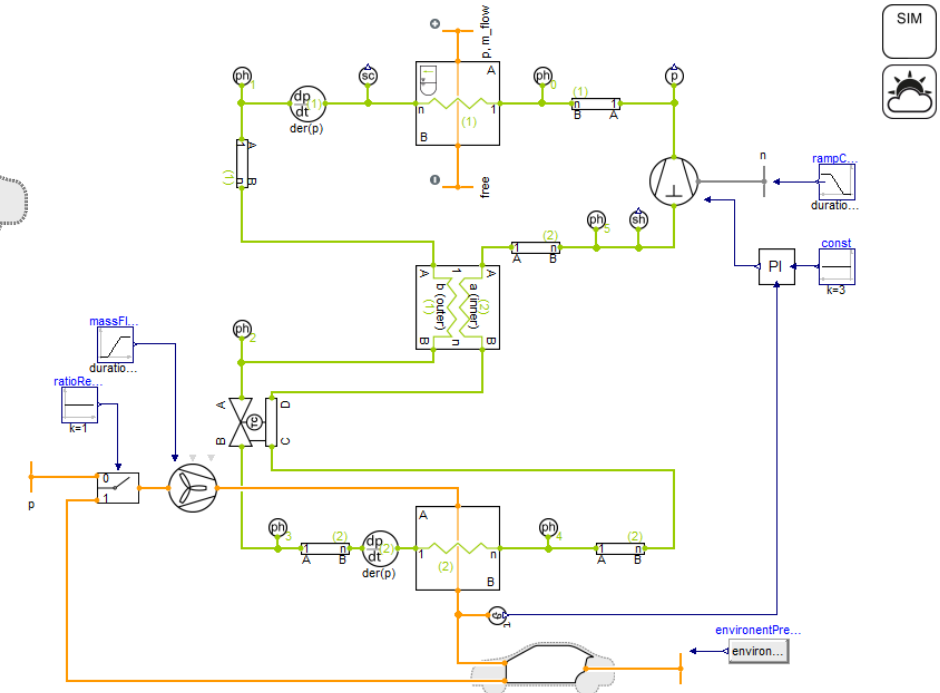
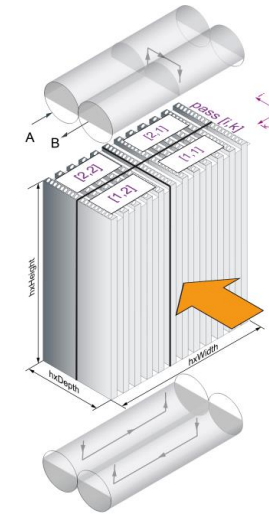
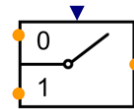
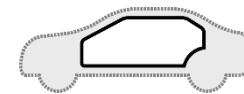
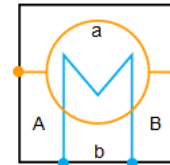
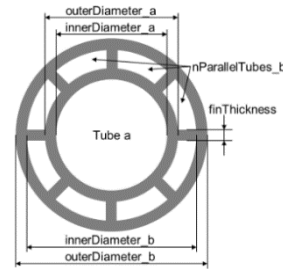
Heat Pump Dryer

2D Heat Exchangers (Fin-And-Tube-HX & Multi-Port-Extruded-Tube-/MPET-HX: Add-On Automotive)

Compressor based on AHRI 540 and EN 12900 (10 Coefficient Polynomial Compressor)

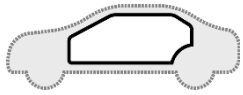
TIL Add-On Automotive

- Detailed MPET Heat Exchanger: multilayer & opt. Receiver
- NTU Heat Exchanger (Q-ETD)
- Internal TubeInTube Heat Exchanger
- Add On Cabin Compartment Models
- Damper / Flap
- Examples / Templates for Automotive Applications



TIL Add-On Cabin

Cars



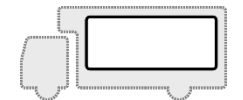
Busses



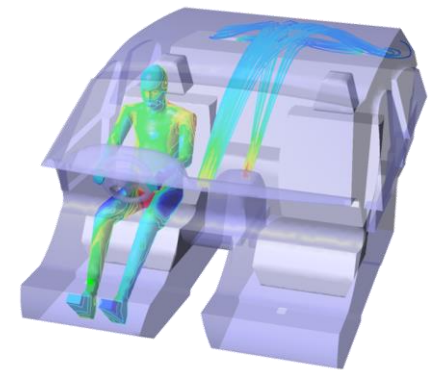
Railway



Transportation



- One or more dimensional air cabin compartment models
- One or three layer wall models with manifold options for parametrization
- Global sited environment settings for:
 - General ambient conditions
 - Solar conditions
 - Vehicle positioning
 - Wind settings



Content



TIL

Model library for thermal components and systems



TILMedia for MODELICA

Model library providing thermophysical properties



TILFileReader

Imports tabular data from files



TIL Add-On Libraries

Additional components and systems available to TIL



Training courses and Customers

Modelica, TIL introduction and references



Training courses

Modelica Training – 2 days

Introduction to object-oriented modeling and simulation of thermal systems.

TIL Training – 1 day

Modeling and simulation of a thermal system step by step using TIL Suite.

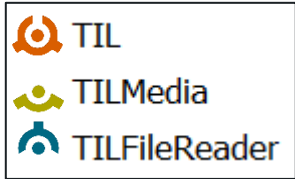
Next dates: www.tlk-thermo.de (Braunschweig) and www.tlk-energy.de (Aachen)

In-house training or web-training upon request





Selection of TIL Suite customers



Audi

BMW

Bosch

Continental

Daimler

Deutsche Bahn

EDF

Ingersoll Rand

Johnson Controls

MAN

Miele

Porsche

Sanden

Sintef

Stiebel Eltron

Vaillant

Volkswagen

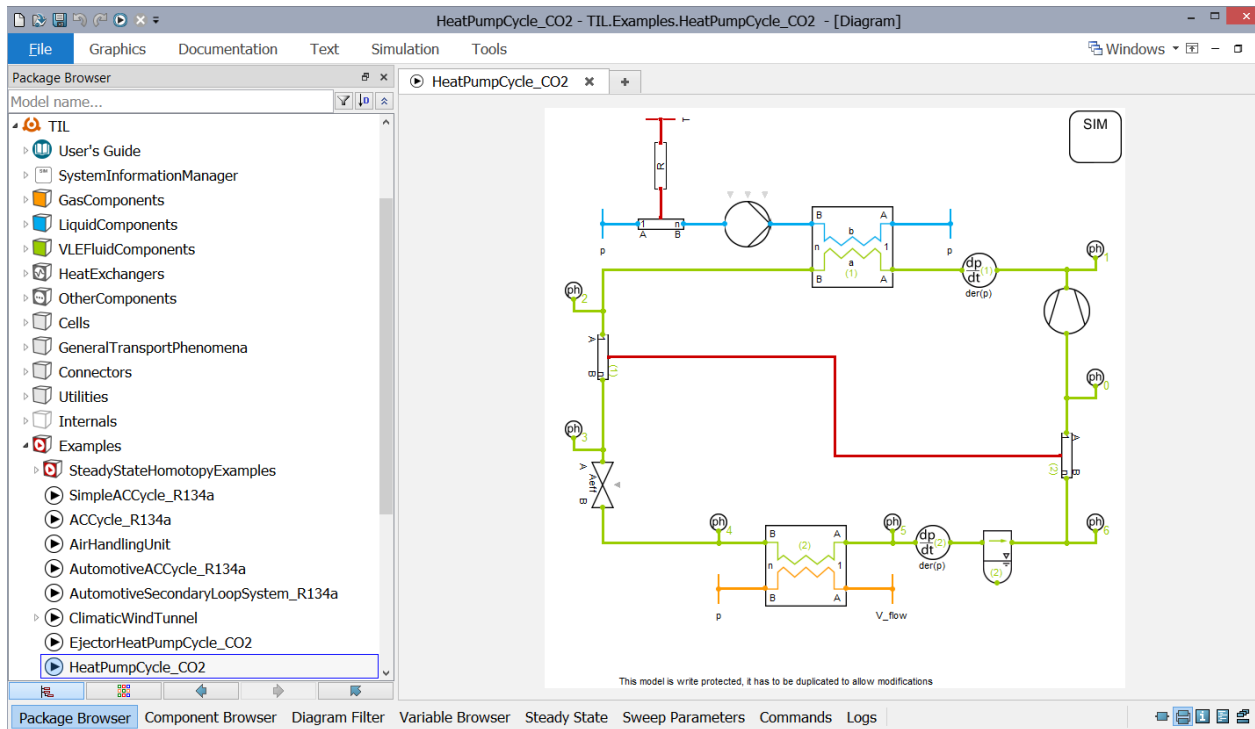
Whirlpool

**Universities and
Institutes**

Summary

TIL Suite contains ...

- Model library for thermal components and systems
- Optimized substance properties for extremely fast simulations
- Tabular data import from files



Advantages are ...

- Exportable models & systems
- Real-time capability
- A well proven design concept
- Maintaining many proper models and examples for long-time
- Additional and user-defined components available

Thank you

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

Or your contact person
Ingo Frohböse
i.frohboese@tlk-thermo.com



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

Tel.: +49/531/390 76 - **234**
Fax: +49/531/390 76 - 29