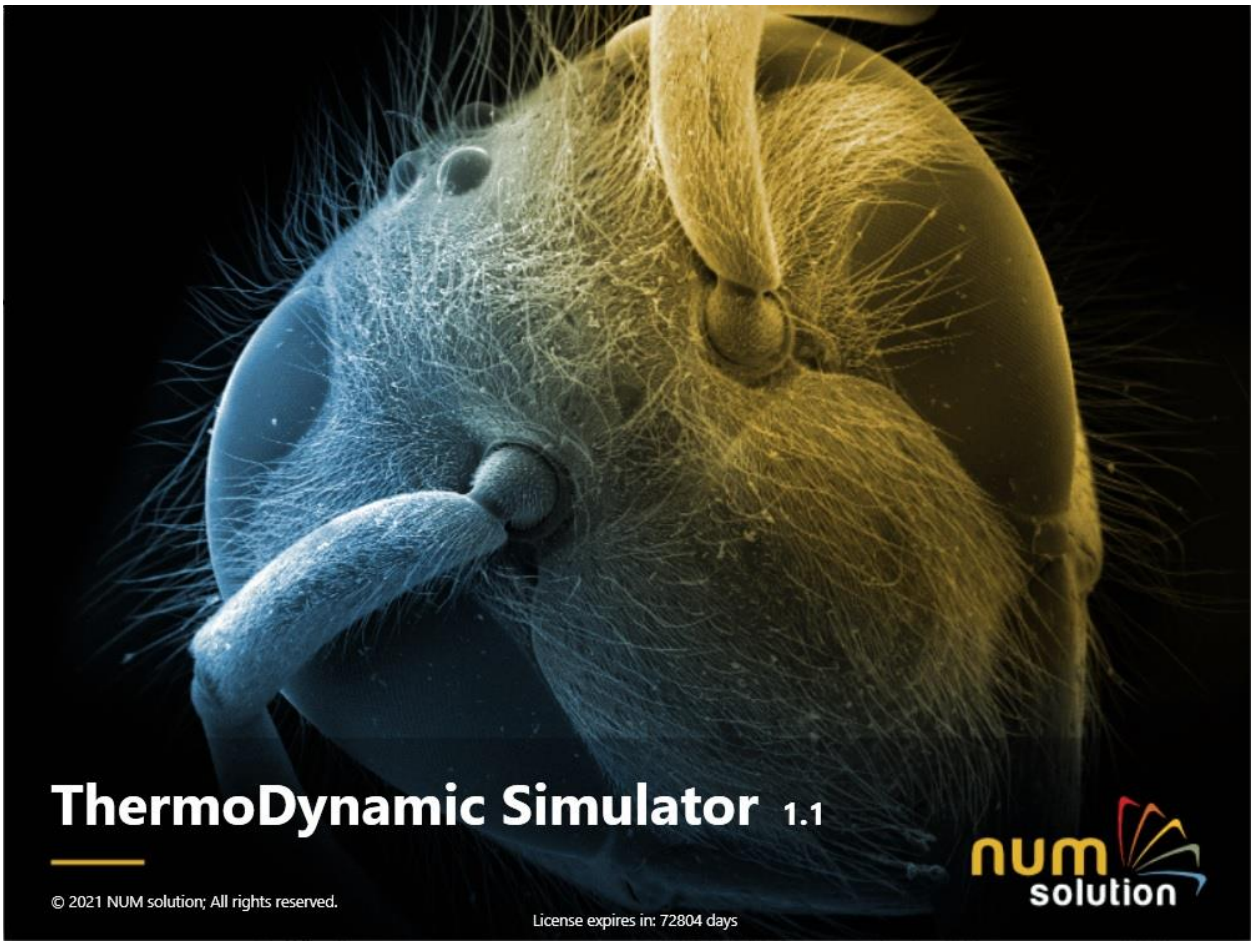
The "AI-CFD" ThermoDynamic Simulator for Electron Microscopy

TDS is specialized software for optimizing the thermodynamic conditions in the chamber of environmental scanning electron microscope during the sample observation process. This software was created on the basis of long-term cooperation between the NUM solution engineering company and Environmental electron microscopy research group at the ISI Academy of Sciences (http://www.aesemgroup.eu)



KEY PURPOSES:

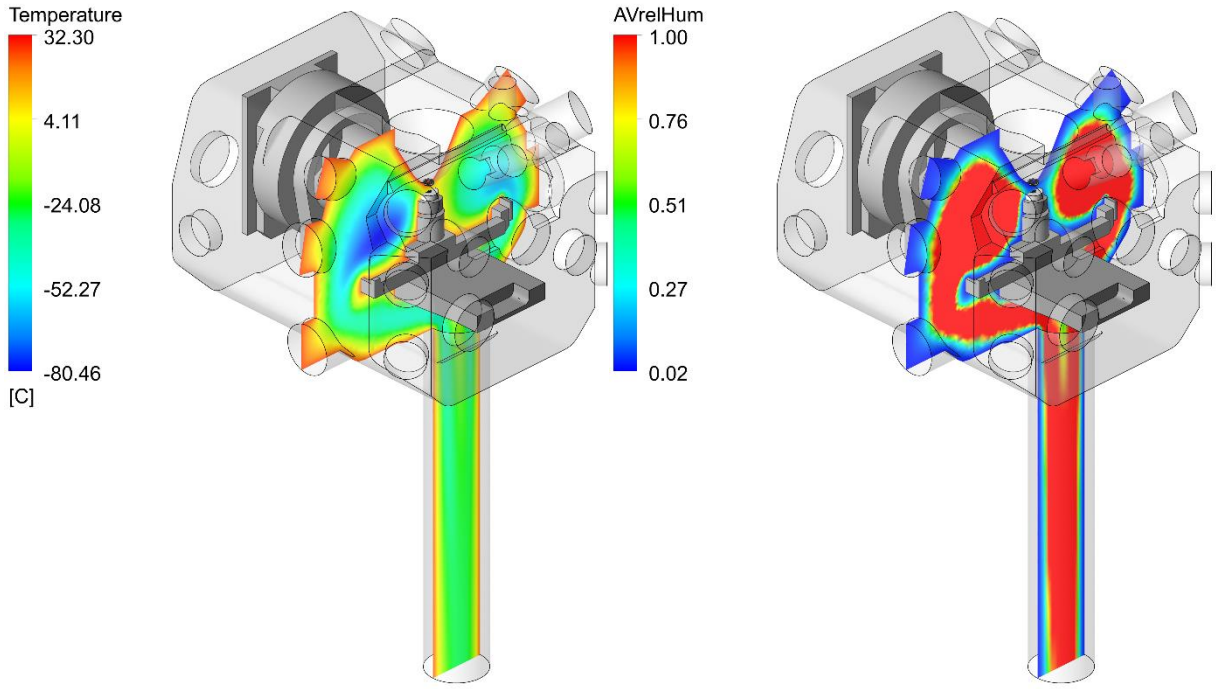
- Optimization of thermodynamic conditions in the advanced environmental scanning electron microscope (A-ESEM) chamber for observation of biological samples like very thin water-containing living samples,
- allows the operator to set the exact water vapor pressure, real sample temperature or sample surrounding humidity in the advanced environmental scanning electron microscope (A-ESEM) mode to achieve required conditions,

- allows successful observation of biological samples in their native state without risking of destruction or damage.

INTRODUCTION:

The ThermoDynamic Simulator (TDS) software was developed for the observation of primarily biological or soft samples in the low-pressure environment of the A-ESEM chamber. This type of microscope allows the observation of electrically non-conductive wet samples without metal coating in their native state or alive. Signal electrons emitted from the sample surface are multiplied in the gaseous environment of the sample chamber and then detected by dedicated detectors of electrons.

Since biological samples are sensitive to environmental factors such as temperature, pressure and humidity, it is indispensable to protect them from damage or destruction and thus keep them in their native state. Therefore, the optimal thermodynamic conditions for a given sample type must be maintained during the observation.



TDS includes

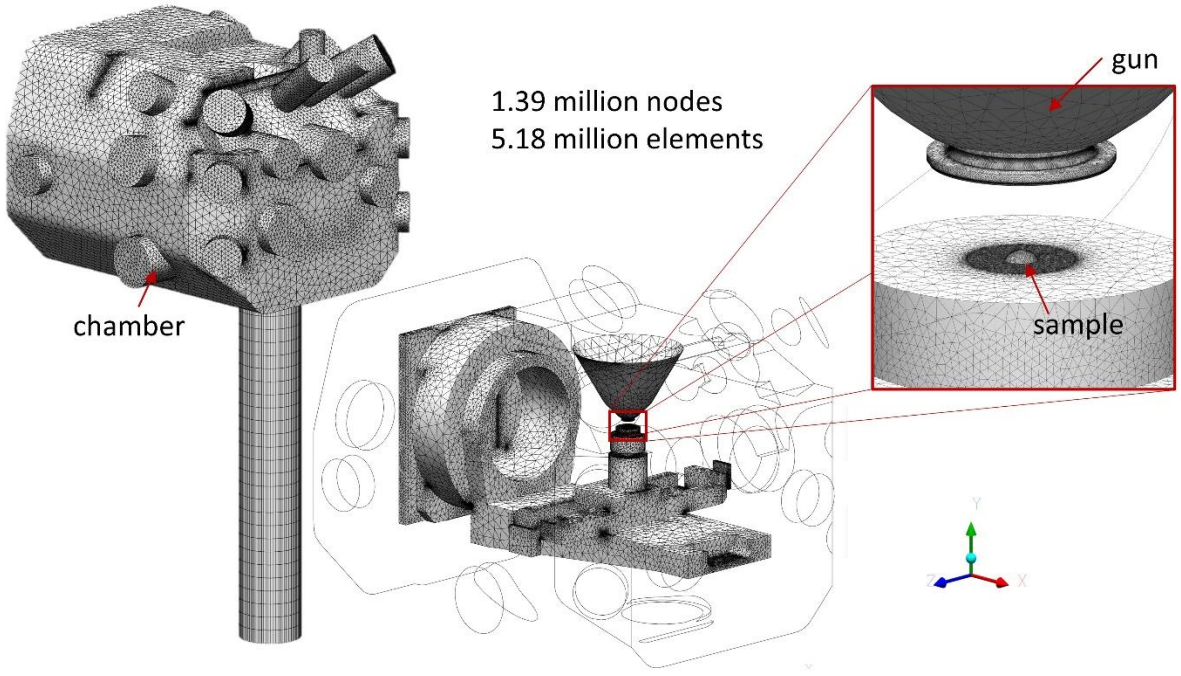
- real geometry of the A-EREM chamber with the sample and with important solids,
- various working distances between the gun and the sample (5 to 15 mm),
- various sample type and (biological, clay, wood, glass, polymer)
- two type of sample holder geometry (plate, bowl).

DESCRIPTION:

TDS is based on combination of computational fluid dynamics (CFD) numerical simulations and the machine learning method which was used to predict the output parameters (water vapor pressure, real sample temperature, sample surrounding humidity).

Results from CFD analyses were used as training data for the algorithm. TDS was used for the sophisticated estimation of thermodynamic parameters of initial settings of the sample processing.

TDS visualized graphical outputs as contours placed in vertical axis of the sample. The correct contour is selected using machine learning based on user specified input values.



RESULTS:

Pre-preparation of the thermodynamic conditions in the A-ESEM chamber using the TDS sw will reduce the time required to set the desired humidity, pressure or temperature level and help to keep the sample in native state for a longer period of time, thus extending the observation time.

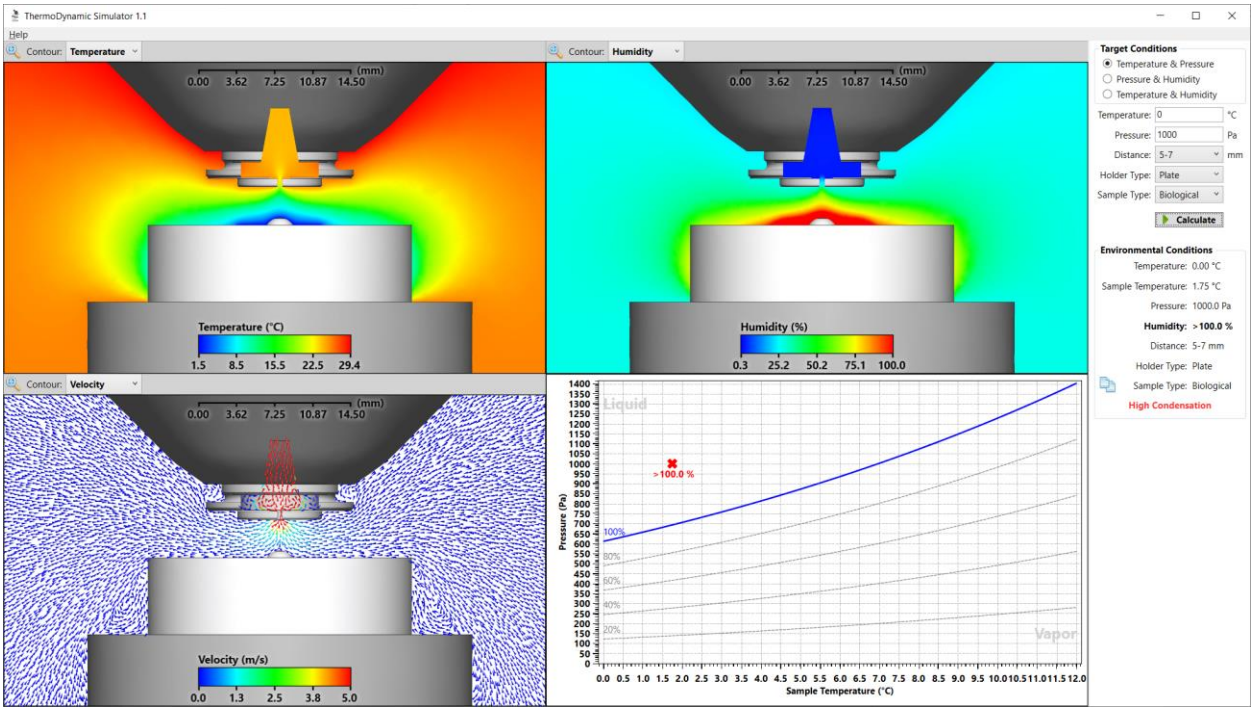
TDS allows user to select one of three calculation modes

- Temperature & Pressure ⇒ TDS will calculate Humidity
- Pressure & Humidity ⇒ TDS will calculate Temperature
- Temperature & Humidity ⇒ TDS will calculate Pressure

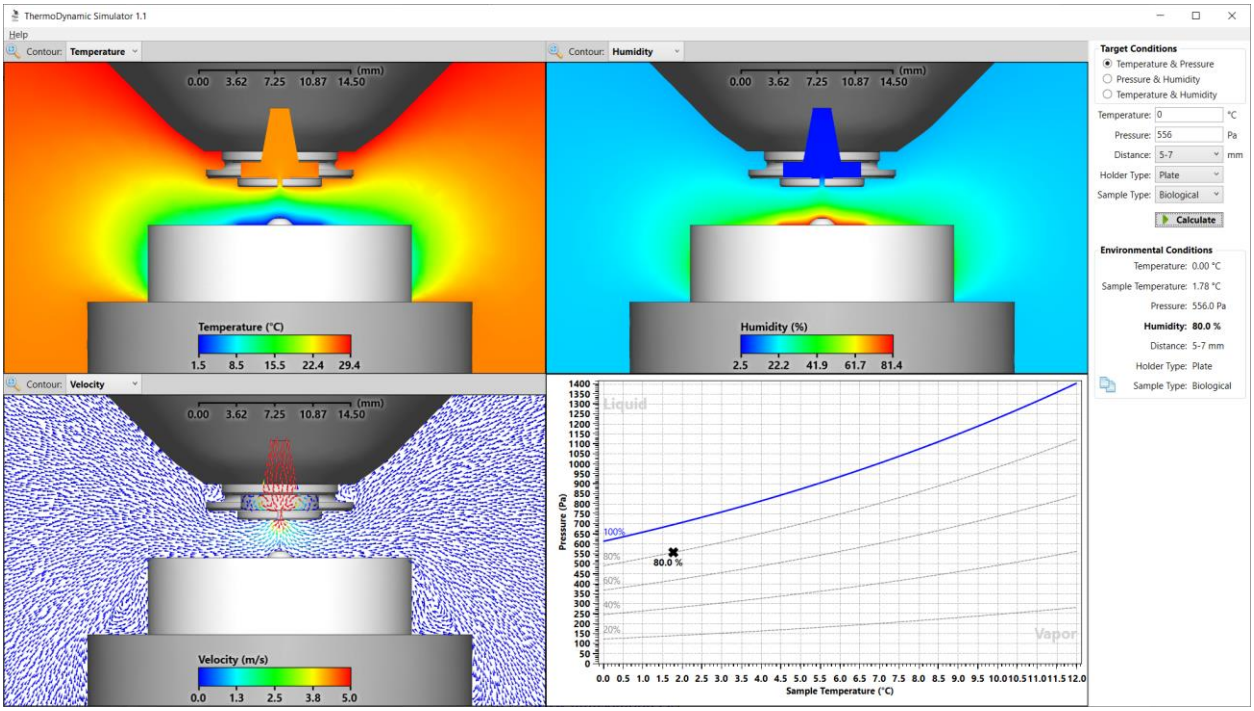
Demonstration of working with TDS

The user selects the values of the input parameters (Target Conditions) and the sw calculates the third unknown parameter, which in this case is the relative humidity.

Based on the result, the user determines whether the humidity value is correct. If not, a new calculation can be made with a modified pressure or temperature value.



The optimal thermodynamic conditions for the observation of the sample were found by changing the input parameters.



The testing procedures have shown that the TDS results are correlated with the measurements up to 3.5% of deviation.

SOFTWARE/HARDWARE REQUIREMENTS

- Supported OS: Microsoft Windows.

CONTACT

Do not hesitate to contact us for more information, **info@numsolution.cz** or visit our web > **www.numsolution.cz**

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