2017

[CMAP 2.0 software Quick Start: Tutorial]

Compressor performances evaluation tool by IPC Industrial Plants Consultants

Software for Windows machines designed to perform centrifugal compressor performance evaluations in an easy and quick way



CMAP Tutorial
IPC
20/12/2017

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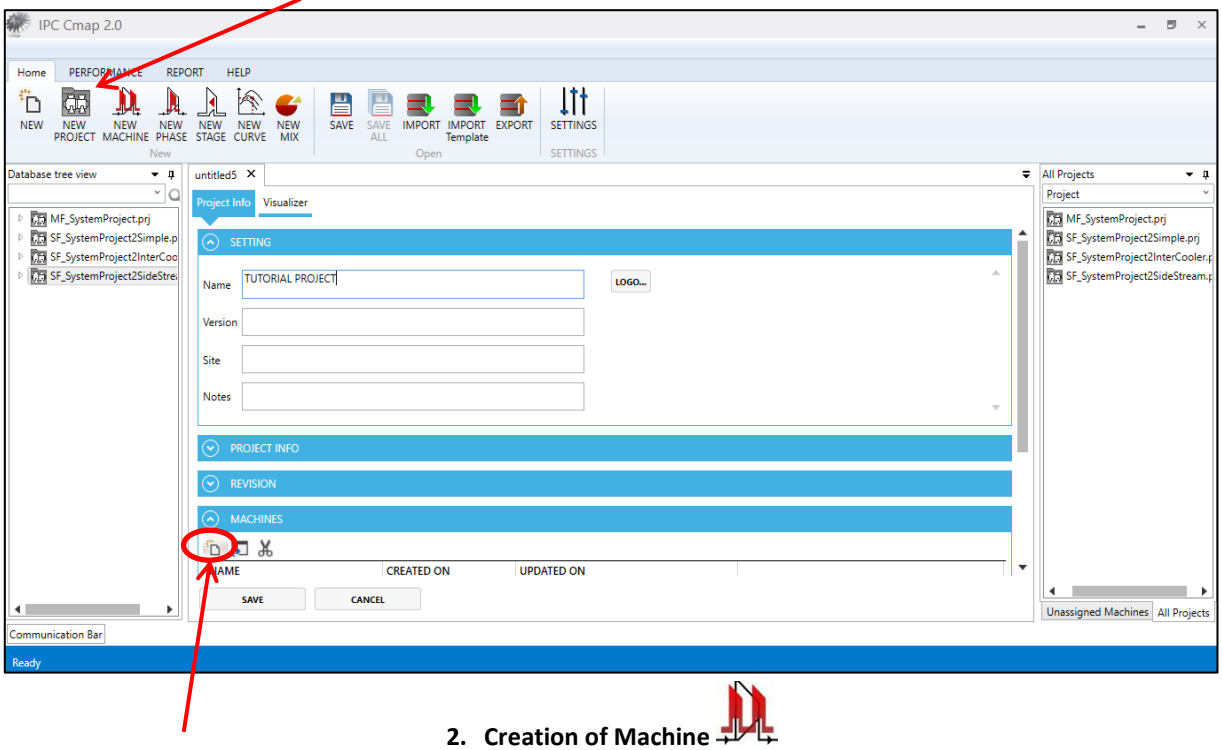
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CENTRIFUGAL COMPRESSOR CONFIGURATION

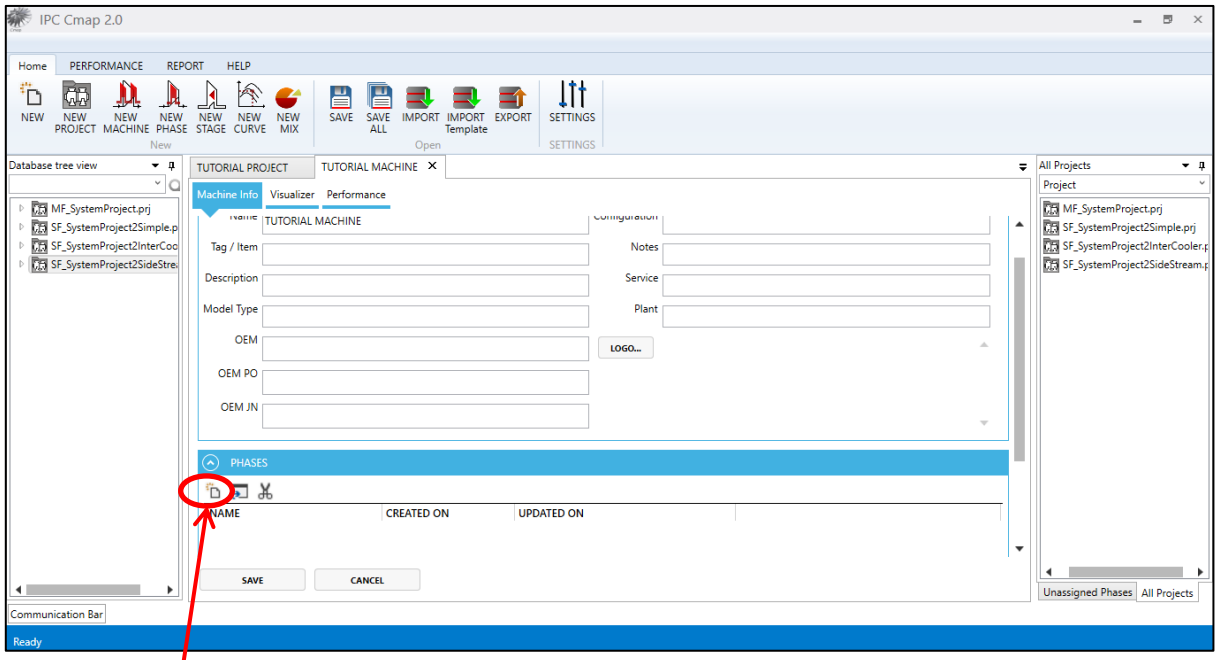
1. Creation of Project

In “Home”, click NEW PROJECT on the Ribbon Bar, you can rename it “TUTORIAL PROJECT”.



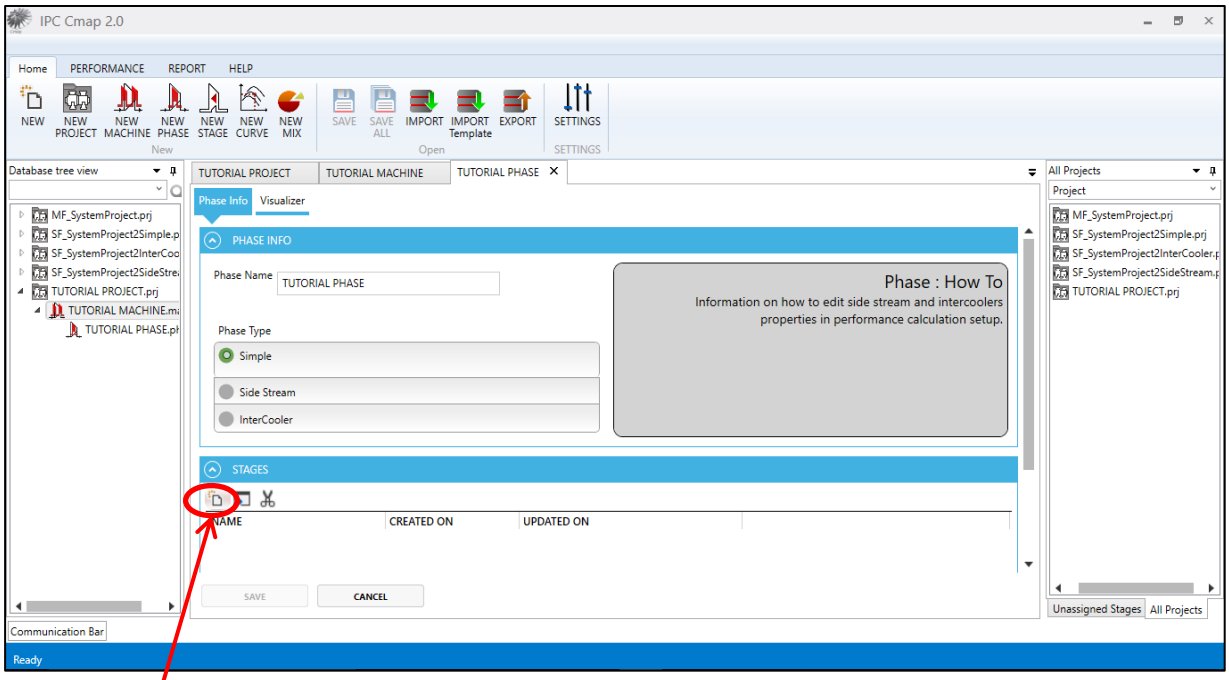
2. Creation of Machine

Click button **New** in MACHINES section to create a new Machine directly linked to upper project and rename it “TUTORIAL MACHINE”.



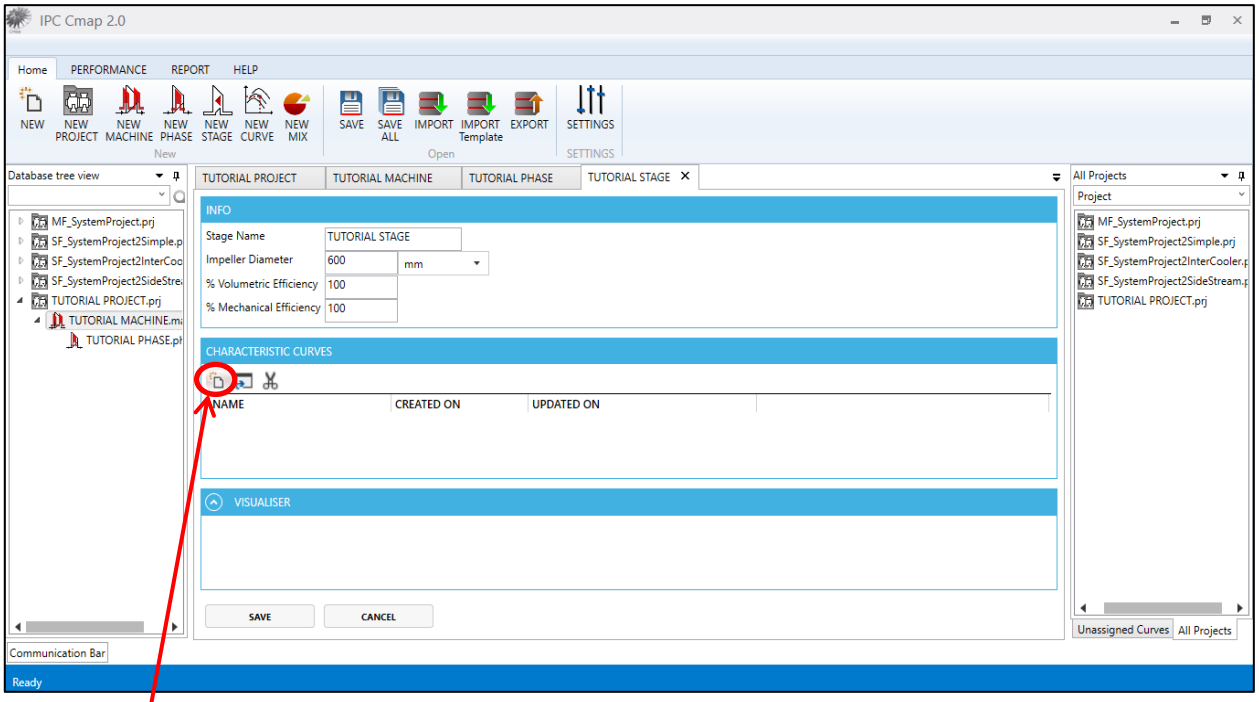
3. Creation of Phase

Click button **New** in PHASES section to create a new Phase directly linked to upper machine and rename it “TUTORIAL PHASE”.



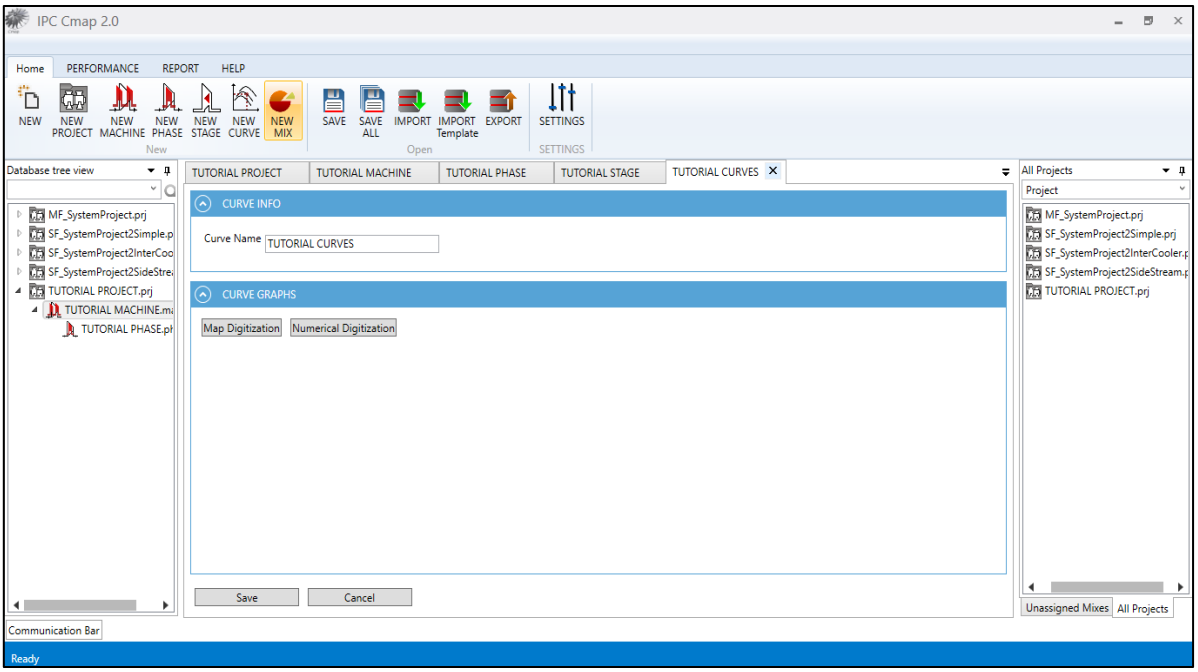
4. Creation of Stage

Click button **New** in STAGES section to create a new Stage directly linked to upper phase and rename it “TUTORIAL STAGE”, input Impeller diameter, mechanical efficiency and volumetric efficiency.



5. Creation of a Curve

Click button **New** in CHARACTERISTIC CURVES section to create a new Curve directly linked to upper stage and rename it “TUTORIAL CURVES”.



In CURVE GRAPHS section, you can upload the characteristic curves by 2 ways:

- Map Digitization, by digitizing graphically point of curves
- Numerical Digitization, by entering numerically point by point of curves

HOW UPLOAD THE MAPS

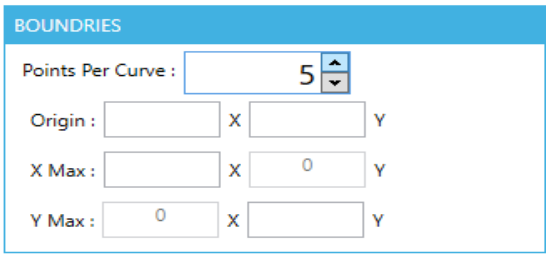
For this tutorial document, only Map digitization procedure is shown.
For numerical digitization, see Cmap2 User Guide.

Map digitization

To open the DIGITIZATION MAP window, click 'Map digitization' button in CURVE GRAPHS.

1. The first step is to upload the first map image (**BMP, JPEG, GIF, TIFF, PNG files**) clicking LOAD MAP IMAGE button.
   Through the roller of mouse is possible to zoom the image.

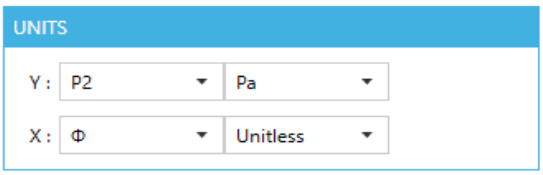
2. Uploaded the map, you have to fill the following fields in BOUNDRIES area:



- Points per Curve
- Origin X, Origin Y
- X Max
- Y Max

You have to fill Origin, X Max and Y Max fields according to indicated values in the map.

3. Then it need select what kind of map you are going to digitize in UNITS: you have to define the axis and relative units of the map uploaded:



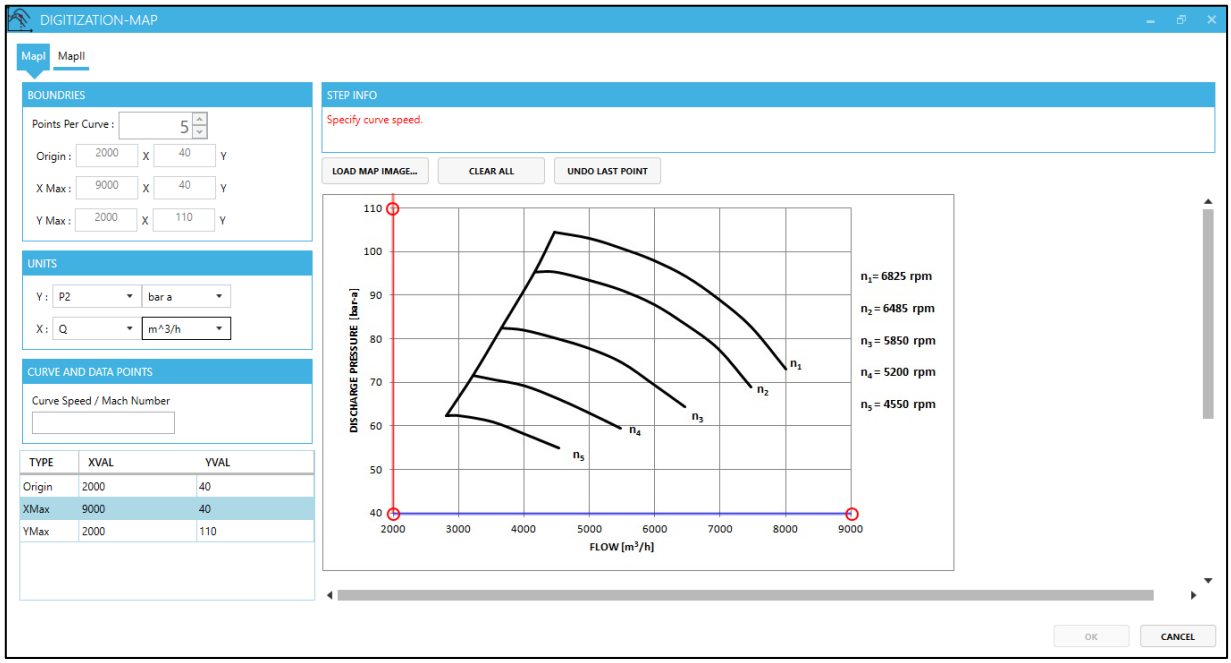
X axis, selecting between

a. Flow coefficient (ϕ)
b. Actual (Q) or Normal (Qn) or Standard(Qstd) volume flow
c. Mass flow (G)

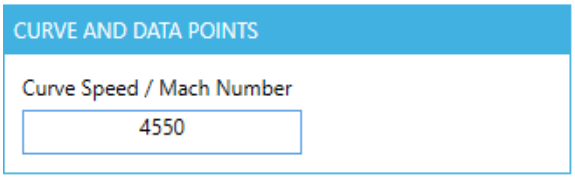
Y axis, selecting among :

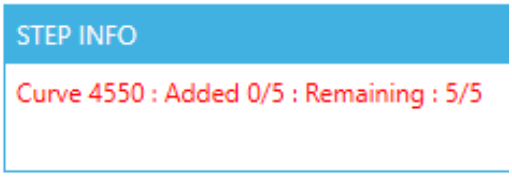
A. Discharge pressure (P2)
B. Discharge temperature (T2)
C. Compressor ratio (β)
D. Shaft Power (Pw)
E. Work coefficient (etaptau)
F. Polytropic Head (Hp)
G. Polytropic efficiency (etap)

4. Now it is possible to digitize Origin, X Max and Y Max points on the picture.



5. In order to digitize the map you have to define the speed (or Mach number if you have non-dimensional map) of the curves in CURVE AND DATA POINTS.



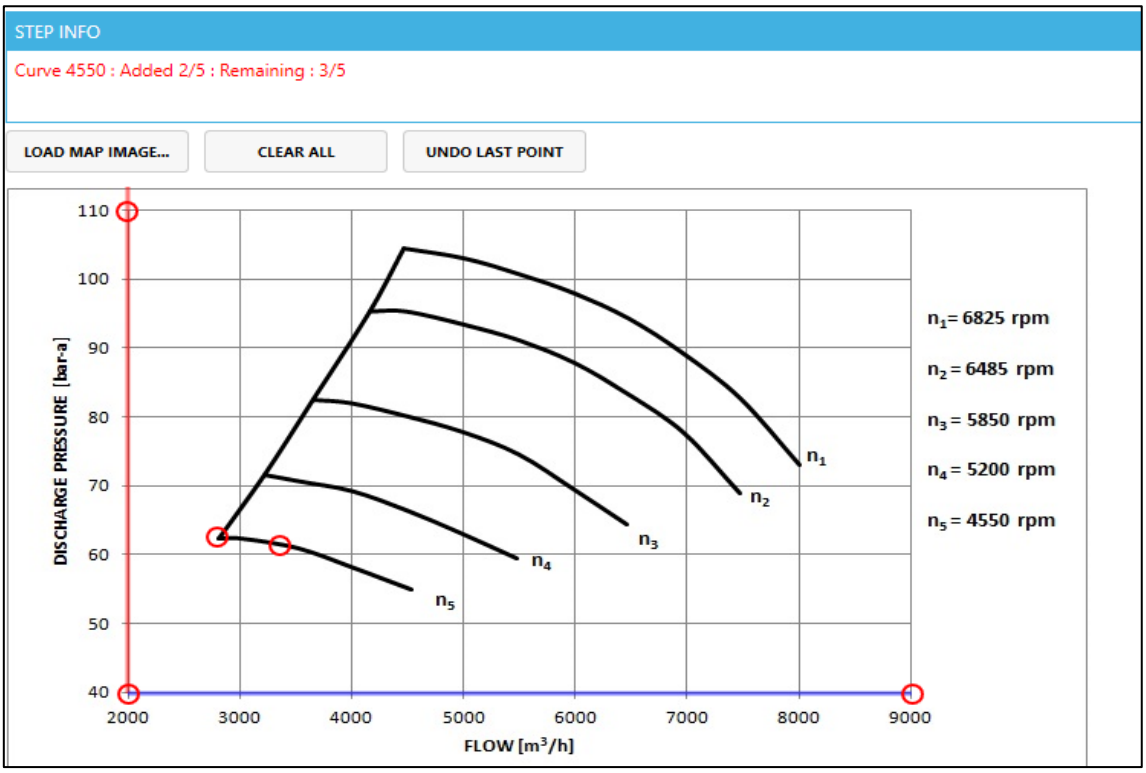


After you edited the 1st speed number (or Mach number), in STEP INFO there will be this message:

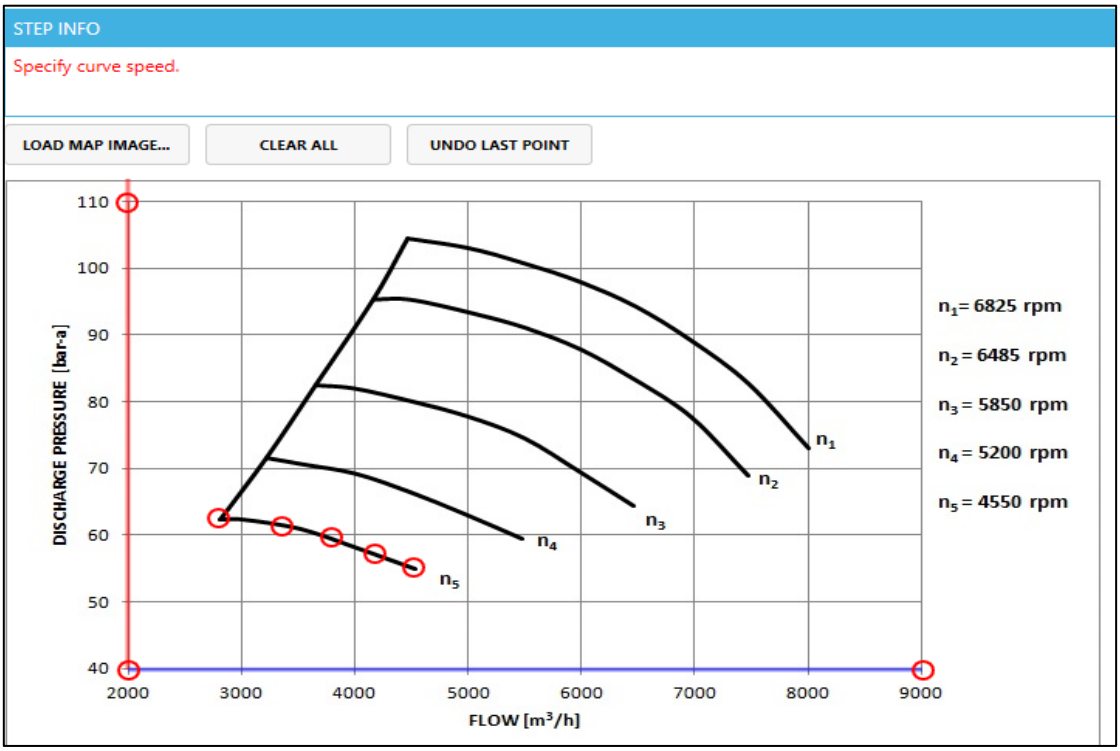
a resume of points already digitized (Added) and points to be digitized (Remaining).

6. Now you can digitize $N_{points_per_curve}$ for 1st curve.

For each point digitized, "Added" increase while "Remaining" decrease.

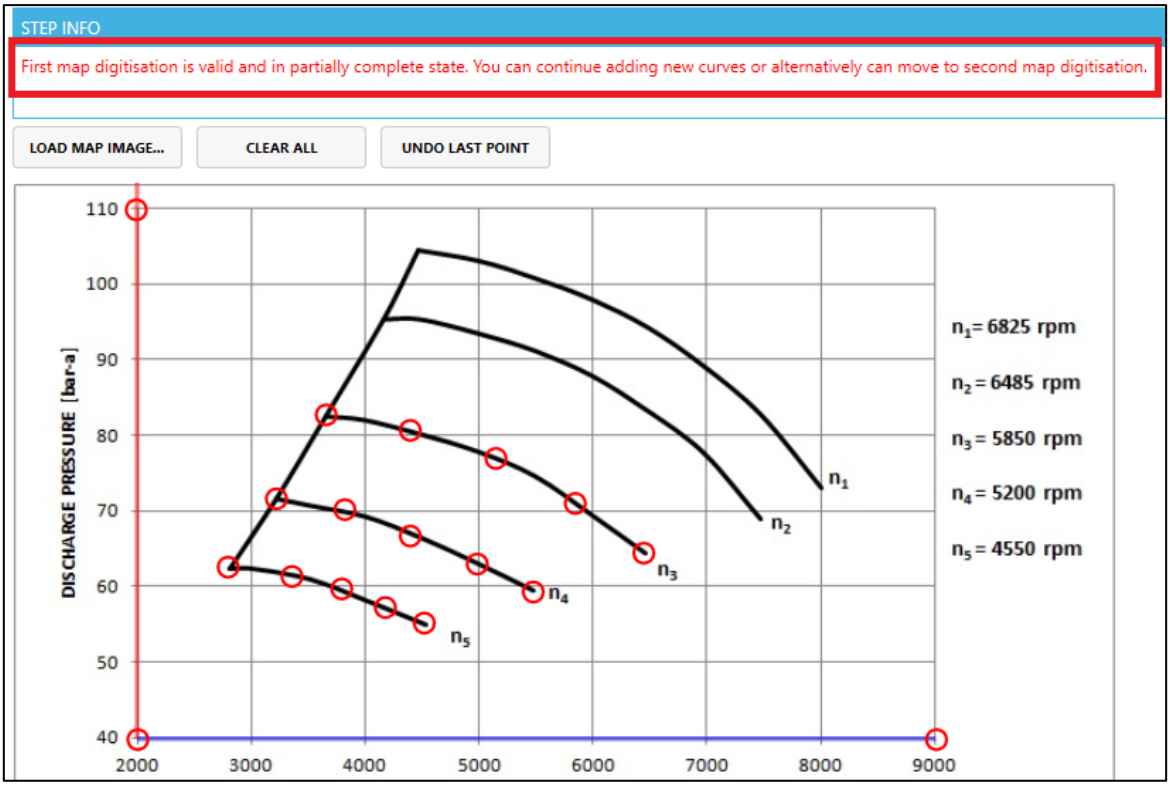


7. Once you digitized all the points of 1st curve, it need to specify the 2nd speed number (or Mach number) for 2nd curve, and so for the successive curves.



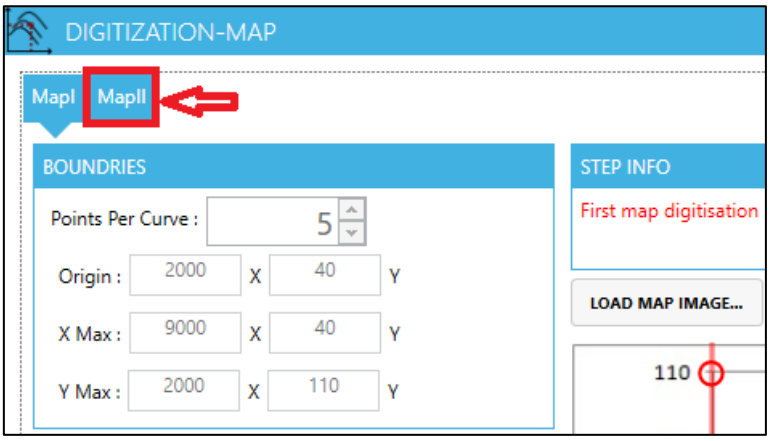
We remind that Cmap 2.0 need at least 3 curves to set correctly a centrifugal compressor.

When the 3rd curve is digitized, in STEP INFO there will be the following message:



8. a) If you want to continue digitizing new curves, you edit 4th speed number (or Mach number) and go on.

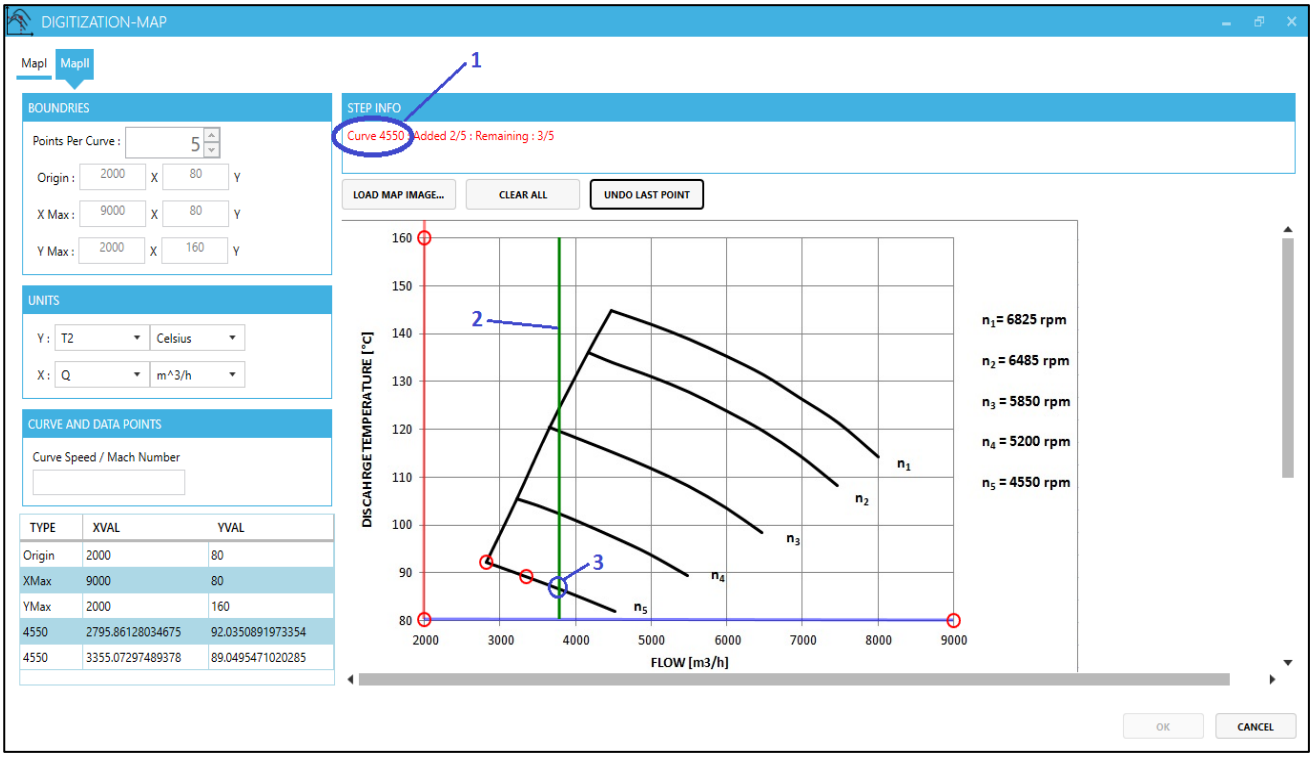
b) If you want to start the digitization of 2nd map, you should click "Map II" button.

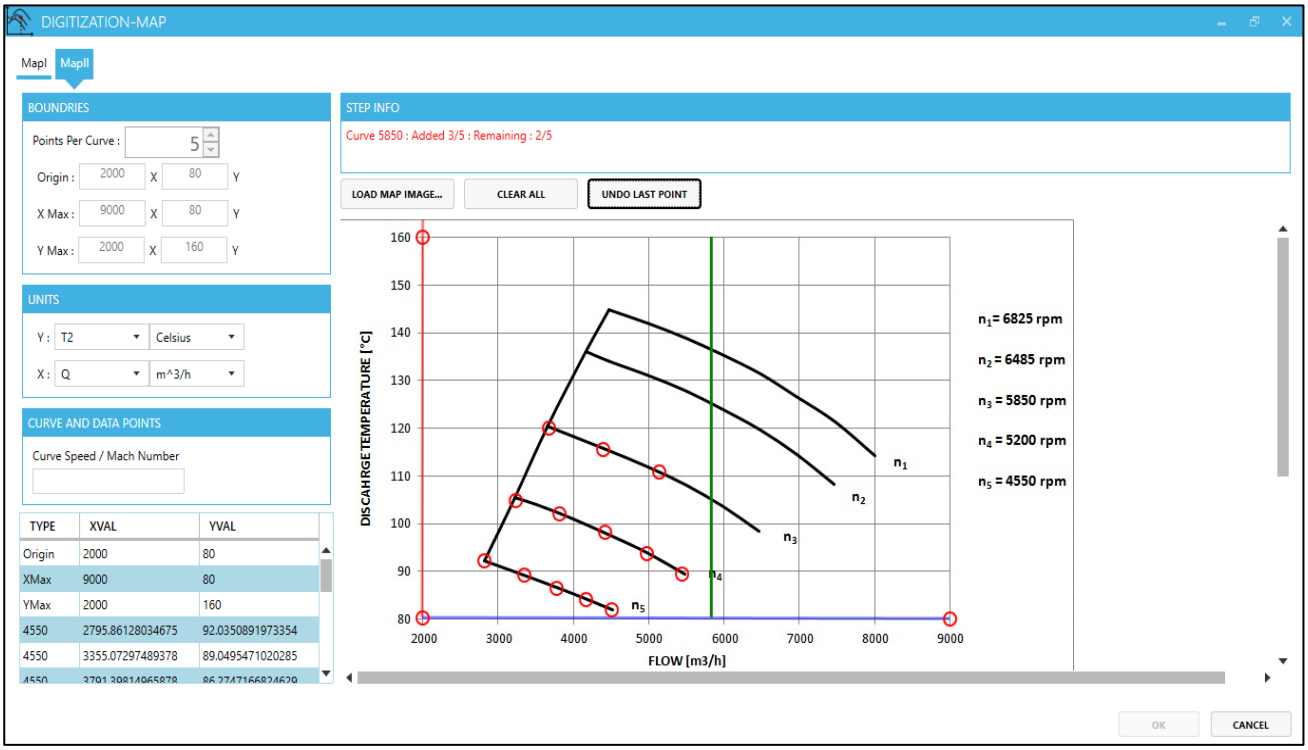


9. For the digitization of 2nd map you can follow the above procedure <u>from point 1 to point 4</u>.

10. After you digitized Origin, X Max and Y Max of 2nd map, a guided digitization will start:

1. You don't need to give speeds (or Mach number) for the curves, they are already stored;
2. A green line at X points fixed in the first curve will guide you to pick all Y points;
3. You have to click where the green line intersects with the curve.

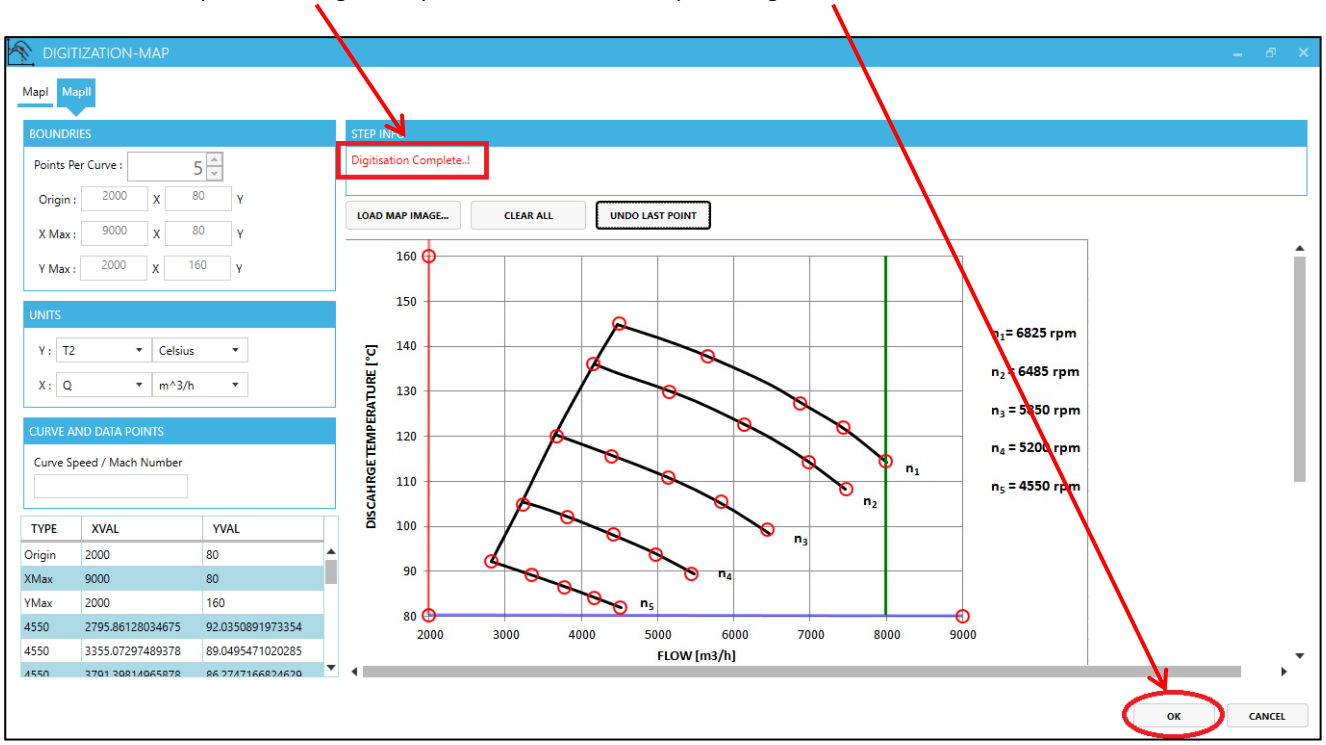


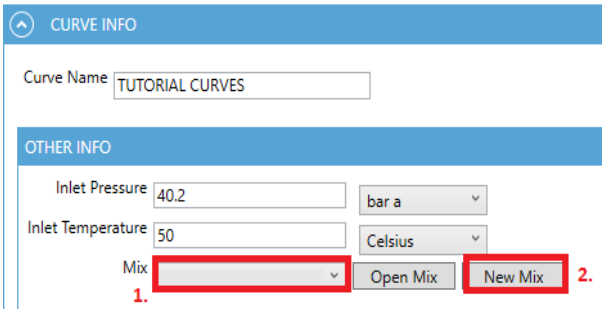


Through button 'CLEAR ALL' it is possible to clear all points digitized;

Through button 'UNDO LAST POINT' it is possible to clear last point digitized.

11. When all points are digitized, you can confirm the maps through “OK” button.





After you uploaded the maps, if you digitized 2 dimensional maps you have to edit the inlet conditions for these maps:

- Inlet Pressure, edit value and its unit
- Inlet Temperature, edit value and its unit
- Mix, assign a Gas mixture to the maps

To assign the Mix:

1. you can choose a previously created Mix from Drop Down Menu (also you can open the Mix through Open Mix button)
2. you can create a new Mix clicking New Mix button (see **Creation of a Mix** and **HOW CREATE A MIX** sections)

If you digitized non-dimensional maps, you don’t need to assign the inlet conditions.

6. Creation of a Mix

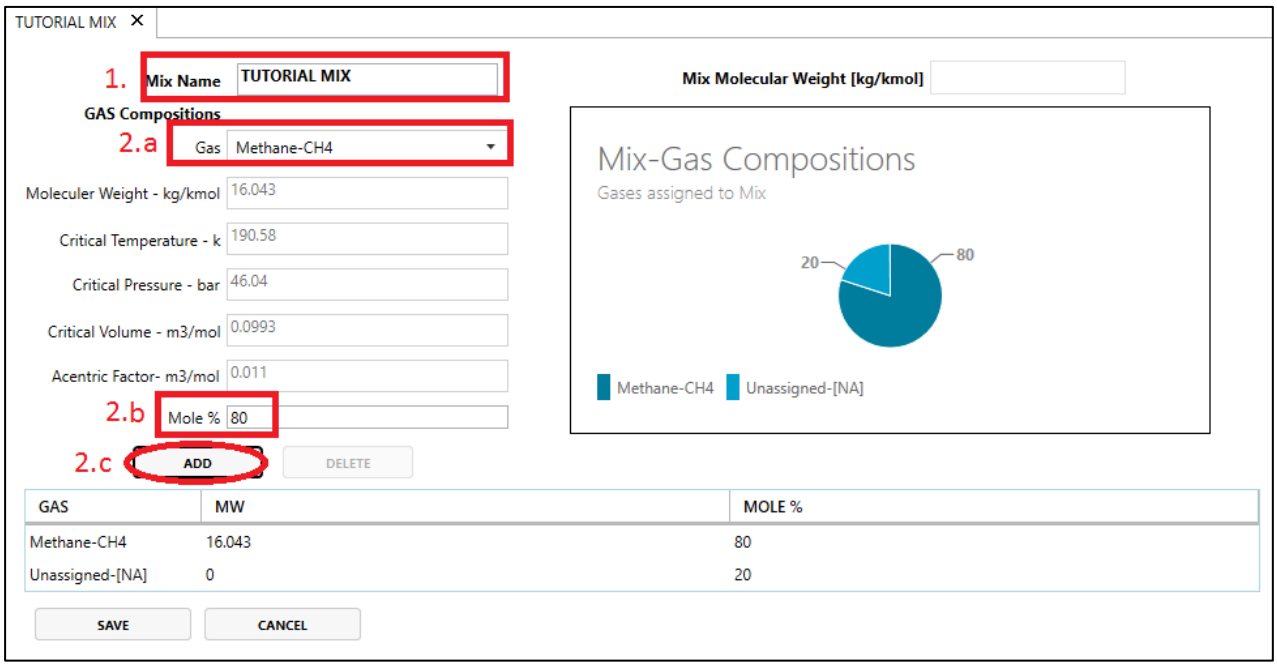
Click button New Mix in CURVE INFO section to create a new Mix directly linked to upper Curves and rename it “TUTORIAL MIX”.

The Mix window will be opened in Work Area.

HOW CREATE THE MIX

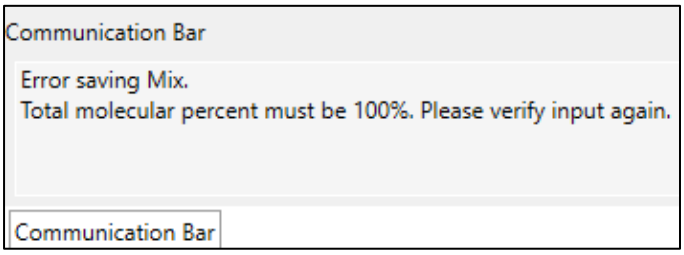
1. You can edit the Mix Name

2. Select the 1st gas compound of mixture (a), edit the MOLE % (b) and confirm through ADD button (c)



3. Repeat the point 2 for each compound of gas mixture. If you want clean a compound previously added, select it from “Assigned Compounds Area” and click DELETE button.

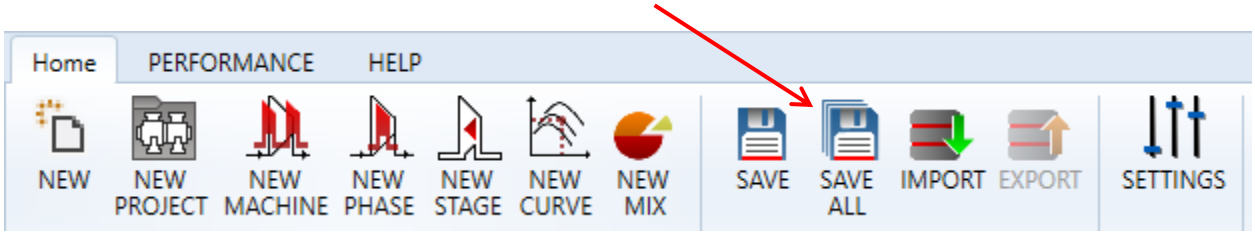
4. It is possible to save the MIX only if the “Unassigned” is 0% (100% assigned mix).



If you click SAVE button when Unassigned is > 0, you will read this message in Communication Bar (clicking “Communication Bar” to show its message)

5. Reached the 100% assigned, click SAVE button to save the MIX object in Cmap2 Database.

After creation of Mix, you can Save all items through SAVE ALL button from ribbon bar.



The Compressor Configuration ended.

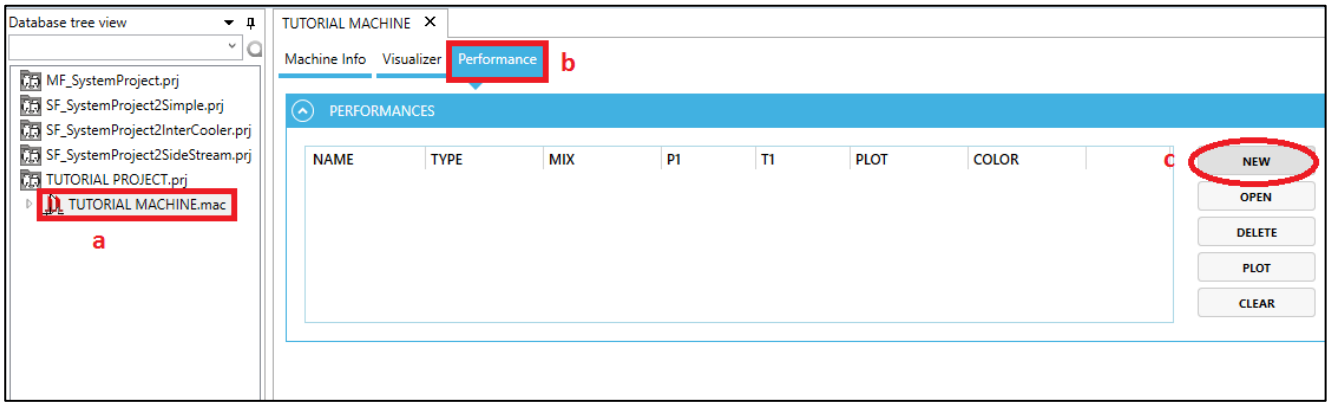
NEW PERFORMANCE CALCULATION

In this section we will show you how to start the performance evaluation. This task will include the following steps:

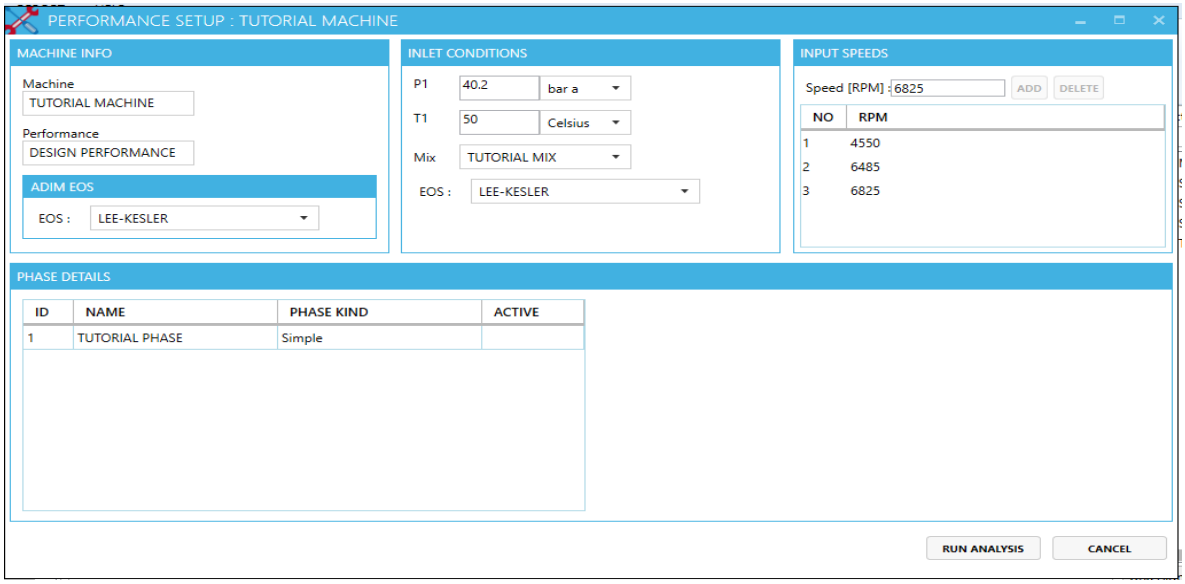
a) Define one or more gas mixes (through NEW MIX button) needed for the calculation of performance in the new conditions and save it or them
b) Launch the calculation tool

For point a) see **HOW CREATE A MIX** section.

To start a performance evaluation of a MACHINE (already created)➔ open the MACHINE (a), choose the "Performance" Tab (b), click button "NEW" (c).



The PERFORMANCE SETUP form will be opened:



Once the pop-up opens:

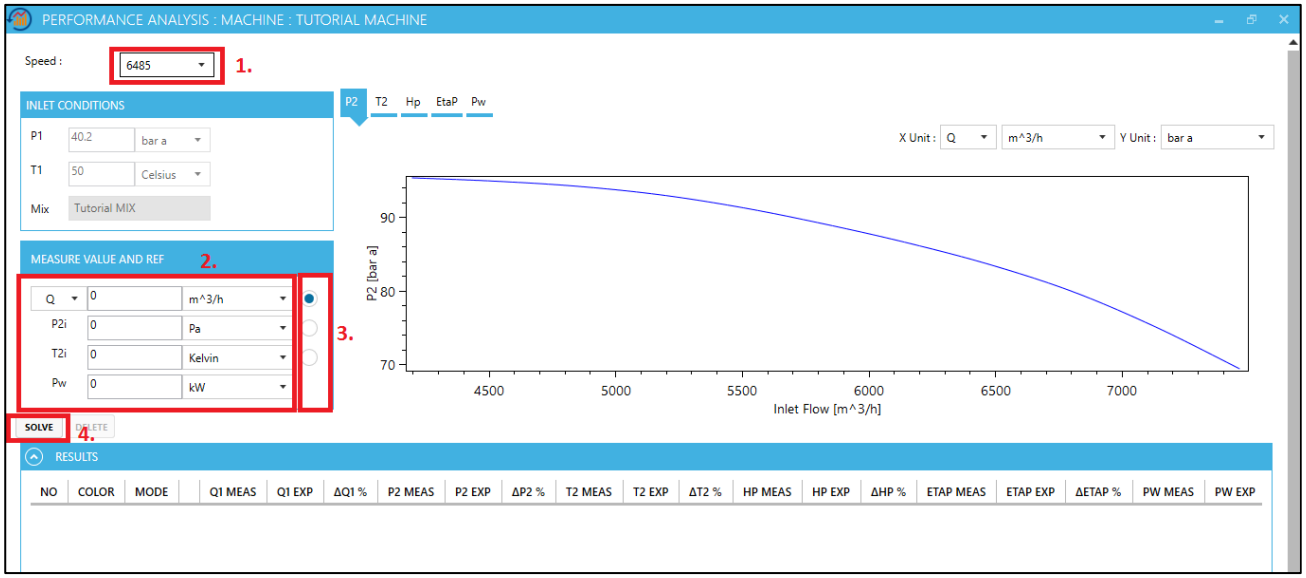
1. edit the name of the performance in MACHINE INFO Area;
2. define ADIM EOS to model (non-dimensional) the compressor: this EOS is linked to **design mix**. For this reason:
    a. **if design mix is a Hydrocarbon mixture you have to select between Lee-Kesler or Peng Robinson EOS.**
    b. **if design mix is Freon R134a you have to select R134a EOS**
3. input new INLET CONDITIONS:

a. new inlet pressure (P1)
b. new inlet temperature (T1)
c. new gas mixture (Mix), previously created

4. define EOS to calculate the performance: this EOS is linked to **off design mix**. For this reason:
   a. **if off design mix is a Hydrocarbon mixture you have to select between Lee-Kesler or Peng Robinson EOS**
   b. **if off design mix is Freon R134a, the software selects automatically R134a EOS**
5. input one or more custom RPM and click ADD to confirm in INPUT SPEEDS Area:
   a. **(!) in case of more RPM they must be input in increasing order**
6. If you want to delete a speed number you have to select it and click DELETE button
7. Click RUN ANALYSIS button to start calculation

The PERFORMANCE ANALYSIS form will be opened.

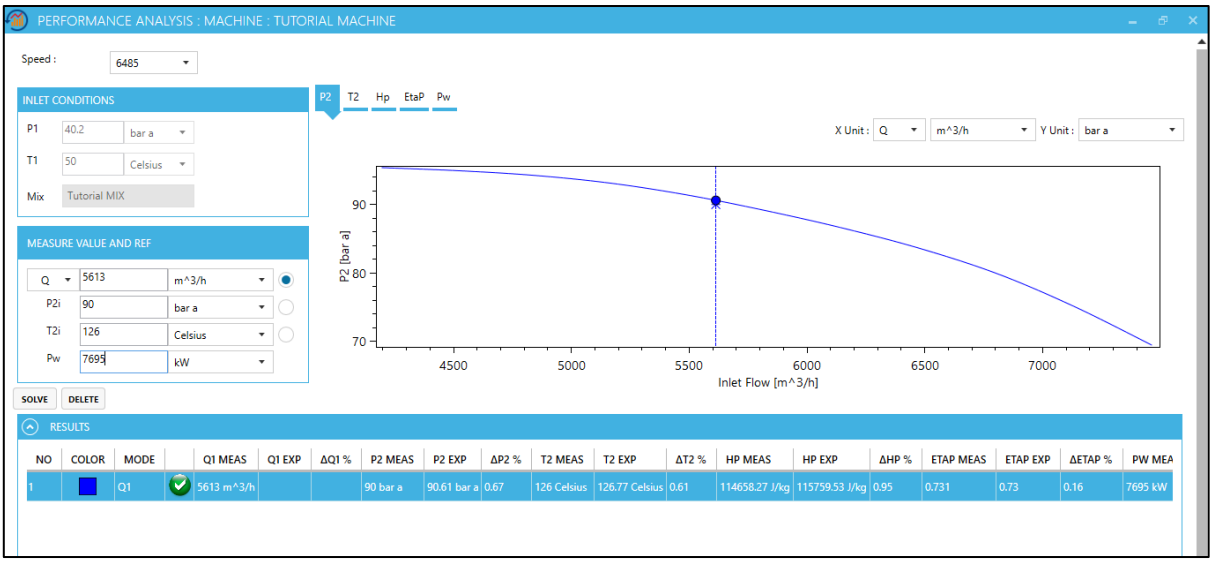
PERFORMANCE ANALYSIS



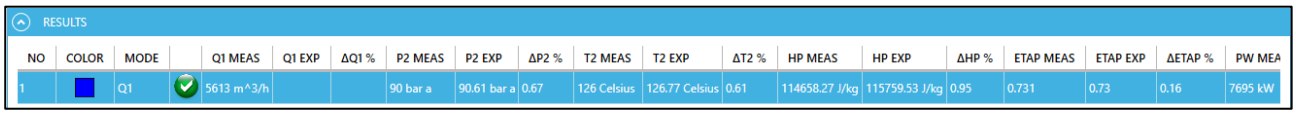
Through this tool you can compare the measured values (from field or a shop-test) with the expected ones from performance Cmap calculation.

To obtain this comparison you have to:

1. Select the speed number of centrifugal compressor
2. Edit the measured values and relative units from transmitters in terms of
   - Inlet flow (Q or Qn or Q std or G)
   - Discharge pressure p2
   - Discharge temperature T2
   - Shaft Power Pw
3. Flag the reference measured value (Q1 or p2 or T2) to calculate performances
4. Click SOLVE button.



As the point 3 describe, the software offers the possibility to make checks with reference to measured inlet flow or pressure or temperature.

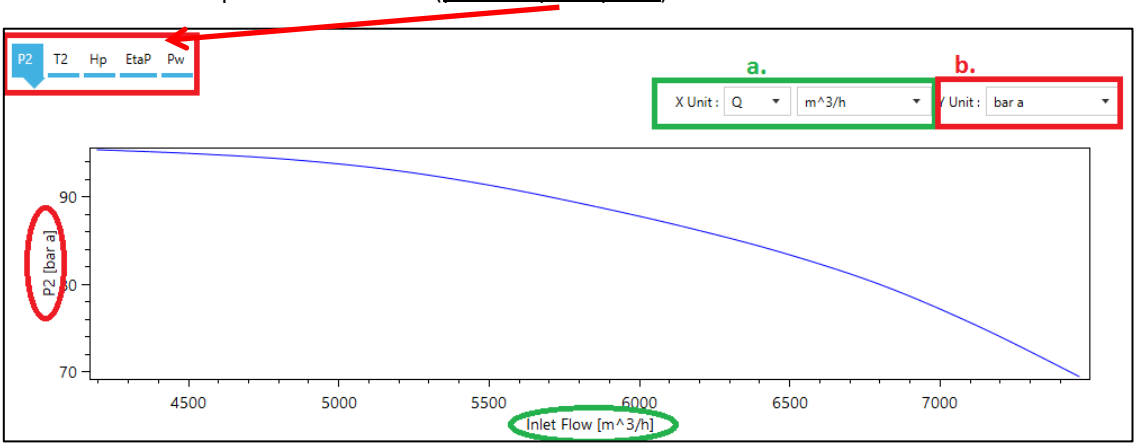


In RESULTS, it's possible to see the expected and measured values of:

- inlet flow (Q or Qn or Q std or G)
- Discharge pressure (p2)
- Discharge temperature (T2)
- Polytropic Head (Hp)
- Polytropic efficiency (Etap)
- Shaft Power (Pw)

and their comparison through the calculation of percentage error. Also you can see the analyzed point in the charts.

There is one chart for each performance curve (p2, T2, Hp, Etap, Pw).



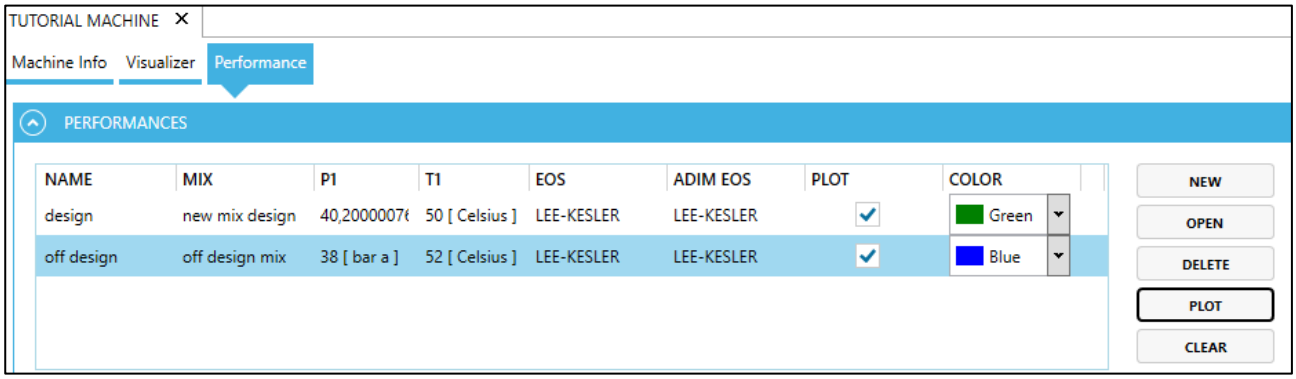
You can define:

a. the inlet flow type and its unit for X Axis (X Unit)
b. the unit of measure for Y Axis (Y Unit)

Clicking REPORT button you can also simply report the results through PDF format.

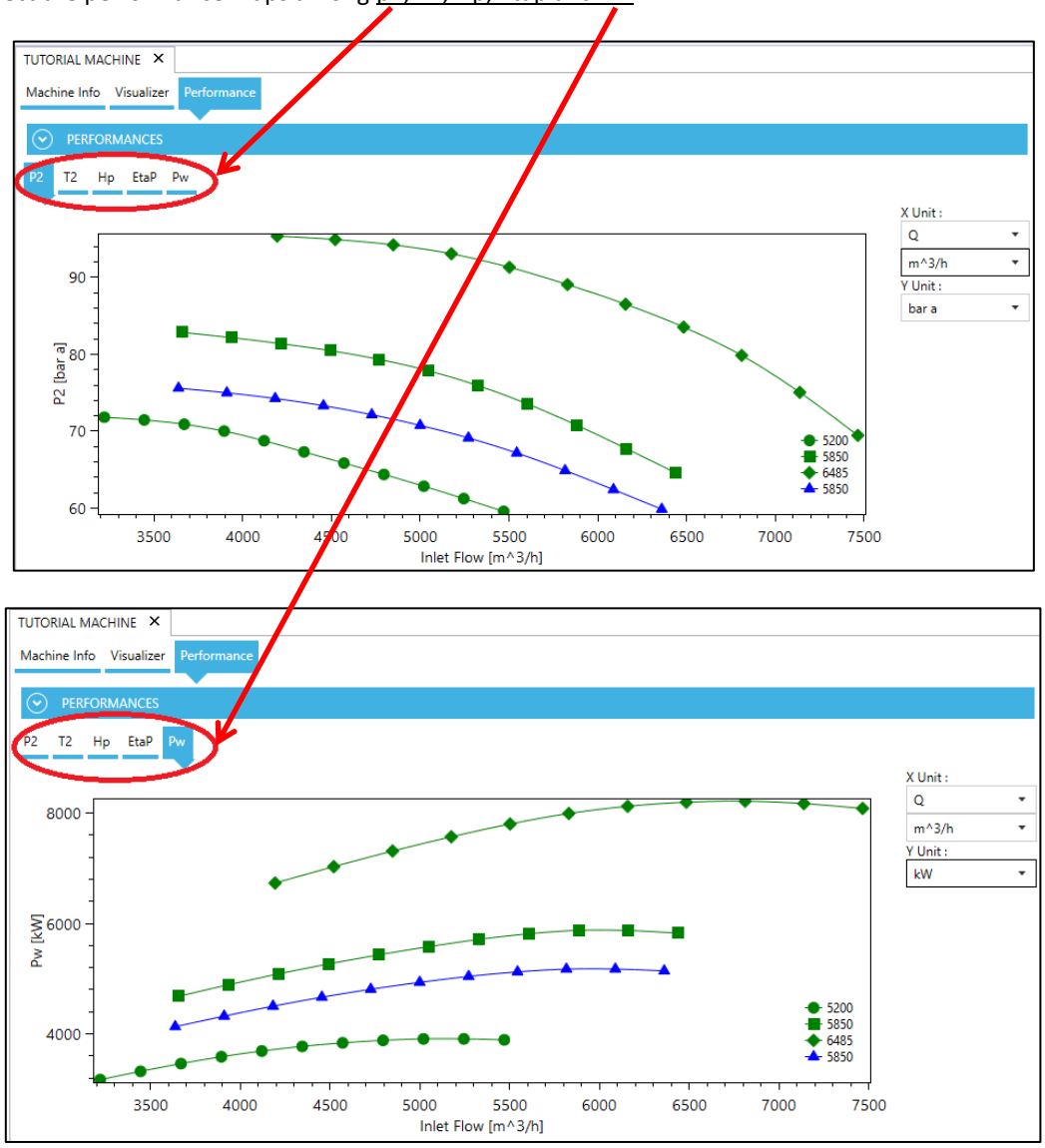
PLOT OF PERFORMANCES

In PERFORMANCES, you can plot two or more performances simultaneously.



Flag in the column PLOT one or more Performances, click PLOT button and the Curves are shown.

You can select the performance maps among p2, T2, Hp, Etap and Pw.



SUPPORT AND ASSISTANCE

If you have got any problem or for any additional info we invite you to contact us at the following addresses:

IPC Srl - Industrial Plants Consultants

www.ipc-eng.com

Via Paradiso, 18/F

70026 Modugno (BA), Italy

cmapsupport@ipc-eng.com