2021

[CMAP 2.0 software User guide]-rev12.1

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 User Guide
IPC
30/08/2018

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INTRODUCTION

CMAP Centrifugal Compressor performances evaluation tool is a software designed and produced in IPC laboratories. CMAP is a software for windows machines, designed to perform easily and quickly centrifugal compressors performance evaluations.

This software was developed to be the most user-friendly possible and it has been built to give to the centrifugal compressor analyst or industry user a powerful and easy tool to predict the machine performances out of specification conditions.

To use CMAP, the starting point is the availability of a centrifugal compressor performance map, along with the relevant gas mix composition and thermodynamic condition (pressure and temperature). Having this inputs data available, the software will perform all complex calculation in fully automated way and will produce the expected compressor performances for inlet pressures, inlet temperatures and gas mix compositions different for design/reference ones.

The software is easy and intuitive and will provide also automatic storage of data in a project archive for quick consultation. Evaluation of differences from expected performances will be a powerful tool to support diagnostic and maintenance decisions.

CMAP is based on the latest machinery modeling approach and embeds the most advanced thermodynamic theories for prediction of real gas mixtures properties. CMAP has been designed to guide the user through streamlined workflows aimed to perform complex analysis making available to the user software calculation capabilities in a very simple way.

It is very important to note that CMap predictions speed range depends on the Mach extension range of original reference data. It extracts from reference / input available data the MACH NUMBER range. When the software calculates off-design performances this Mach range is used to generate the new speed range according to actual off-design inlet conditions. The final range of speed number depends therefore on actual inlet condition and from the gas mix composition. If new inlet conditions are very far from design/reference ones (e.g., new Molecular weight is very different from reference mix M_W) Mach number may exceed the available Range and consequently CMap software may not provide the desired output.

This guide describes the basic procedures of CMap 2.0.

CMap 2 is the new release of CMap software that embeds many improvements over the previous one. Some of additional features of CMap2 are:

- Generalized input: the user can input the compressor reference data in many formats leaving to the software the duty to convert and transform in the CMap native format.
- Possibility to use several new EOSs
- Possibility to configure multiphase machines
- Machine train calculation (side stream and heat exchangers)
- Possibility to configure single impeller
- Guided wizards for quick machine configuration
- Extended units (SI and Imperial)
- Several additional gas components

CMap 2.0 implements the following equation of state:

- Lee-Kesler (LK)
- Peng-Robinson (PR)
- Modified Benedict-Webb-Rubin (MBWR) for Freon R134a

42 most common hydrocarbons can be configured for gas mix composition.

Item	Gas name:	Symbol
1	Acetylene	C_2H_2
2	Ammonia	NH_3
3	Argon	Ar
4	Benzene	C_6H_6
5	Iso-Butane	C_4H_{10}
6	n-Butane	C_4H_{10}
7	Iso-Butylene	C_4H_8
8	Carbon Dioxide	CO_2
9	Carbon Monoxide	CO
10	Chlorine	Cl_2
11	n-Decane	$C_{10}H_{22}$
12	Ethane	C_2H_6
13	Ethyl Acohol	C_2H_5OH
14	Ethylene	C_2H_4
15	Helium	He
16	n-Heptane	C_7H_{16}
17	n-Hexane	C_6H_{14}
18	Hydrogen	H_2
19	Hydrogen Chloride	HCL
20	Hydrogen Sulphide	H_2S
21	Methane	CH_4
22	Methyl Alcohol	CH_3OH
23	Nitrogen	N_2
24	n-Nonane	C_9H_{20}
25	Iso-Pentane	C_5H_{12}
26	n-Pentane	C_5H_{12}
27	n-Octane	C_8H_{18}
28	Oxygen	O_2
29	Propane	C_3H_8
30	Propylene	C_3H_6
31	Sulphur Dioxide	SO_2
32	Water Vapour	H_20
33	1-Butene	C_4H_8
34	2-Butene	C_4H_8
35	1.3 Butadiene	C_4H_6
36	Ethyl chloride	C_2H_5Cl
37	Methyl Chloride	CH_3Cl
38	Pentylene	C_5H_{10}
39	Propadiene (Allene)	C_3H_4
40	Methyl Acetylene (Propyne)	C_3H_4
41	Toluene	C_7H_8
42	Freon R134a	CH_2FCF_3

Advanced real gas properties are used for calculation of gas and machine performance. All properties are dependent from each gas mix composition, this means that properties modifications caused by changes of every single gas component are considered by the software.

Possible applications of the software are:

- Performance analysis
- Efficiency deviation trend (machine performance-based monitoring systems)
- Maintenance schedule
- Advanced anti-surge control systems
- Anti-surge checks
- Inspections
- Investigations and RCAs

Basic operation procedure

CMap is easy and intuitive, the basic workflow consists of very few steps:

- machine configuration
- performance calculations
- analysis and reports

All machine data, inputs and calculations are stored in a database and available for user reference and consultation.

In CMap the user can configure the machine providing compressor reference data in several ways:

- Numerical input
- Graphical input

Once the reference data have been stored in the software database it's possible to recall and use it for calculation of the compressor performance in actual operative conditions.

The following paragraphs will provide more detailed instruction on how to operate the software.

Notes:

1) CMap 2.0 doesn't solve the multiphase machine and multistage phase.

GENERAL SYSTEM REQUIREMENTS AND RECOMMENDATIONS

This topic specifies the minimum hardware configurations required by CMAP and the operating systems on which CMAP is supported. In general, the better the hardware configuration of your computer, the better your experience with CMAP will be.

The software is designed with the intention to offer a good user experience also with minimum software and hardware requirements, to execute also on out-of-date computers.

Attention to the following areas can make a significant improvement to your overall experience and enjoyment of the software:

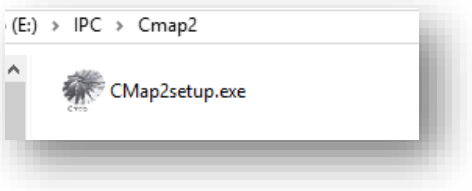
- Minimum CPU speed of 1.33GHz.
- Microsoft Windows 7 with Service Pack 1 or higher (Microsoft Windows 8, Microsoft Windows 10).
- 512 MB of RAM.
- 250 MB of available hard-disk space for installation.
- 1024 x 768 display (1280 x 800 recommended) with 16-bit color
- A high-quality OpenGL graphics card can make a significant difference to the graphics performance.
- CMap is supplied on DVD. DVD-ROM drive is recommended. USB key option is possible

- CMap software doesn't operate without Sentinel HASP Hardware key. The key is sold with the software
- An important requirement is related to the user rights on installation PC: the user must have administrator rights because CMap1.0 must be run with administrator privileges
- Mouse - although not strictly necessary, a three-button mouse or a two-button mouse with a wheel is strongly recommended. Such a mouse facilitates the manipulation of many of the views used.

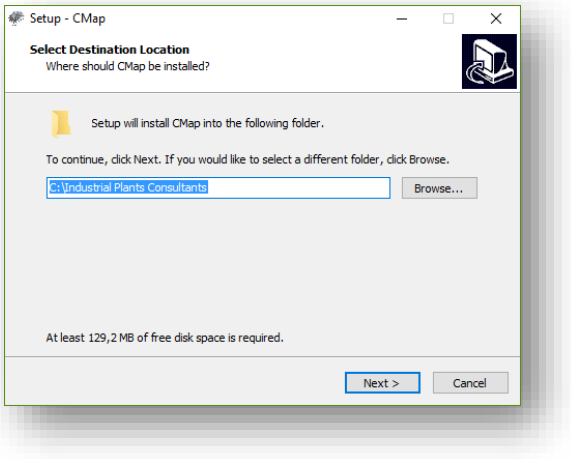
INSTALLATION

To install CMAP you can follow below instructions:

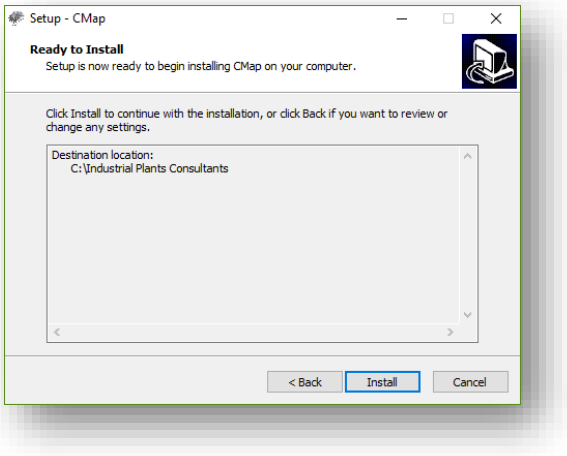
1. Insert installation CD or installation USB key.
2. Open installation support folder. You can find the CMap2.0 installation setup file: CMap2setup.exe (see picture below)



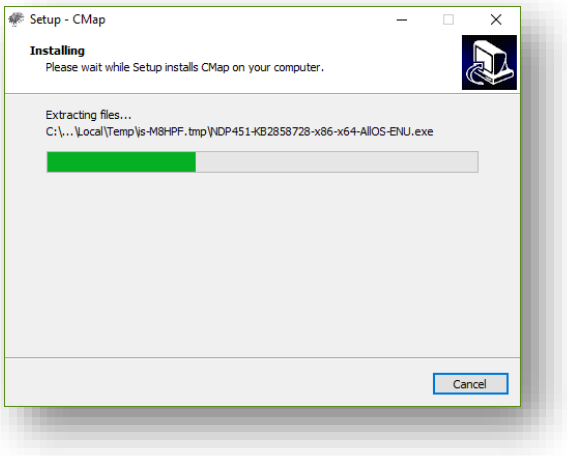
3. Double-click CMap2setup.exe: the CMap2 setup assistant starts.



Accept the default installation folder or click **Browse** to select a different one. If the folder does not exist, the installer creates it. After making your selection, click **Next**, and the follow windows appear.

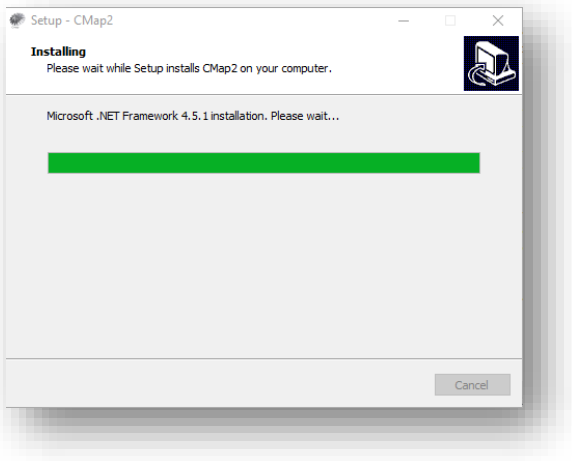


Click Install and the installation procedure starts:

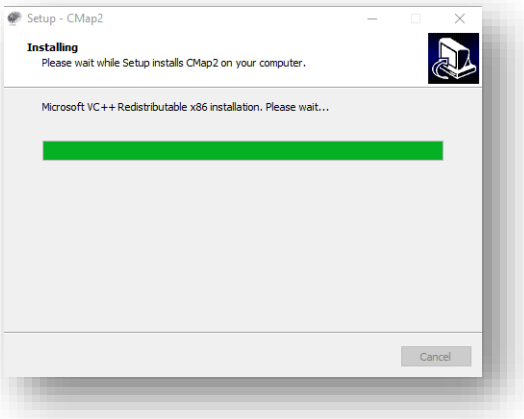


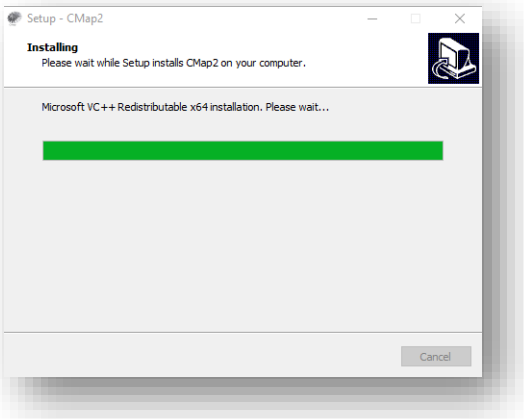
4. The software wizard installs the following components, in order:
    a. Microsoft .NET Framework 4.5.1
    b. Microsoft Visual C++ Redistributable
    c. SQL server compact edition 4.0
    d. CMap2 Window Service
    e. CMap2 GUI (Graphical User Interface)
    f. Sentinel HASP Key driver

a. **Microsoft .NET Framework 4.5.1**

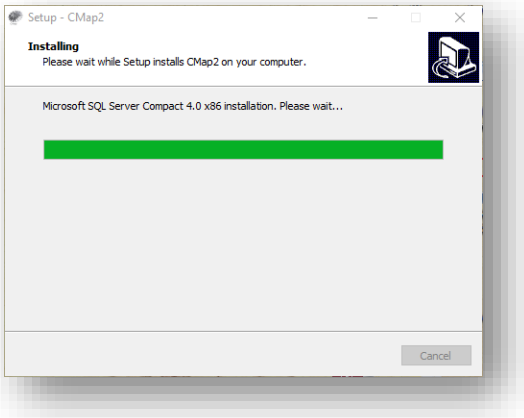


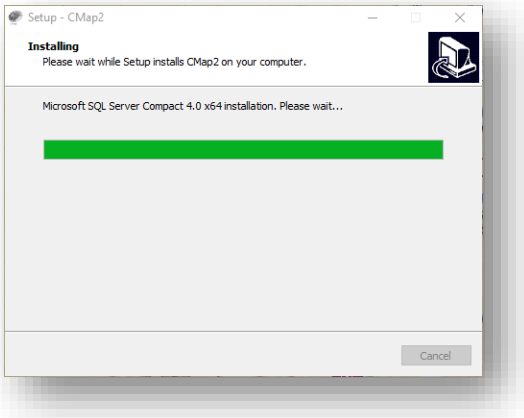
b. **Microsoft Visual C++ Redistributable**: the software wizard will try to install x86 and x64 component version. If your system is x86 operating system, the x64 component version will not be installed (if the wizard returns "*x64 installation package is not supported on x86 Operating System*" click on "*OK*" button and the setup will proceed with installation procedure).



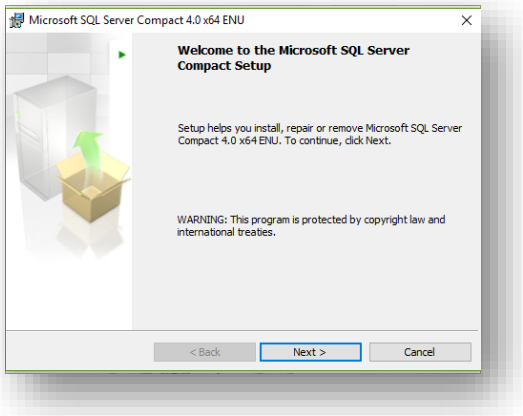


c. **SQL server compact edition 4.0**: the software wizard will try to install x86 and x64 component version. The wizard will only install the right version for your system.

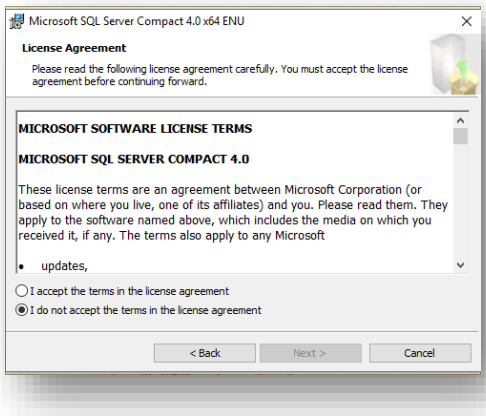




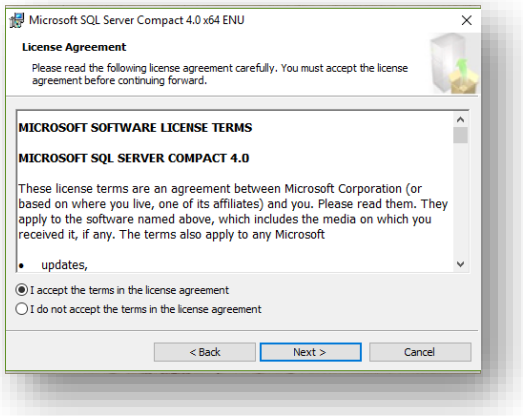
The Microsoft SQL Server Compact 4.0 wizard starts, the steps are shown below:



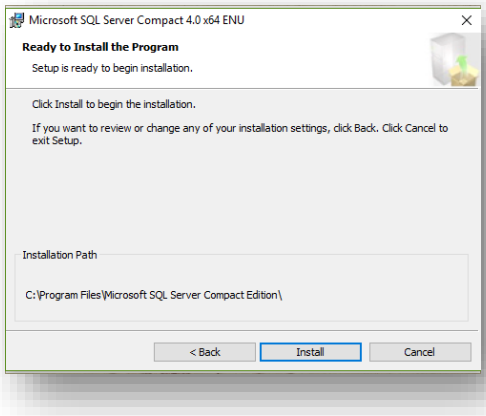
Step 1: Click Next



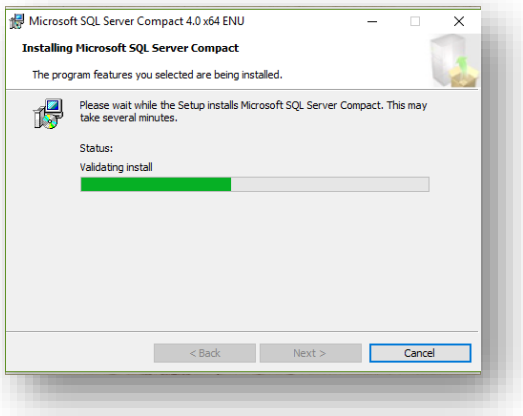
Step 2: Read license terms



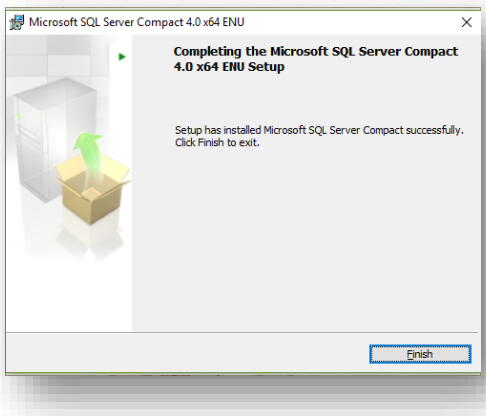
Step 3: Accept the terms in the license and click Next



Step 4: Click Install to begin the installation



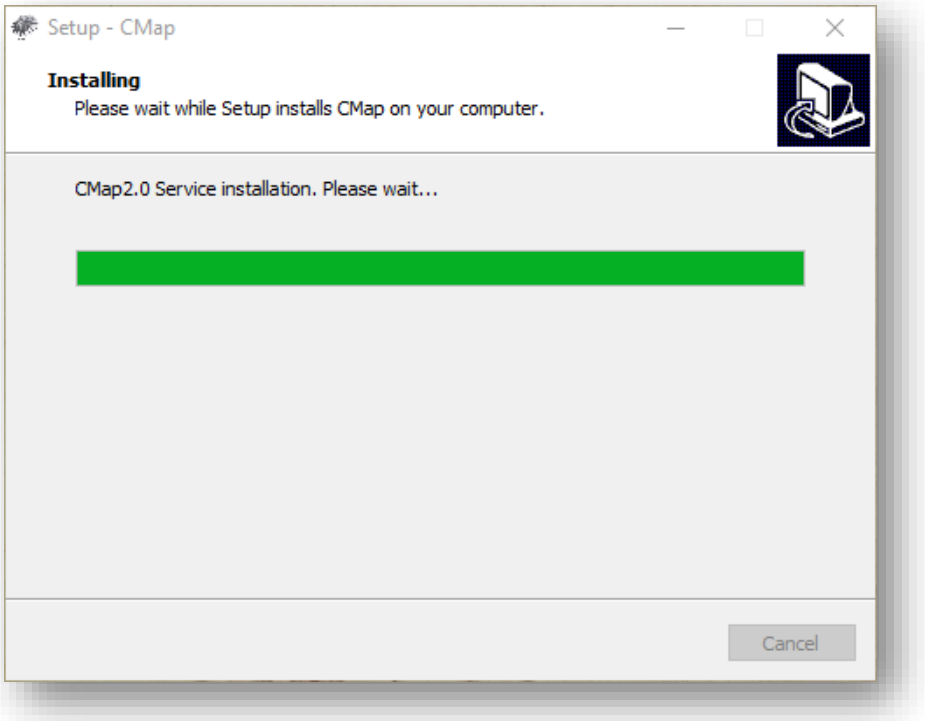
Step 5: The wizard installs Microsoft SQL Server Compact

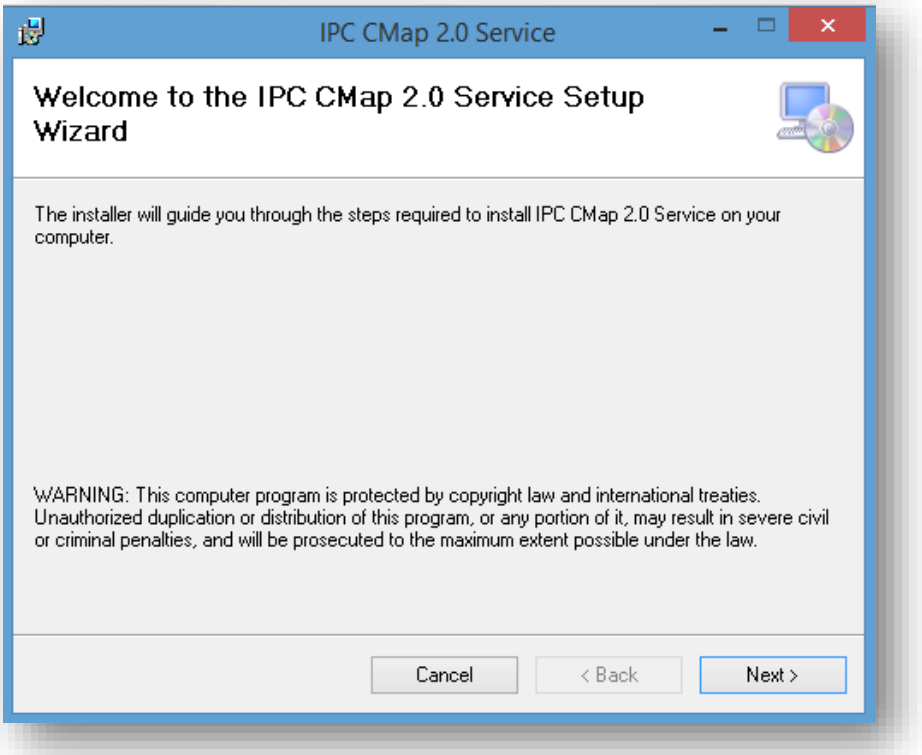


Step 6: The installation is finished, click Finish

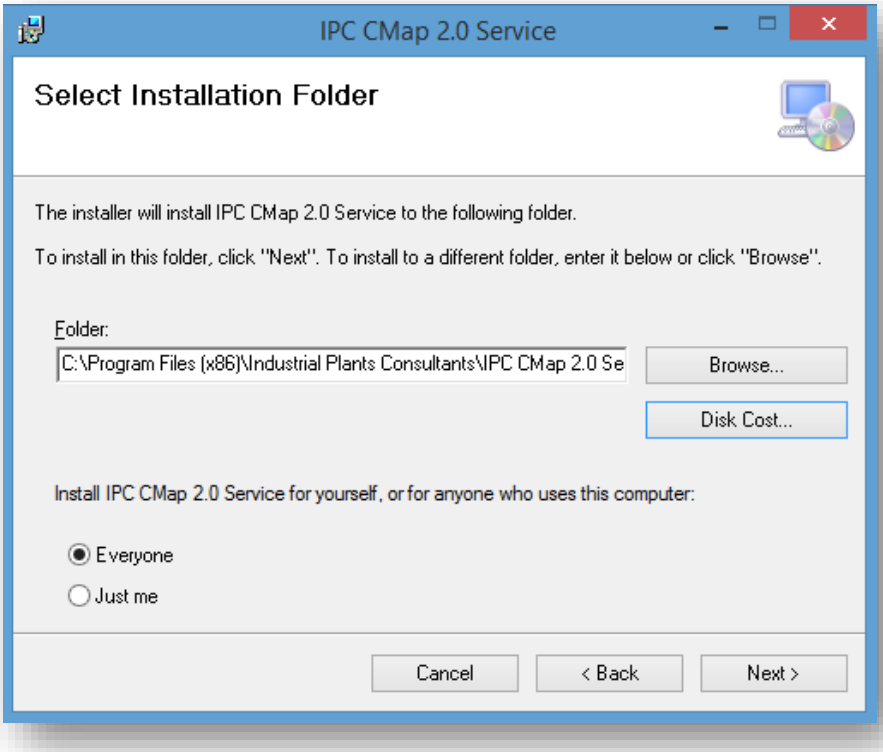
a,b and c are prerequisites. The following points show how the wizard installs the CMap2.0 Service and CMap2.0 GUI.

d. CMap2 Window Service (not used with CMap2.0 Trial Version)

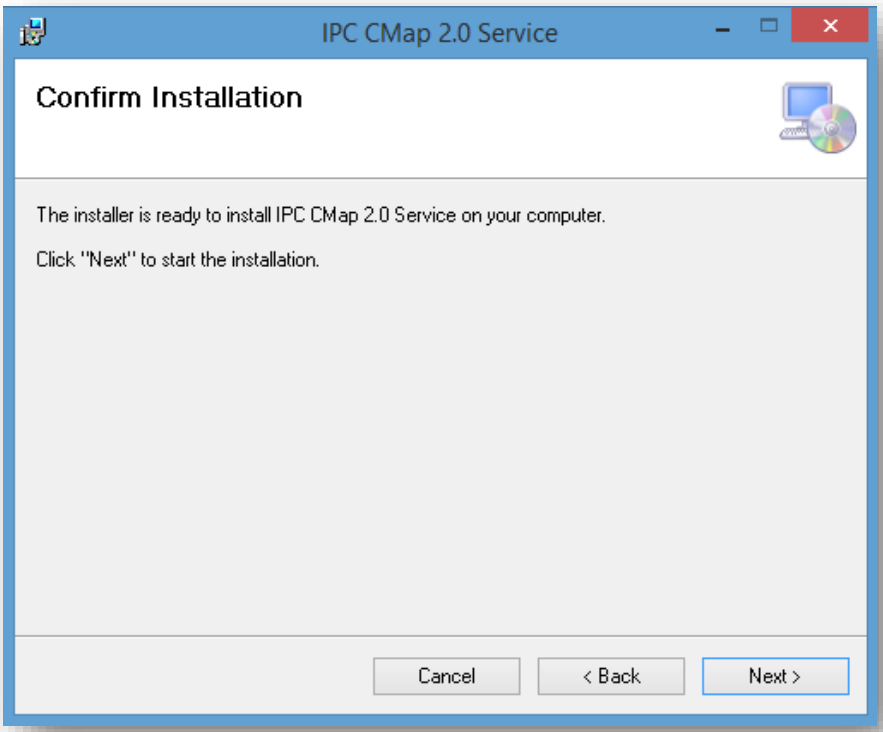




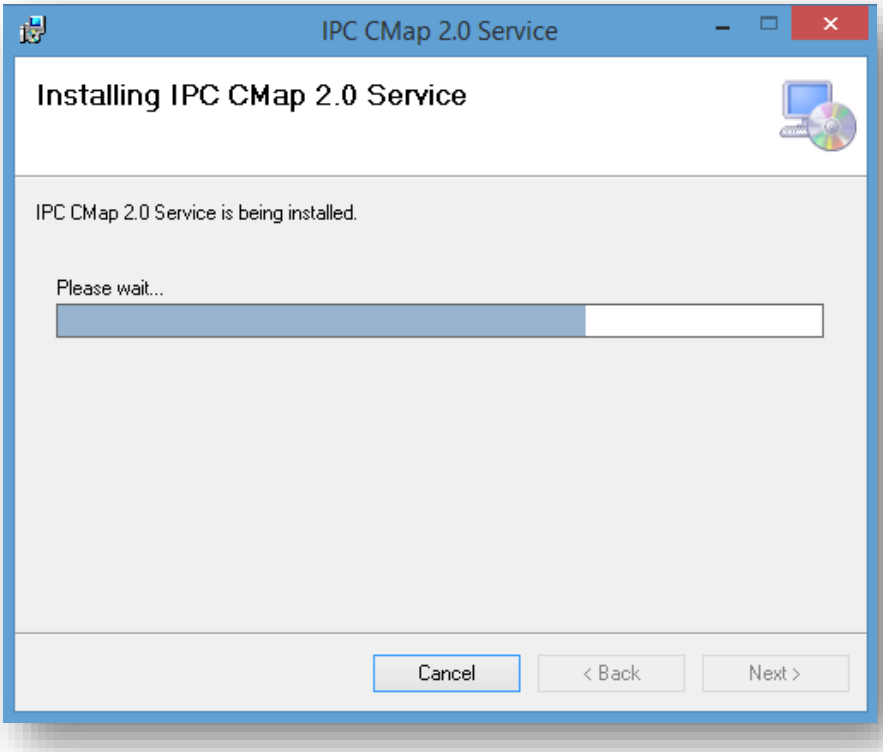
Read the Warning and click *Next*, the following window appears:



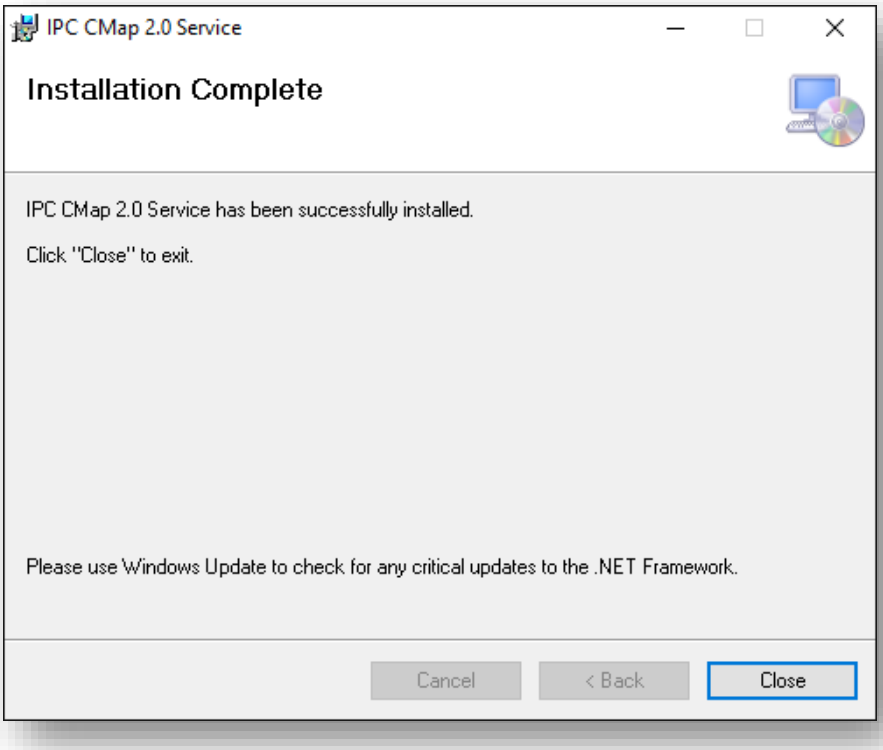
Choose installation folder and user setting and click *Next* , the Confirm Installation window appears:



Click *Next* to continue and the installation starts:



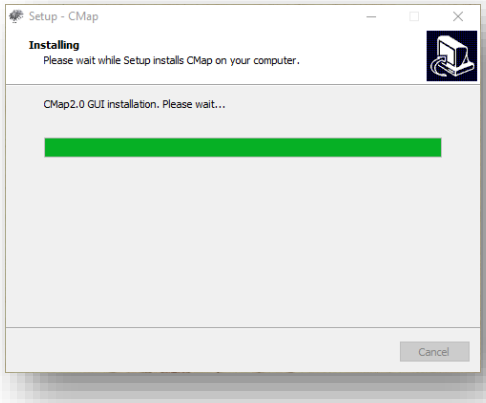
When the service installation ends, the following window appears:



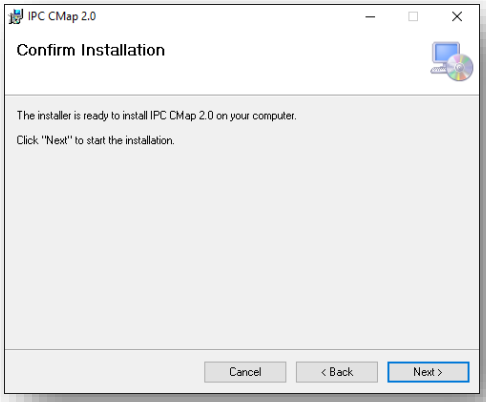
The service installation is completed click close and exit from service installation procedure.

e. CMap2 GUI (Graphical User Interface)

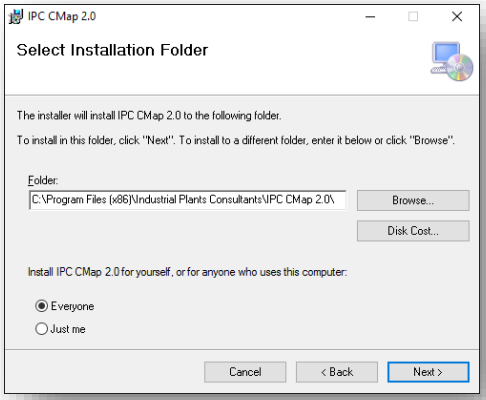
The GUI installation procedure is similar to Service installation, the steps are shown below :



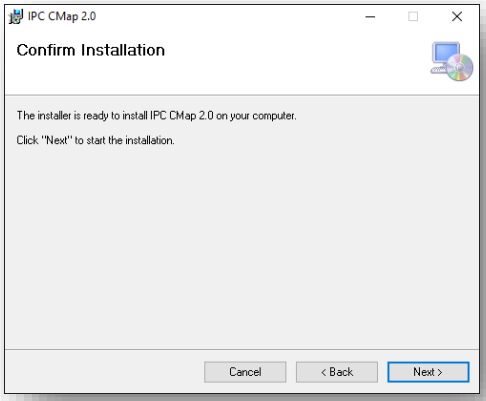
Step 1: CMap 2.0 installation starts



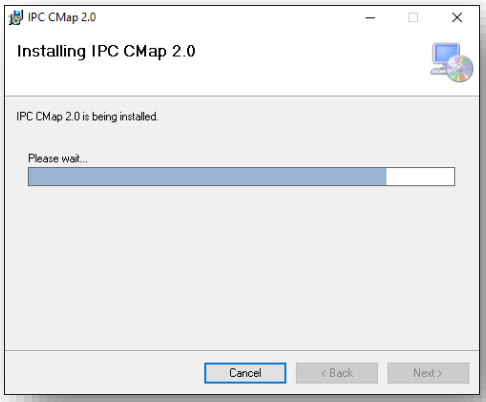
Step 2: Click *Next* to continue and the installation starts



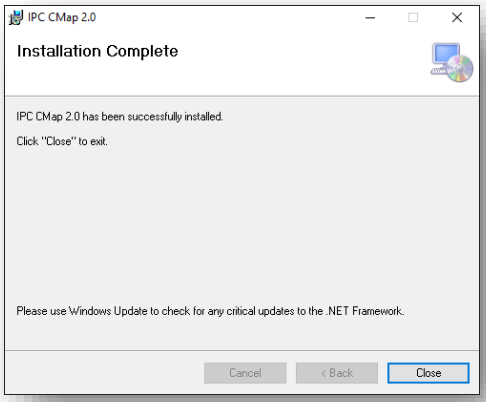
Step 3: Choose installation folder and user setting and click *Next* , the Confirm Installation window appears (*)



Step 4: Click *Next* to continue and the installation starts



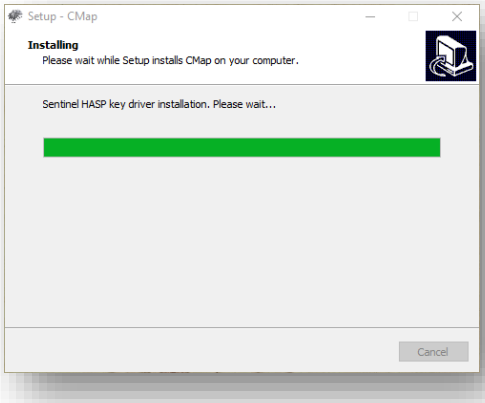
Step 5: Installing IPC CMap 2.0 GUI



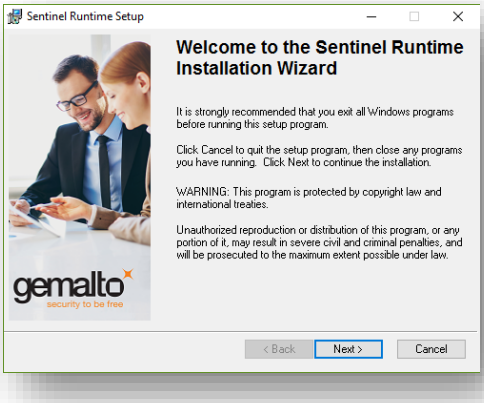
Step 6: The installation is completed, click on *Close*

f. Sentinel HASP Key Driver installation (not used with CMap2.0 Trial Version)

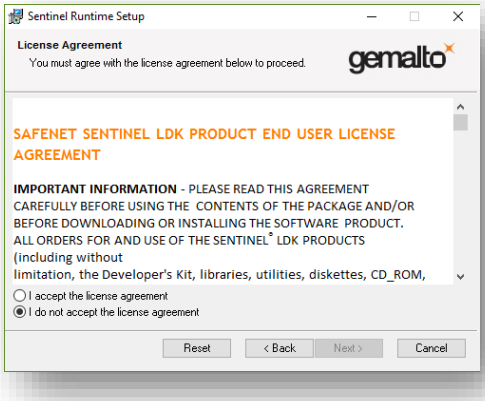
The Sentinel HASP Key Driver installation steps are shown below :



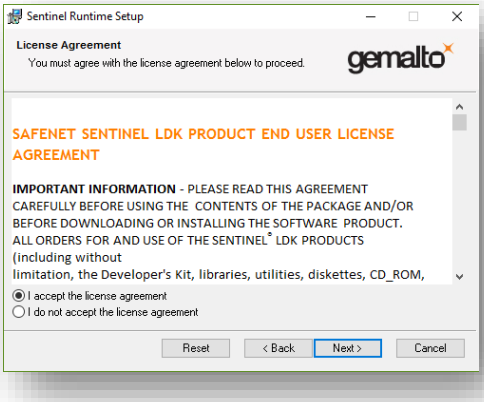
Step 1:Sentinel HASP Key Driver installation starts



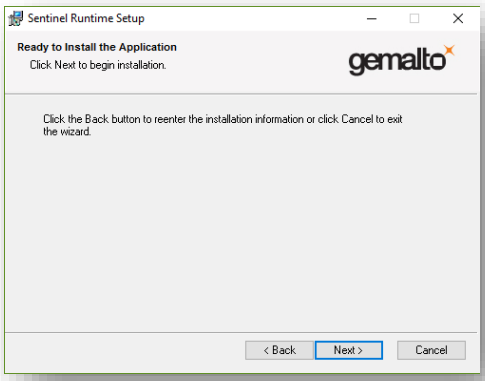
Step 2: Click *Next* to continue



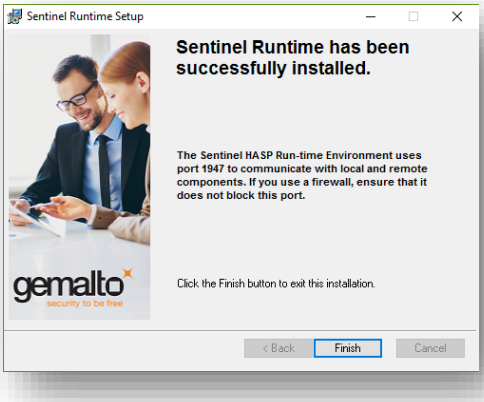
Step 3: Accept The license agreement and click *Next*



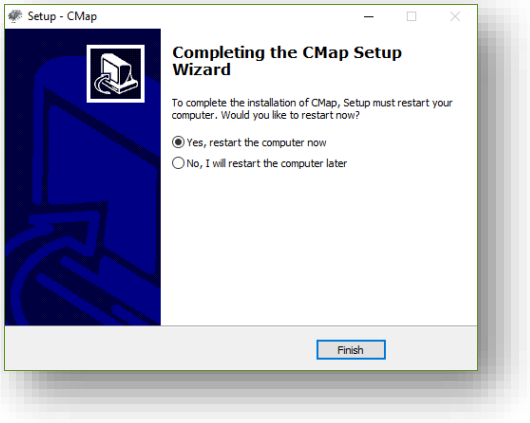
Step 4: Click *Next* to continue and the installation starts



Step 5: Ready to install: click *Next*



Step 6: The installation is completed, click on *Finish*

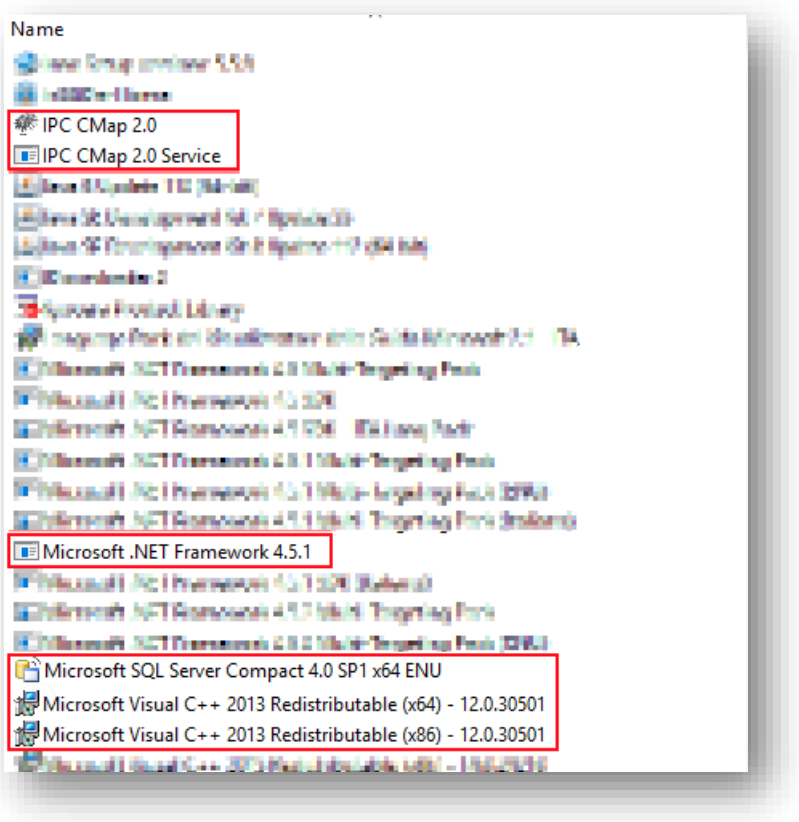


Step 6: Restart your computer: the CMap2.0 installation procedure is finished

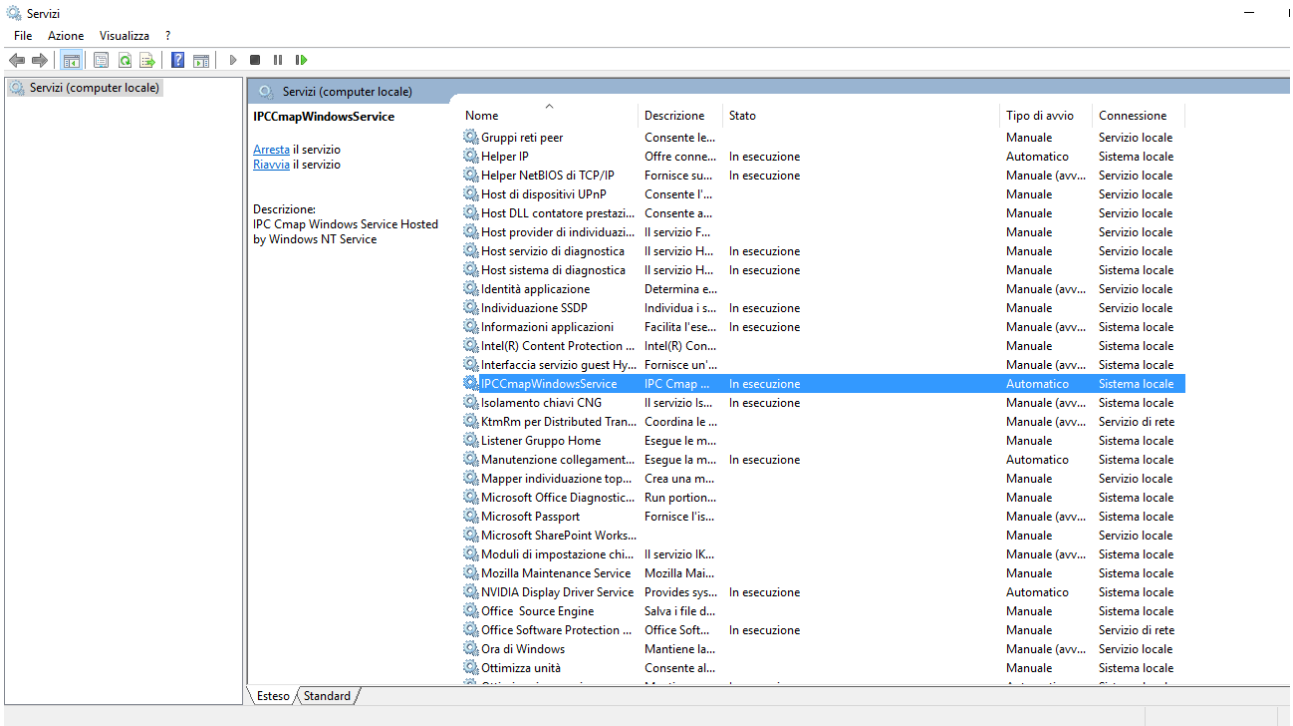
The wizard installation creates Desktop icon automatically.



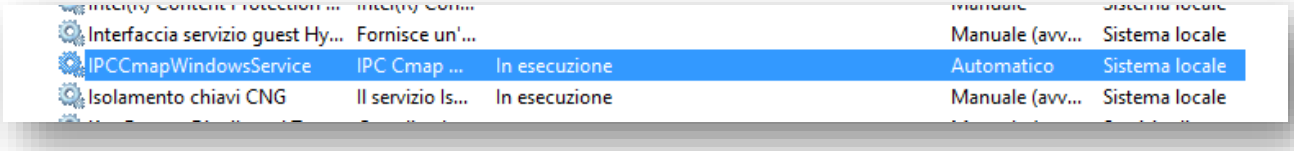
Check from Programs and Features in Control Panel the packages installation:



Check if the service is correctly installed and if it is started, open *Windows Service Management Console*:

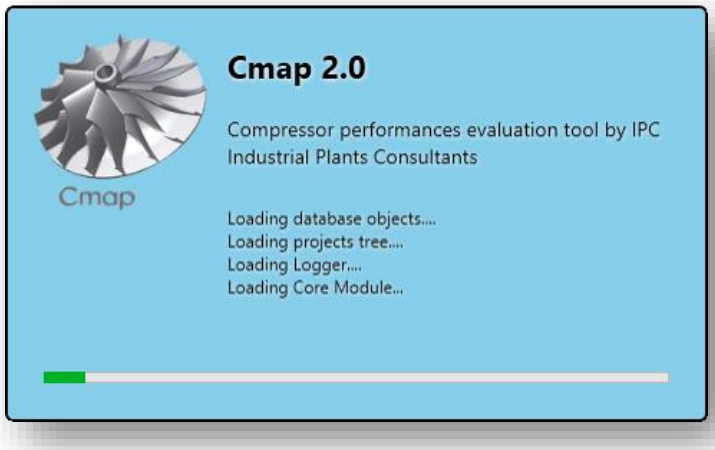


The CMap 2.0 service name is *IPCCMapWindowsService* and it is an automatic service.

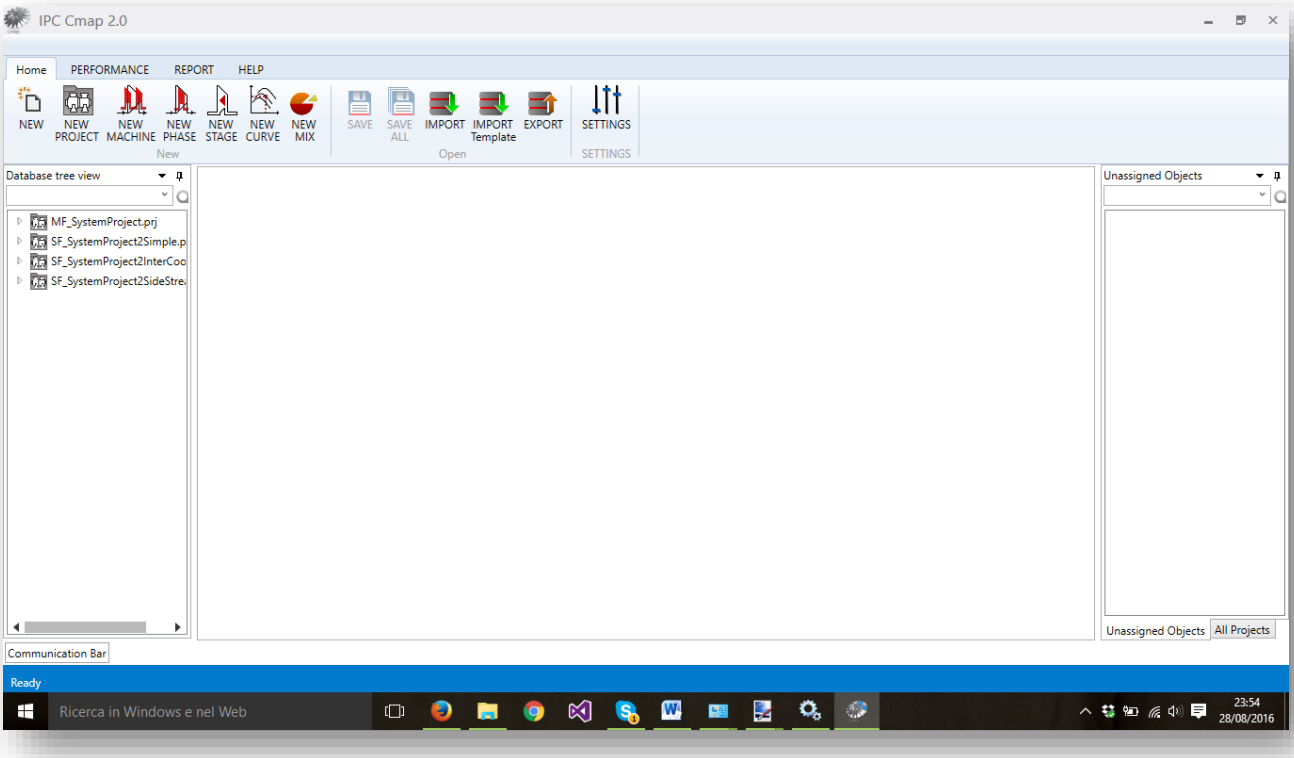


Before clicking on CMap2.0 icon, insert the Sentinel Hasp USB Key (**).

Double-Click on CMap 2.0 icon, the software stars with the following splash screen:



The main window appears:



(*) If the software will be use from standard user it's strongly recommended to install the CMap2.0 GUI in a folder with right administration and outside the system folder (C:\Program Files, C:\Windows).
(**) During the same work session, if you remove Sentinel Hasp USB Key after a first use of CMap2.0 and you want to reuse it, it's necessary to restart the service if you have right administrator from *Service Management Console*, if you use a standard user account it's necessary to restart the PC.
(***) If you have any problems with Sentinel HL driver installation, you can find the stand-alone driver in installation support (folder: Sentinel HL Driver).

Enjoy with your version of CMAP 2.0 Compressor performances evaluation tool.

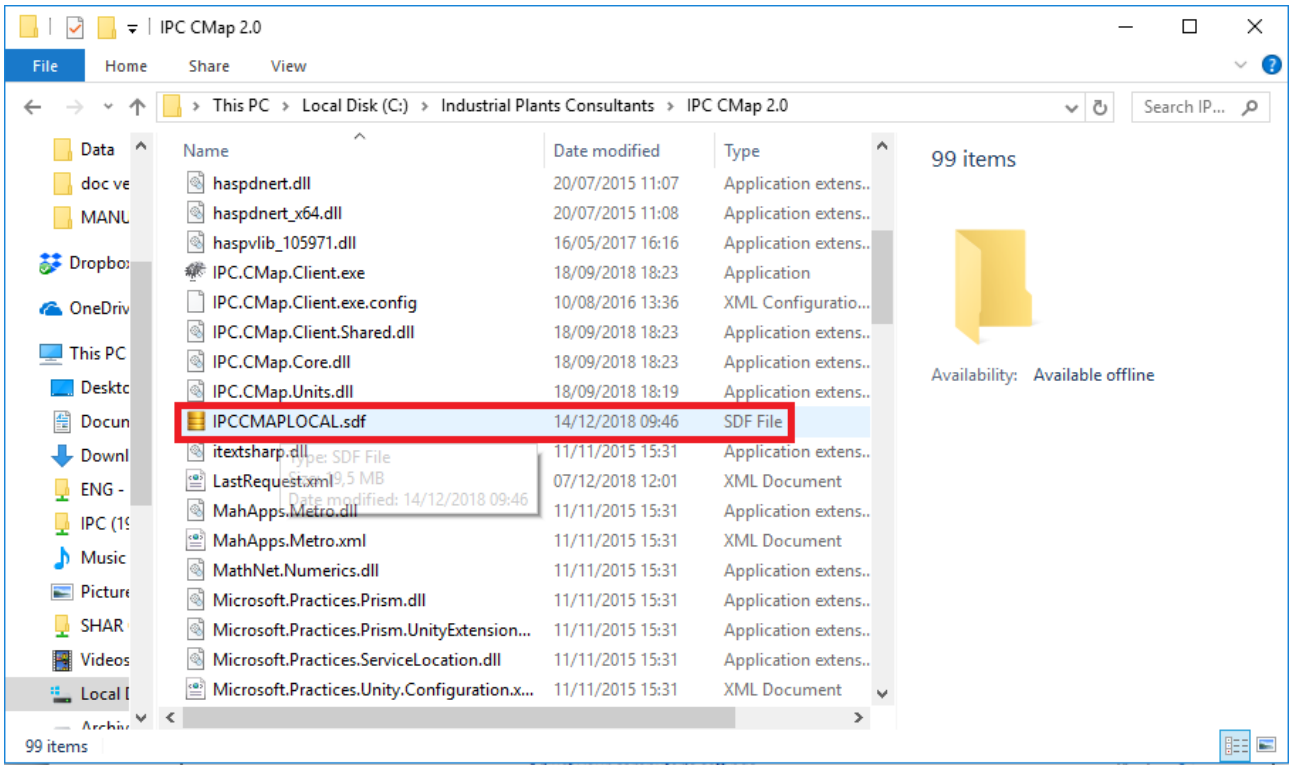
If you have got any problem or for any additional info, we invite you to contact us:

CMapsupport@ipc-eng.com

UNINSTALLATION

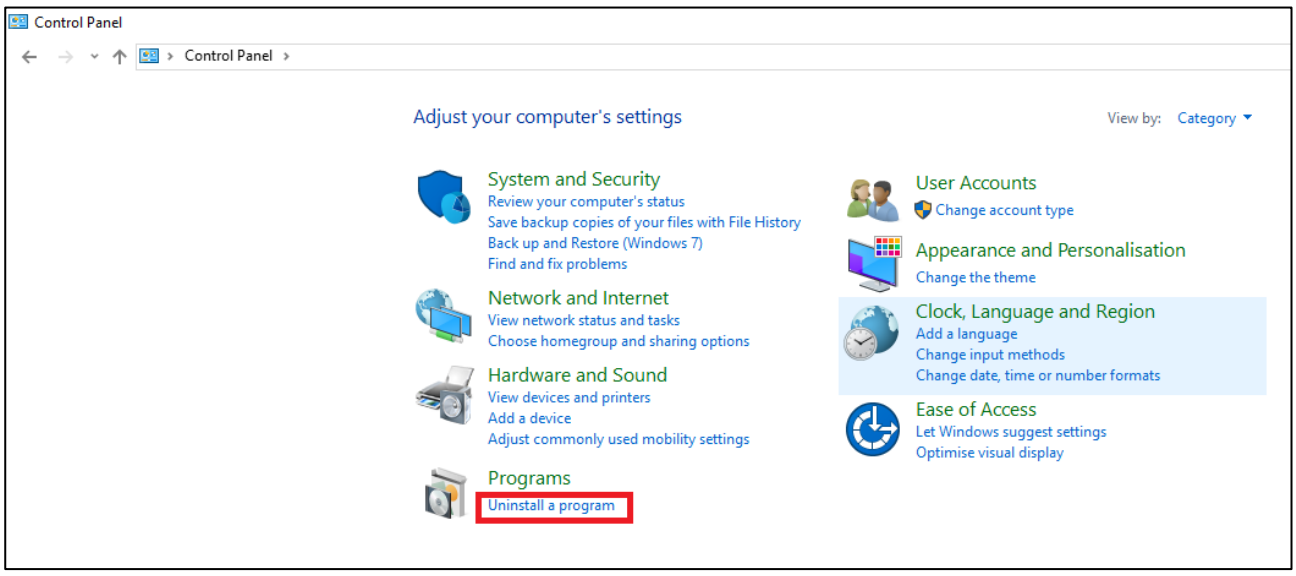
If you need to uninstall CMap2.0 software, you can follow these steps:

1. Before to start the uninstallation procedure, we suggest to Save CMap Database.
   Search **IPCCMAPLOCA.sdf** file within program folder in:
   Local Disk(C:) ➔ Industrial Plant Consultant ➔ IPC CMAP 2.0

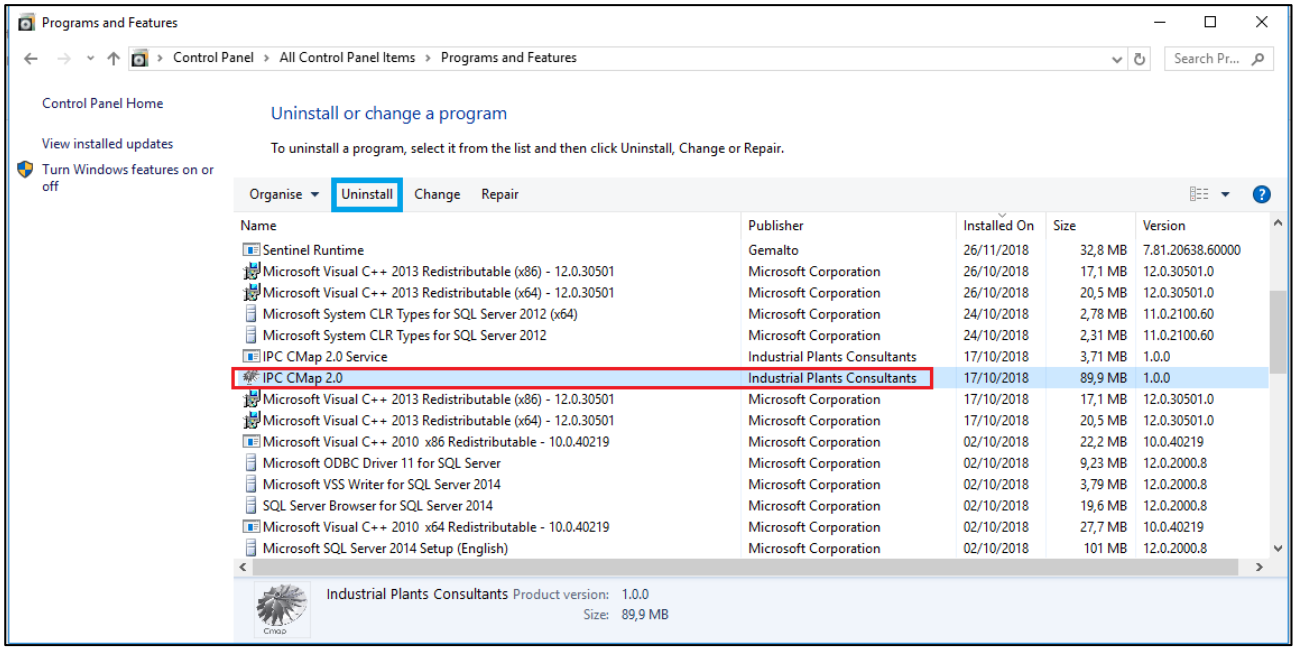


2. Copy **IPCCMAPLOCA.sdf** file and paste in a writable directory (e.g Documents, Desktop, New folder, etc).

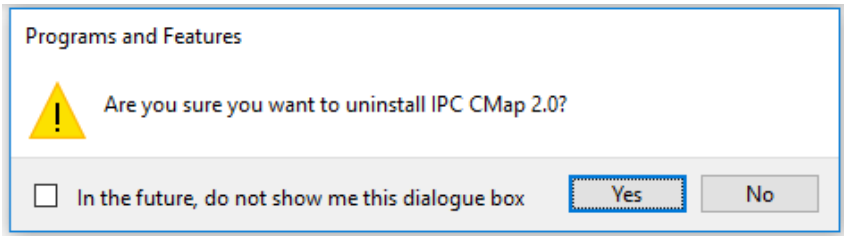
3. Now you can proceed to uninstallation.
   Go to Control Panel ➔ Programs ➔ Uninstall Program



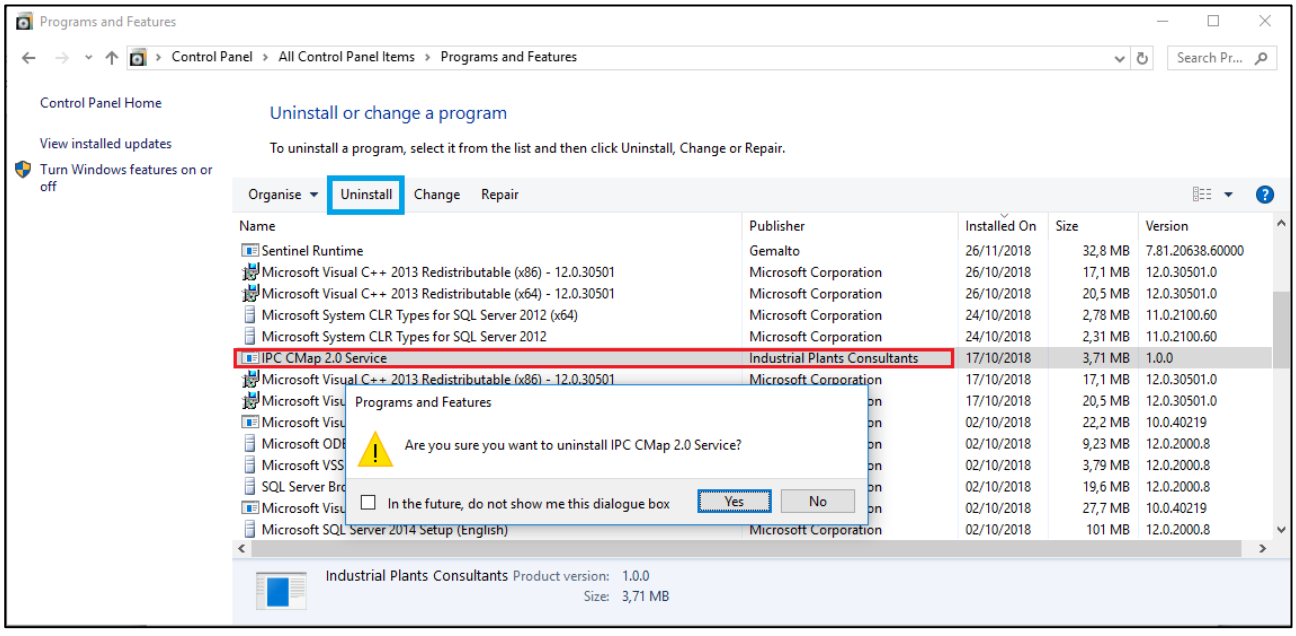
4. Search “IPC CMap 2.0”, then click Uninstall button:



5. Confirm through “Yes” button when this pop-up appears.



6. After the uninstallation of “IPC CMap 2.0”, repeat the above points 4 and 5 for “IPC CMap 2.0 Service”:



7. Finally you should have to delete the “Industrial Plant Consultant” folder from Local Disk (C:).

GUIDE AT FIRST USE

CMAP2.0 STRUCTURE

CMap 2.0 is structured according to different levels:

- Project :
  - Machine 
    - Phase 
      - Stage 
        - Curve 
          - Mix 

Project

The *Project* is highest level and provides the summary information of the machine or machine group in consideration. The project level may include also reference information such as the customer name, the site, ad other additional data that may be useful for the customer In the project it is possible configure one or more machines.

Machine

The Machine level is the level that groups all the information relative to every single machine. In CMap it is considered a single machine the one driven by the same driver. According to this definition a machine can be also a compression train, including several different compression phases.

The *Machine* could be:

- a single centrifugal compressor with single phase
- a single centrifugal compressor multiphase (with side stream or intercooler)
- a compression train with more centrifugal compressor single phase or multiphase

Phase

A *Phase* is a machine section that includes one or more compression stages and interstage side-streams or heat exchangers.

The *Phase* is the section of centrifugal compressor between an inlet and discharge connection. The phase could be:

- Simple phase: without side stream and without intercooler
- Side Stream: with side stream after discharge connection
- Intercooler: with intercooler after discharge connection

Each phase could be single stage or multistage

Stage

The *Stage* is the section of centrifugal compressor that contains a single impeller.

In CMap 2 it's possible to configure every single compressor impeller.

Curve

The *Curve* level is made of a couple of maps necessary to configure the machine stage.

Based on availability of reference maps it is possible to configure the machine as single phase or multiphase, single stage or multistage.

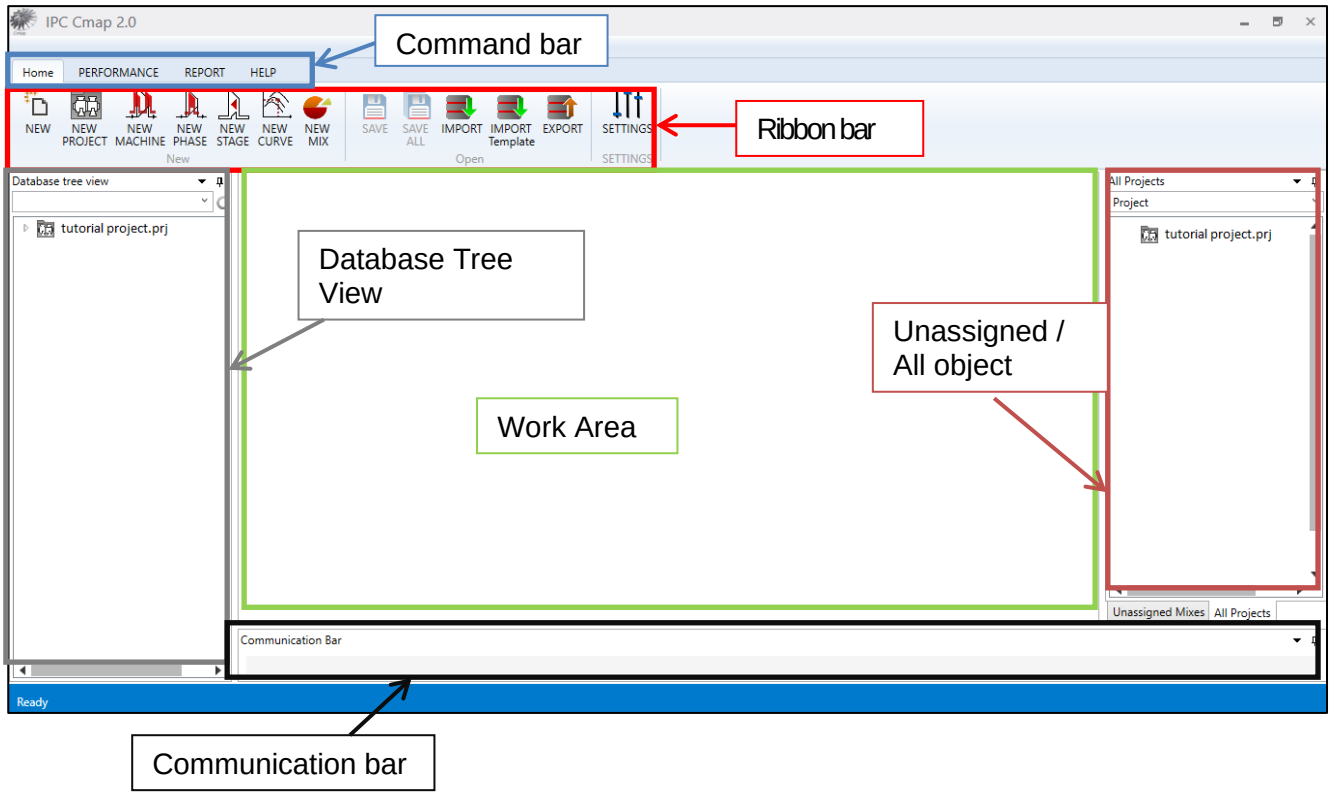
Mix

The *Mix* is the lowest level. It has the purpose to create a gas mix composition. In the reference configuration, it have to be assigned to the reference curve. The user can also create new mix levels for calculation in actual/off-design conditions.

CENTRIFUGAL COMPRESSOR CONFIGURATION

The following section will explain how to configure a centrifugal compressor.

The follow picture shows the GUI of CMap 2.0.

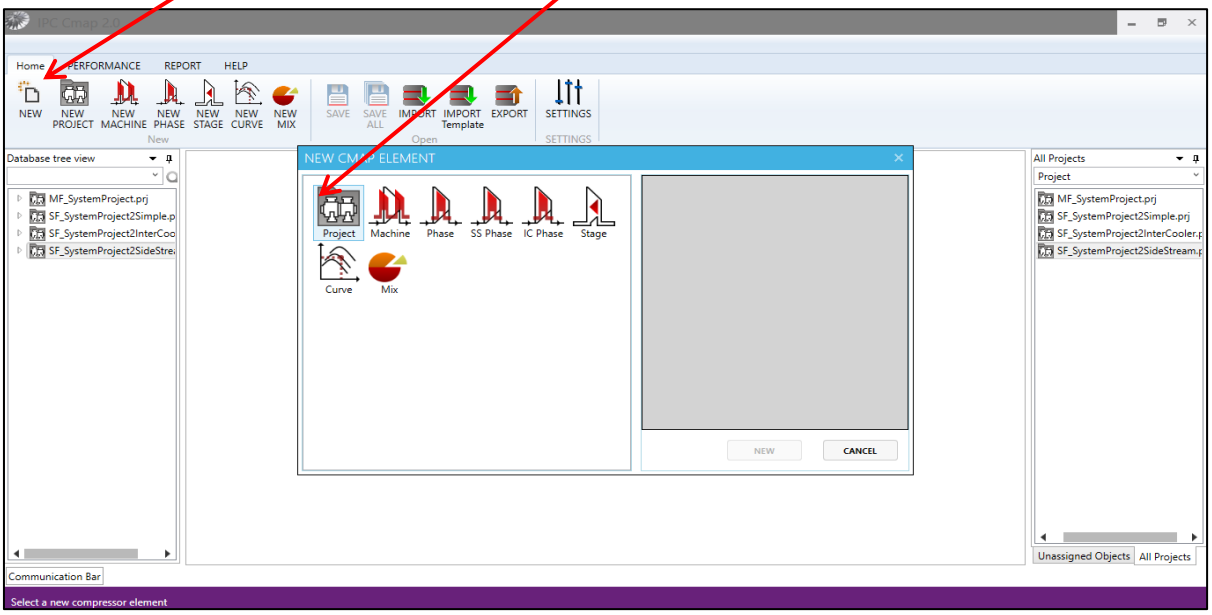


In the next paragraph it will describe each button in **"Home"** tab.

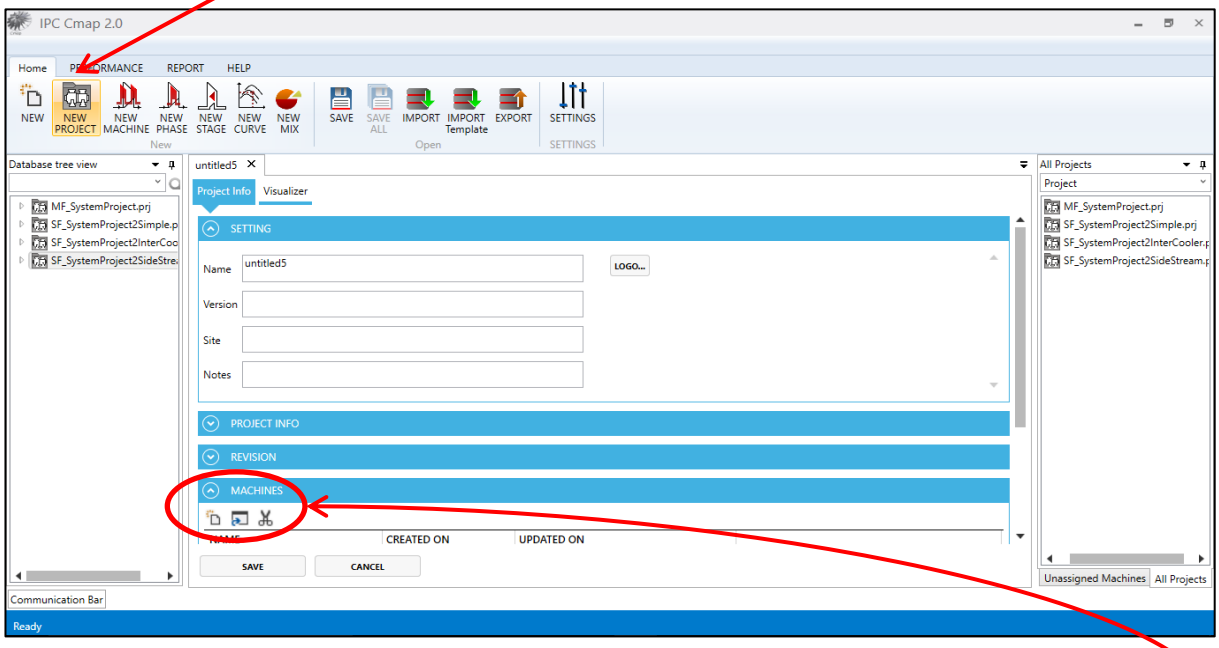
Creation of a Project

To create a new project, there are 2 ways:

a) In “Home”, click NEW on the Ribbon Bar, then click PROJECT in the NEW CMAP ELEMENT pop-up



b) In “Home”, click NEW PROJECT on the Ribbon Bar



In the window PROJECT INFO, you can edit:

- SETTING: Name, Version, Site, Notes and upload a logo (BMP, JPEG, GIF, TIFF, PNG files)
- PROJECT INFO: Customer, Job Number, Plant, Service.
- REVISION: Analyst, Approver, Controller, Sing, Date
- MACHINES: management of machines (create New Machine , Open or Cut a linked Machine).

The above fields are all optional, and you could left them empty.

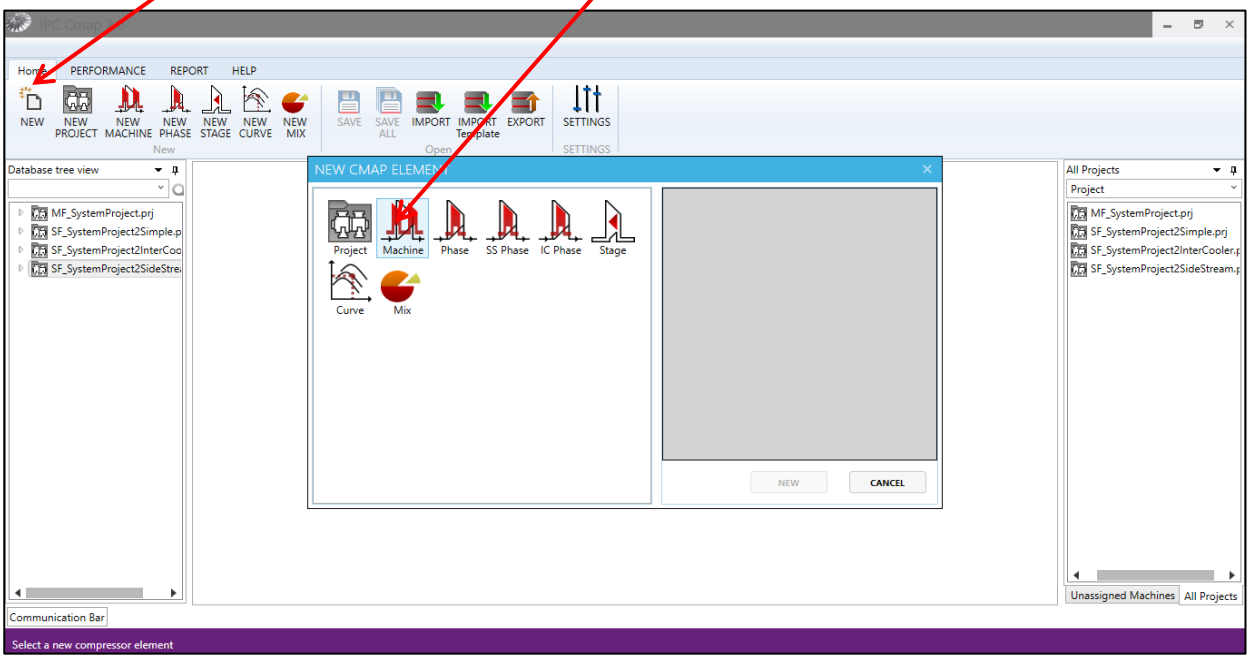
In the window VISUALIZER, you can drag and drop one or more machines from database.

Click SAVE button to save the modifications.

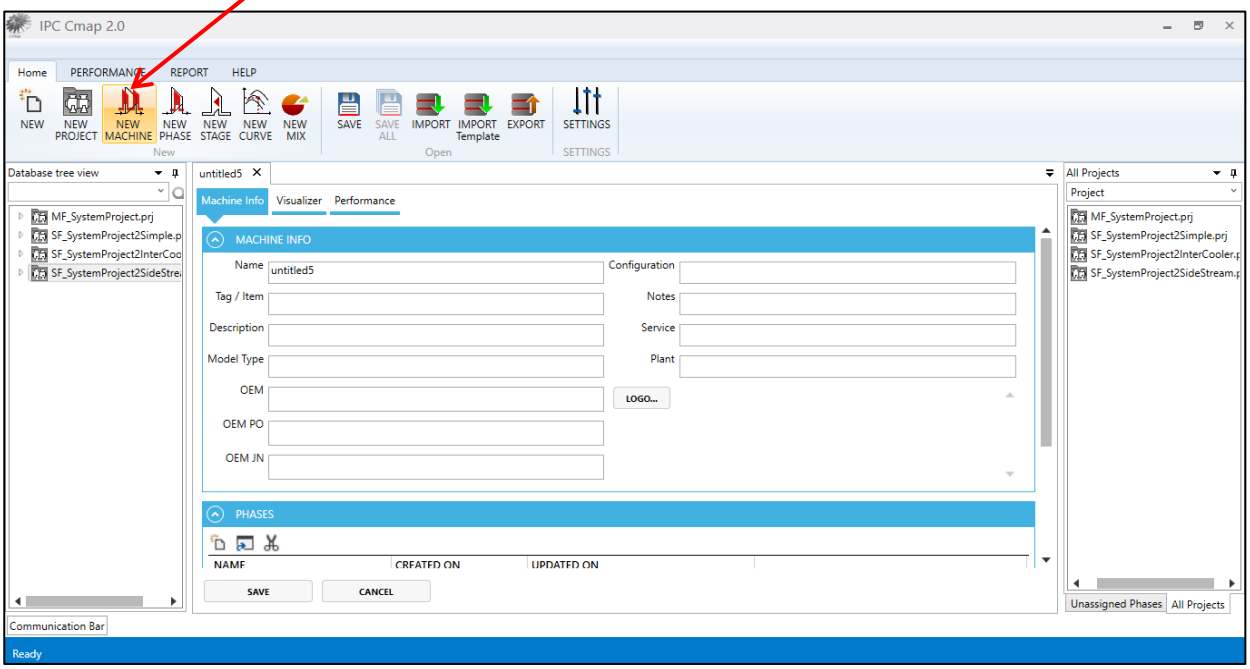
Creation of a Machine

To create a new machine, there are 3 ways:

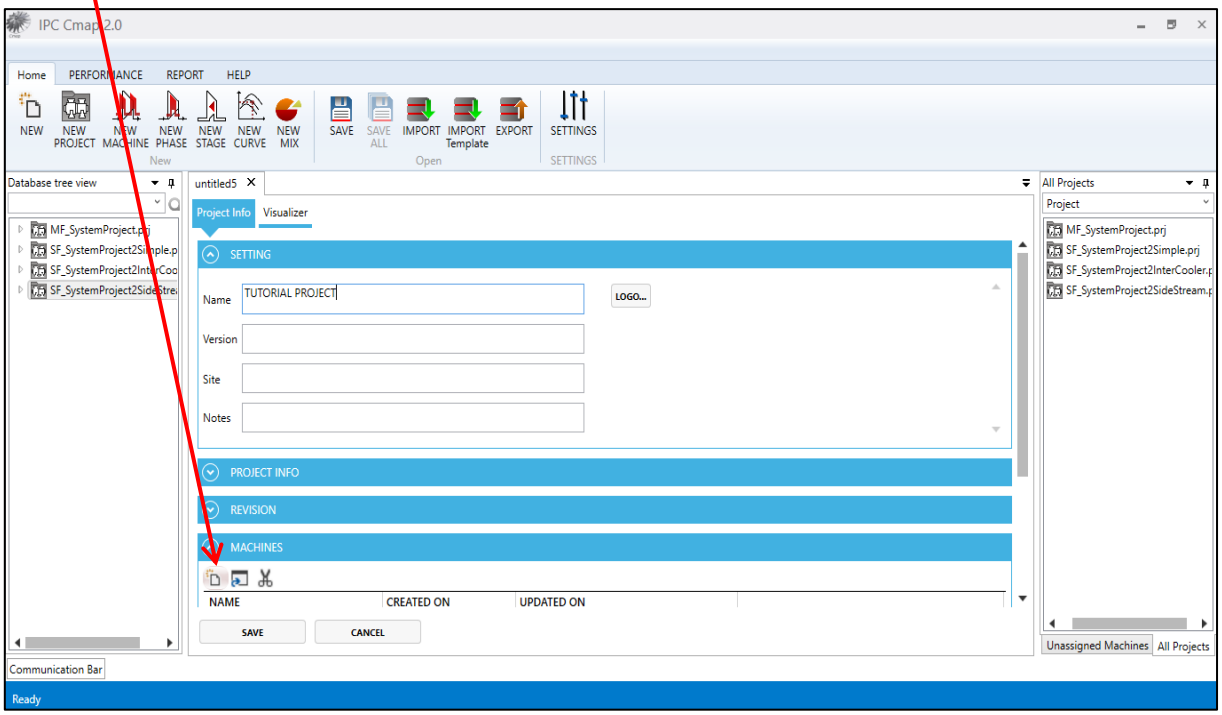
a) In “Home”, click NEW on the Ribbon Bar, then click MACHINE in the NEW CMAP ELEMENT pop-up



b) In “Home”, click NEW MACHINE on the Ribbon Bar



c) Click NEW directly from the project



In order to assign new machines, created with method a) or b), to the project, you can drag and drop them in the window VISUALIZER of the Project.

In the window MACHINE INFO, you can edit:

- MACHINE INFO: Name, Tag/Item, Description, Model Type, OEM, OEM PO, OEM JN, Notes, Service, Plant and upload a logo (BMP, JPEG, GIF, TIFF, PNG files)
- PHASES: management of Phases (create New Phase , Open or cut a linked Phase)

In the window VISUALIZER, you can drag and drop one or more phases from database.

In the window PERFOMANCE, there is the analysis tool to:

- calculate the new expected performances of centrifugal compressor
- open the performances previously calculated
- plot the performances previously calculated.

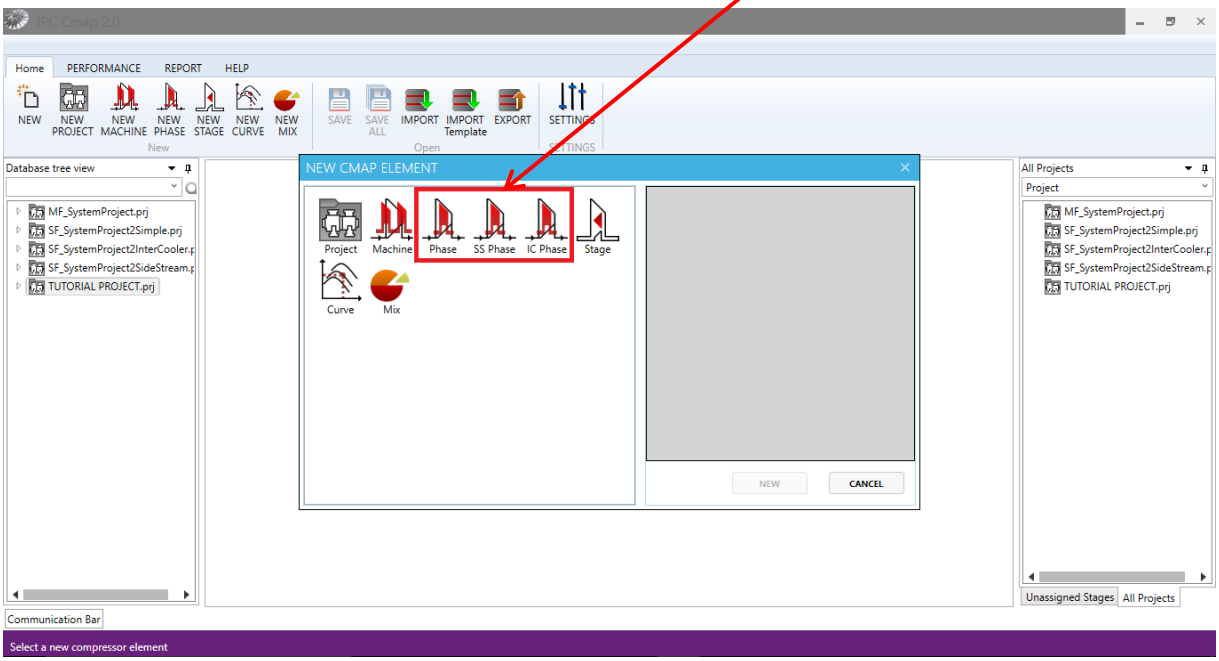
For more details about performance, see **PERFORMANCE EVALUATION** and **PERFORMANCE ANALYSIS** sections in the following pages of this User Guide.

Click SAVE button to save the modifications.

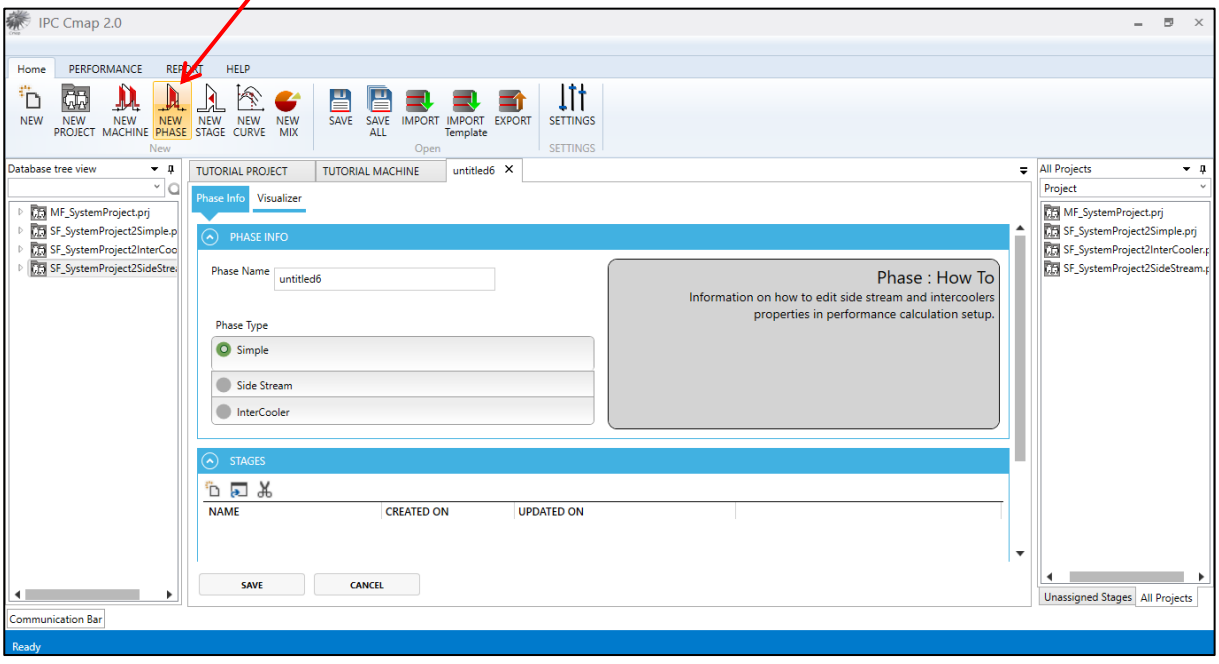
Creation of a Phase

To create a new phase, there are 3 ways:

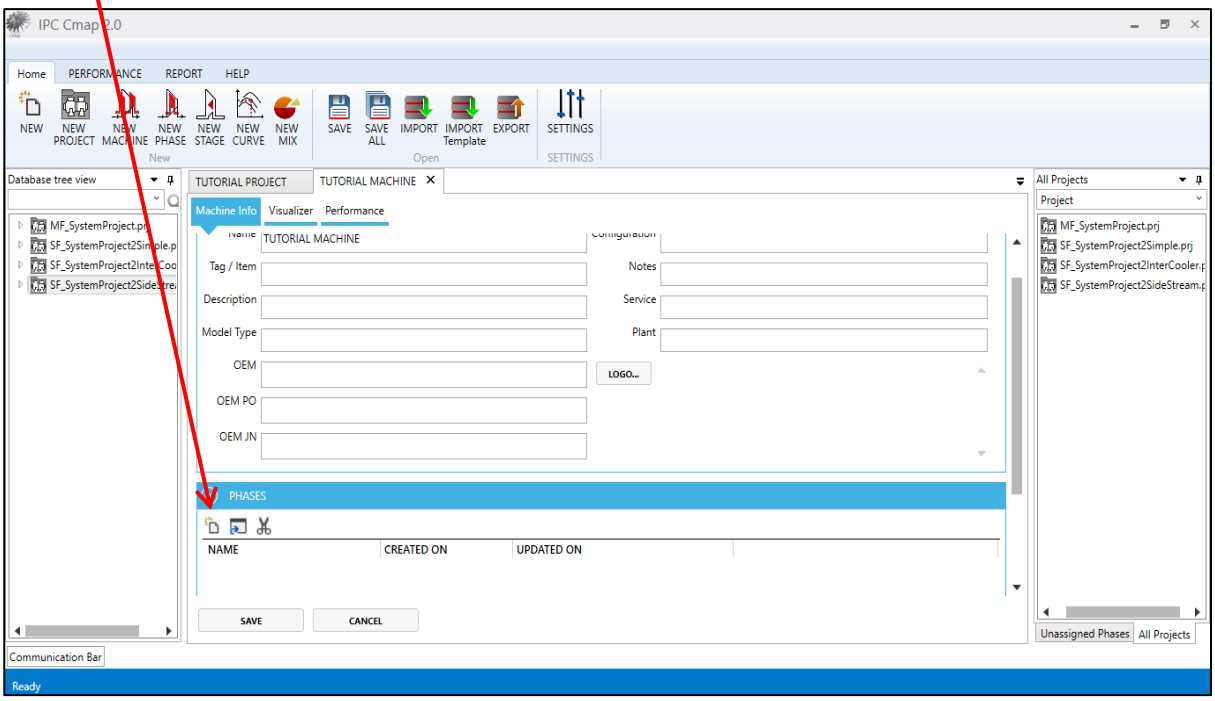
a) In “Home”, Click NEW on the Ribbon Bar, then click PHASE or SS PHASE or IC PHASE in the NEW CMAP ELEMENT pop-up



b) In “Home”, click NEW PHASE on the Ribbon Bar



c) Click NEW directly from the Machine



In order to assign new phases, created with method a) or b), to the machine, you can drag and drop them in the window VISUALIZER of the Machine

In the window PHASE INFO, you can edit:

- PHASE INFO: Name and Type (Simple, Side Stream or InterCooler)
- STAGES: management of Stages (create New Stage , Open or Cut a linked Stage).

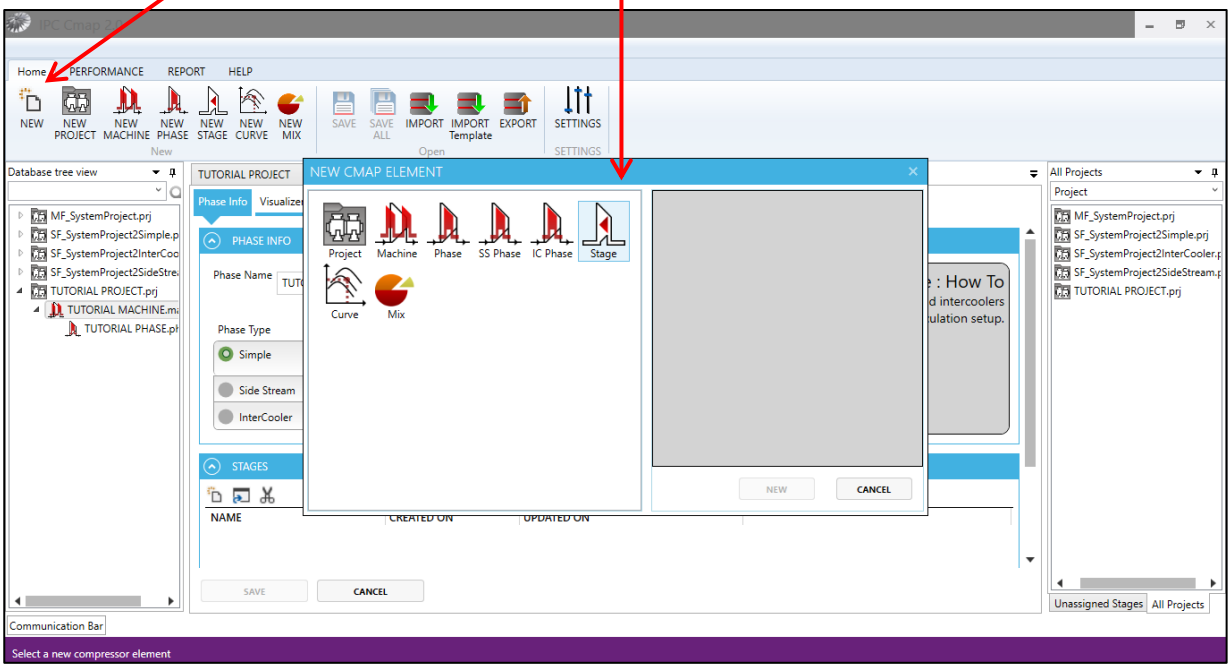
In the window VISUALIZER, you can drag and drop one or more stages from database.

Click SAVE button to save the modifications.

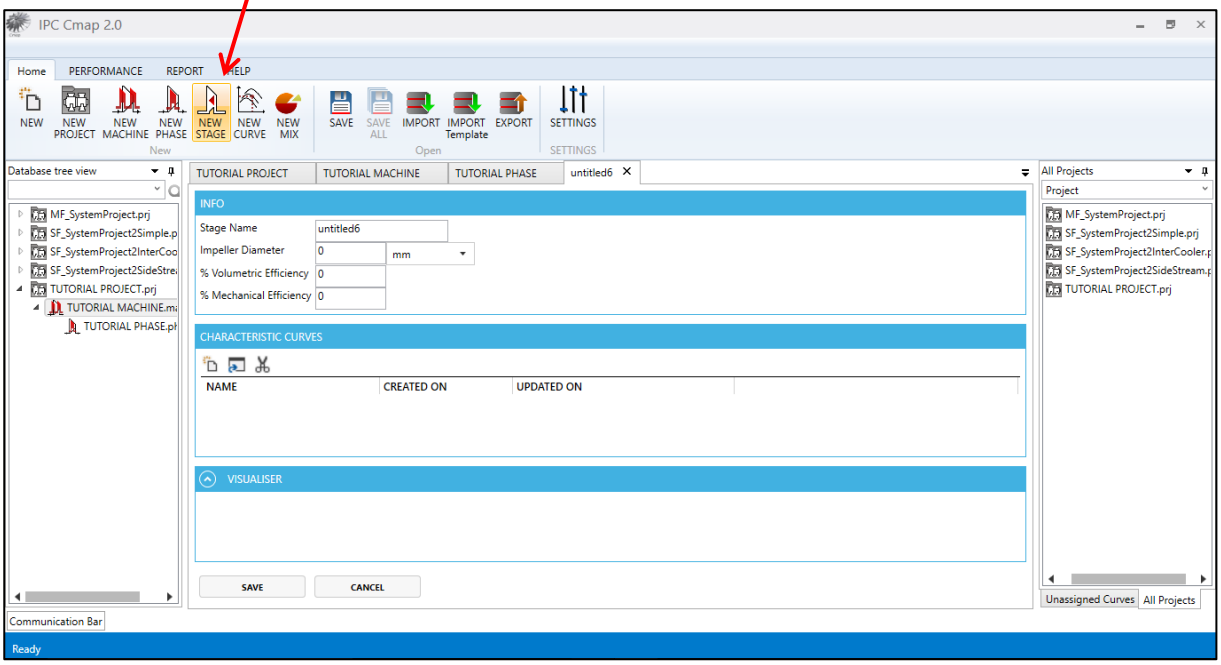
Creation of a Stage

To create a new stage, there are 3 ways:

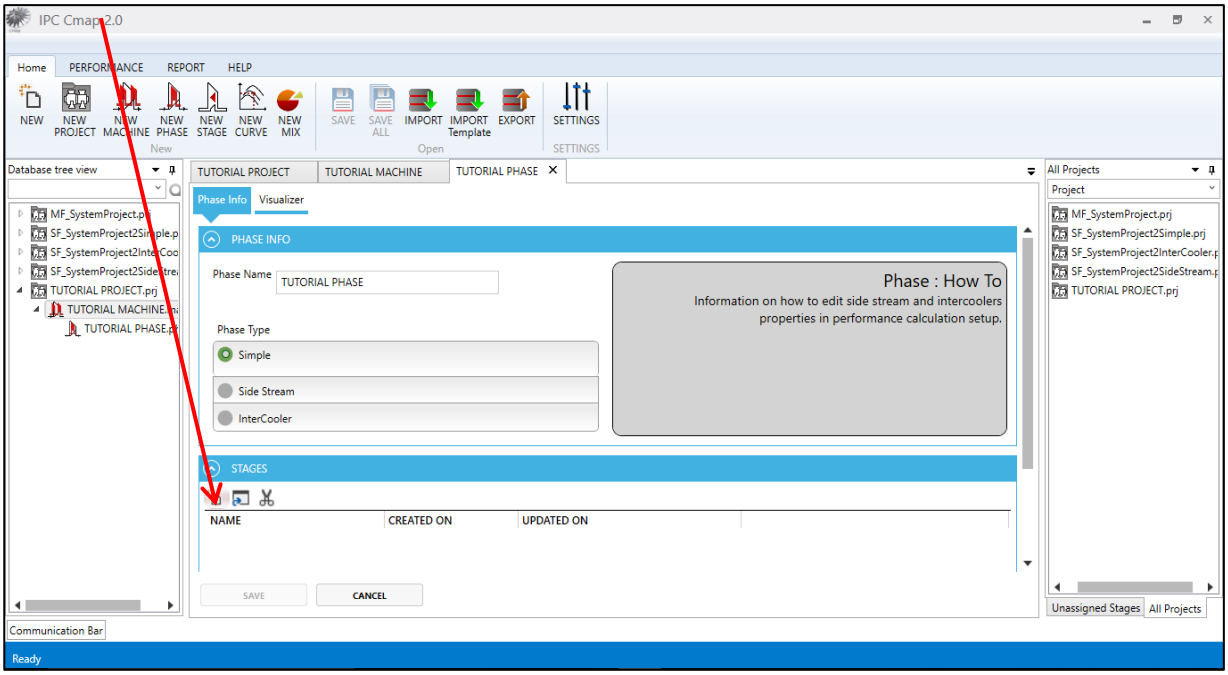
a) In “Home”, click NEW on the Ribbon Bar, then click STAGE in the NEW CMAP ELEMENT pop-up



b) In “Home”, click NEW STAGE on the Ribbon Bar



c) Click NEW directly from the Phase



To assign new stages, created with method a) or b), to the phase, you can drag and drop them in the window VISUALIZER of the phase

In the main window, you can edit:

- INFO:
  - Stage Name
  - Impeller Diameter[1]
  - Volumetric Efficiency[2]
  - Mechanical Efficiency[2]

- CHARACTERISTIC CURVES: management of Curves (create New Curve , Open or Cut a linked Curve).

In the window VISUALIZER, you can drag and drop one or more Curves from database.

Click SAVE button to save the modifications.

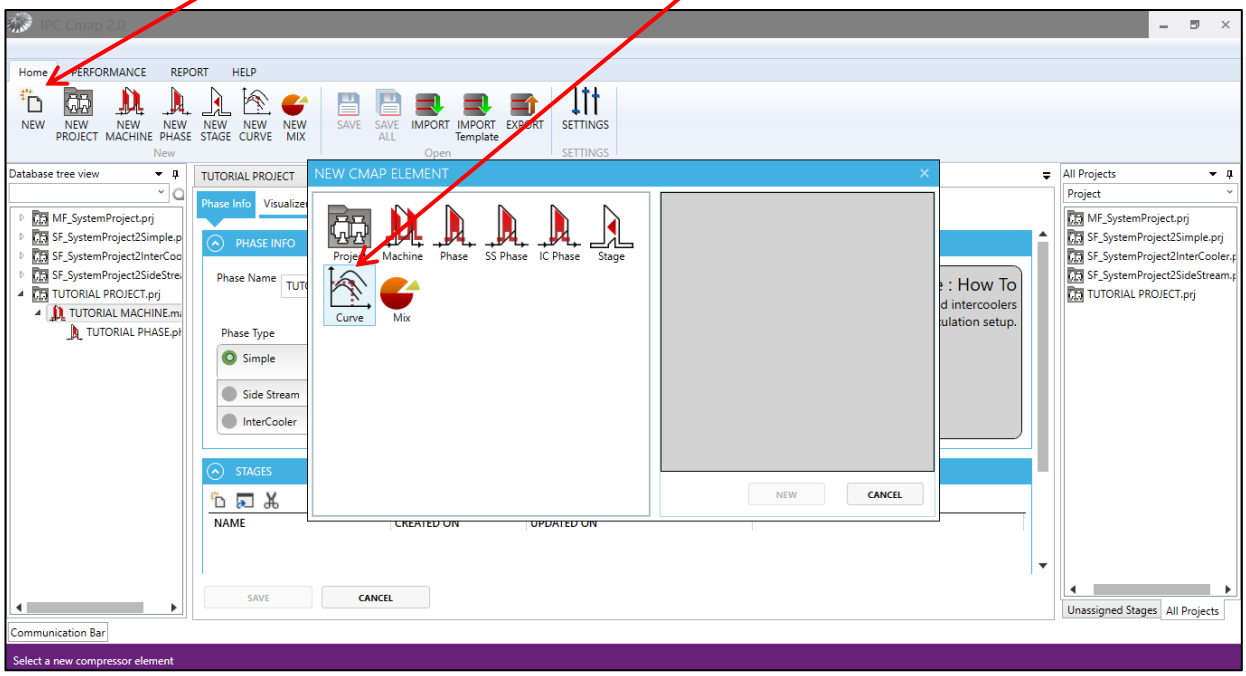
Notes:

1. If you have the reference performance maps of a phase (section) with multi- stages (impellers), you can edit the IMPELLER DIAMETER field using the geometric mean of impeller diameters.
2. If you don't know the volumetric and/or mechanical efficiency values, you can edit 100% for both efficiency.

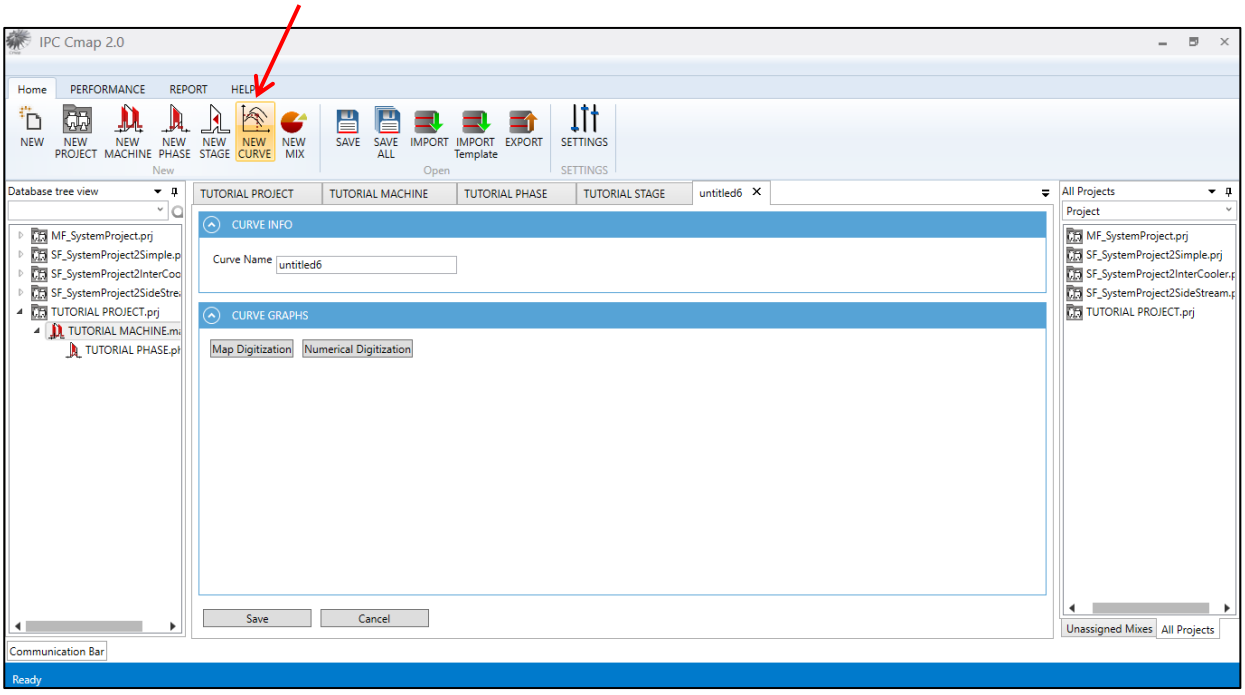
Creation of a Curve

To create a new couple of curves, there are 3 ways:

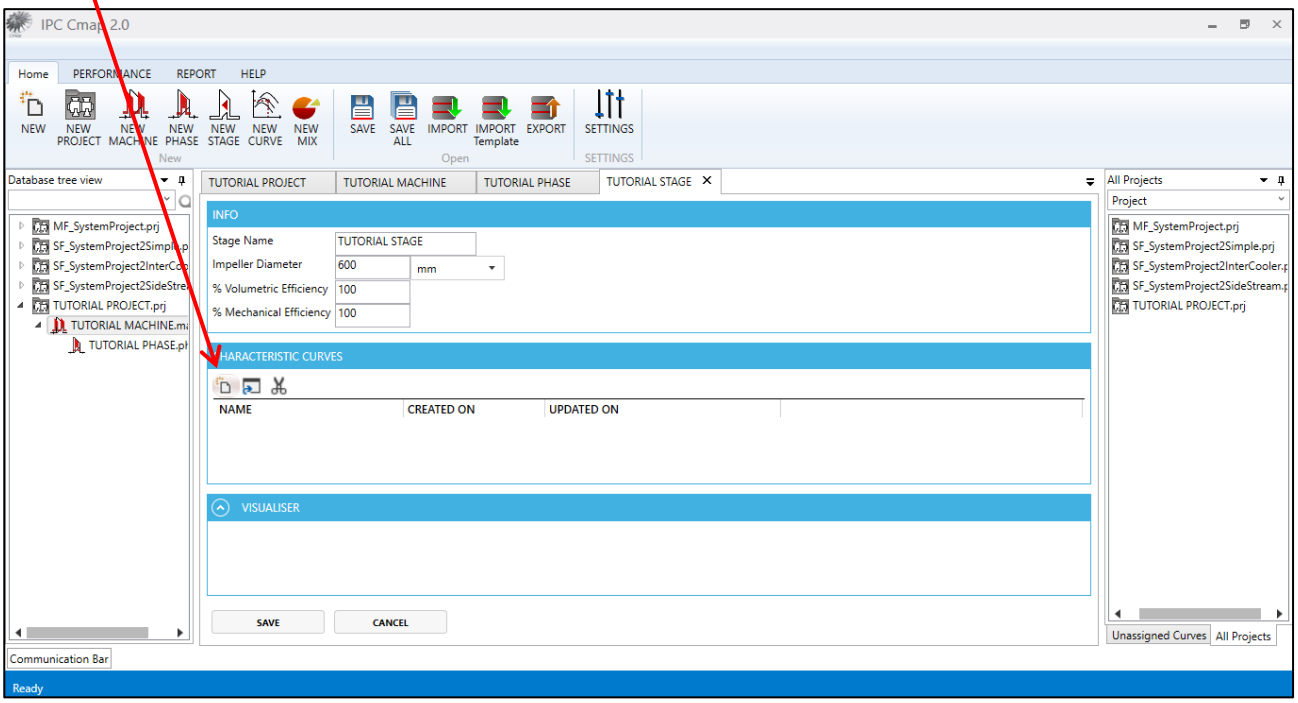
a) In “Home”, click NEW on the Ribbon Bar, then click CURVE in the NEW CMAP ELEMENT pop-up



b) In “Home”, Click NEW CURVE on the Ribbon Bar



c) Click NEW directly from the stage

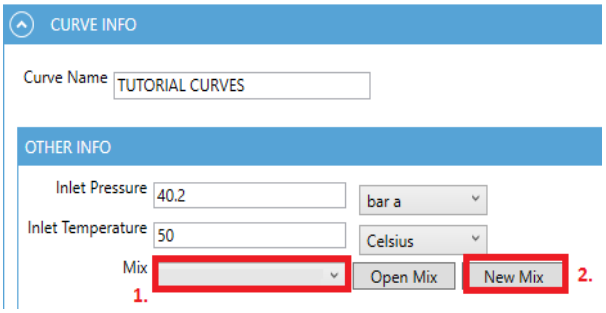


To assign new curves, created with method a) or b), to the stage, you can drag and drop them in the window VISUALIZER of the stage

In the window CURVE INFO, you can edit the name of CURVES.

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

- Map Digitization, by digitizing graphically point of curves (see **HOW UPLOAD A MAP** section)
- Numerical Digitization, by entering numerically point by point of curves (see **HOW UPLOAD A MAP** section).



After you uploaded the maps, if you digitized 2 dimensional maps user must 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:

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

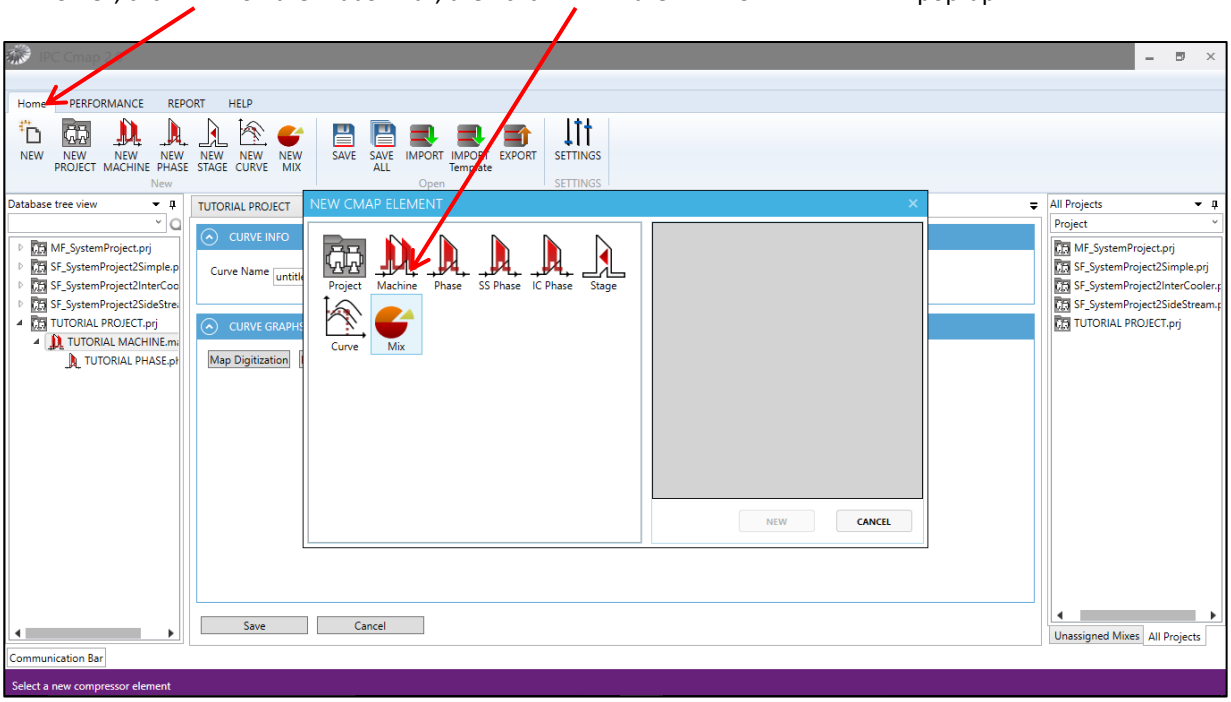
If you digitized non-dimensional maps, you don't need to assign the inlet conditions.

Click SAVE button to save the modifications.

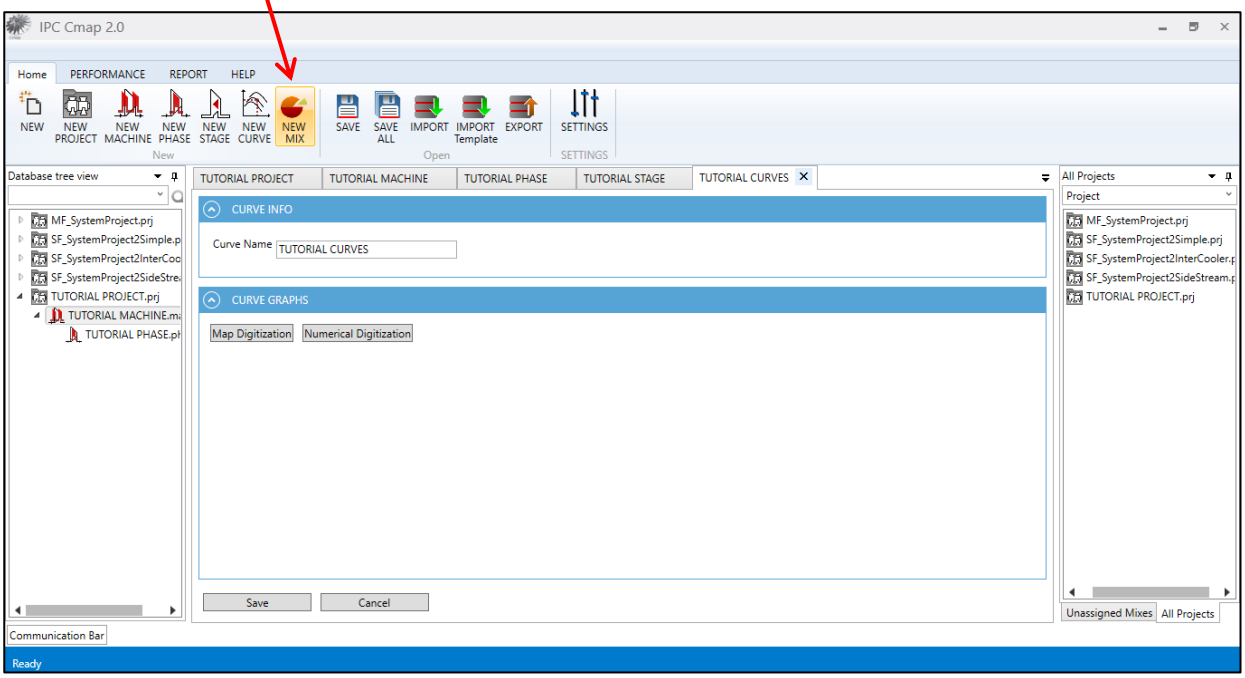
Creation of a Mix

To create a new mix, there are 3 ways:

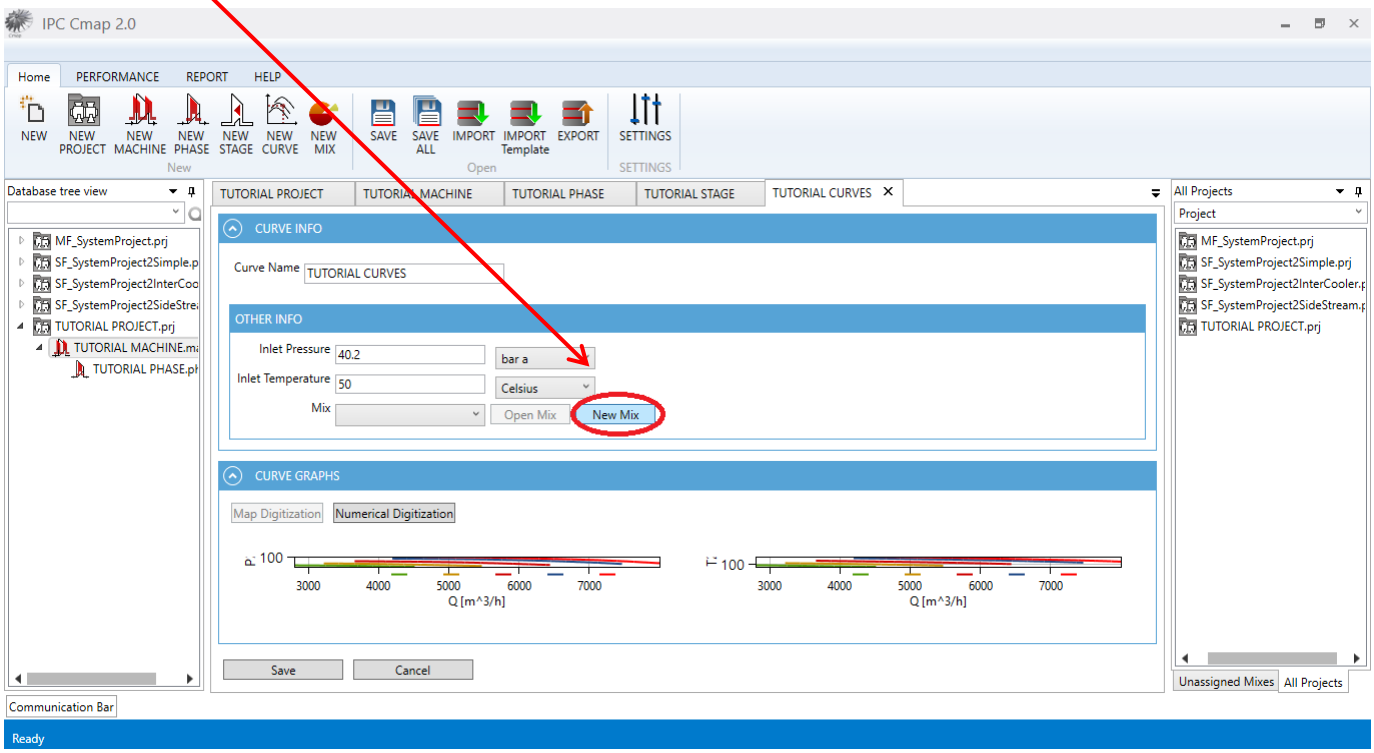
a) In “Home”, click NEW on the Ribbon Bar, then click MIX in the NEW CMAP ELEMENT pop-up



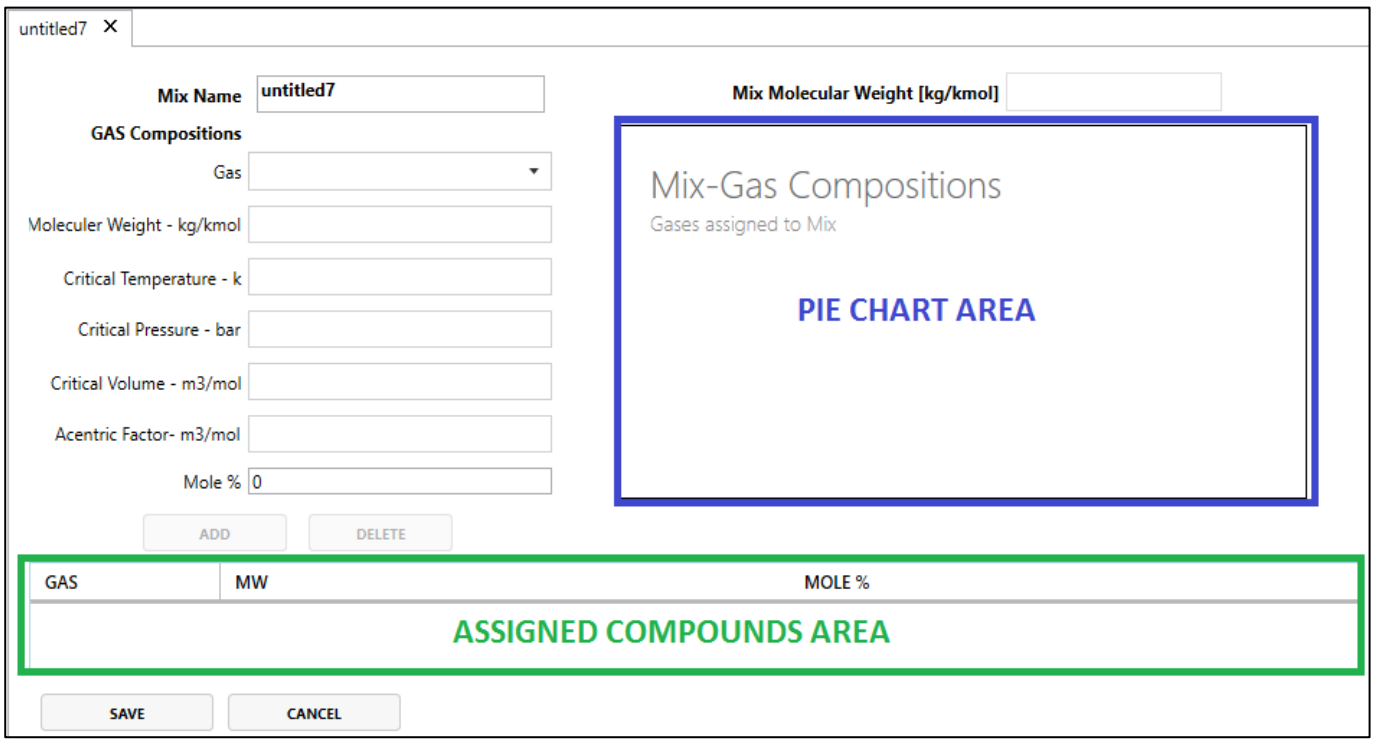
b) In “Home”, click NEW MIX on the Ribbon Bar



c) Click NEW MIX after digitization of the curve



The Mix window will be opened in Work Area:



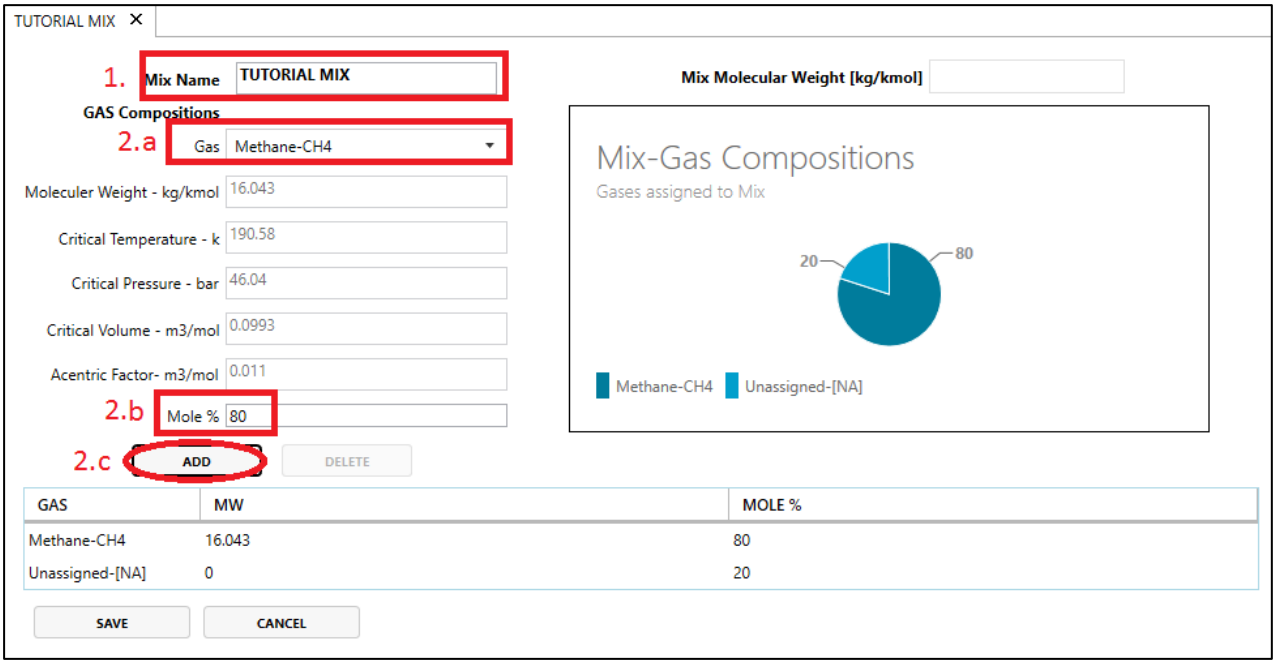
HOW CREATE A MIX

In this section of User Guide a detailed procedure to create the gas mixture will be shown.

Once MIX window is opened:

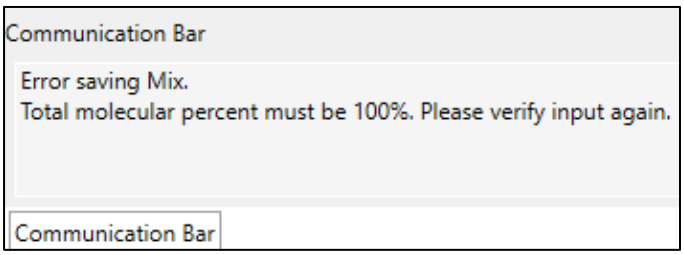
1. You can edit the Mix Name

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 to 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).

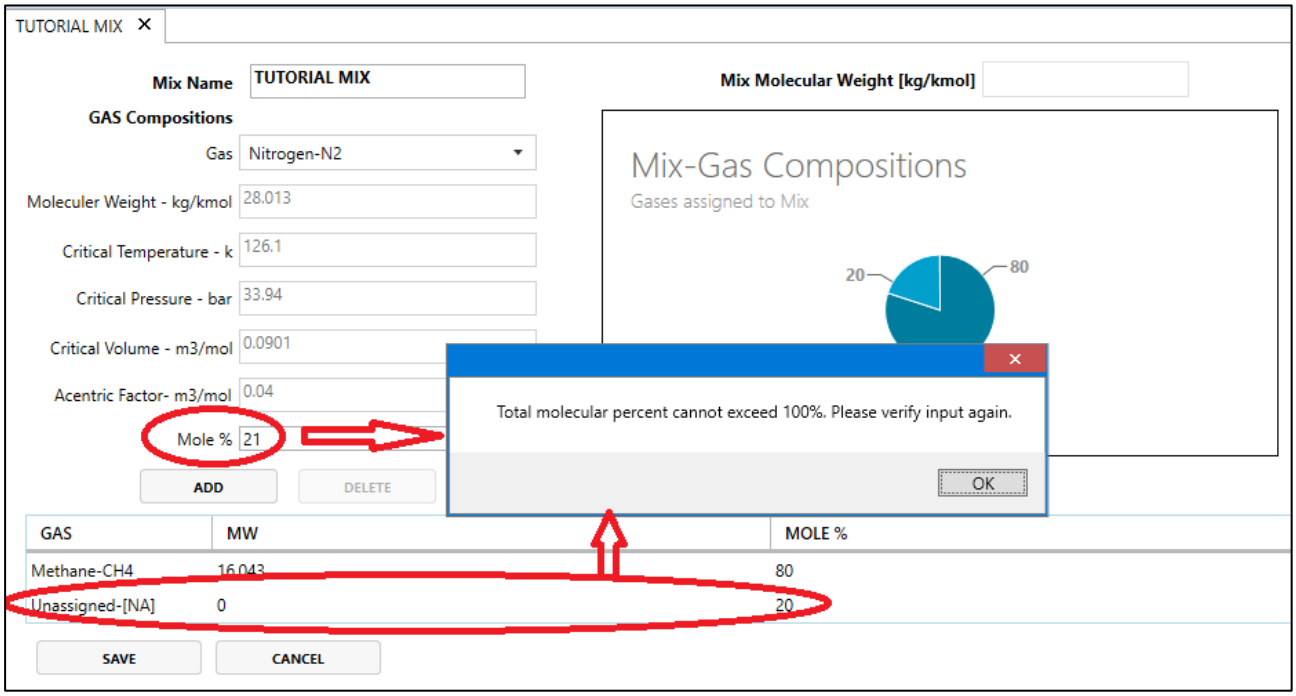


If you click SAVE button when Unassigned is > 0, you will read this message in Communication Bar (clicking “Communication Bar” to show its message)

5. Reached the 100% assigned, click SAVE button to save the MIX object in CMap2 Database.

More Info:

- If you edit a Mole % > Unassigned %, when you confirm it through ADD button, the following WARNIGN pop-up will opened:



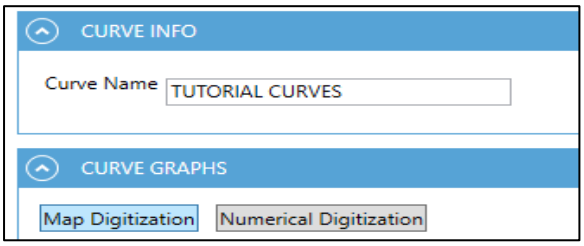
- The physical and chemical properties of each compound are visualized when it is selected.
- On the right side, the gas mixture is represented through a Pie Chart.
- The Mix Molecular Weight will be shown over the “Pie Chart Area”.

HOW UPLOAD THE MAPS

In this part of CMap user guide both procedures to upload the maps will be shown.

For both procedures, you must insert at least 3 curves per map to upload correctly a reference map in CMap 2.0

Map digitization



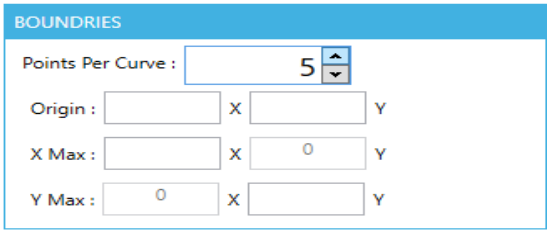
To open the DIGITIZATION MAP window, click 'Map digitization' button in CURVE GRAPHS.

In STEP INFO you can read some messages which help you to digitization of maps.



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.

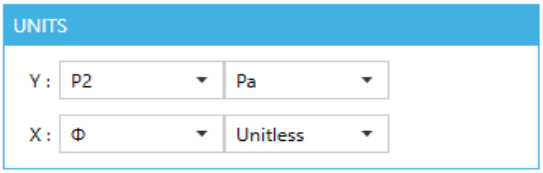
2. Uploaded the map, you have to fill the following fields in BOUNDRIES area:



- 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:



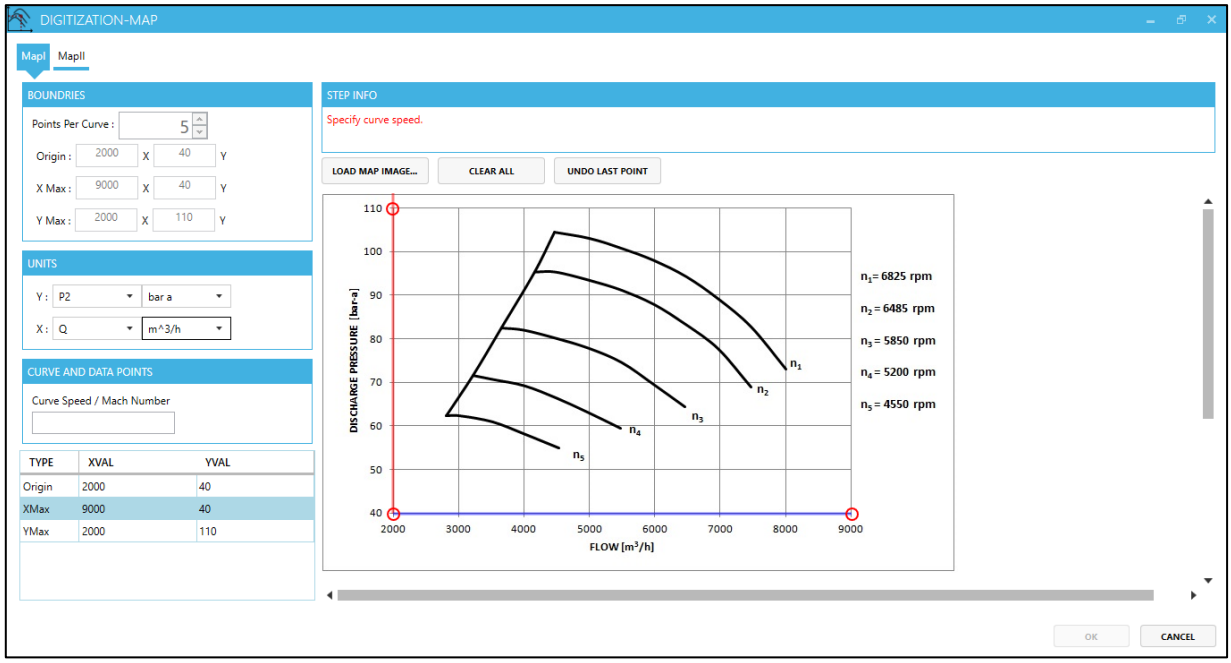
<u>X axis</u>, selecting between

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

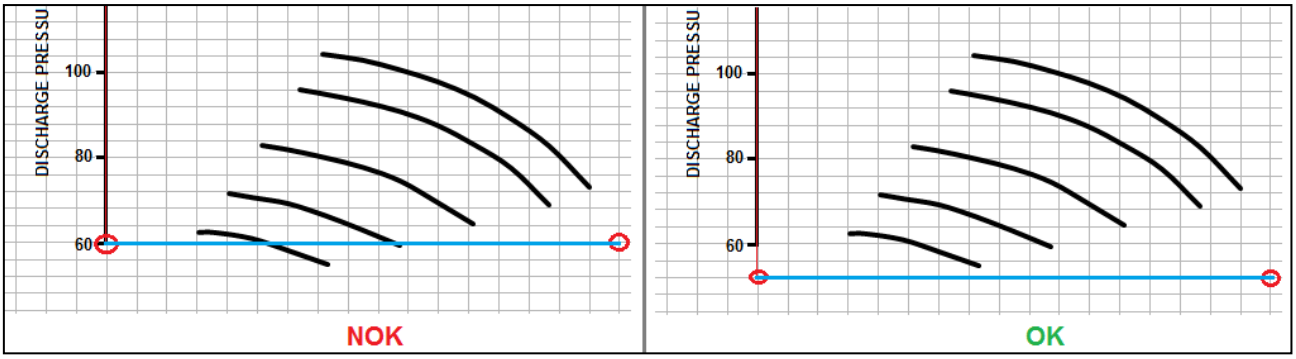
<u>Y axis</u>, selecting among:

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)

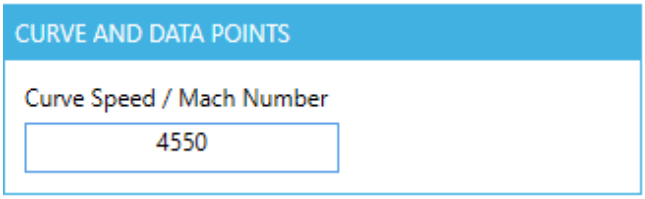
4. Now it is possible to digitize Origin, X Max and Y Max points on the picture.



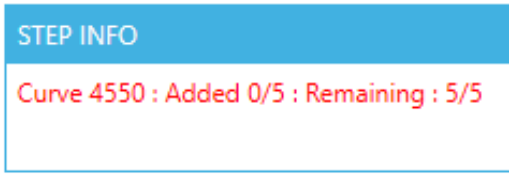
WARNING: the Origin values must be less than all points on the map.



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.



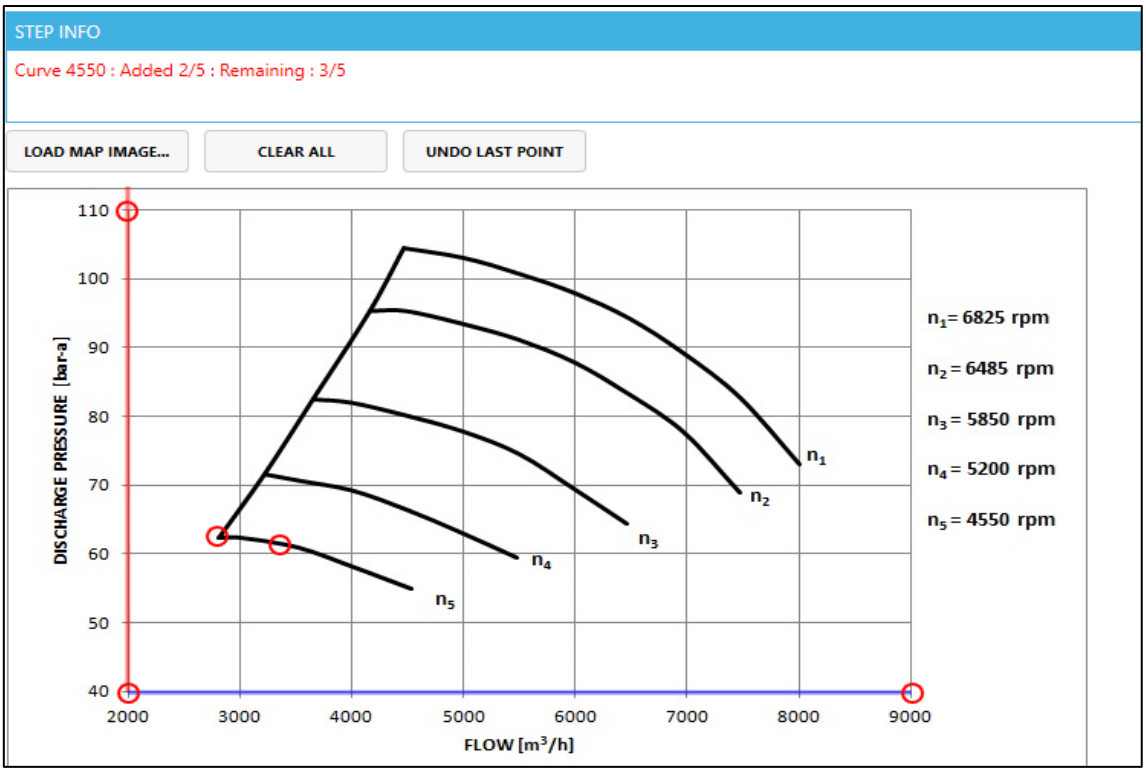
After you edited the 1st speed number (or Mach number), in STEP INFO there will be this message:



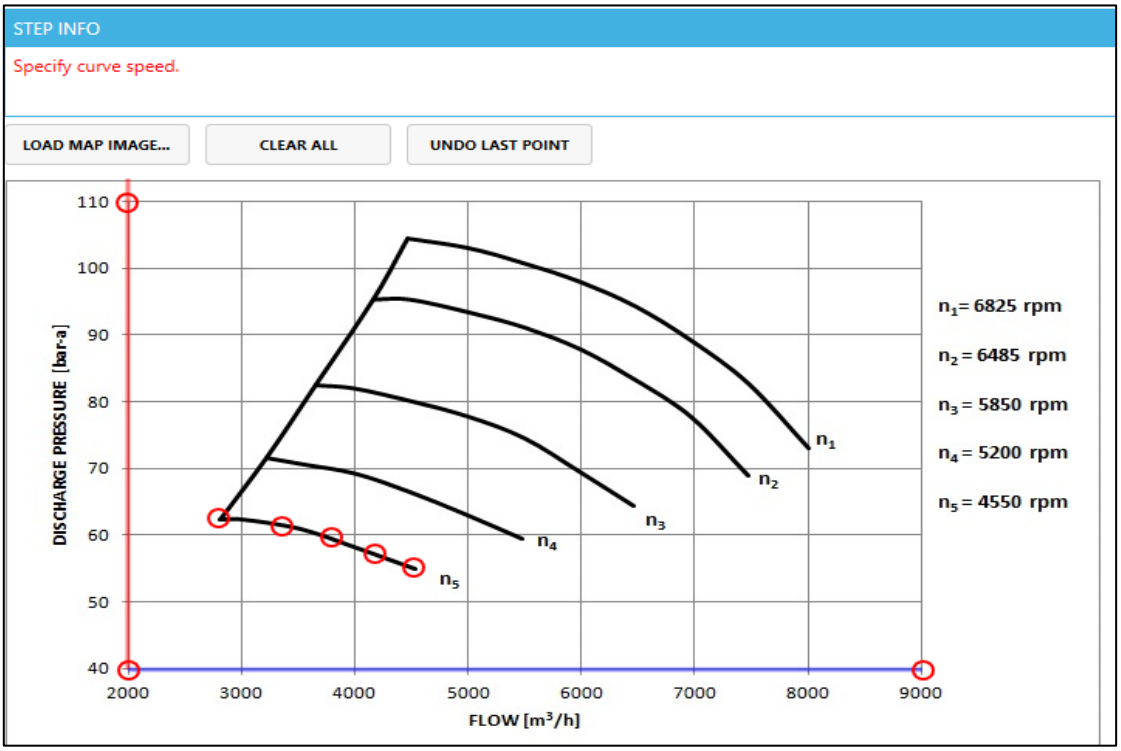
a resume of points already digitized (Added) and points to be digitized (Remaining).

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

For each point digitized, “Added” increase while “Remaining” decrease.

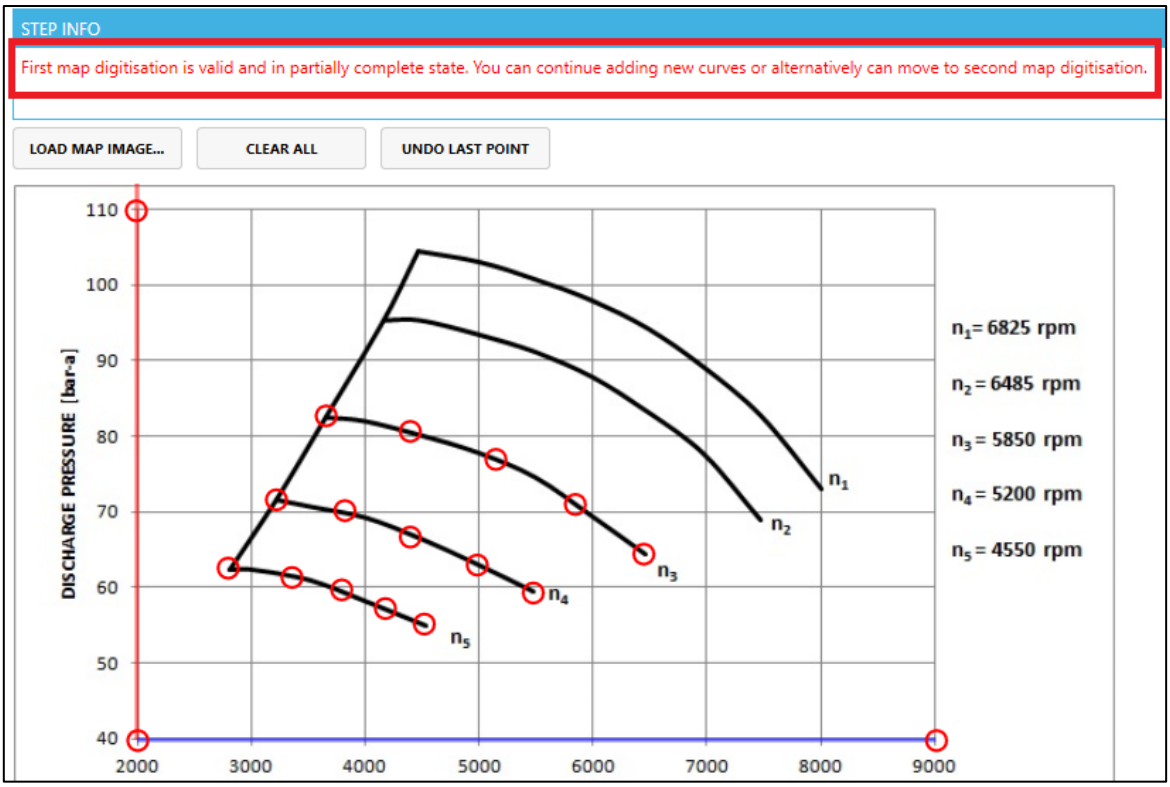


7. Once you digitized all the points of 1st curve, it need to specify the 2nd speed number (or Mach number) for 2nd curve, and so for the successive curves.



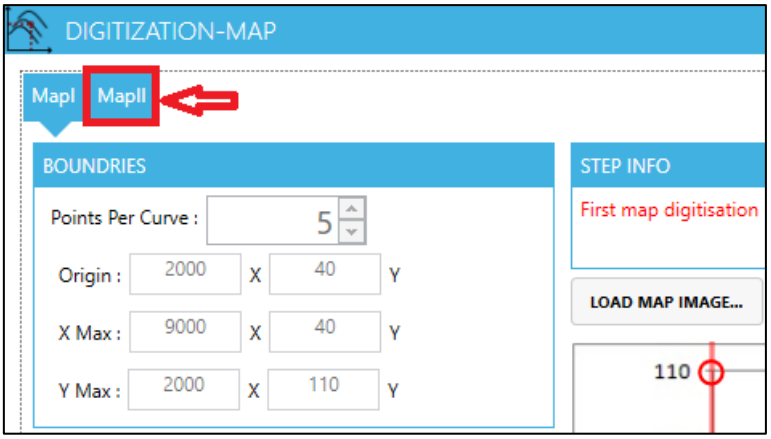
We remind that CMap 2.0 need <u>at least 3 curves</u> to set correctly a centrifugal compressor.

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.

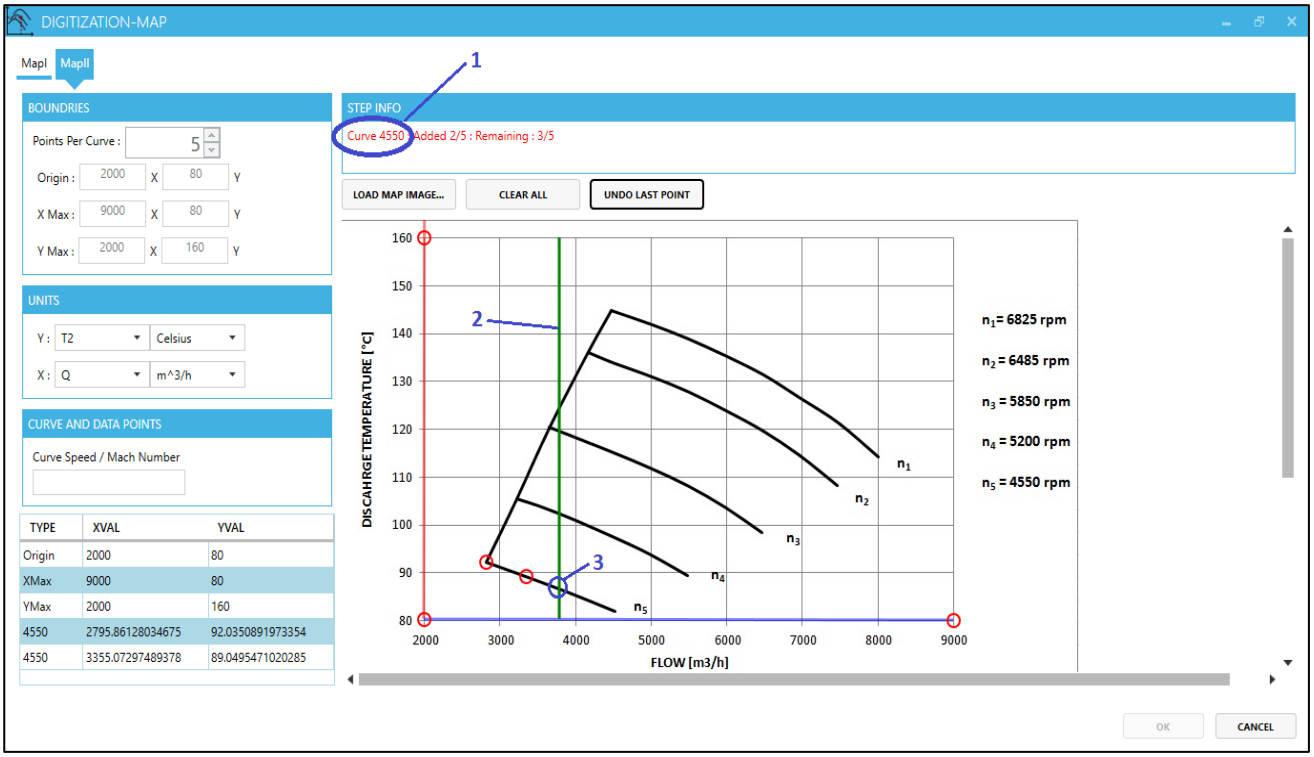
b) If you want to start the digitization of 2nd map, you should click "Map II" button.

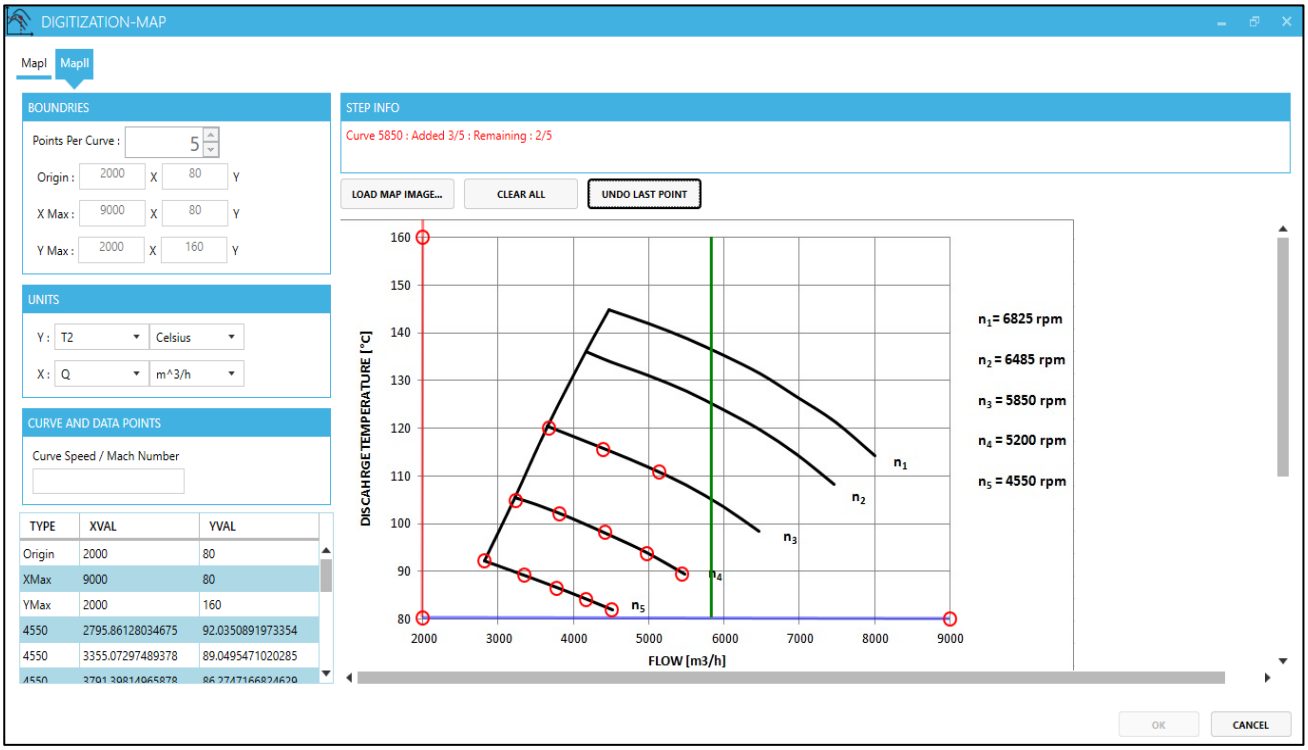


9. For the digitization of 2nd map you can follow the above procedure from point 1 to point 4.

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 must click where the green line intersects with the curve.

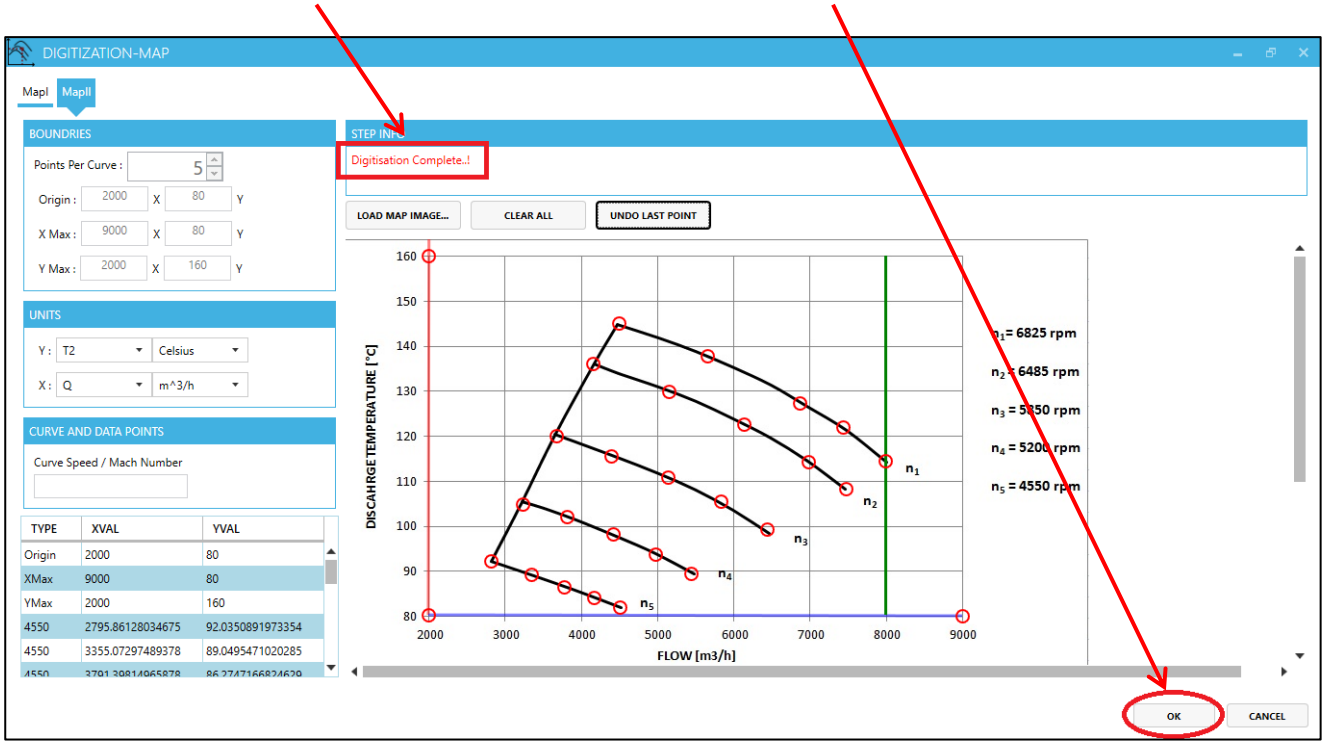




Through button 'CLEAR ALL' it is possible to clear all points digitized.

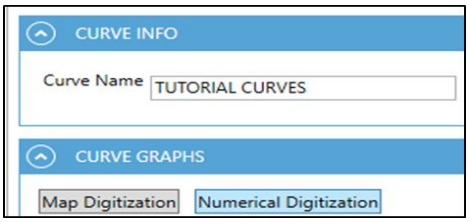
Through button 'UNDO LAST POINT' it is possible to clear last point digitized.

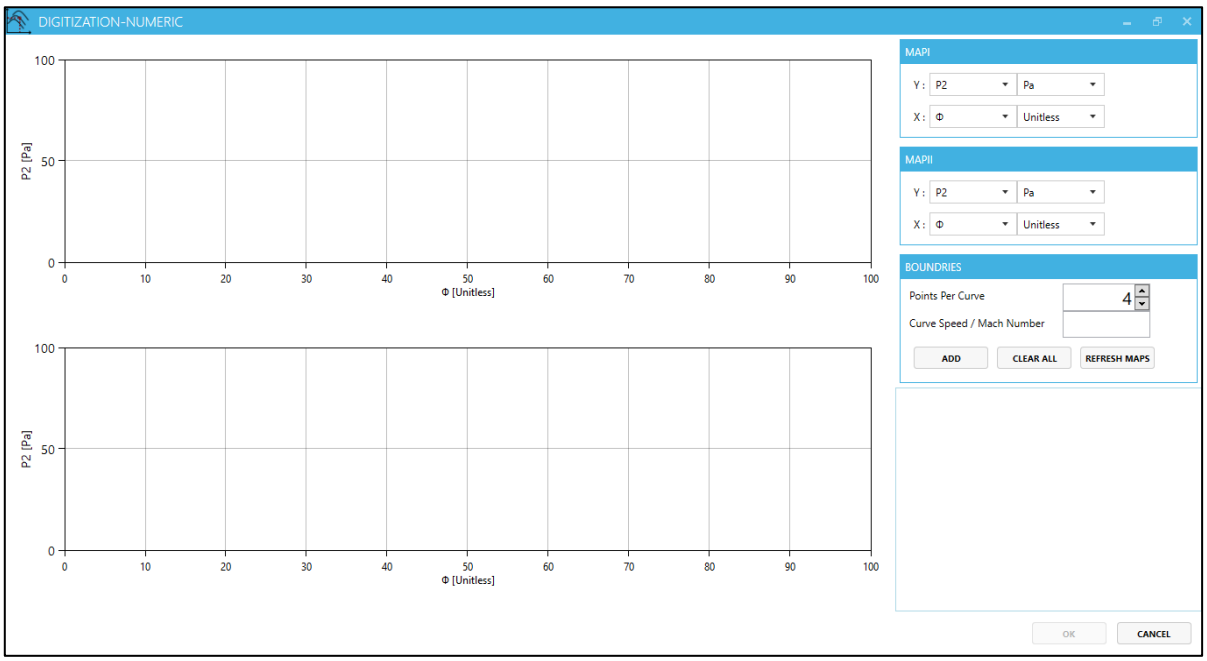
11. When all points are digitized, you can confirm the maps through “OK” button.



Numerical digitization

To open the DIGITIZATION NUMERIC window, click ‘Numerical digitization’ button in CURVE GRAPHS.

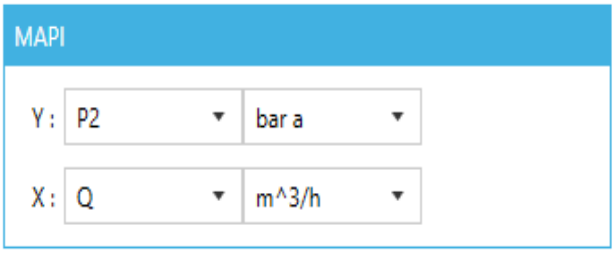




The DIGITIZATION NUMERIC window is structured as follow:

- In the main area there are 2 charts where the maps will refreshed in real time during the user input the numerical data
- In the right side there are the settings of numerical digitization.

1. The first step is to select what kind of map you are going to input in MAP I: you have to define the axis and relative units of the 1st map (discharge pressure vs actual volume flow for this tutorial).



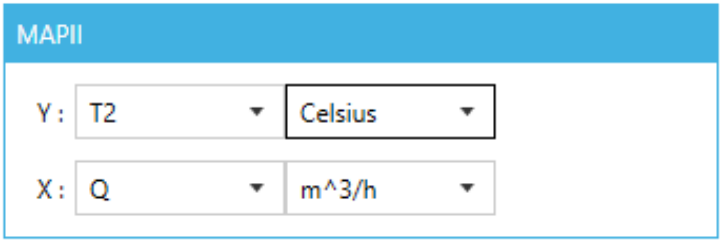
X axis, selecting between

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

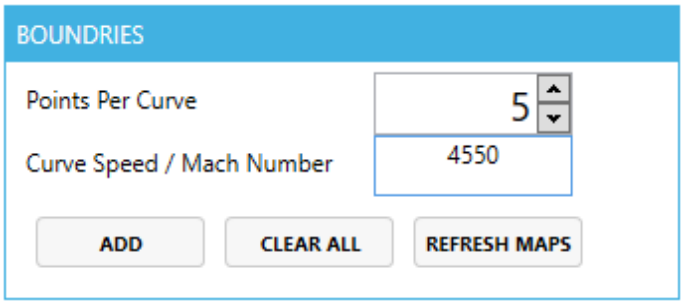
Y axis, selecting among:

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)

2. In MAP II: you have to define the axis and relative units of the 2nd map (discharge temperature vs actual volume flow for this tutorial)

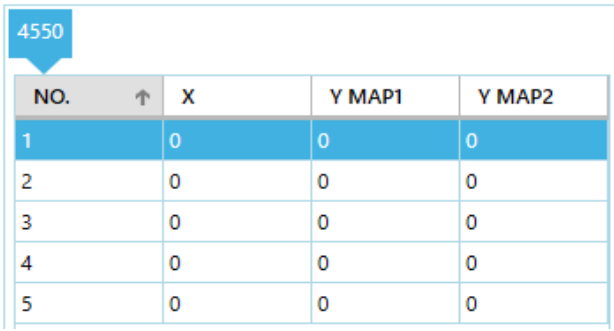


3. In BOUNDRIES: you have to define how much number of points per curve you are going to input.



Then you can edit the 1st speed (or Mach number if you have non-dimensional map) for 1st curve. Click "ADD" to start the numerical input.

4. This table will be shown where you can insert the values of 1st curve.



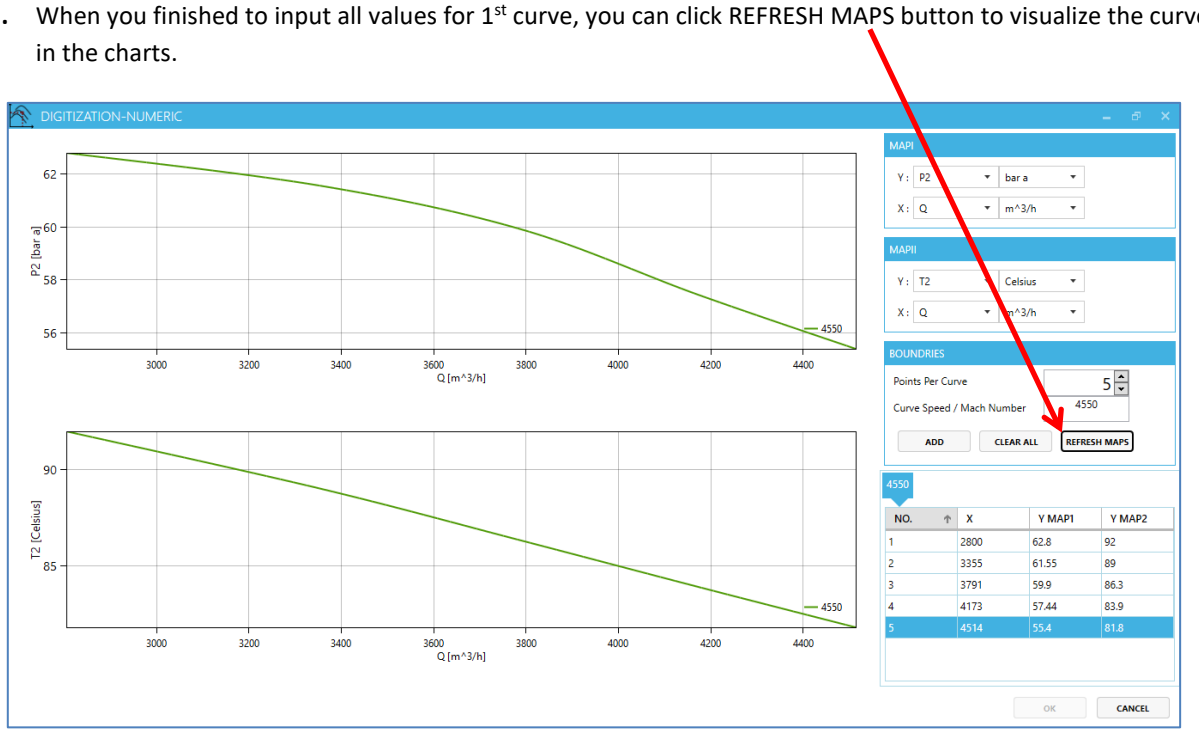
4550

NO.	X	Y MAP1	Y MAP2
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0

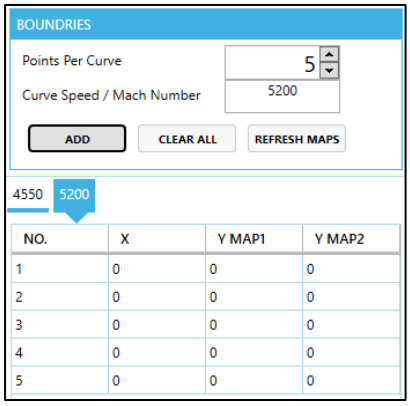
As example, following this tutorial project:

- in the X Column you have to input the values of inlet volume flow in m^3/h
- in Y MAP1 Column you have to input the values of discharge pressure in bar-a
- in Y MAP2 Column you have to input the values of discharge temperature in °C.

5. When you finished to input all values for 1st curve, you can click REFRESH MAPS button to visualize the curves in the charts.



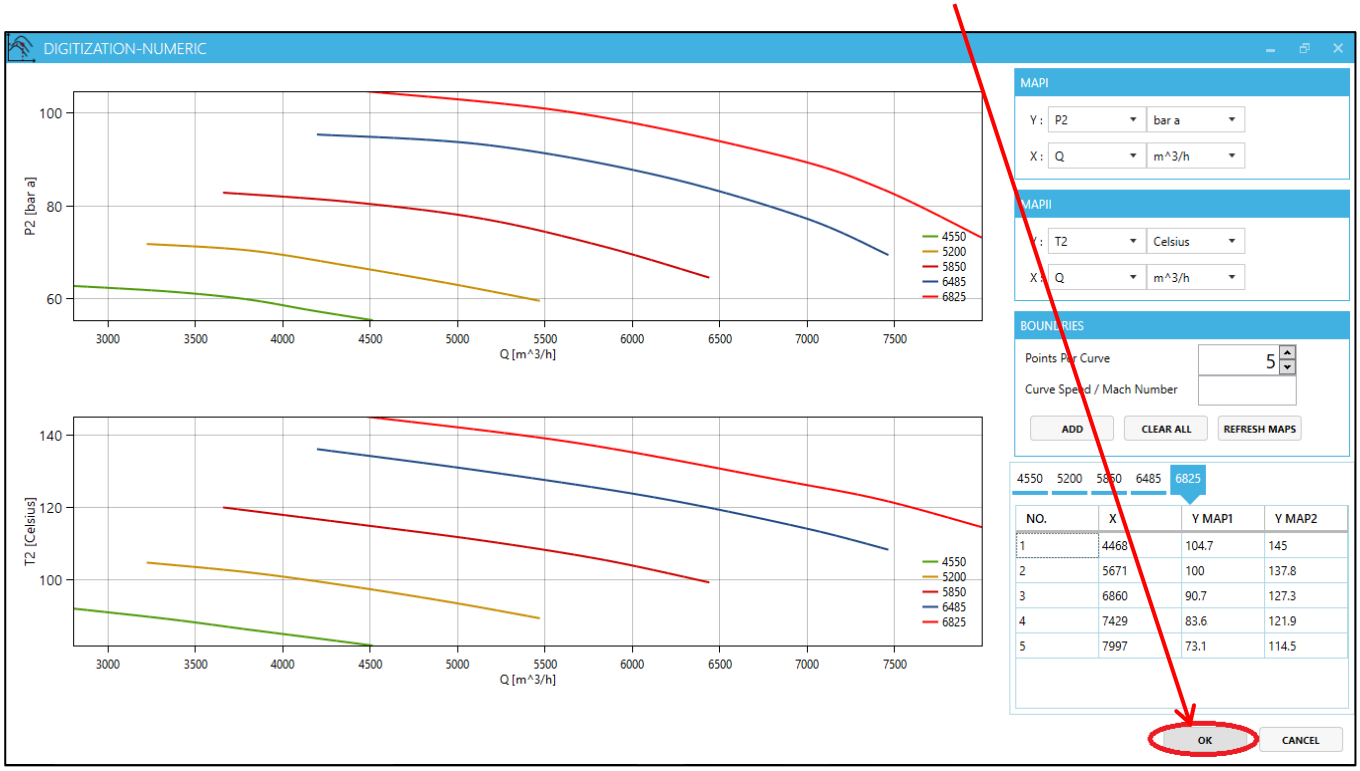
This tool will help you to detect any input error if the plotted curve appear not-compliant.



6. To start the numerical digitization of 2nd curve, you need to input the 2nd speed number (or Mach number), click ADD button and the new table of 2nd curve will be shown.

7. Repeat the points from 4 to 6 to conclude the numerical digitization of all curves.
We remind that CMap 2.0 need <u>at least 3 curves</u> to correctly set a centrifugal compressor.

8. After you inserted all values of all curves, you can confirm the maps through “OK” button.



PERFORMANCE EVALUATION

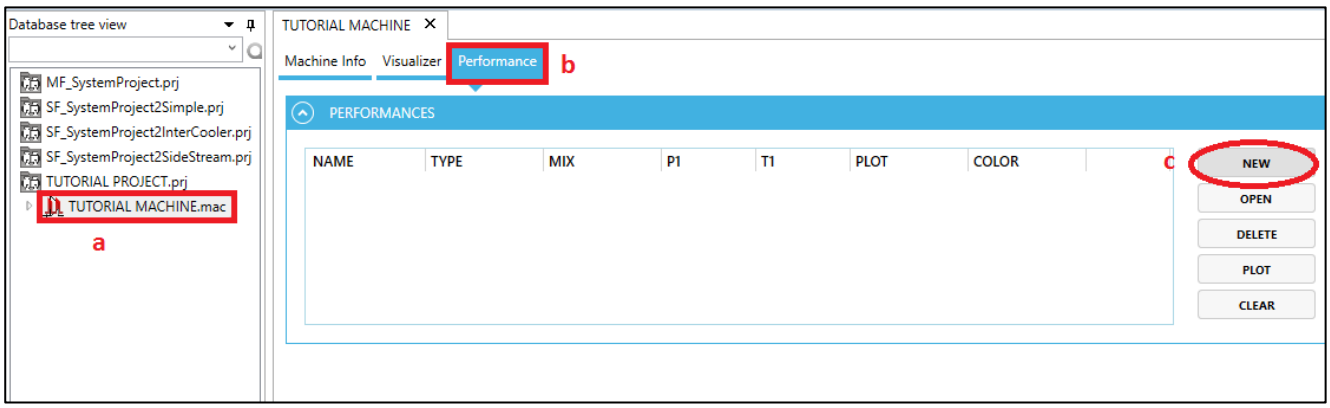
In this section we will show you how to start the performance evaluation. This task will include the following steps:

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

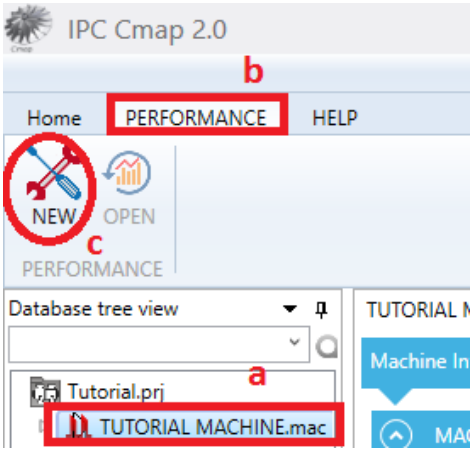
For point a) see **HOW CREATE A MIX** section.

To start a performance evaluation of a MACHINE (already created), there are two ways:

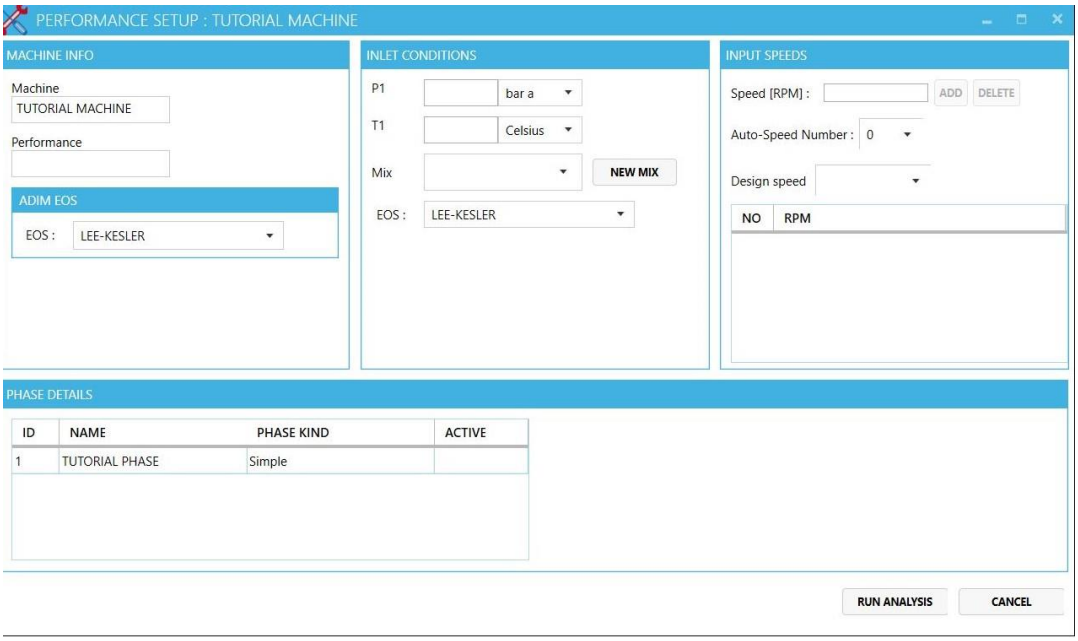
1) open the MACHINE (a), choose the “Performance” Tab (b), click button “NEW” (c).



2) open the MACHINE (a), click PERFORMANCE tab of Ribbon bar (b), click NEW (c).



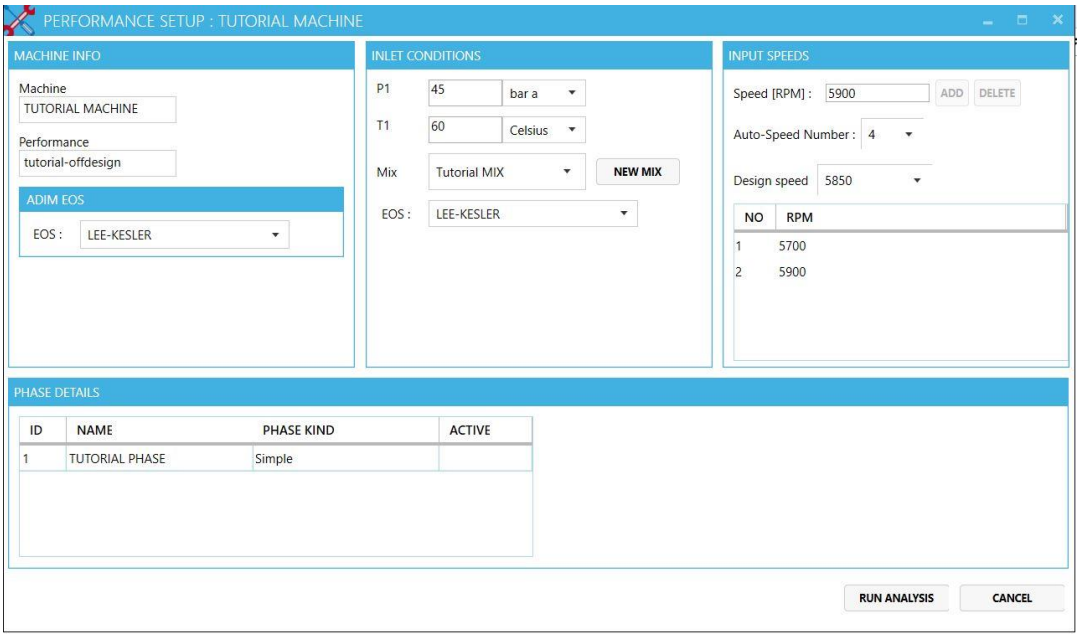
The PERFORMANCE SETUP form will be opened:



Once the pop-up window opens:

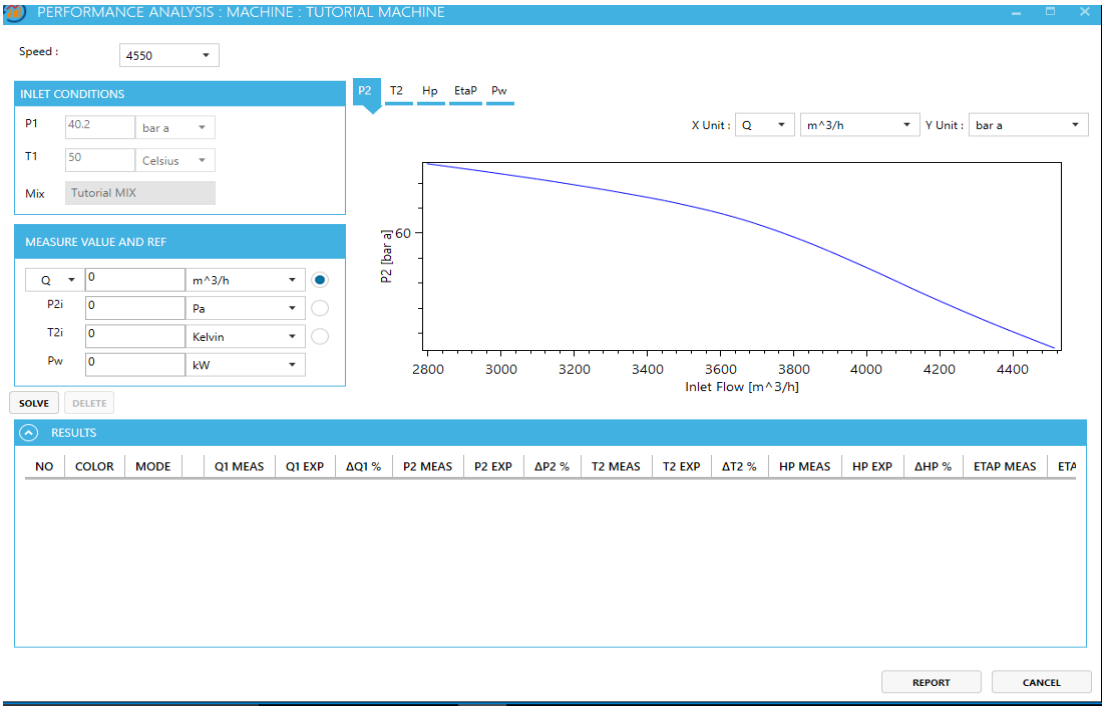
1. edit the name of the performance in MACHINE INFO Area.
2. define ADIM EOS to model (non-dimensional) the compressor: this EOS is linked to **design mix**. For this reason:
    a. **if design mix is a Hydrocarbon mixture you have to select between Lee-Kesler or Peng Robinson EOS.**
    b. **if design 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.
6. In Auto Speed drop down menu, select the number of speeds that shall be automatically calculated. For example, if you select 4, CMap will automatically calculate 4 speeds equally spaced. This feature could be useful to quickly generate a performance map in new conditions.
7. In Design Speed drop down menu, select which one of the design speeds shall be projected to new operating condition. This feature could be useful to understand at which speed the compressor should run in new condition to be in flow similarity to design conditions.
8. If you want to delete a speed number, you must select it and click DELETE button
9. Click RUN ANALYSIS button to start calculation

Example of PERFORMANCE SETUP for TUTORIAL MACHINE.



After clicking on RUN ANALYSIS CMap will perform the calculations and inform of the analysis completion.

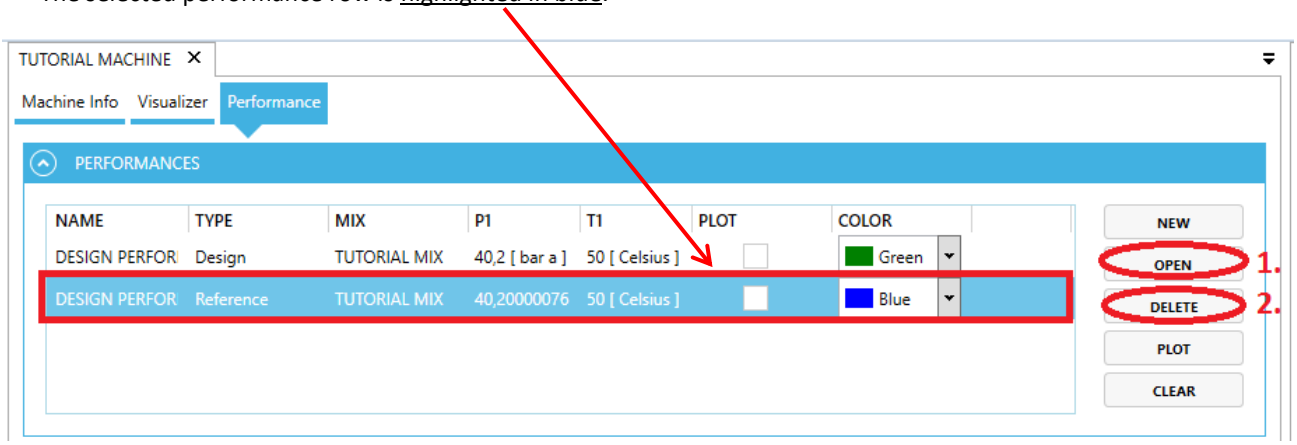
The PERFORMANCE ANALYSIS form will be automatically opened (see **PERFORMANCE ANALYSIS** section for more details):



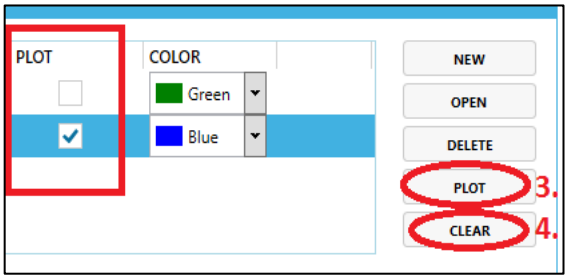
In the section “Perfomance” of the Machine it is possible to select a performance curve to:

1. Open the performance maps (OPEN button)
2. Delete the performance maps (DELETE button)

The selected performance row is highlighted in blue.



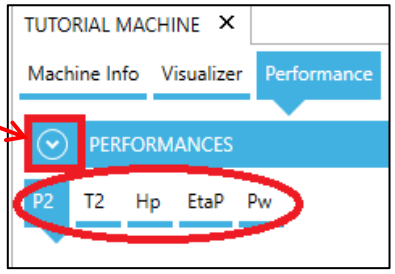
If you select two or more performances simultaneously, it will be opened/deleted the last selected one.



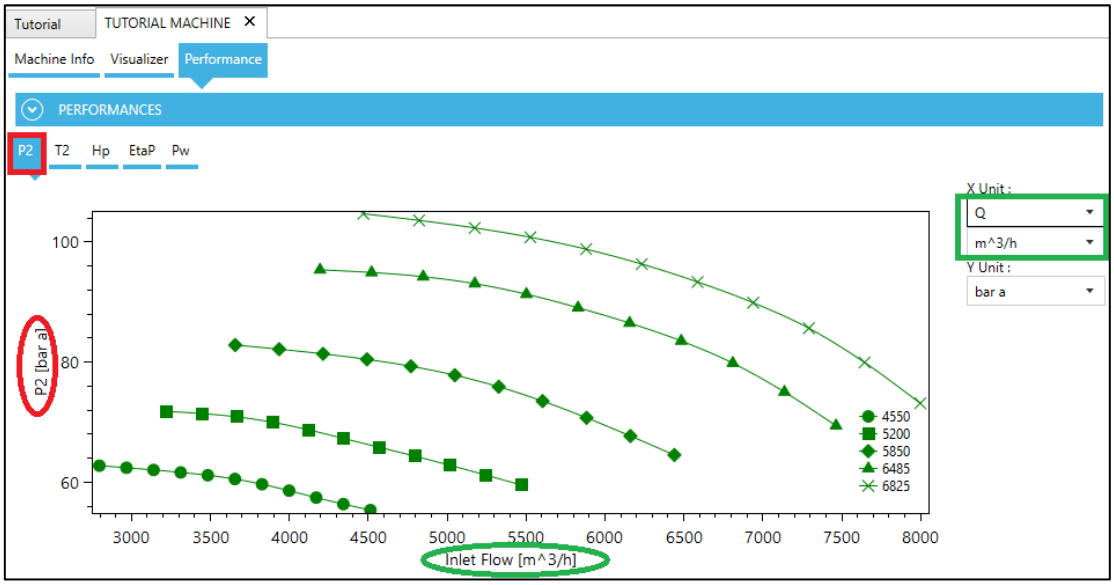
The flag in the column PLOT allow to Plot one or more performance maps if you click PLOT button (3.).

CLEAR button (4.) allow to clean all performance maps (previously plotted).

To hide Performance Data table you have to click the UP ARROW button.



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



In PERFORMANCES tab you can define:

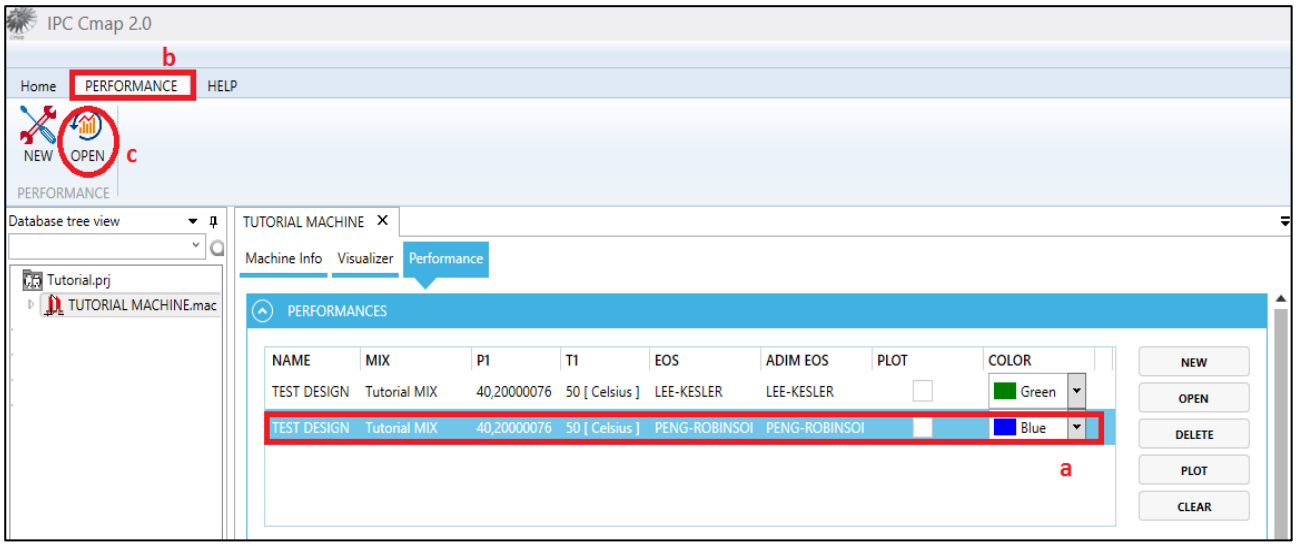
a. the inlet flow (Q or Qn or Qstd or G) and its unit for X Axis (X Unit)
b. the unit of measure for Y Axis (Y Unit)

PERFORMANCE ANALYSIS

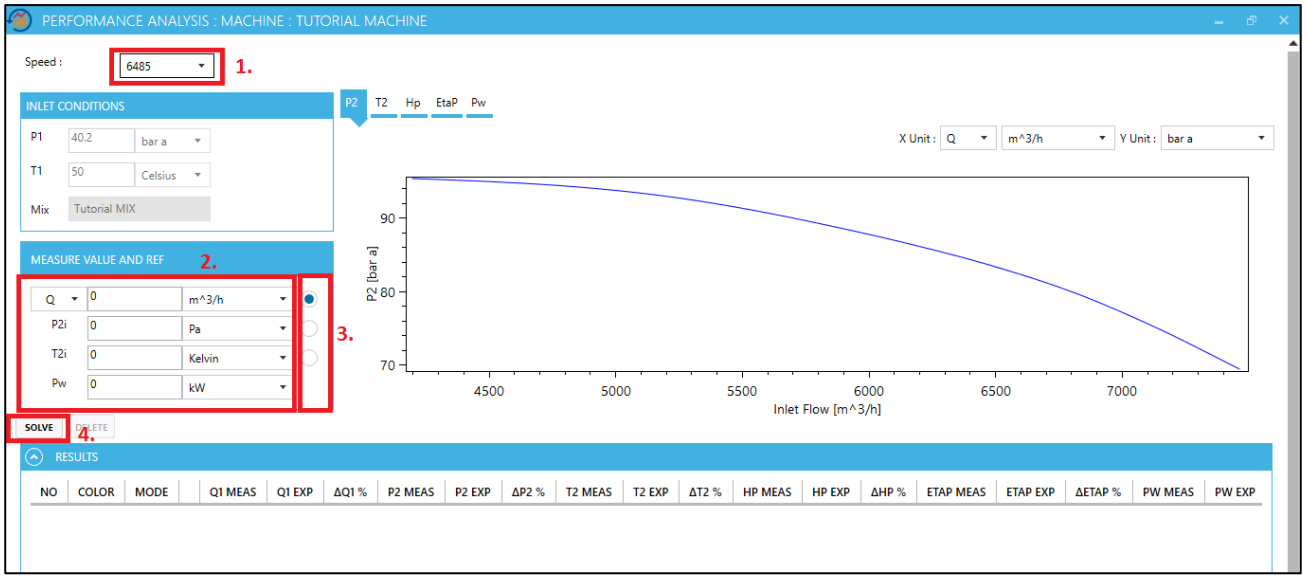
This section of user guide will show how to execute a detailed performance analysis, comparing real test measured values with expected ones.

To run this task in a MACHINE (previously Performanced, see **PERFORMANCE EVALUATION** section), there are 3 ways:

1) click “Performance” tab in MACHINE, select the desired Performance, click Open
2) in “Performance” tab in MACHINE, double left click on desired Performance
3) choose PERFORMANCE Tab of Ribbon Bar (a), select the desired Performance (b), click ANALYSIS button (c).



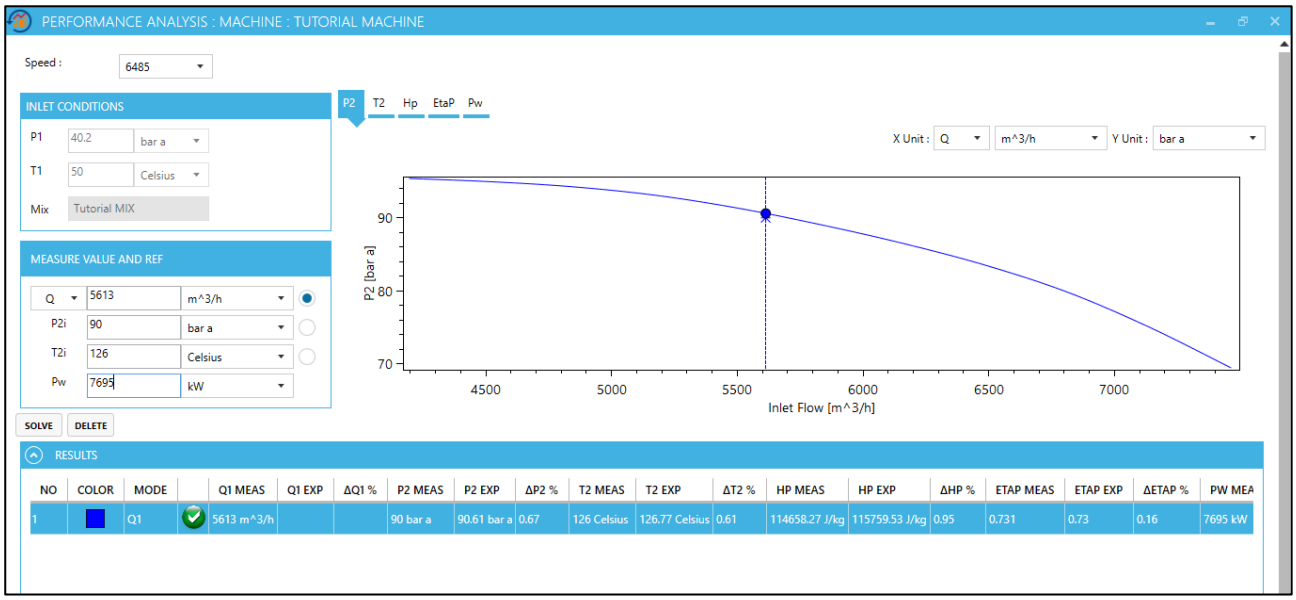
The PERFORMANCE ANALYSIS form will be opened:



Through this tool you can compare the measured values (from field or from 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.



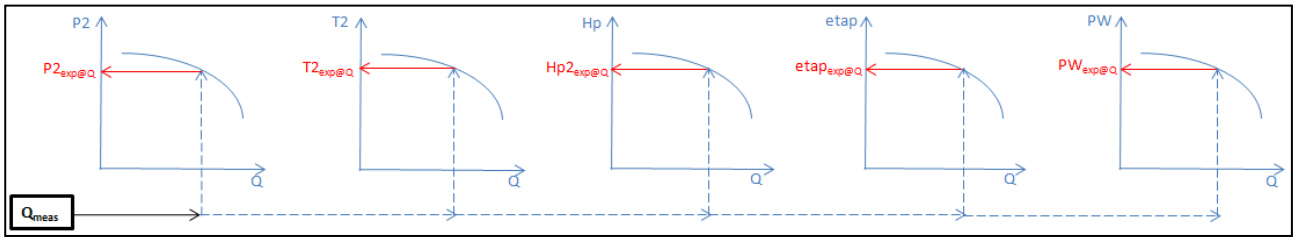
As the point 3 describes, the software offers the possibility to make checks with reference to measured inlet flow (MODE Q) or pressure (MODE P2) or temperature (MODE T2).

<u>MODE Q</u>

If you flag Q, CMap will use the measured flow as reference value and will use it to extract the values of:

- expected Discharge Pressure (P2_exp@Q)
- expected Discharge Temperature (T2_exp@Q)
- expected Polytropic Head (Hp_exp@Q)
- expected Polytropic Efficiency (Etap_exp@Q)
- expected Power (Pw_exp@Q)

The following picture shows as the software get the expected performance values under MODE Q.



MODE P2

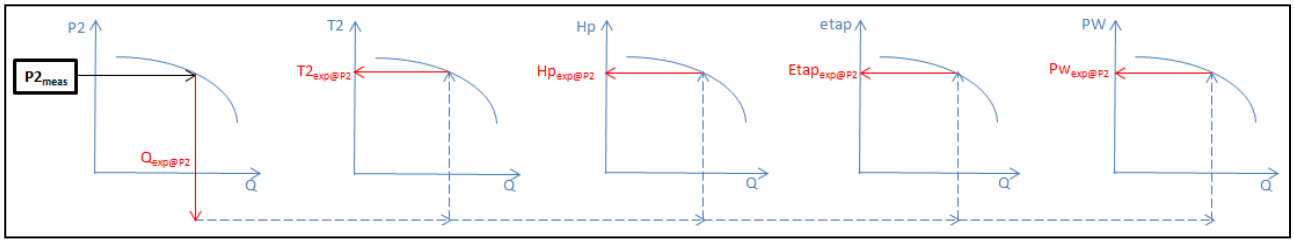
If you flag P2, CMap will use the measured pressure as reference value and will use it to extract the values of:

- expected Inlet Flow (Q_exp@P2)

Then the software will use Q_exp@P2 to extract the values of:

- expected Discharge Temperature (T2_exp@P2)
- expected Polytropic Head (Hp_exp@P2)
- expected Polytropic Efficiency (Etap_exp@P2)
- expected Power (Pw_exp@P2)

The following picture shows as the software get the expected performance values under MODE P2.



MODE T2

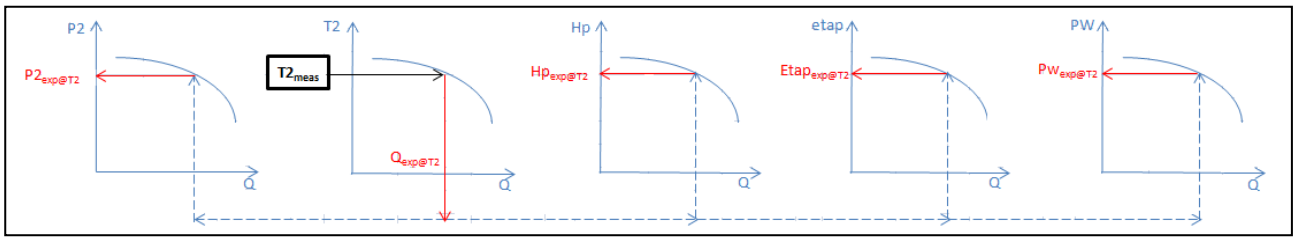
If you flag T2, CMap will use the measured temperature as reference value and will use it to extract the values of:

- expected Inlet Flow (Q_exp@T2)

Then the software will use Q_exp@T2 to extract the values of:

- expected Discharge Pressure (P2_exp@T2)
- expected Polytropic Head (Hp_exp@T2)
- expected Polytropic Efficiency (Etap_exp@T2)
- expected Power (Pw_exp@T2)

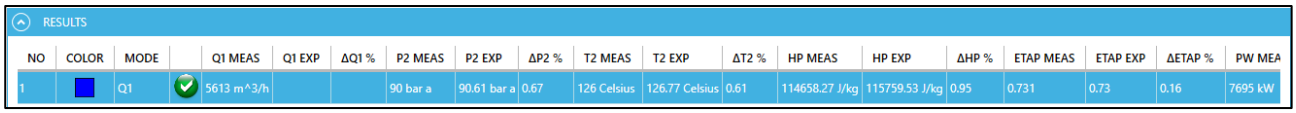
The following picture shows as the software get the expected performance values under MODE T2.



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

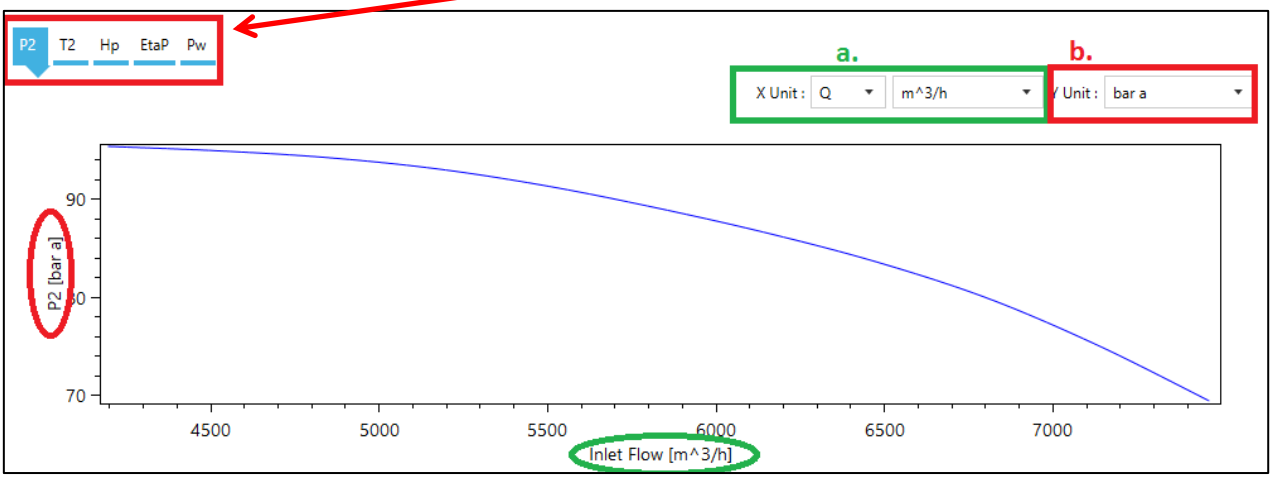
- inlet flow (Q or Qn or Qstd or G)
- Discharge pressure (p2)
- Discharge temperature (T2)
- Polytropic Head (Hp)
- Polytropic efficiency (Etap)
- Shaft Power (Pw)

and also 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)

There are 2 different buttons to get PERFORMANCE ANALYSIS REPORT:

- **XLS REPORT**, to save both info and results about the PERFORMANCE ANALYSIS through a Spreadsheet,
- **PDF REPORT**, to save both info and results about the PERFORMANCE ANALYSIS through PDF format.

In the section SOFTWARE IN DETAIL/REPORT, these 2 REPORT files will be described.

WARNINGS message: in the last column of RESULTS, you could see the following messages:

1. Compressor OK
2. Mechanical degradation
3. Measurements or instrumentation problem
4. Check

The messages 1-2-3 are linked to comparison about polytropic efficiency between $Etap_{meas}$ and $Etap_{exp}$. Their difference ($Etap_{meas}$- $Etap_{exp}$)* is compared with two different diagnostic thresholds:

- S_eta1, % efficiency difference warning threshold ($Etap_{meas}$< Eta_{exp})
- S_eta2, % efficiency difference error threshold ($Etap_{meas}$> Eta_{exp})

The message 4 is linked to comparison about discharge pressure and discharge temperature between measured and expected values. Their difference is compared with the following diagnostic thresholds:

- S_p, % pressure difference check threshold
- S_T, % temperature difference check threshold

The thresholds values can be edited from user in SETTINGS ➔ Advanced (see **SETTINGS** section).

Note:

* Difference between $etap_{meas}$ and $etap_{exp}$ depends on small differences between $T2_{meas}$ and $T2_{exp}$

SOFTWARE IN DETAILS

SAVE AND IMPORT/EXPORT

This paragraph provides info and instructions about the followings commands of Ribbon Bar:



SAVE: clicking this command the user is able to save the current object opened in the Work Area (Project, Machine, Phase, Stage, Curve or Mix).
The command is active if the last modification of current object is not yet saved.



SAVE ALL: clicking this command the user is able to save all the objects opened in the Work Area (Project, Machine, Phase, Stage, Curve or Mix).
The command is active if the last modifications of two or more objects are not yet saved.



IMPORT: clicking this command the user is able to import an object previously exported (Project, Machine, Phase, Stage, Curve or Mix) from the same PC or others PCs. See the section "How Import an Object" for more details.



EXPORT: clicking this command the user is able to export an object (Project, Machine, Phase, Stage, Curve or Mix) to import subsequently in the same PC or others PCs. To export an object, also you can right click on the object, then click Export button.

How Import an object

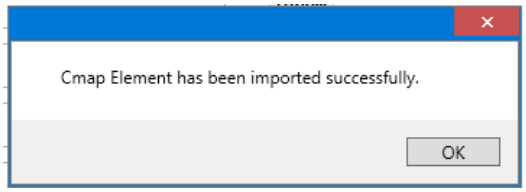
This section describes the procedure to import in CMap 2.0 any object (Project, Machine, Phase, Stage, Curve, Mix).

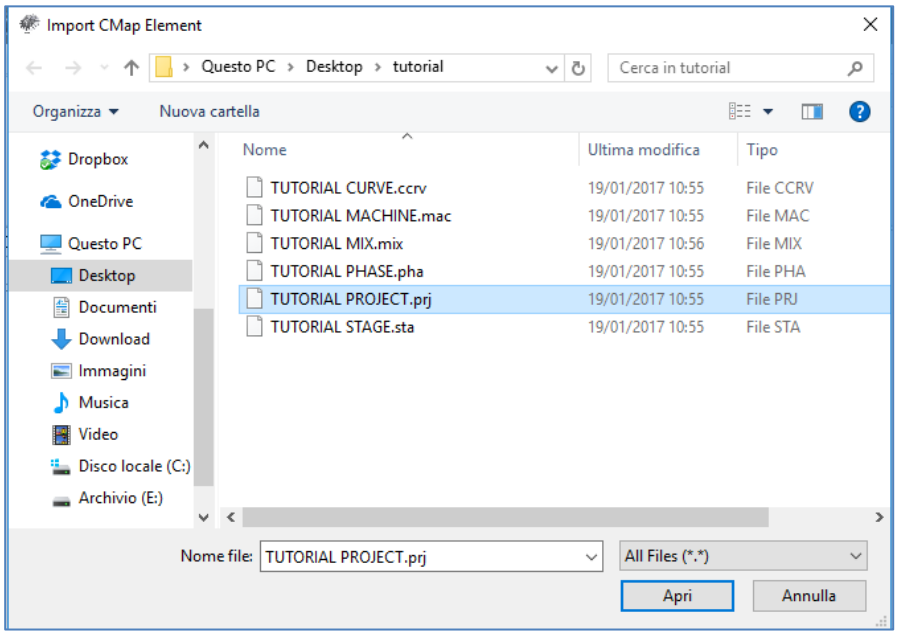
If you import a *Project*, it will be shown in the ***Database Tree View***.

If you import a *Machine* or *Phase* or *Stage* or *Curve* or *Mix*, it will be shown in ***Unassigned/ All Objects*** and then you can assign the imported object to an higher level object (to assign a machine to a project, a phase to a machine, etc).

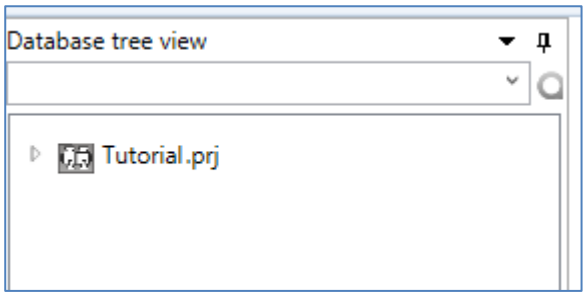
To Import an Object (Project or Machine or Phase or Stage or Curve or Mix):

1. click the Import button in the Ribbon Bar
2. search the file
3. select it
4. click Open to confirm
5. the message "CMap Element has been imported successfully" will be shown.

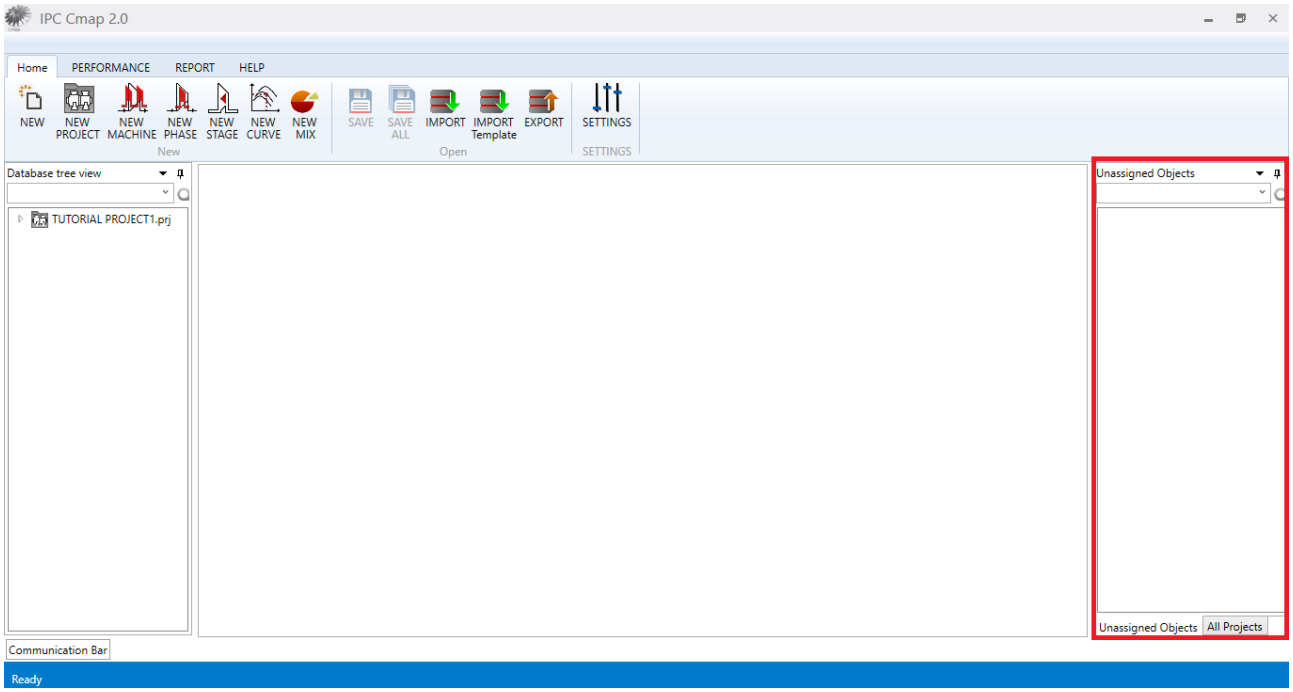




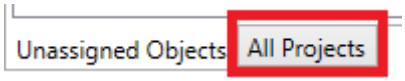
You can find the Imported Project in the ***Database Tree View***, and it is ready to work.



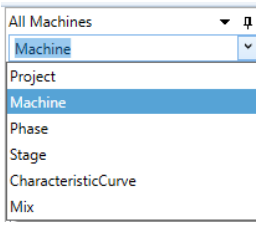
For the others objects, they will be stored in **Unassigned / All Objects** in the right side of GUI.



To visualize the Imported Object, Click All Projects button

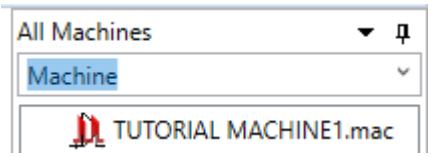


then select from drop-down Menu the Object window to visualize

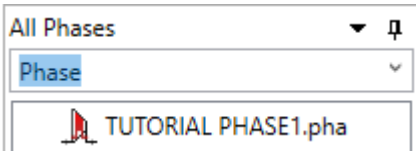


You will find :

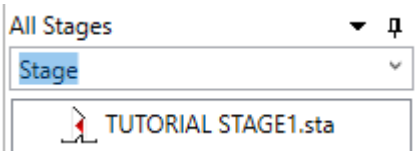
the Imported Machine in All Machines window



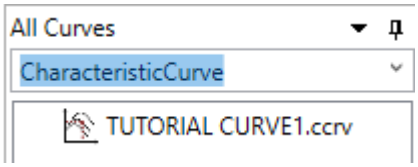
the Imported Phase in All Phases window



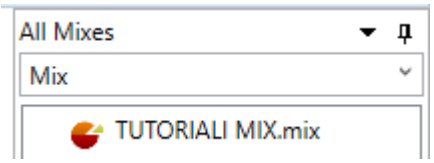
the Imported Stage in All Stages window



the Imported Curve in All Curves window



the Imported Mix in All Mixes window



All the Objects from Machine to Mix can be assigned to a higher level Object through Drag and drop way.

SETTINGS



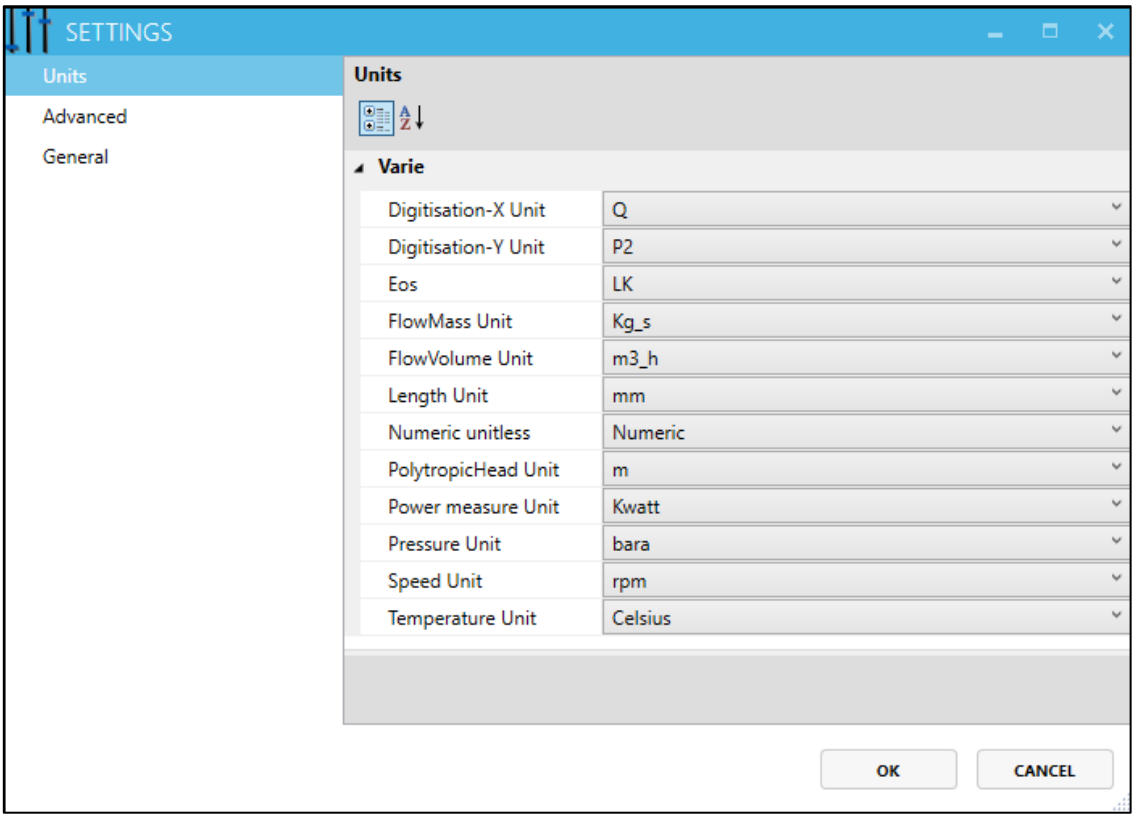
This section of user guide describes the SETTINGS of CMap software.

Click SETTINGS button on the ribbon bar.

There are 3 sub-settings: Units, Advanced, General.

Units

Click Units to open Units tab.



This section allow to select the default unit for each parameter within the software.

Click OK to save the configuration.

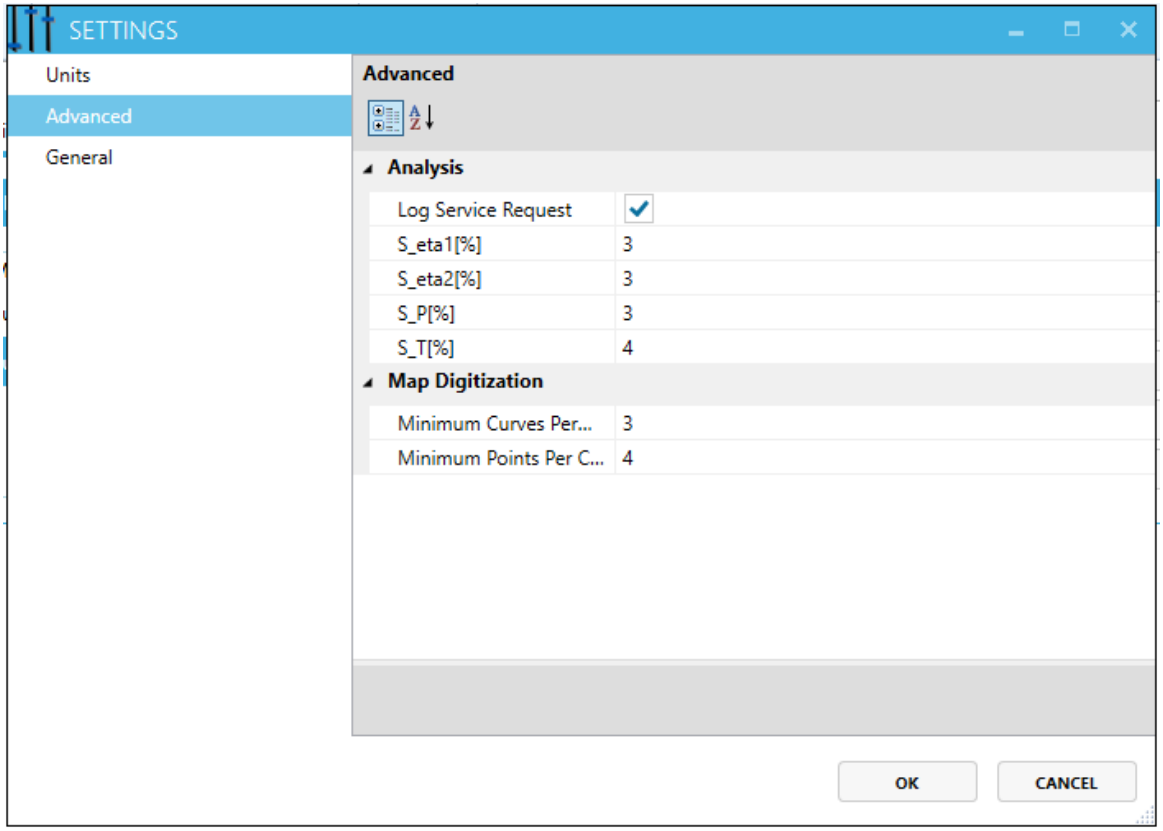
Click CANCEL to exit.

The following table is a summary of the available units in the current version of the software.

UNITS									
Pressure	**Temperature**	**Power**	**Polytropic Head**	**Polytropic Efficiency**	**Actual/Normal/Standard Volume Flow**			**Mass Flow**	**Lenght**
Pa (abs)	*Kelvin*	*W*	*J/kg*	*0-1*	*m^3/s*	*Nm^3/s*	*Sm^3/s*	*kg/s*	*mm*
bar a (abs)	*Celsius*	*kW*	*kJ/kg*	*%*	*m^3/h*	*Nm^3/h*	*Sm^3/h*	*kg/min*	*cm*
bar g (gauge)	*Fahrenheit*	*cv*	*m*		*GPM (US)*	*NGPM (US)*	*SGPM (US)*	*kg/h*	*m*
kPa (abs)	*Rankine*	*HP*	*ft*		*L/h*	*NL/h*	*SL/h*	*lb/s*	*inch*
Mpa (abs)	*Reamur*				*L/s*	*NL/s*	*SL/s*	*lb/min*	*feet*
atm (abs)					*L/min*	*NL/min*	*SL/min*	*lb/h*	*yeards*
psi a (abs)					*MMCFD*	*Nft^3/s*	*MMSCFD*		
psi g (gauge)					*ft^3/s*	*Nft^3/min*	*Sft^3/s*		
mmHg (abs)					*ft^3/min*	*Nft^3/h*	*Sft^3/min*		
kg/cm^2(abs)					*ft^3/h*	*Nm^3/min*	*Sft^3/h*		
					m^3/min		*Sm^3/min*		

Advanced

Click Advanced to open Advanced tab.



In Analysis you could:

- Enable / Disable the "Log Service Request" (enabling this box the software is able to create a XML file called "Last Request.xml", see **TROUBLESHOOTING/FAQ** section for more details)
  (It's recommended to enable the "Log Service Request", see **TROUBLESHOOTING/FAQ** for more details)
- Define the values of the diagnostic thresholds S_eta1, S_eta2, S_p and S_T (see **PERFORMANCE ANALYSIS** section).
  (It's recommended to set S_eta1>S_eta2, anyway both ≤ 5)

In Map Digitization you could edit the values of:

- Minimum Curves Per Map (always ≥ 3)
- Minimum Points Per Curve (always ≥ 3)

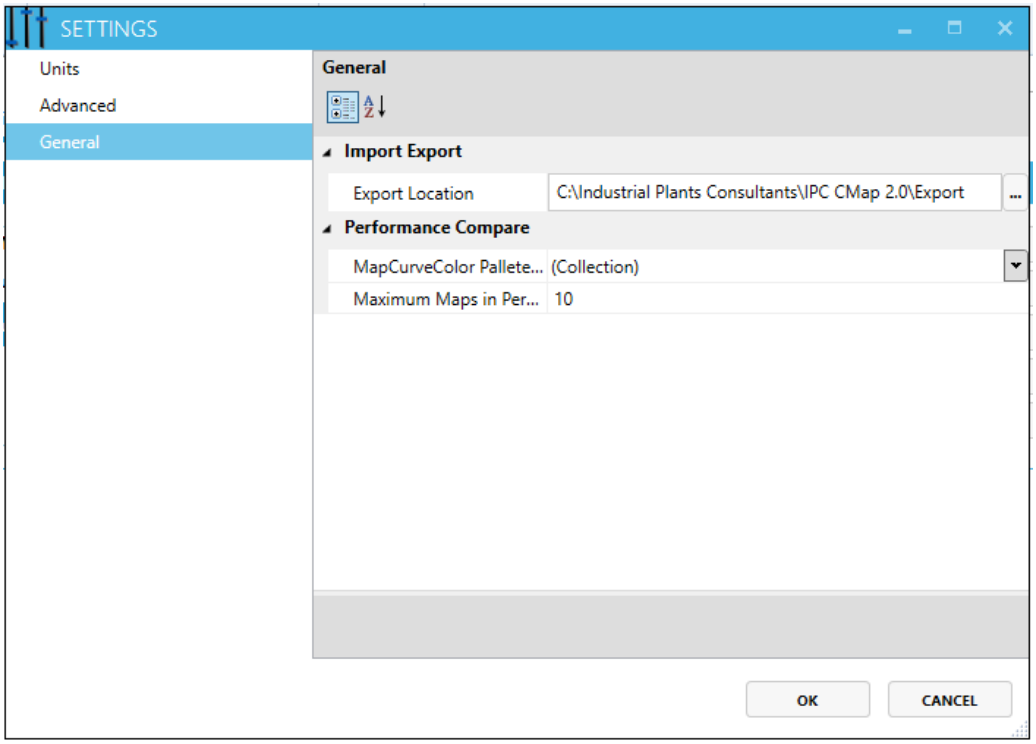
Once you defined these values, in Map/Numerical Digitization you could only increase the values of Curves Per Map (digitizing more curves than minimum) and Points Per Curve (see **HOW UPLOAD A MAP** section).

Click OK to save the configuration.

Click CANCEL to exit.

General

Click General to open General tab.



In Import/Export you could define the default directory to:

- export CMap objects in “Export Location”
- import CMap Templates “Templates Location”

In Performance Compare you could:

- assign default colors for several performance maps in “MapCurvecolor”
- define the Maximum Maps in Performance Compare

Click OK to save the configuration.

Click CANCEL to exit.

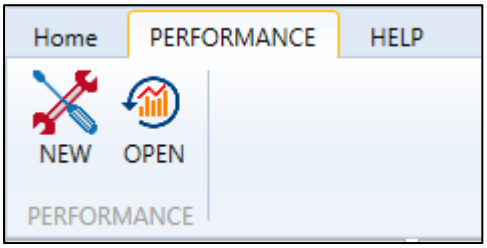
OTHER FEATURES

In this section you will find info and instructions about the followings main tabs:

- Performance
- Help

Performance

The PERFORMANCE tab of the Ribbon bar provides 2 shortcuts as:

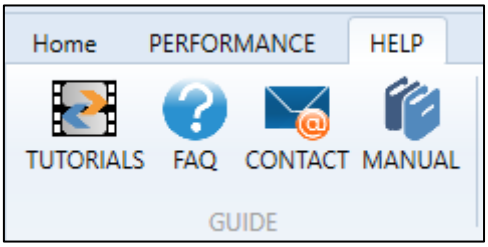


✓ *NEW*, to open the PERFORMANCE SETUP form in MACHINE

✓ *OPEN*, to open the PERFORMANCE ANALYSIS form of a selected performance

Help

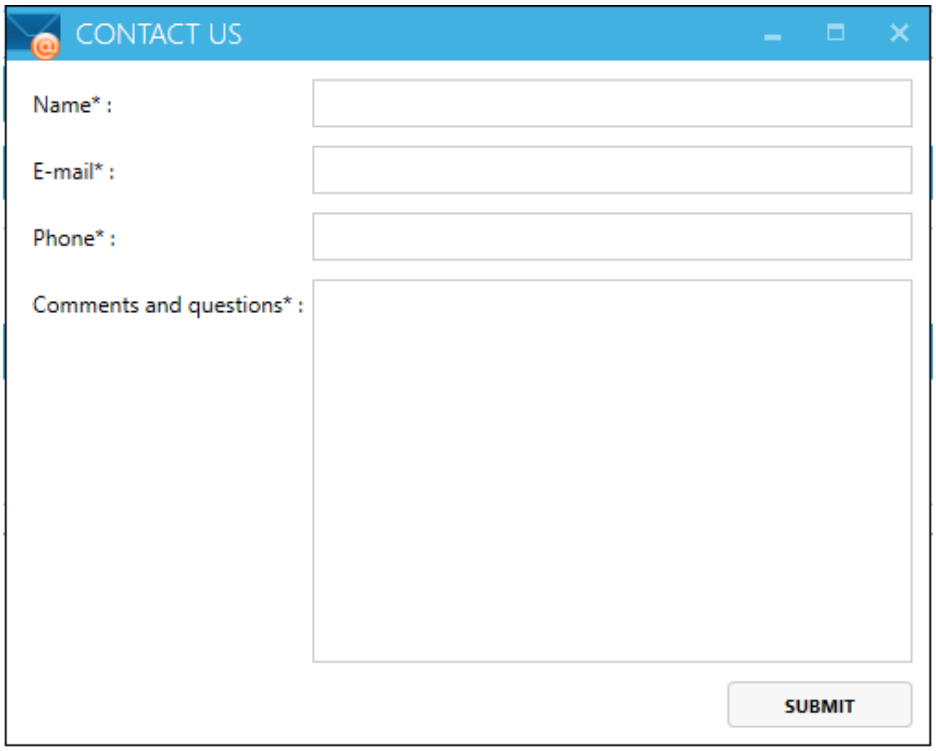
The HELP tab of the Ribbon bar provides 4 shortcuts to guide the user.



TUTORIALS: clicking this shortcut, a tutorial video will start to help you to create the different objects (from project to mix), calculate the performances, run the performance analysis, etc.

FAQ: clicking this shortcut, a pop-up will open where you could find the answers to any issues or also the troubleshooting about CMap 2.0 operations.

CONTACT: clicking this shortcut, the form CONTACT US will open where you could contact the **IPC CMap support team** by e-mail for any comments or questions or clarifications.

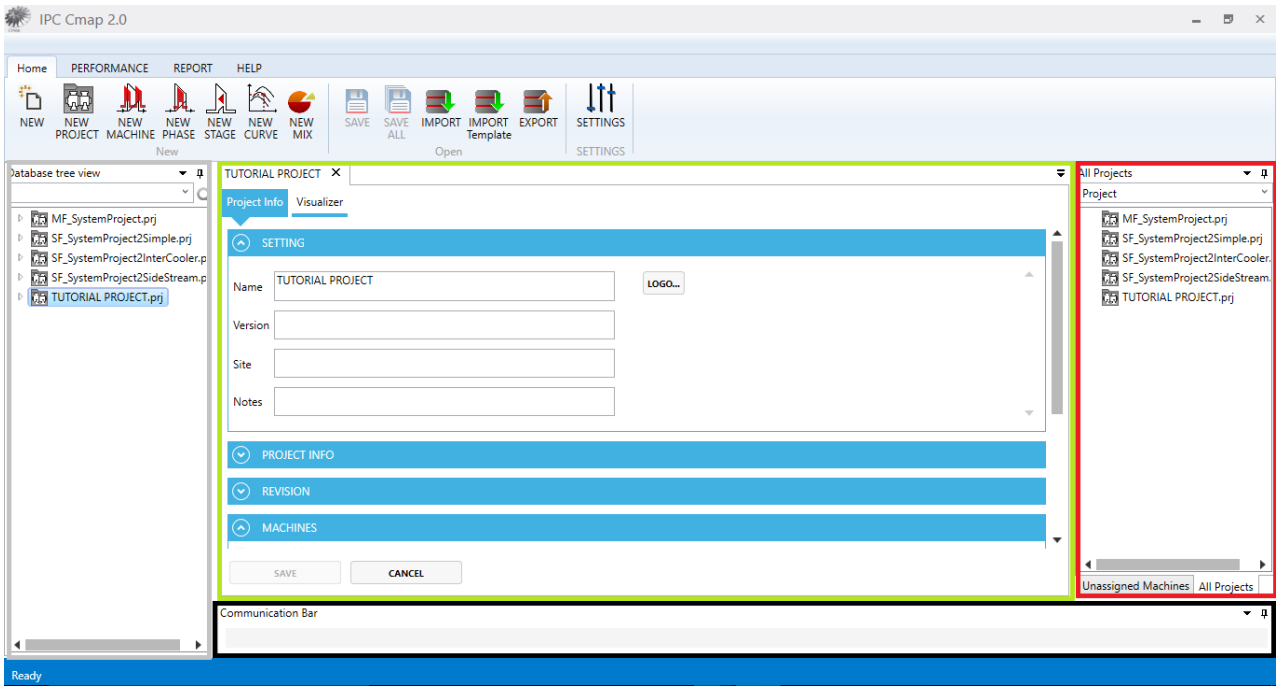


MANUAL: clicking this shortcut, the “USER GUIDE OF CMAP2” document will be opened.

MANAGEMENT OF WINDOWS

CMap 2.0 offers the possibility to modify the layout of windows as the user prefers arrange them.

As you have already seen in **CENTRIFUGAL COMPRESSOR CONFIGURATION** section, the default layout of ***Home*** is shown:

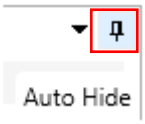


In the *Work Area* the TUTORIAL PROJECT is opened (as example).

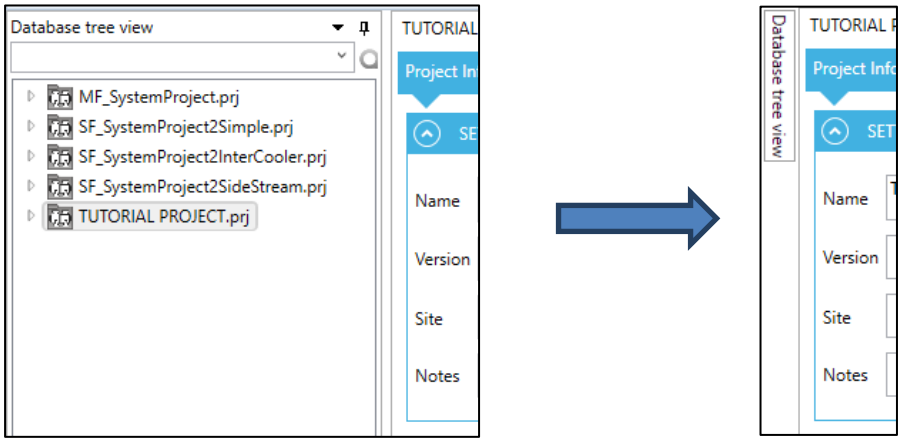
The windows of default Home are arranged as follow:

- *Database tree view* Window is on the left
- *Communication bar* Window is down
- *Unassigned Objects and All Objects* Windows are on the right

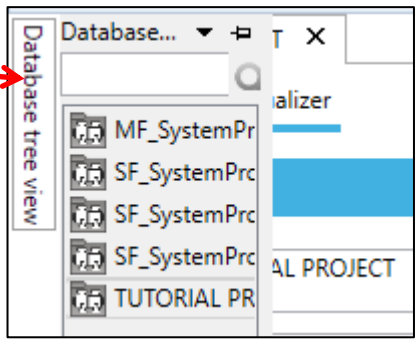
Each of above windows provides the following buttons:



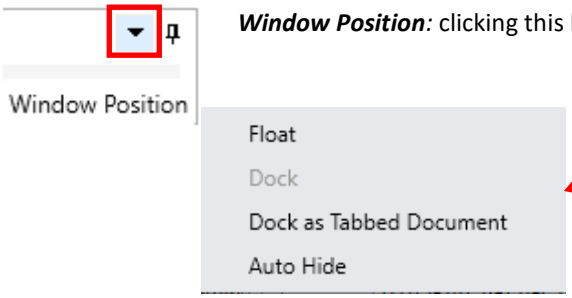
***Auto Hide**:* clicking this button, the window is hidden.



To visualize the minimized window click or mouse over the title of window.



To restore the window click again *Auto Hide*.

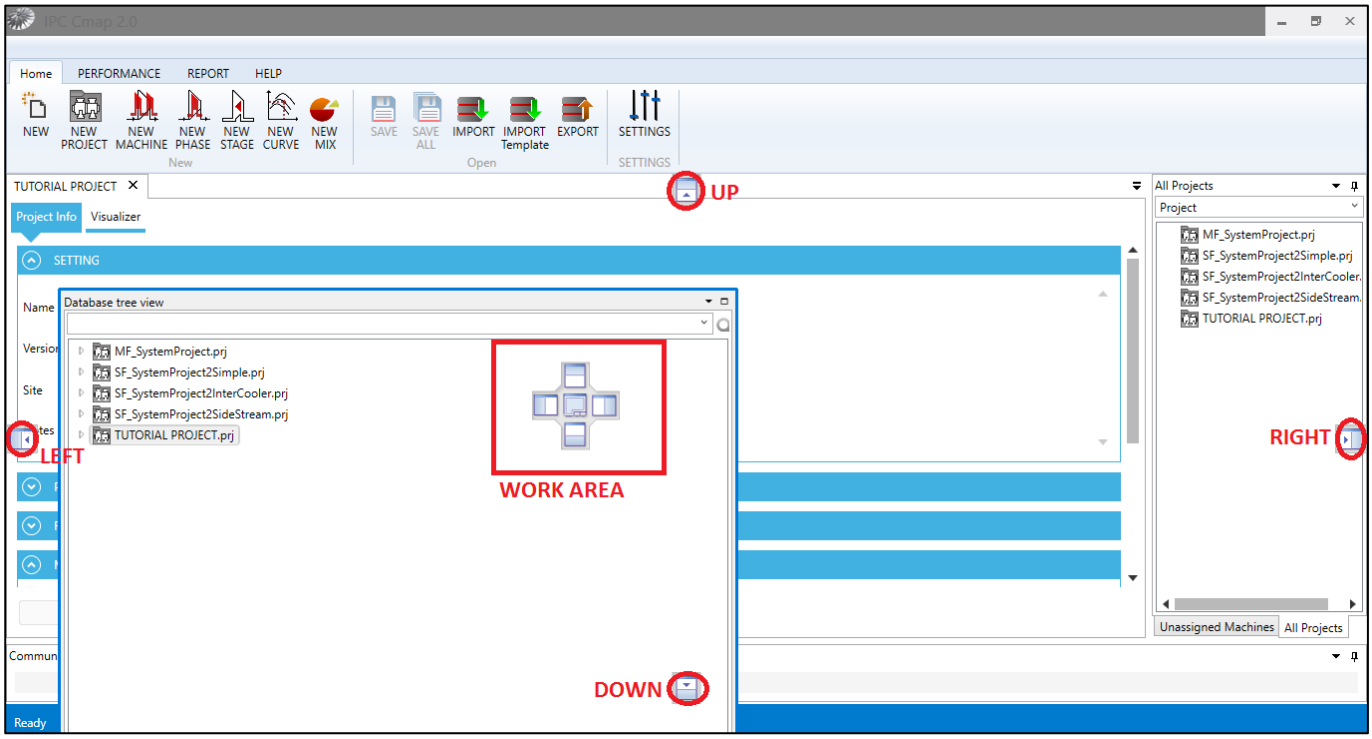


Window Position*:* clicking this button, you're presented with 4 display choices via a menu.

Float: clicking this button, the window will float and you will be able to move it to a new location in the screen. The button is active if the window is docked.

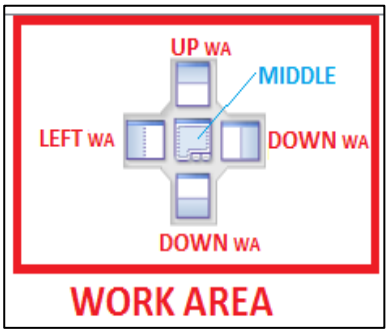
To float a window you can also hold left mouse on the window Title bar.

You can select among UP, DOWN, LEFT or RIGHT in the main screen or a position within the Work Area.



Clicking a Work Area button, the window will be docked in the Work Area as tabbed document.

The Work Area buttons are:



UP_{WA}, (docks the window over the other windows of Work Area)

$DOWN_{WA}$, (moves the window under the other windows of WA)

$LEFT_{WA}$, (moves the window to the left of the other windows of WA)

$RIGHT_{WA}$, (moves the window to the right of the other windows of WA)

MIDDLE, (allows the window to overlap the other windows of WA).

Dock: clicking this button, the floating window will be docked in the previous location. The button is active when the window is floating.

Dock as Tabbed Document: clicking this button, the window will be docked directly as tabbed document (the same shortcut of MIDDLE button of WA). The button is active when the window is docked outside the Work Area.

Auto Hide*:* see the previous description .

REPORT

CMap2.0 is able to print out 2 types of REPORT files: by excel spreadsheet and/or PDF format.

XLS REPORT

This Report will be arranged as follow:

- *Sheet 1 - "General Data"*, includes the info about Project, Machine, Stage (Id, Eta_Mech, Eta_volum)

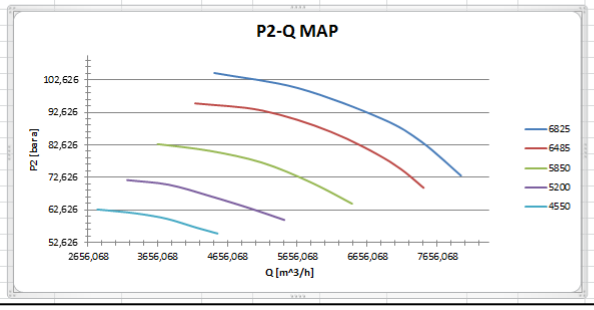
1	**Performance Analysis : Machine : TUTORIAL MACHINE**		
2	Project name :	Tutorial	
3	Machine name :	TUTORIAL MACHINE	
4			
5	Stage name :	TUTORIAL STAGE	
6	Impeller diameter :	600	mm
7	% Volumetric Efficiency :	100	
8	% Mechanical Efficiency :	100	
9			

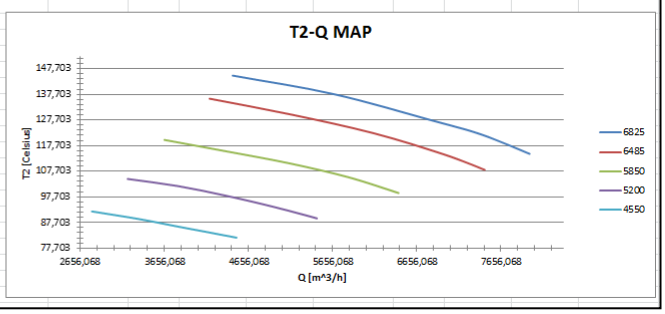
- *Sheet 2 - "Reference Condition"*, includes:
  - the reference inlet conditions (p1, T1, Gas mixture, Mw)

	A	B	C	D
1	**REFERENCE CONDITIONS**			
2	Inlet pressure (P1) :	40,2	bara	
3	Inlet Temperature (T1) :	50	Celsius	
4	Mix Molecular Weight :	19,55	kg/kmol	
5	Mix name :	Tutorial MIX		
6	**Gas**	**Mole fraction**		
7	Methane-CH4	0,8		
8	Ethane-C2H6	0,15		
9	Propane-C3H8	0,05		
10				

  - the couple of reference maps both numerically and graphically

Speed :	6825		Speed :	6485		Speed :	5850		Speed :	5200		Speed :	4550	
Q [m^3/h]	P2 [bar a]	T2 [Celsius]	Q [m^3/h]	P2 [bar a]	T2 [Celsius]	Q [m^3/h]	P2 [bar a]	T2 [Celsius]	Q [m^3/h]	P2 [bar a]	T2 [Celsius]	Q [m^3/h]	P2 [bar a]	T2 [Celsius]
4468,74547	104,718742	145,0621309	4194,02329	95,3878966	136,0456853	3657,14733	82,8690127	119,9434709	3220,62208	71,8181818	104,7022386	2795,86128	62,7859238	92,0350892
5671,09154	100,053319	137,8067569	5161,15305	93,1484937	129,8554887	4395,86031	80,8162268	115,4620906	3816,18086	70,3812317	101,9322871	3355,07297	61,5542522	89,0495471
6860,12348	90,722474	127,333822	6139,85081	86,6169022	122,5932622	5145,64414	77,2238514	110,7665726	4397,70767	66,9599218	98,08952124	3791,39815	59,9120235	86,27471668
7429,35715	83,6310317	121,9893415	6981,58764	77,472674	114,2544549	5838,10628	71,2365591	105,4258678	4979,15445	63,1280547	93,60332237	4172,9826	57,4486804	83,92716276
7997,93603	73,1804852	114,5000723	7463,80655	69,4481472	108,2638777	6439,46727	64,5650049	99,22446415	5469,68681	59,5698925	89,32881479	4513,71159	55,3958944	81,79283391

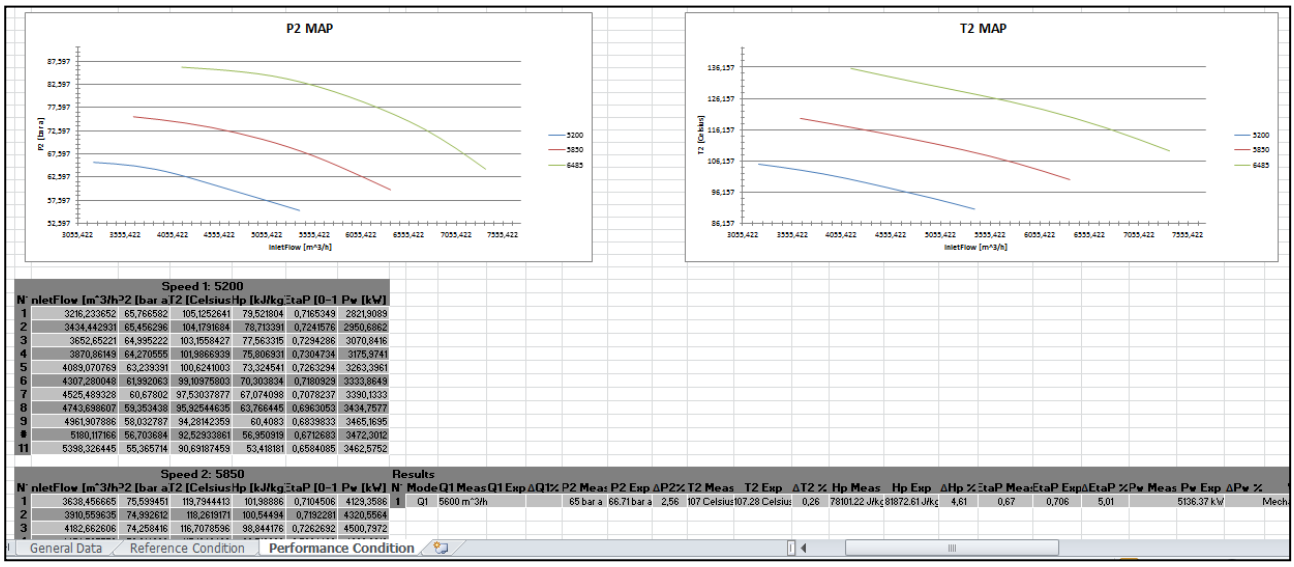




- *Sheet 3 - "Performance condition"*, includes:
    - the new performance inlet conditions (p1, T1, Gas mixture, Mw)

	A	B	C	D
1	**PERFORMANCE CONDITIONS**			
2	Performance name :	off design		
3	Inlet pressure (P1) :	38	bara	
4	Inlet Temperature (T1) :	52	Celsius	
5	Mix Molecular Weight :	18,85	kg/kmol	
6	Mix name :	off design mix		
7	**Gas**	**Mole fraction**		
8	Methane-CH4	0,8		
9	Ethane-C2H6	0,2		

    - the 5 typical CMap2.0 performance maps (or curves) both numerically and graphically and the results of analysis.



PDF REPORT

This Report will be arranged as follow:

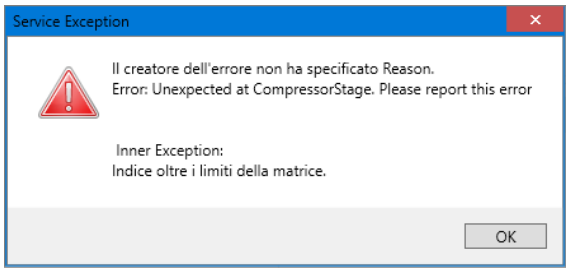
- Part 1: includes info about Project, Machine, Stage (Id, Eta_Mech, Eta_volum)
- Part 2: includes
    - the reference inlet conditions (p1, T1, Gas mixture, Mw)
    - the couple of reference maps both numerically and graphically
- Part 3: includes
    - the new performance inlet conditions (p1, T1, Gas mixture, Mw)
    - the 5 typical CMap2.0 performance maps (or curves) both numerically and graphically and the results of analysis.

TROUBLESHOOTING / FAQ

In this part of the user guide you could find the answers to any issues or also the troubleshooting about CMap 2.0 operations.

Troubleshooting

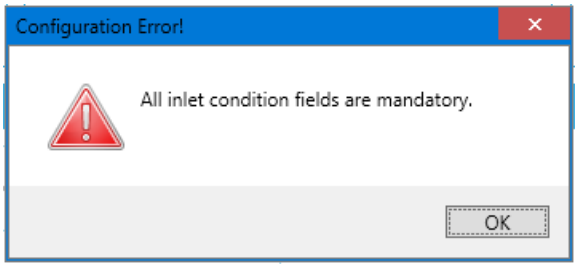
1) In PERFORMANCE SETUP, I launch the calculation through RUN ANALYSIS and I read this service exception:



Answer: this issue could occur when you edited:

- an invalid value for Impeller Diameter in the Stage Tab, please verify both value and unit;
- an invalid value for Inlet Pressure in Curve Tab, please verify both value and unit;
- an invalid value for Inlet Temperature in Curve Tab, please verify both value and unit;
- an invalid value for p1 in Performance Setup, please verify both value and unit;
- an invalid value for T1 in Performance Setup, please verify both value and unit.

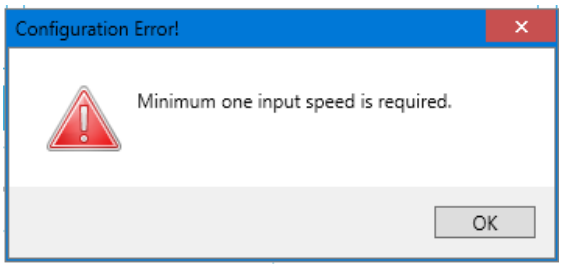
2) In PERFORMANCE SETUP, I launch the calculation through RUN ANALYSIS and I read this Configuration Error:



Answer: this issue could occur when one or more mandatory fields are not filled:

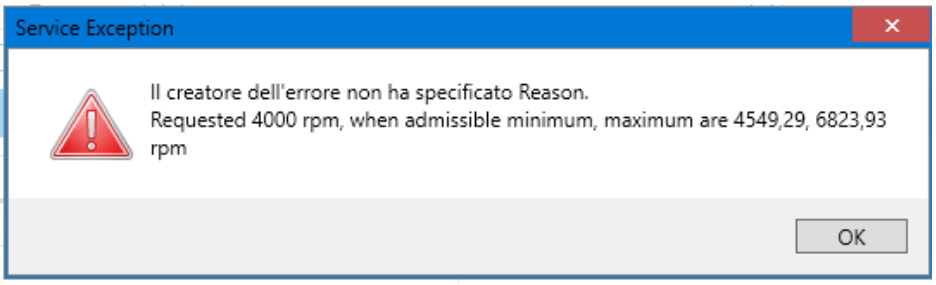
- if Inlet Pressure field is not yet filled, please enter the value and its unit
- if Inlet Temperature field is not yet filled, please enter the value and its unit
- if no gas mix has been selected, please select the gas mix from database

3) In PERFORMANCE SETUP, I launch the calculation through RUN ANALYSIS and I read this Configuration Error:



Answer: this issue could occur when no speed number have been entered in INPUT SPEEDS. Please enter at least one speed number and confirm it through ADD command.

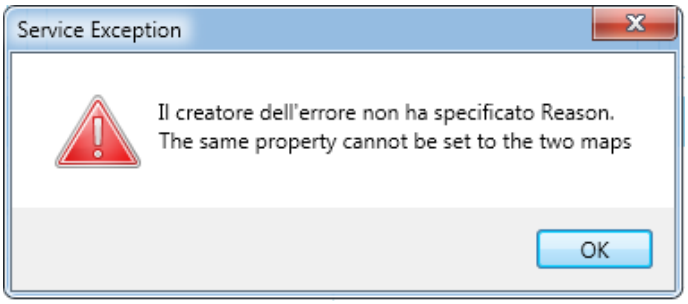
4) In PERFORMANCE SETUP, I launch the calculation through RUN ANALYSIS and I read this Service Exception:



Answer: this issue could occur when:

- one or more required speed number is/are higher than maximum speed number (Nmax)
- one or more required speed number is/are less than minimum speed number (Nmin).

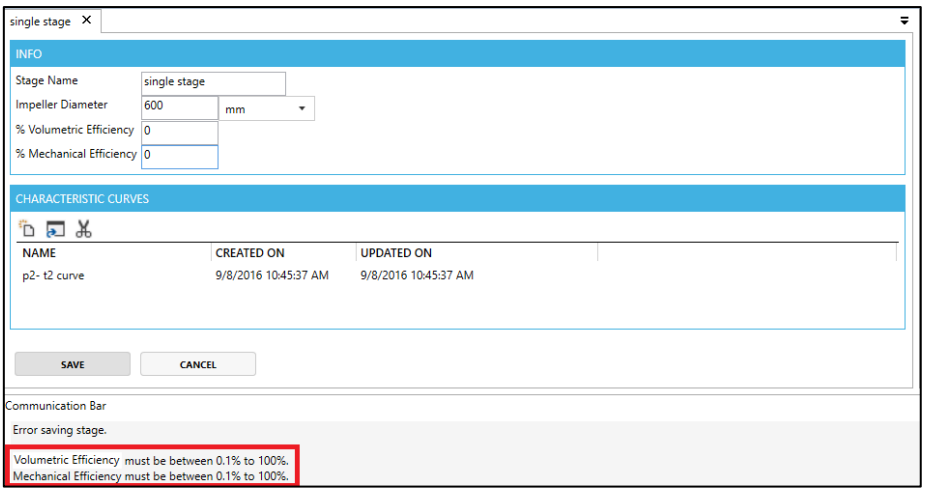
5) In PERFORMANCE SETUP, I launch the calculation through RUN ANALYSIS and I read this Service Exception:



Answer: this issue could occur if the uploaded maps are equal (for example both p2-Q). Please check the uploaded maps, and then through Numerical Digitization you can modify the Y axis for the first or second map.

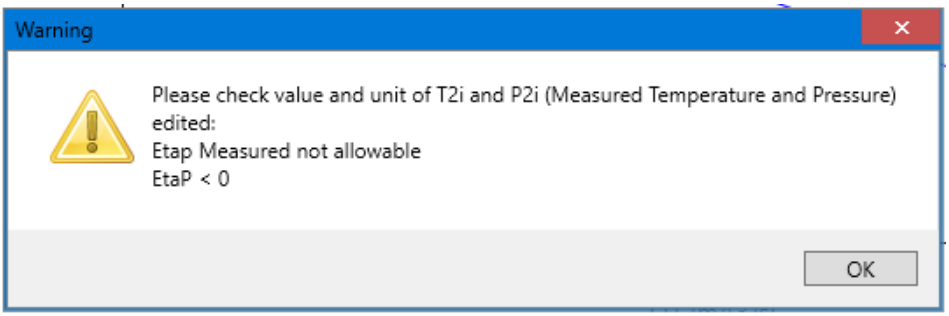
6) I am not able to save the Stage Tab when I click on SAVE button.

Answer: open the Communication bar, the following message could be shown:



Please edit a valid value of volumetric and/or mechanical efficiency. If you don't know these values, you can edit 100% for both efficiencies.

7) In PERFORMANCE ANALYSIS, I am not able to calculate the performance after clicking SOLVE button because this Warning Message appear:



Answer: this issue could occur when you edited:

- an invalid value for measured Discharge Pressure, please verify both value and unit;
- an invalid value for measured Discharge Temperature, please verify both value and unit;

This issue could occur also if you left the default value (0) for measured Discharge Temperature. In this case please enter a valid value.

FAQ

What is CMap

CMap deals with process gas centrifugal compressors for energy/Oil&Gas/Chemical Petrochemical plants,

It provides capability to predict centrifugal compressor performance in off-design conditions, with changes in suction pressure, suction temperature and gas mix composition (available about 42 among most common gas industry gas compounds).

4 Equation of state are available for gas modelling.

Which are possible applications of CMap?

Possible applications of the software are:

- Performance analysis
- Efficiency deviation trends (machine performance-based monitoring systems)
- Maintenance schedule
- Advanced anti-surge control systems, Anti-surge valves checks
- Compressor Inspections
- Investigations and RCAs

How to Use CMap

CMap is a software tool for prediction of centrifugal compressor performance in off design conditions.

To use CMap you need a set of reference data required to set up the compressor model.

These reference data usually are provided by the compressor OEM on data sheets and performance curves.

Following the compressor configuration you can run performance calculation in new conditions, analyse that and generate detailed graphical and numerical reports.

What are required data for compressor configuration?

In CMap compressor configuration can be done using compressor performance curves in, at least 3 speeds or 3 Mach numbers, suction pressure and temperature, gas mix composition.

Having these data, you can configure a compressor in CMap and proceed to following analysis.

Which parameters should I use for compressor configuration?

To configure a compressor CMap needs two reference maps, called map-I and map-II.

Each map is a set of at least 3 curves, linking two performance parameters among the following: flow, suction temperature and pressure, discharge temperature and pressure, polytropic Head and efficiency, power and compression ratio.

Many OEMs provide discharge pressure vs flow, polytropic efficiency vs flow, polytropic head vs flow but also other curves may be provided such as compression ration vs flow, power vs flow, compression ratio vs flow.

User can choose which performance parameter to use for compressor configuration, usually following available maps received from the compressor OEM. CMap automatically checks the compatibility of provided curves and adapts calculation to available inputs. When provided curves are not compatible it generates a message to the user.

What is the CMap workflow

CMap is easy and intuitive, the basic workflow consists of very few steps:

- machine configuration
- gas mix configuration
- performance calculations
- analysis and reports

All machine data, inputs and calculations are stored in a database and available for user reference and consultation.

Which methods are available for data input?

In CMap the user can configure the machine providing compressor reference data in the following ways:

- Numerical input
- Graphical input

Which are preferred maps to use in the compressor configuration?

According to our experience we prefer and suggest using discharge pressure vs flow as map-I and discharge temperature vs flow as map-II

How many compressor may I configure in CMap

User can configure unlimited number of projects and machines in CMap limited only by the available computer memory.

Which EOS can be used in CMap

The following equation of state are available in CMap

- Lee Kesler (LK)

- Peng-Robinson (PR)
- Modified Benedict-Webb-Rubin for Freon R134a (MBWR)
- Gerg2008 - optional

How the analysis tool works?

The analysis tool works in fact in these ways:

a) Flag on inlet flow (Q):
The user enters the measured inlet flow as reference value.
The user may input discharge pressure, discharge temperature and power as measured values to be checked.
CMap calculates discharge pressure, temperature and power and provides indication of deviation of measured values from calculated ones
CMap calculates also polytropic Head and efficiency

b) Flag on discharge pressure (p2):
The user enters the measured discharge pressure as reference value.
The user may input the inlet flow, discharge temperature and power as measured values to be checked.
CMap calculates inlet flow, discharge temperature and power and provides indication of deviation of measured values from calculated ones
CMap calculates also polytropic Head and efficiency

c) Flag on discharge temperature (T2):
The user enters the measured discharge temperature as reference value.
The user may input inlet flow, discharge pressure and power as measured values to be checked.
CMap calculates inlet flow, discharge pressure and power and provides indication of deviation of measured values from calculated ones
CMap calculates also polytropic Head and efficiency

Which gas compounds are available in CMap?

CMap 2.0 standard library already includes the following gas components:

Item	Gas name:	Formula
1	Acetylene	C2H2
2	Ammonia	NH3
3	Argon	Ar
4	Benzene	C6H6
5	Iso-Butane	C4H10
6	n-Butane	C4H10
7	Iso-Butylene	C4H8
8	Carbon Dioxide	CO2
9	Carbon Monoxide	CO
10	Chlorine	Cl2
11	n-Decane	C10H22
12	Ethane	C2H6
13	Ethyl Acohol	C2H5OH

14	Ethylene	C2H4
15	Helium	He
16	n-Heptane	C7H16
17	n-Hexane	C6H16
18	Hydrogen	H2
19	Hydrogen Chloride	HCl
20	Hydrogen Sulphide	H2S
21	Methane	CH4
22	Methyl Alcohol	CH3OH
23	Nitrogen	N2
24	n-Nonane	C9H20
25	Iso-Pentane	C5H12
26	n-Pentane	C5H12
27	n-Octane	C8H18
28	Oxygen	O2
29	Propane	C3H8
30	Propylene	C3H6
31	Sulphur Dioxide	SO2
32	Water Vapour	H20
33	1-Butene	C4H8
34	2-Butene	C4H8
35	1.3 Butadiene	C4H6
36	Ethyl chloride	C2H5Cl
37	Methyl Chloride	CH3Cl
38	Pentylene	C5H10
39	Propadiene (Allene)	C3H4
40	Methyl Acetylene (Propyne)	C3H4
41	Toluene	C7H8
42	Freon R134a	CH2FCF3

Can I export data from CMap

Yes, CMap allows to export data in the following ways:

-full DB export, this can be useful for migrating your entire DB from one computer to another

-project element export (project/machine/curve/gas mix)

-calculation result .pdf export

-calculation result .xls export

Which are hardware requirements for CMap?

- Physical machine
- Minimum CPU speed of 1.33GHz.

- Microsoft Windows 7 with Service Pack 1 or higher (Microsoft Windows 8, Microsoft Windows 10).
- 512 MB of RAM.
- 250 MB of available hard-disk space for installation.
- 1024 x 768 display (1280 x 800 recommended) with 16-bit color
- A high-quality OpenGL graphics card can make a significant difference to the graphics performance.
- CMap is supplied on DVD. DVD-ROM drive is recommended. USB key option is possible
- CMap software doesn't operate without Sentinel HASP Hardware key. The key is sold with the software
- An important requirement is related to the user rights on installation PC: the user must have administrator rights because CMap1.0 must be run with administrator privileges
- Three-button mouse or a two-button mouse with a wheel is strongly recommended. Such mouse facilitates the manipulation of many of the views used.

What is the stand-alone licence?

With this option the CMap software is provided with a safety hard key (USB dongle).
The hard key is necessary to allow the software to run on a single PC. It is possible install the software on several machines but to run, it will be necessary mount the hard key (that can be used on different computers).

What is the LAN option?

With this option the USB dongle can be mounted on any computer on your local network. The CMap software can be activated from any one of the computers connected to the same network where the software is installed. The number of the computers that can simultaneously run the CMap software depends on the number of licensed seats

SUPPORT AND ASSISTANCE

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

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