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# **TILMedia Release Notes**

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**Kontakt.**

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## TILMedia 3.14.0

### Improvements

The following new Liquid Mixtures were added in TILMedia. The input of mass or volume fraction can be set via underline and a per cent value behind the name e.g., Dynalene\_EG\_43 or \_54vol (43 equals 43wt).

- TILMedia.Dynalene\_Calcium\_Chloride \*
- TILMedia.Dynalene\_EG
- TILMedia.Dynalene\_EG-V1
- TILMedia.Dynalene\_LC-Bio \*\*
- TILMedia.Dynalene\_LC-EG
- TILMedia.Dynalene\_LC-PG
- TILMedia.Dynalene\_PG
- TILMedia.Dynalene\_PG-V1
- TILMedia.Dynalene\_TEG
- TILMedia.Tyfocor \*\*
- TILMedia.Tyfoxit \*\*

\* only wt % input possible, \*\* only vol % input possible

TILMedia-Liquids: Dowterm\_A, Baysilone\_KT\_5, Baysilone\_KT\_10, Baysilone\_KT\_20 were added.

TILMedia.Glysantin & PropyleneGlycol enable input of mass fraction and volume fraction.

The derivatives of pure and mixture gas properties and the corresponding interface functions were implemented. The derivatives are accessible through the Modelica interface, enabling the use of analytic Jacobians, e.g., to increase simulation speed in Dymola.

### Bug fixes

TILMedia.Glysantin has corrected interpolation between given mass fractions e.g., Glysantin\_37.5 interpolates correct between 30 and 40 % mass fraction. Obsolete variant available as TILMedia.Obsolete\_Glysantin. Conversion in Modelica to obsolete variant.

## TILMedia 3.13.0

### Improvements

All TILMedia.\*-mediums for VLEFluids have improved internal equations. The calculation time is reduced about 40%.

All VDI 4670 Gases have improved heat capacity, enthalpy, and entropy calculations without numerical noise.

The VLEFluid TILMedia.R1336MZZZ is renamed. Obsolete TILMedia.R1336MZZ is mapped to new name.

Python:

- TILMedia interface is only compatible with Python 3. Improved code and features included (PEP 8, stub-files/autocomplete, ...).

- Classes, functions etc. are named with lowercase letters. With “python tilmedia.convert my\_script.py” is a conversion of TILMedia user scripts possible.

TILMedia for Simulink includes only SLX-files and 64 bit (compatible until MATLAB R2012a).

## TILMedia 3.12.1

Hotfix release. No changes in this library.

## TILMedia 3.12.0

### Improvements

TILMedia.Methanol was added as VLEFluid.

VLEFluid spline interpolated mediums updated to REFPROP 10: R134a, R1234yf (obsolete variant available), R410A, Methane.

The reference state of enthalpy and entropy of the gases TILMedia.ExhaustGas and TILMediaXTR.MoistAir were changed.

Improved robustness of dew point calculate of all Gases.

Improved numeric behavior of TILMedia VLEFluids at the critical point.

Fixed issue with parallel computation of different REFPROP mixtures.

## TILMedia 3.11.0

### Improvements

In all VLEFluids the heat capacity ratio / isentropic expansion factor ( $\gamma$ ) is linearized in two phase region.

Improved multithreaded handling of errors

Added Refprop Interface now supports mixture reference states

Absolute entropy of a gas is now available

Linux: Medium name detection and information parsing for Refprop was implemented

Modelica:

- Added function prototypes to simplify inheritance
- Additional files like images, equations, pdf-documents, conversion-scripts, etc. are moved into the resources folder and obsolete files were removed.

Python:

- Support for matrices
- Implemented exceptions for errors
- Set data path function was implemented

## Bug fixes

For VLEFluid splines and linear interpolated mediums the calculations near critical point and saturation lines are corrected e.g. for cv and cp.

## TILMedia 3.10.0

### Improvements

About 40 new heat transfer fluids are available as TILMedia.Liquids e.g. by Dynalene, Fragol and Eastman (Therminol & Marlotherm).

Update CoolProp to version 6.4.2.

TILMedia Modelica is using Modelica Standard Library 4.0.0.

## TILMedia 3.9.1

### Improvements

TILMedia.ORTHOHYDROGEN and TILMedia.PARAHYDROGEN were added as new VLEFluid models.

R134a, R1234yf and R410A were added as new spline-interpolated VLEFluid models in TILMedia for Modelica.

New SLE Mediums Copper and Aluminum.

### Bug fixes

Fixed derivatives of cubic equation of state model at high pressures.

Fixed unwanted partial compilation of TILMedia functions in Dymola.

Worked on deadlocks in FMUs.

Fix handling of incomplete limit information in Refprop models.

Fix reading of CFG user liquid file format.

## TILMedia 3.9.0

### Improvements

The TILMedia interface for Python was updated e.g. the handling of vectors/arrays was improved and further input choices for VLEFluid-calculations beside dT, ph, ps and pT were made available.

The documentation was updated e.g. the medium lists and comments were expanded and the font-design in the pdf-files was improved.

The calculation of water and ammonia mixture as VLEFluid, based on “Tillner-Roth et al. (1996)”, was structurally improved and a first implementation of an approach by “Bell et al. (2018)” was added.

The Multiflash™ interface was improved. It is now compatible to the newest version 7.1 and has new input choices for VLEFluid-calculations like e.g. Th, pd, pq and Tq.

### Bug fixes

The TILMedia interface for Java now supports external mediums e.g. from REFPROP.

The VLEFluid information, which are available in the TILMedia Python interface, now support all mediums by REFPROP (version 10).

## TILMedia 3.8.0

### Improvements

Multiflash™ interface: The interface to KBCs Multiflash™ allows a detailed calculation of real fluid mixtures (VLEFluids).

The calculations of the partial density derivatives in VLEFluid objects can be deactivated, which results in a significantly higher overall calculation speed of VLEFluid-mixtures.

### Bug fixes

The MATLAB Gas.m-model supports TILMedia.Exhaustgas\_lambda\_1 now.

The frosting of water in Gas calculations depending on pressure and entropy is corrected.

## TILMedia 3.7.0

### Improvements

TILMediaXTR.METHANE was added as new gas.

TILMedia.SES36 was added as new VLEFluid.

New MoistAir model: LibHuAir.MoistAir was added. (Additional license needed.)

REFPROP 10 was included with 248 updated and the following 32 new mediums:

- Refprop.13BUTADIENE.FLD
- Refprop.1BUTYNE.FLD
- Refprop.1PENTENE.FLD
- Refprop.22DIMETHYLBUTANE.FLD
- Refprop.23DIMETHYLBUTANE.FLD
- Refprop.3METHYLPENTANE.FLD
- Refprop.ACETYLENE.FLD
- Refprop.C16.FLD
- Refprop.C22.FLD
- Refprop.C6F14.FLD
- Refprop.CHLORINE.FLD
- Refprop.CHLOROBENZENE.FLD
- Refprop.CYCLOBUTENE.FLD
- Refprop.DEA.FLD
- Refprop.EGLYCOL.FLD
- Refprop.ETHYLENEOXIDE.FLD
- Refprop.MEA.FLD
- Refprop.PROPADIENE.FLD
- Refprop.PROPYLENEOXIDE.FLD
- Refprop.R1123.FLD
- Refprop.R1224YDZ.FLD
- Refprop.R1243ZF.FLD
- Refprop.R150.FLD
- Refprop.R407H.MIX
- Refprop.R447B.MIX
- Refprop.R449C.MIX
- Refprop.R458A.MIX
- Refprop.R459A.MIX
- Refprop.R459B.MIX
- Refprop.R460A.MIX
- Refprop.R460B.MIX
- Refprop.VINYLCHLORIDE.FLD

Installation of Resources-folder with TILMedia Modelica.

## Bug fixes

Density derivatives of gas mixtures with condensing component and relative humidity ( $\phi$ ) greater than 100% are calculated correct now.

Steady-state calculation of composition-related properties of VDIWA mixtures with Peng-Robinson EoS works correctly now.

Vapor pressure of VDIWA pure fluids is set to their critical pressure, if temperature is greater than their critical temperature.

Fixed access violation in solver of gas model

## TILMedia 3.6.0

### Improvements

Added new Liquid TILMedia.Novec7500: "3M™ Novec™ 7500 Engineered Fluid"

Introduced base classes in Modelica

Added new medium class in Modelica

In the Python interface and VLEFluid-object, additional property calculation can be switched off with the use of flags

UserLiquids can be added to FMUs

Implemented surface tension for R1234zeZ

TILMedia module for Java available (for Windows)

## Bug fixes

Improved parallel usage of FMUs which include TILMedia

Avoiding division by zero

## TILMedia 3.5.1

### Improvements

Fixed upper temperature bounds for VDIWA2006 liquid mediums.

Improved robustness of dew point calculation for Gases.

Improved extrapolation/robustness of VLEFluid TILMedia mediums.

Added thermal conductivity model of Tufeu for ammonia.

Added pseudo pure fluid for air.

New speed of sound models for VLEFluids (Wood, Henry).

### Bug fixes

Extrapolation of liquid properties is now thermodynamically correct.

Fixed extrapolation of Glysantin and PropylenGlykol.

Fixed issues with TILMediaXTR.MoistAir above 647K.

Fixed access violation in a transport property model.

Fixed names of some exported functions.

## TILMedia 3.5.0

### Improvements

Transport properties for the following VLEFluid mediums have implemented:

- |                              |                         |
|------------------------------|-------------------------|
| • TILMedia.1-BUTENE          | • TILMedia.N-NONANE     |
| • TILMedia.ACETONE           | • TILMedia.NEON         |
| • TILMedia.AMMONIA           | • TILMedia.NEOPENTANE   |
| • TILMedia.ARGON             | • TILMedia.NITROUSOXIDE |
| • TILMedia.DEUTERIUM         | • TILMedia.OXYGEN       |
| • TILMedia.DIMETHYLCARBONATE | • TILMedia.PARAHYDROGEN |

- TILMedia.DIMETHYLETHER
- TILMedia.ETHANE
- TILMedia.ETHYLENE
- TILMedia.HEAVYWATER
- TILMedia.HELIIUM
- TILMedia.HYDROGENSULFIDE
- TILMedia.ISOBUTANE
- TILMedia.ISOPENTANE
- TILMedia.KRYPTON
- TILMedia.M-XYLENE
- TILMedia.METHANE
- TILMedia.METHYLLINOLEATE
- TILMedia.METHYLOLEATE
- TILMedia.METHYLPALMITATE
- TILMedia.METHYLSTEARATE
- TILMedia.MM
- TILMedia.N-BUTANE
- TILMedia.N-DODECANE
- TILMedia.PROPYLENE
- TILMedia.R113
- TILMedia.R116
- TILMedia.R12
- TILMedia.R1233ZDE
- TILMedia.R1234YF
- TILMedia.R124
- TILMedia.R141B
- TILMedia.R143A
- TILMedia.R161
- TILMedia.R227EA
- TILMedia.R23
- TILMedia.R245FA
- TILMedia.R32
- TILMedia.R365MFC
- TILMedia.SULFURHEXAFLUORIDE
- TILMedia.TOLUENE
- TILMedia.XENON

The reference state for the enthalpy and entropy of the following VLEFluid mediums was changed:

- TILMedia.ARGON
- TILMedia.D4
- TILMedia.D5
- TILMedia.ETHANE
- TILMedia.ETHYLENE
- TILMedia.ISOBUTANE
- TILMedia.MD4M
- TILMedia.METHANE
- TILMedia.METHYLLINOLEATE
- TILMedia.METHYLOLEATE
- TILMedia.METHYLPALMITATE
- TILMedia.METHYLSTEARATE
- TILMedia.N-BUTANE
- TILMedia.N-DODECANE
- TILMedia.NEON
- TILMedia.OXYGEN
- TILMedia.PROPYLENE
- TILMedia.R113
- TILMedia.R12
- TILMedia.SULFURHEXAFLUORIDE

R1234ZE is renamed to R1234ZEE.

A new equation for TILMedia.R125 is implemented.

A more powerful backend for TILMedia VLEFluids has been implemented.

The properties in the proximity of the critical point were modified for isobutane, cyclopentane and acetone to increase the robustness.

Robustness of the TILMedia and SplineInterpolation VLEFluids was increased.

Updated Coolprop to Version 6.1.0.

Changed reference state for the Liquids Glysantin and Propylenglykol.

New Liquid mixtures from the IIR Secondary Working Fluids publication:



IIR\_SWF.AMMONIA-WATER\_XX, IIR\_SWF.CALCIUMCHLORIDE-WATER\_XX,  
IIR\_SWF.ETHYLALCOHOL-WATER\_XX, IIR\_SWF.ETHYLENEGLYCOL-WATER\_XX,  
IIR\_SWF.GLYCEROL-WATER\_XX, IIR\_SWF.POTASSIUMACETATE-WATER\_XX,  
IIR\_SWF.POTASSIUMCARBONATE-WATER\_XX, IIR\_SWF.POTASSIUMFORMATE-  
WATER\_XX, IIR\_SWF.LITHIUMCHLORIDE-WATER\_XX, IIR\_SWF.METHYLALCOHOL-  
WATER\_XX, IIR\_SWF.MAGNESIUMCHLORIDE-WATER\_XX,  
IIR\_SWF.SODIUMCHLORIDE-WATER\_XX, IIR\_SWF.PROPYLENEGLYCOL-WATER\_XX

New Liquids from the IIR Secondary Working Fluids publication:

IIR\_SWF.DOWTHERM\_J, IIR\_SWF.DYNALENE\_MV, IIR\_SWF.GILOTHERM\_D12,  
IIR\_SWF.3M\_NOVEC\_HFE7100, IIR\_SWF.BAYSILONE\_KT3, IIR\_SWF.SYLATHERM\_XLT,  
IIR\_SWF.MARLOTHERM\_X, IIR\_SWF.D\_LIMONENE

Improved precision of TILMediaXTR.MoistAir model.

New Refprop mixture files were added for R407G, R433B, R433C, R449B, R451A, R451B, R452A, R452B, R452C, R453A, R454A, R454B, R454C, R455A, R456A, R457A, R513B, and R515A.

Refprop.R1234ze has been renamed to Refprop.R1234zee.

## Bug fixes

Caching failures for Refprop mixtures and gas mixtures have been fixed.

## TILMedia 3.4.2

### Improvements

Enhanced thread-safety of all interfaces.

Improved smoothness of spline interpolated properties with input choice pT and ps.

The reference state of the Peng-Robinson EOS and TILMedia VLEFluids can be changed.

Changed the definition of the critical point for TILMedia VLEFluids.

Rebuild saturation tables of some TILMedia VLEFluids with higher precision.

### Bug fixes

Peng-Robinson equation caching is now working correctly.

Transport properties of saturated liquid and vapor for a given temperature are now calculated correctly.

## TILMedia 3.4.1

### Improvements

New exhaust gas added. TILMediaXTR.Exhaustgas can be parametrized flexibly e.g. for diesel or petrol exhaust gas with various lambda values.

Calculation of wet-bulb and ice-bulb temperature added. Implementation in MoistAir category of Excel and Python, as well as Modelica internal GasObjectFunctions.

Linux compatibility of REFPROP in TILMedia is made.

### Interface improvements

VLEFluid-calculations in TILMedia are compatible with Dymola 2017. (The variable “phase” is deleted).

### Bug fixes

Memory leaks are fixed, which could occur when a huge amount of calculations are made.

Stability improved using VDIWA-VLEFluid mixtures especially in DaVE.

The density of gas mixtures takes the temperature dependency of the condensed liquid phase into account.

## TILMedia 3.4.0

### Improvements

More than 40 new reference quality equations of state are implemented as TILMedia-VLEFluids. They can replace the slower REFPROP- or CoolProp EOS-implementation. (All mediums listed in TILMedia documentation.)

New REFPROP VLEFluids added (some HFE / Novec among others).

Warning messages for all Liquids implemented. Messages occur when liquid properties leave the valid temperature range.

A modified version of the VLEFluid-Oil mixture model by Thome has been implemented.

The density of gas mixtures now includes the liquid phase.

Transport properties for Acetone and Cyclopentane added.

Numerical improvements for Gases and VLEFluids.

CoolProp updated to version 5.1.1

## Interface improvements

In Dymola 2016 FD01 (Modelica) the graphical Icons are not flipped any more. TILMedia-Icons displayed now correct.

## Bug fixes

Gas mixtures inclusive Moist Air are handling freezing/icing correctly now.

Gas temperature above 100 °C and input of relative humidity phi working correctly now.

The VDIWA (2006) Gas entropy is calculated now correctly.

Spline interpolation based VLEFluids calculate the liquid thermal conductivity in the two phase region now correctly.

## TILMedia 3.3.1

### Improvements

Optional REFPROP internal interpolation feature for VLE-fluid-mixtures can be activated with flags/parameter-settings.

The Gas interface now enables the user to define the dry air composition and the humidity information separately.

### Interface improvements

In MATLAB and in Simulink are calculations of REFPROP\*.mix-files as pseudo pure fluid (with fixed mixing ratio) possible.

TILMedia for Modelica is now compatible with Dymola 2016.

### Bug fixes

Calculation of liquids with input choice ph was partly wrong. Therminol72, Tyfocorl33, ZitrecM10, ZitrecM20 among other are working properly again.

Transport properties like dynamic viscosity of Oil\_15W40 and Aral\_0W30 corrected.

Calculation of isobaric thermal expansion coefficient for Glysantin is new and correct now.

Installation of TILMedia-COM-Server, DIAdem, VBS/VBA-Interface corrected.

Density of moist gas mixtures above saturation temperature is now correct

Fixed erratic behavior of transport property models as regards TILMedia.\* VLEFluids.

## TILMedia 3.3.0

### Improvements

Refprop source code have been updated to version 9.11 and also FLD/BNC/MIX-files (9.12).

Calculation speed improvement of the Refprop interface.

TILMedia is now thread-safe (but still one medium pointer should be used by only one thread in parallel).

ECS-Model for transport properties has been added for several TILMedia VLEFluids.

New VLEFluids have been implemented, e.g. R-1234ze(E) and R-1234ze(Z).

Transport property model of water has been updated to newer equation.

TILMediaXTR library for gases with extended temperature range (e.g. combustion gases) is now available.

Saturation tables for TILMedia VLEFluids have been rebuild (this affects in particular the pseudo pure fluids).

TILMedia now distinguishes between cricondenbar and cricondentherm.

TILMedia VLEFluid property model has been revised largely.

Liquid model has been rebuild.

Interface to CoolProp has been added.

VDIWA mediums were renamed to VDIWA2006 (since these are the properties described in VDI-Wärmeatlas published in 2006).

### Interface improvements

LabVIEW-Interface for TILMedia 3 was added.

### Bug fixes

Reset of cache in VLEFluids TILMedia mediums is now working correctly.

dT-input choice for TILMediaRT mediums is now calculating more robust and faster.

## TILMedia 3.2.3

### Improvements

Ethanol: new implementation of fundamental equation.

Liquid type Therminol72 added.

More stable calculations of TILMedia VLEFluids at critical point implemented.

## Interface improvements

Simulink-Interface for TILMedia 3 added.

Python-Interface for TILMedia 3 added.

Display of TILMedia-messages (errors & warnings) in Matlab & SimulationX implemented.

Various Moist Air Excel functions edited for better usability.

## Bug fixes

Functionality of Propylenglykol fixed.

Bug fixes in psxi and dTxi input calculation.

## TILMedia 3.2.2

### Improvements

Build a refprop.dll for TILMedia to enable multi-threading especially in DaVE (TLK-Software).

Documentation for Excel improved and temperature range for liquids added.

### Interface improvements

Matlab-Interface for TILMedia 3 added.

### Bug fixes

Input of variable names for VLEFluid-mixtures improved.

Internal calculation optimization in one- and two-phase regions.

## TILMedia 3.2.1

### Improvements

Modelica documentation improved.

### Bug fixes

Internal caching problems fixed for calculation of transport properties of VLEFluids.

License check for Microsoft Excel and COM-Server fixed.

## TILMedia 3.2.0

### Improvements

Refprop updated to version 9.1.

Mixture functions in Excel Add-In implemented.

All 275 VDI-Wärmeatlas media (including transport properties) can be used and mixed.

Interpolated spline media for air, methane and R134a added.

Liquid SHC XMP320 Synthetic Gear Oil added.

Functions for triple point (p,T) added.

### Bug fixes

Internal solver problems fixed for calculation of equations of state.

## TILMedia 3.1.0

### Improvements

Refprop FLD files were updated: R-1234yf, R-1234ze(E), Novec 649, Novec 7000.

Liquid type AddinolXW15 added.

All gases can be mixed.

NASA Glenn Coefficients for ideal gases have been added.

Interpolation based VLEFluids have been added.

Error messages improved.

### Bug fixes

Partial derivatives of the density and molar mass of pure gases fixed.

Viscosity of gas mixtures fixed.

## TILMedia 3.0.2

### Improvements

Switched to the same surface tension model as Refprop for R134a.

Liquid types ZitrecM10 and ZitrecM20 added.

Added VLEFluids O-Xylene, M-Xylene, P-Xylene, Ethylbenzene

Prevented Prandtl  $< 0$  for different cases.

Added algorithm to calculate partial derivatives of Refprop Mixtures.

Enlarged range of validity of Gases.

Gas mixtures now can handle negative mass fractions.

### **Bug fixes**

Fixed caching issues for VLEFluids and Gases.

Rebuild saturated property table of R134a, R744, R717, R718, GERG-CO2, Ethanol, AstinaSatoR134a.

Critical surface tension for interpolated VLEFluids fixed.