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Thermolib

The Key to Thermal Management in Simulink®

Introduction and Applications in the Automotive Industry

Release 5.3

5.3.0.x/5.3.0

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Introduction

Introduction

Thermolib is ...

... modeling thermodynamic systems in Simulink.

... simulation for control.

... Model-Based Design.

... completion of physical modeling toolchain – engineering thermodynamics.

EUtech Scientific Engineering GmbH is a MathWorks Connections Partner.

Introduction

Industries

Introduction

Fields of Application

- Thermodynamic processes (cooling/heating circuits)
- Thermal Power Plants
- Process Industries
- µ-CHPs Systems
- Fuel Cells
- Heat-engines
- HVAC systems

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Features & Benefits

Features & Benefits

Key Features

- Based on the fundamental principles of engineering thermodynamics
- Thermodynamic state and state change calculations including real gas modeling
- Component blocks including heat exchangers, reactors, pumps, turbines, and valves
- Equilibrium and reaction chemistry
- Customizable and extendable thermophysical database and IAPWS-IF97 water and steam properties
- MATLAB command-line functions for thermodynamic calculations and plots

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Benefits of Thermolib

- Customer can concentrate on his core business
  - Consistent basic thermodynamic already implemented
  - Ready-to-use components
- Intuitive process design
  - Flow sheet orientated
- Cost and project time reduction
  - Model Based Design allows earlier error detection
- Risk free safety analysis
- Continuous development and support
  - Compatible with latest MATLAB® version
  - Support via on-site assistance, training, web sessions, e-mail, phone

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Examples – Automotive Industry

Please note: Demo models marked with * are not included in the scope of supply of the Thermolib-Basic License.

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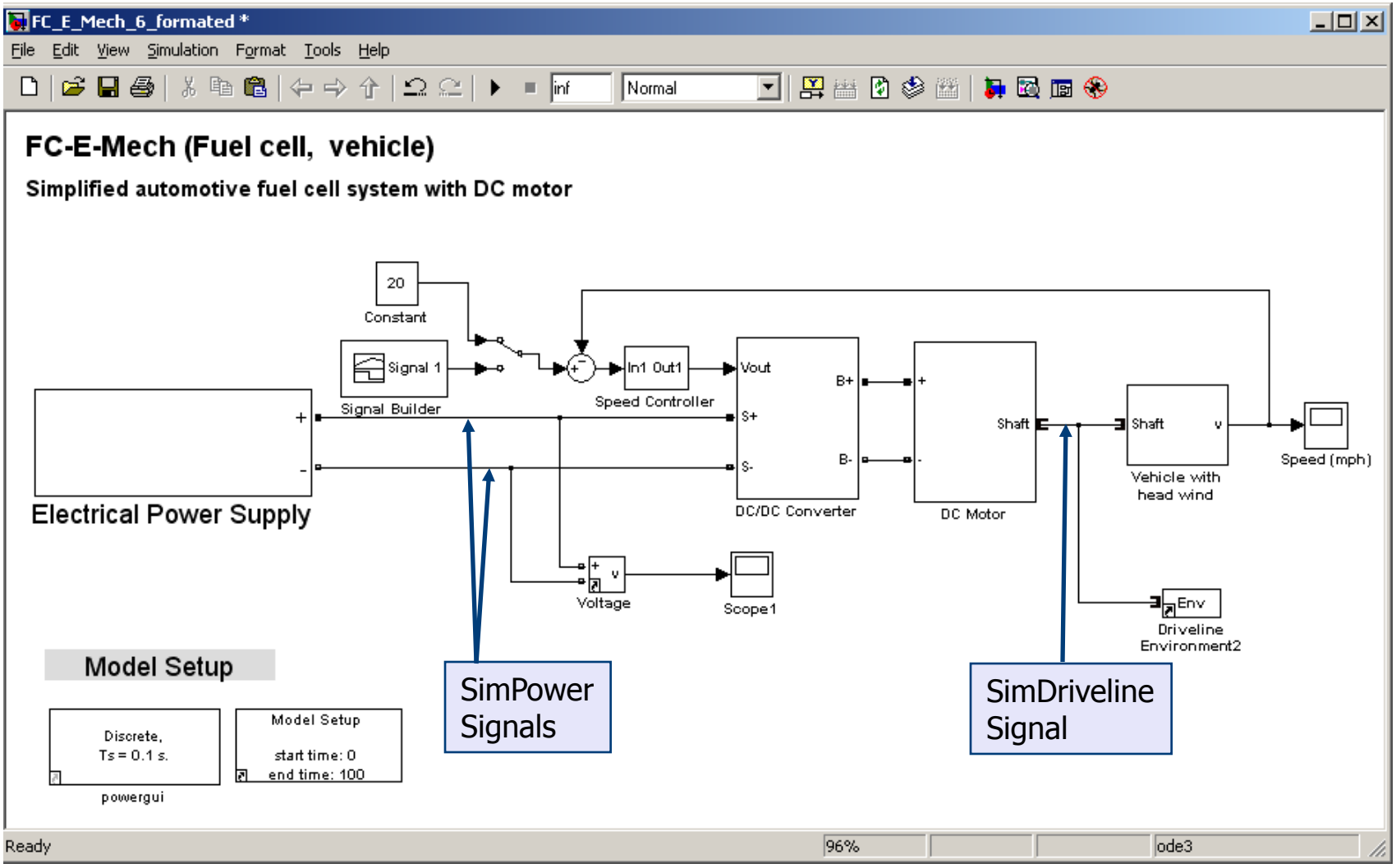
Example – Fuel Cell Vehicle

Example – Fuel Cell Vehicle

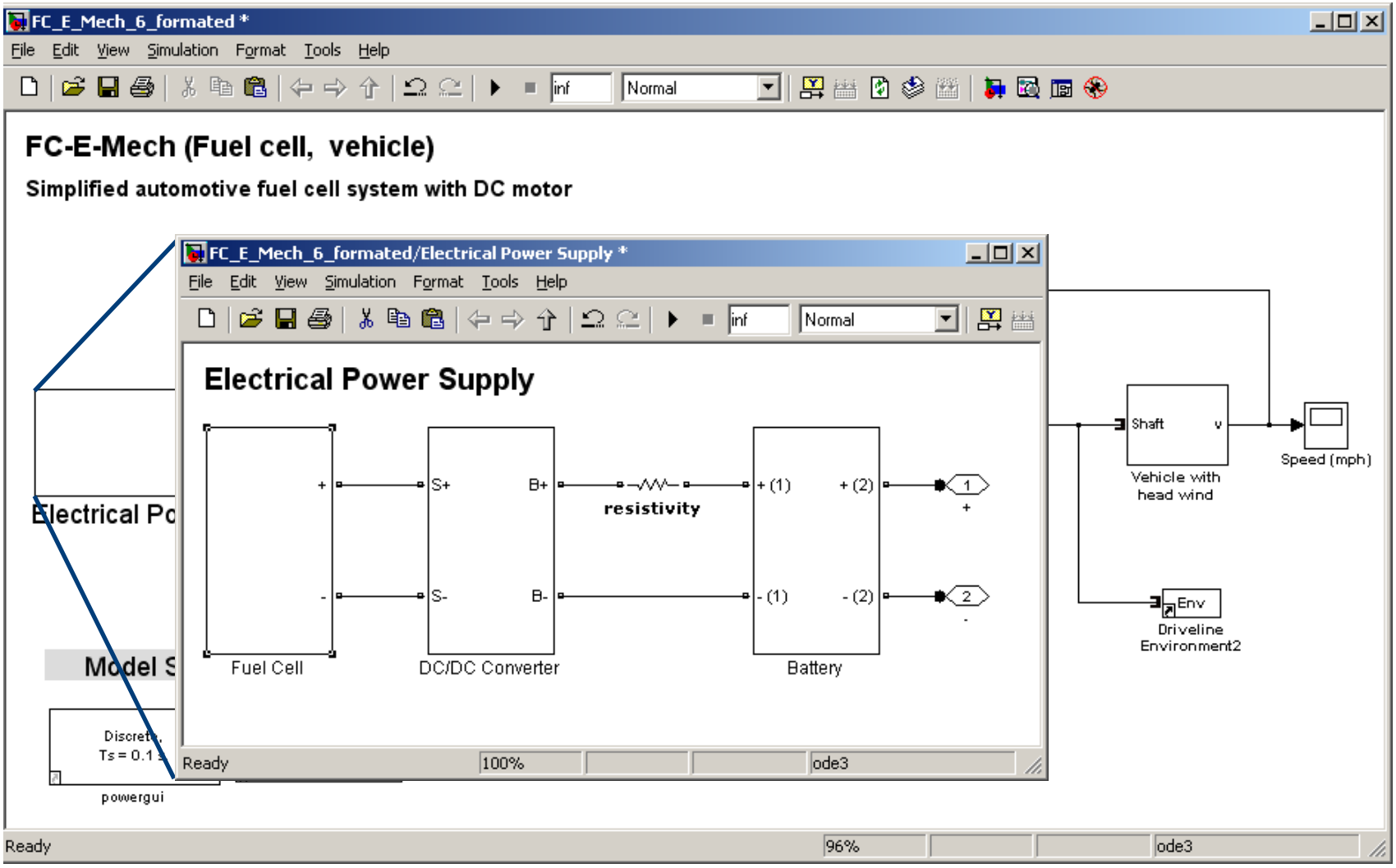
Overview



DemoFuelCellVehicle.mdl*

Example – Fuel Cell Vehicle

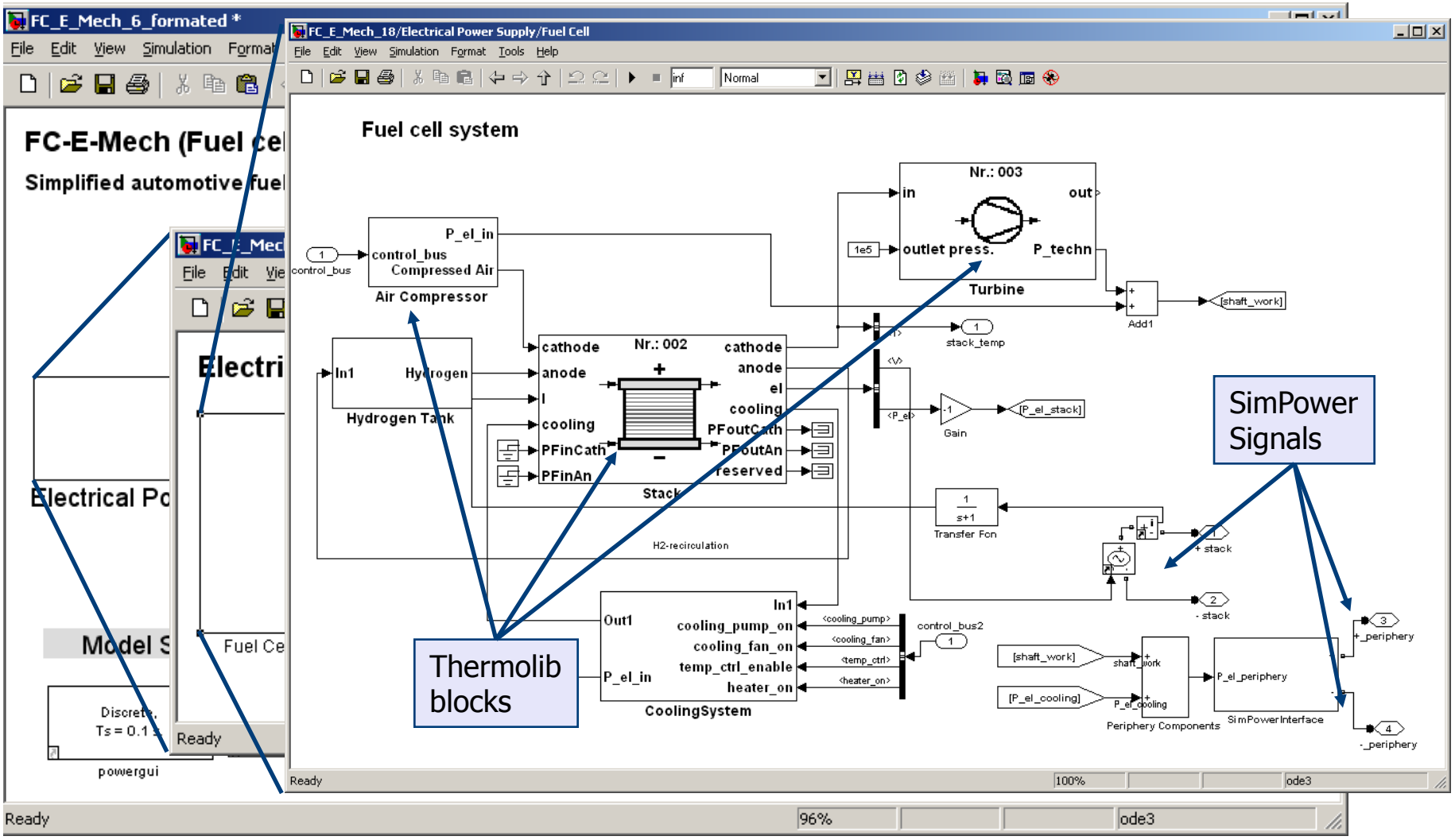
Electrical Power Supply



DemoFuelCellVehicle.mdl*

Example – Fuel Cell Vehicle

Fuel Cell modeled with Thermolib



DemoFuelCellVehicle.mdl*

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Example – Air Conditioning

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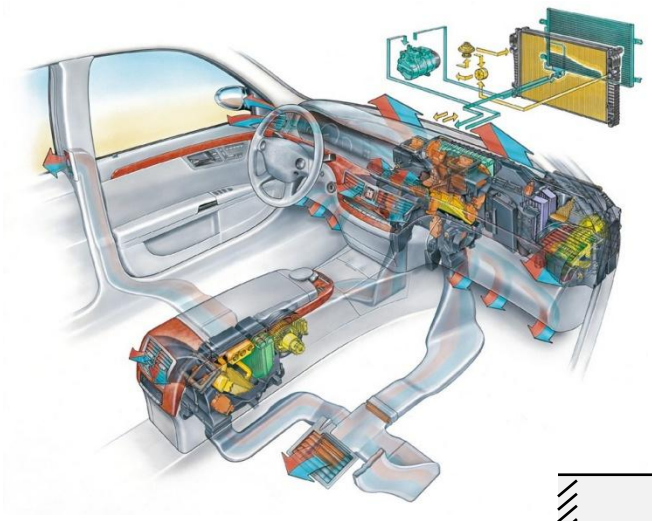
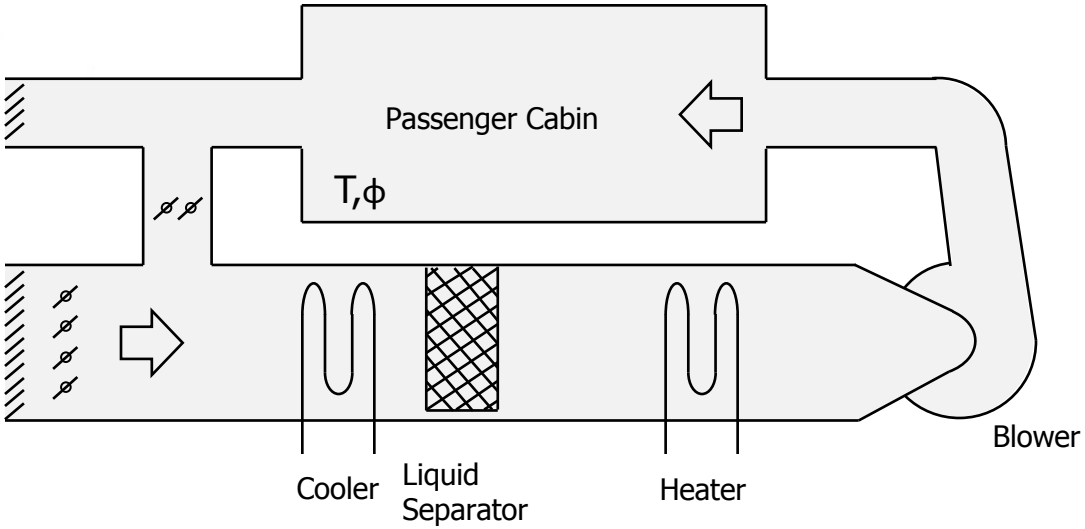
Example – Air Conditioning

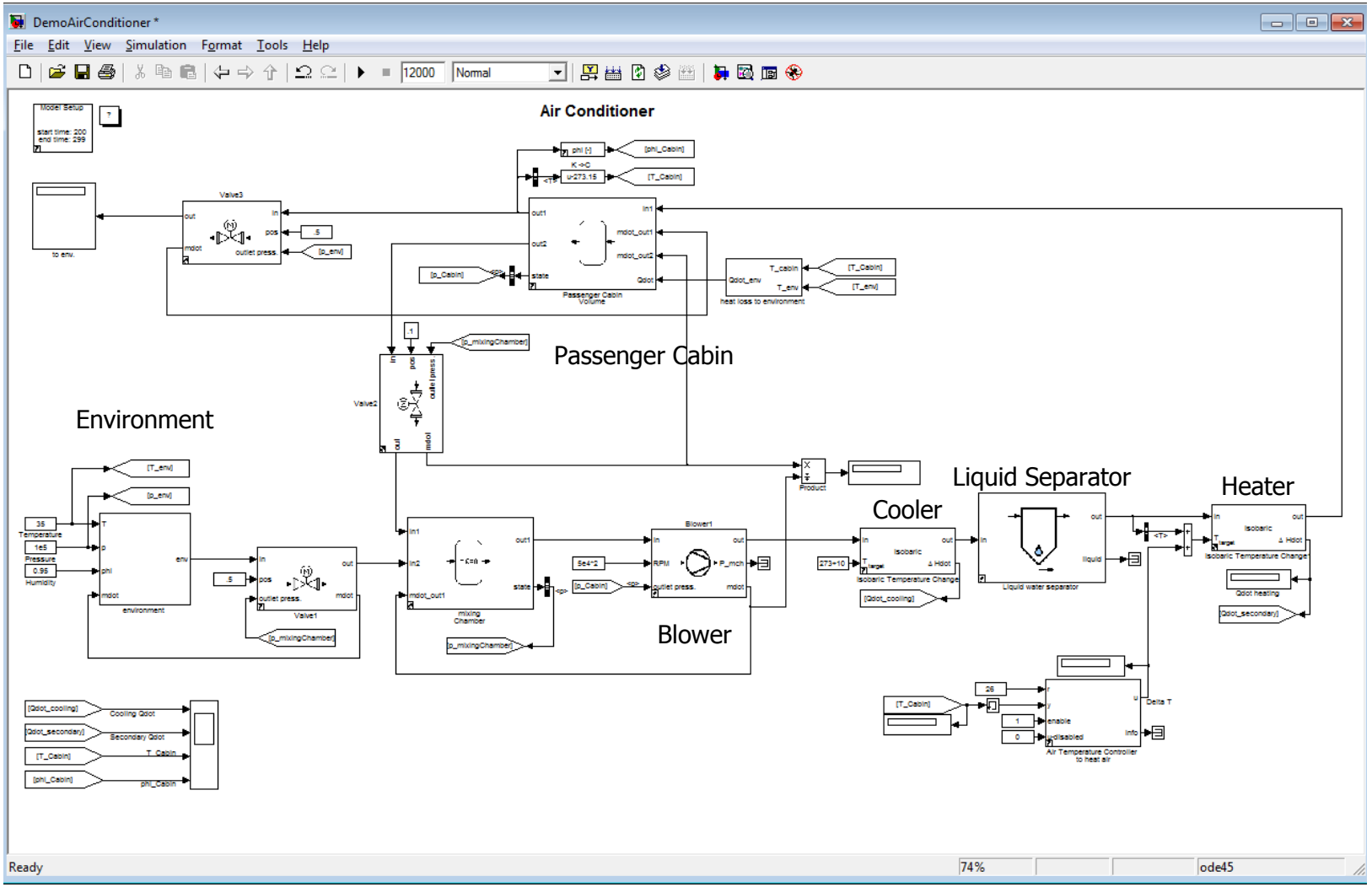
Flow scheme





Example – Air Conditioning

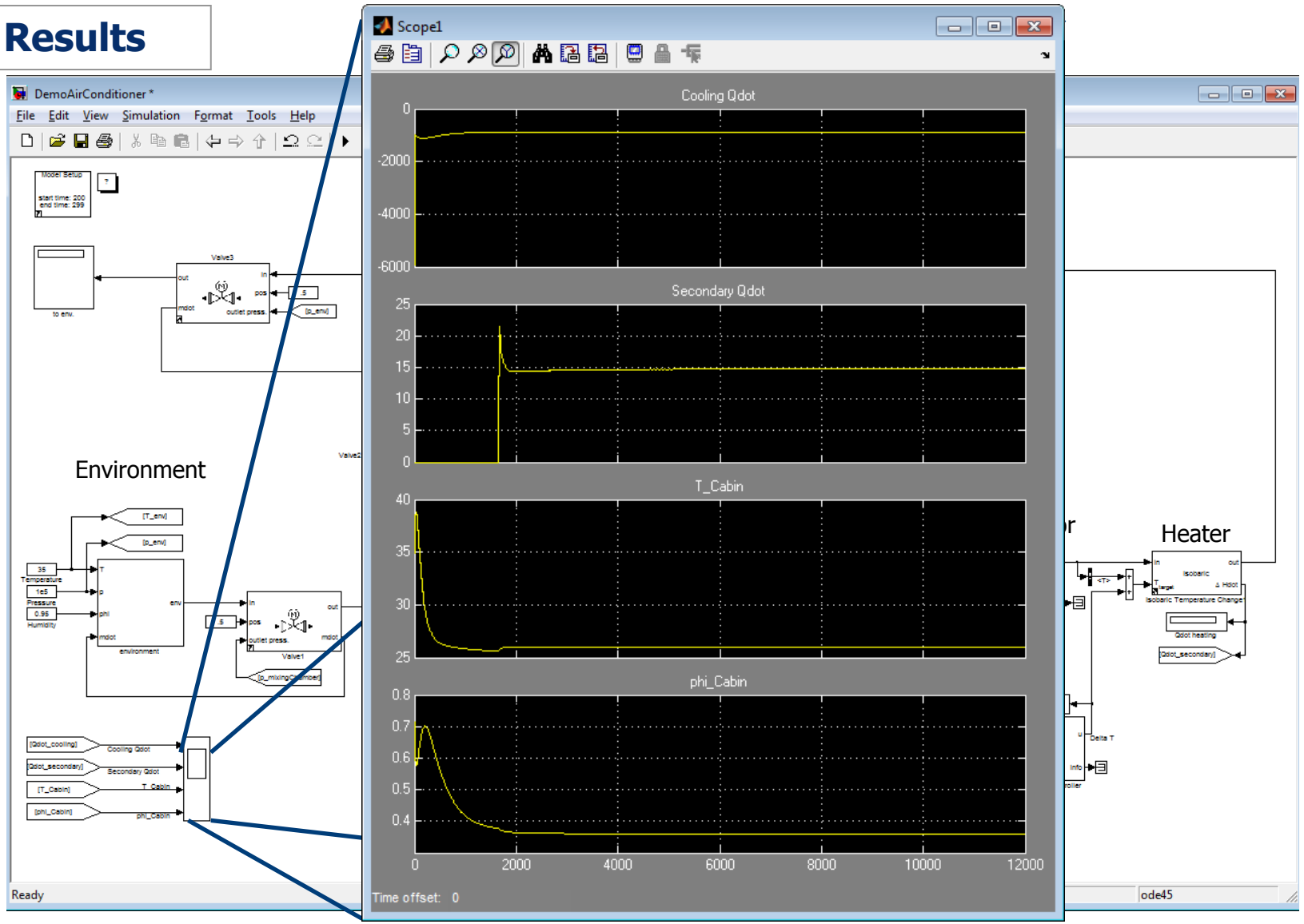
Simulink Model with Thermolib blocks



DemoAirConditioner.mdl

Example – Air Conditioning

Results



DemoAirConditioner.mdl

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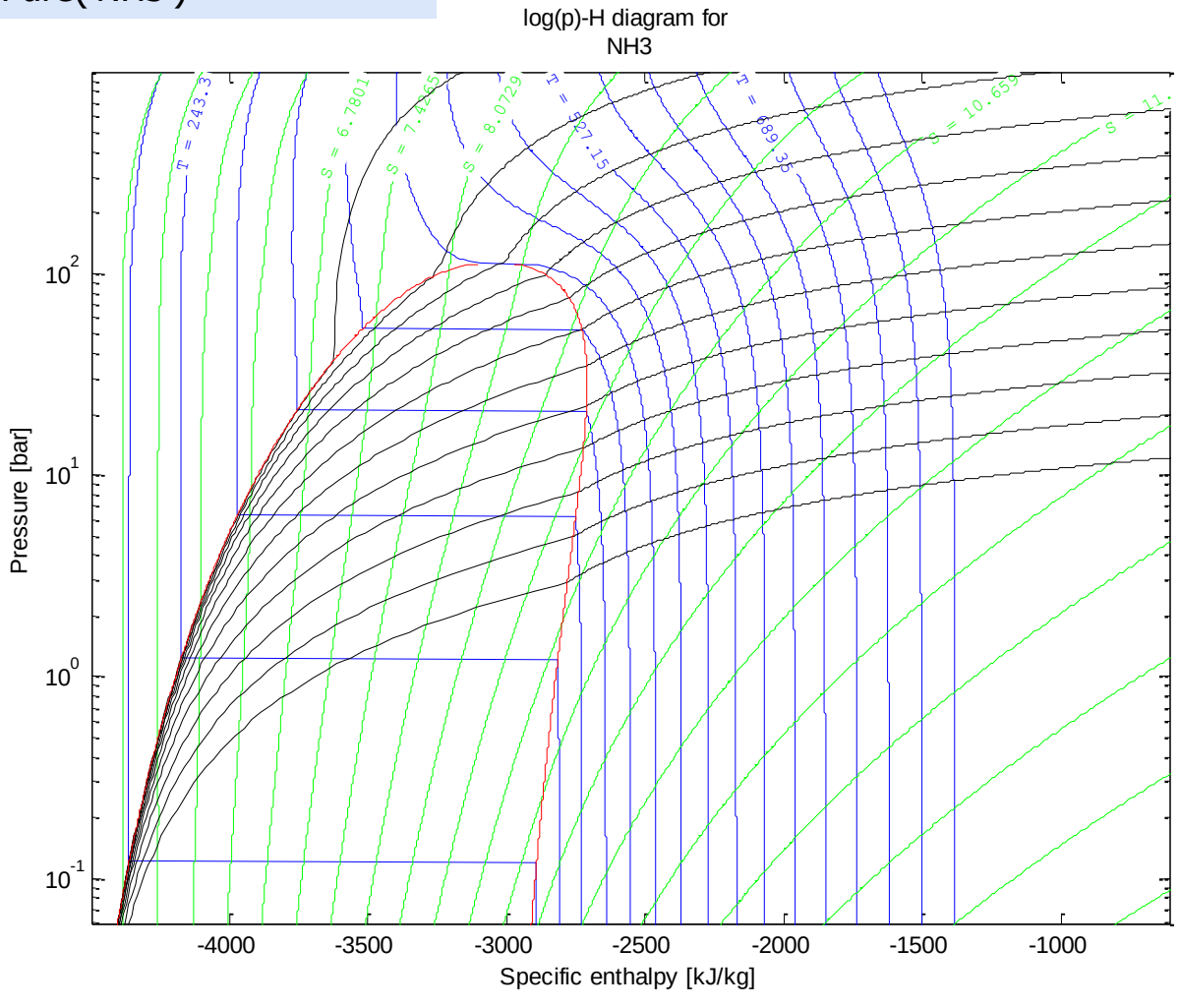
Example – Species Diagrams

Example – Species Diagrams

Species Diagrams

```
>>th_PlotLogPHPure('NH3')
```



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Example – Command Line Functions

Command Line Functions

Compression of Air

Defining the initial state:

```
initial_state = th_TpState(
    'ndot',1000/28.85,
    'T',300,
    'p',1e5,
    'psi',[0.21; 0.79],
    'species',{'O2','N2'},
    'MediaData',SMediaData);

initial_state =

     ndot: 34.6620
        T: 300
        p: 100000
     Hdot: 1.8711e+003
     Sdot: 6.8945e+003
     Gdot: -2.0665e+006
    Cpdot: 1.0115e+003
        x: [2x1 double]
      psi: [2x1 double]
```

A massflow of 1kg/s of Air (21% O2, 79% N2) At 300K and 1bar

Result is a struct containing the defined state

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Compression of Air

Calculate isentropic compression first:

```
isentropic_compression = th_SpState(
    'ndot',1000/28.85,
    'Sdot',initial_state.Sdot,
    'p',10e5,
    'psi',[0.21; 0.79],
    'species',{'O2','N2'},
    'MediaData',SMediaData);
```

Isentropic State Change

Compression by 9 bar

Calculate final state with isentropic efficiency

```
final_state = th_HpState(
    'ndot',1000/28.85,
    'Hdot',initial_state.Hdot + (isentropic_compression.Hdot -
       initial_state.Hdot) / 0.85,
    'p',10e5,
    'T_initial', isentropic_compression.T,
    'psi',[0.21; 0.79],
    'species',{'O2','N2'},
    'MediaData',SMediaData);
```

Final enthalpy calculation with isentropic efficiency of 85%

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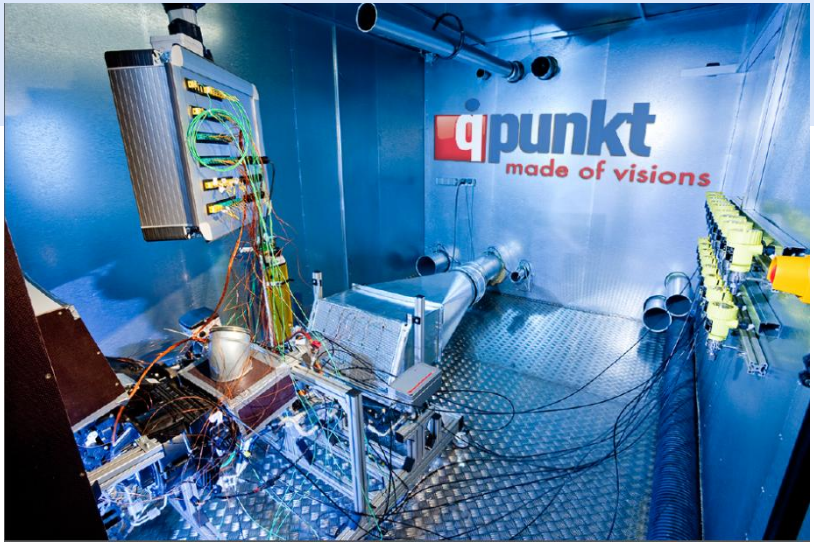
User Story

User Story

Automotive Thermomanagement

"Applying Thermolib to our design process has significantly reduced the length of the product development cycle without compromising the level of accuracy required or product quality. With Thermolib we identified the best simulation choice, because the model ran much faster than competitive models and we detected implementation errors much quicker. On account of this we shortened our time-to-market."

Sebastian Jagsch, Branch Manager, qpunkt GmbH



Read More

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Summary

Summary

Thermolib allows you to...

- Concentrate on your core business
- Enjoy the intuitive process design
- Reduce your costs and project time
- Benefit from continuous development and support

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www.thermolib.de