

COSMOtherm Version C2.1 Release 01.10 (November 2009)

New features of this distribution include:

1. Improved **accuracy** and **applicability** of COSMOtherm predictions:

- Further improved sets of COSMOtherm parameters for both high level (BP-TZVP-COSMO, BP-TZVP-ISOCAV, DMOL3-PBE) and screening level (BP-SVP-AM1) sigma-profiles were obtained from a thorough reconsideration of conformers for all compounds involved in the fitting and validation procedure. In addition the fitting and validation procedures were further enhanced, now including temperature dependent pure compound and mixture thermodynamic data of organic, and inorganic neutral compounds, salts and ionic liquids. The new fitting and validation procedure ensures an improved overall quality of COSMOtherm predictions and assures a widespread applicability over all areas of organic chemistry and some areas of inorganic chemistry. The new parameter sets include some significant improvements (especially for compounds with elements containing F, Br, I, S, P). Overall (i.e. in all fit and validation data sets and for all properties and compounds) the new parameter sets perform better than the previous parameter sets by about 2-5%.

2. New and improved COSMOtherm **functionality**:

- **Liquid Extraction:** free two phase multi-component liquid-liquid equilibrium calculation. From a given starting concentration for two phases I and II, both of which may be mixtures of compounds including Ionic Liquids or dissolved salts, the thermodynamic phase equilibrium is solved via computing the affinity of each compound to each of the two phases (i.e. the impetus of the compound to stay in the phase where it is or to move to the opposite phase), with the side of mass conservation and neutrality of the phases. This corresponds to the solution of liquid-liquid extraction equilibrium.
- **pKa:** three new pka LFER models are provided for aprotic solvents **heptane** (acid solutes) and **THF** (acid solutes & base solutes).

- **Reactions:** computation of chemical equilibrium in terms of reaction energies and equilibrium constants. The equilibrium of a chemical reaction in solution is described in terms of the reaction free energy of the system as the difference of the free energies of the reactant and product species of the chemical reaction. Because the expectable prediction quality of reaction equilibrium constants, reaction Gibbs free energies, and reaction enthalpies is not very high if the calculations are based on DFT energies such as BP-TZVP, a methodology is provided to include high level quantum chemistry computed energies into the reaction calculation.
- **Liquid-liquid equilibrium (LLE):** computation of LLE tie lines of **ternary** systems (including Ionic Liquid phases) and LLE tie points of n-dimensional **multinary** systems ($n > 3$, restricted to neutral compounds).
- **Henry** constant computation: it is now possible to use the experimental pure compound
- **Solvation energy, partition constant, and solubility** computations: the output conversion of the free energy of solvation ΔG_{solv} , the partition constants $\log P_{12}$, and the molar solubility now by default are computed with the *COSMOtherm* QSPR estimate of the **solvent density**, thus avoiding the need for the input of an experimental solvent density.
- **Solvation energy** computations: now it is possible to compute the free energy of solvation ΔG_{solv} for ions, too.
- Solubility: computations of relative solubility and solvent screening lists (also see below in section 3: *COSMOthermX* graphical user interface (GUI)).
- Compound conformer treatment: **molecular symmetry** is detected automatically. If there are conformers with different symmetry the conformer multiplicity that results from that symmetry is taken into account in the conformer weight pre-factors.
- Compound conformer treatment: individual gas phase conformer weights.
- Compound conformer treatment: meta-file conformer treatment enabled.
- Contact probability option: now it is possible to also create weakly bonded clusters of contacting molecules.

3. COSMOthermX graphical user interface (GUI):

- Significantly improved and extended graphical user interface with newly written graphics routines that are significantly faster and more reliable. Overall new look and feel of the GUI, with lesser clicks required to obtain a result. In addition numerous new usage features have been implemented into the GUI:
 - o New and improved compound database handling: if the user is missing a compound in the database we offer a "**compound wizard**" which guides him through all the steps that are necessary for him to create the cosmo-file (i.e. get compound SMILES-code online or use built-in molecule builder, convert SMILES-code to 3D geometry, check validity of the structure, call MOPAC and Turbomole to optimize - all in one simple and automated procedure).
 - o Improved threading (COSMOtherm calculation job control): multiple jobs can be run, controlled, stored and reopened from the main window of COSMOthermX.
 - o Simplified handling of COSMOtherm jobs: inputs now are editable as a whole (text edit) and partially (mixture computation input lines are editable in the COSMOthermX job setup window).
 - o Novel color management for compound sigma-surfaces allows for a better recognition and distinction of surface charges.
 - o New graphical output: plotting of property vs. temperature curves such as temperature dependent tie lines of **LLE(T)** and **SLE(T)** curves (e.g. plot upper/lower critical solution temperature in LLE or SLE) as well as vapor pressure **pvap(T)** curves.
 - o New graphical output: computation and plotting of **ternary** and **quaternary LLE** phase separation tie lines.
 - o Batch processing and screening: a new **solubility screening** procedure is provided for the setup, running, and simple post-processing of solubility computations of one solute compound in a list of several solvents. The relative and absolute solubility can be computed in a list, allowing for easy comparison of the results.

4. Further extension of **COSMObase**, the database of COSMO-files:

- All of COSMObase's compounds have been re-optimized with the latest Turbomole version TM5.10 and some database entries and/or cosmo-files have been bug-fixed.
- To ensure an optimum prediction quality in COSMOtherm, COSMObase compound geometries have been critically reviewed for conformational effects and for more than one third of the compounds already present in COSMObase, additional conformers have been added and/or existing conformers have been replaced by better (lower energy) conformers.
- Currently COSMObase holds over 12000 molecular COSMO-files, gas phase energy-files and geometry xyz-files for high level (BP-TZVP-COSMO, BP-TZVP-ISOCAV, and DMOL3-PBE) quantum chemistry and over 17000 molecular COSMO-files, gas phase energy-files and geometry xyz-files for screening level (BP-SVP-AM1) quantum chemistry. This corresponds to over **5200** chemical compounds. Geometry xyz-files are provided for both COSMO and gas phase energy files.
- A large number of compound synonyma and alternative and trivial names has been added to the COSMObase database index file, allowing for a simpler identification of a given compound in the database. A unique smiles code (USMI) of the compound geometry has been added to the synonyma of all nonionic compounds in COSMObase. Moreover, if available, the Beilstein-, RTECS-, EC-, and Merck-Index code of the compounds has been added to the synonyma. Solvent compounds are marked by special solvent identifier.
- Every compound COSMO-file now is accompanied by a vapor pressure and property (`name.vap`) file, holding the compounds CAS registry number, a unique code identifier, and compound experimental data information:
 - Pure compound vapor pressure Wagner or Antoine coefficients, which can be used to obtain the pure compound measured/validated vapor pressure, are available in over 1100 vapor pressure / experimental data property compound vap-files.
 - For more than 3000 of the COSMObase compounds experimental boiling points and/or melting points are available in the database index file and the compound vap-files.
 - For over 250 COSMObase compounds experimental heat of fusion data (enthalpy of fusion and melting point) and critical point data are available in the compound vap-files.
 - For over 100 COSMObase compounds UNIQUAC volume and area coefficients are available. This data can be used in the fitting of activity coefficients to the UNIQUAC equation.