CMap tutorial

Supplier: IPCENG
Customer:
Plant:
Item: Cmap 2.0
Job:

July 2022



Cmap

Performance Evaluation Software



IPC

INDUSTRIAL PLANTS CONSULTANTS

THE MAIN PURPOSE OF THIS PRESENTATION:

Describe the procedures necessary to set up and use

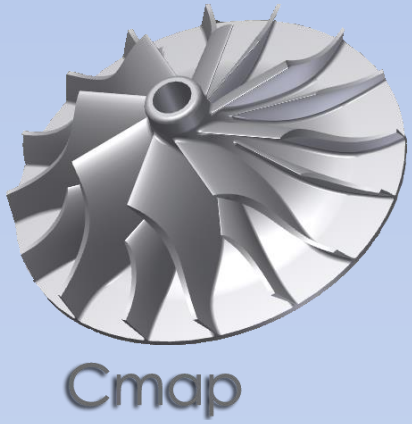
Cmap 2.0 for compressor performance prediction

Cmap pratical guide

1. What is Cmap?
2. Setup and Installation
3. Cmap 2.0 structure
4. GUI of Cmap 2.0
5. Centrifugal Compressor configuration
6. Performance evaluation
7. Performance Analysis
8. Additional functions
9. PDF Report
10. XLS Report
11. FAQ & Troubleshooting

1. What is CMAP?

- A software designed to evaluate centrifugal compressors performance
- Allows some additional tasks useful to compare centrifugal compressor expected performances with field data measured ones
  - Easy and intuitive, provide automatic storage of data in a project archives



2. Setup and installation

Steps:

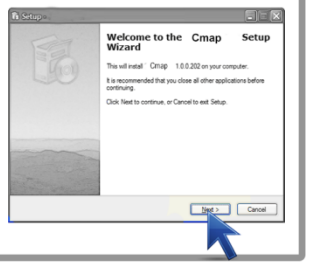
1. Insert CD into your PC



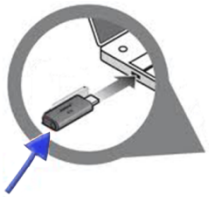
2. Open Cmap folder and click on Setup Icon



3. Follow setup instructions and install Cmap Software



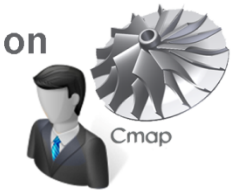
4. Insert USB license key provided with CD



5. Wait until key drivers are installed into PC (may require internet connection)

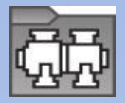


6. Click on Cmap Software icon on your desktop and run as Admin



3. Cmap 2.0 structure

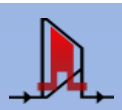
Cmap 2.0 is structured according to different levels:

Project 

- is the highest level
- includes the information about customer, site, etc
- one or more machines can be assigned

Machine 

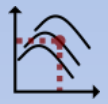
- is driven by the same driver
- Could be a centrifugal compressor single phase or multiphase
- Or also a compression train with more centrifugal compressors

Phase 

- is the section of machine between suction and discharge connection
- 3 type: Simple or Side Stream or Intercooler
- Includes one or more stages

Stage 

- is the section of centrifugal compressor wich contains the impeller

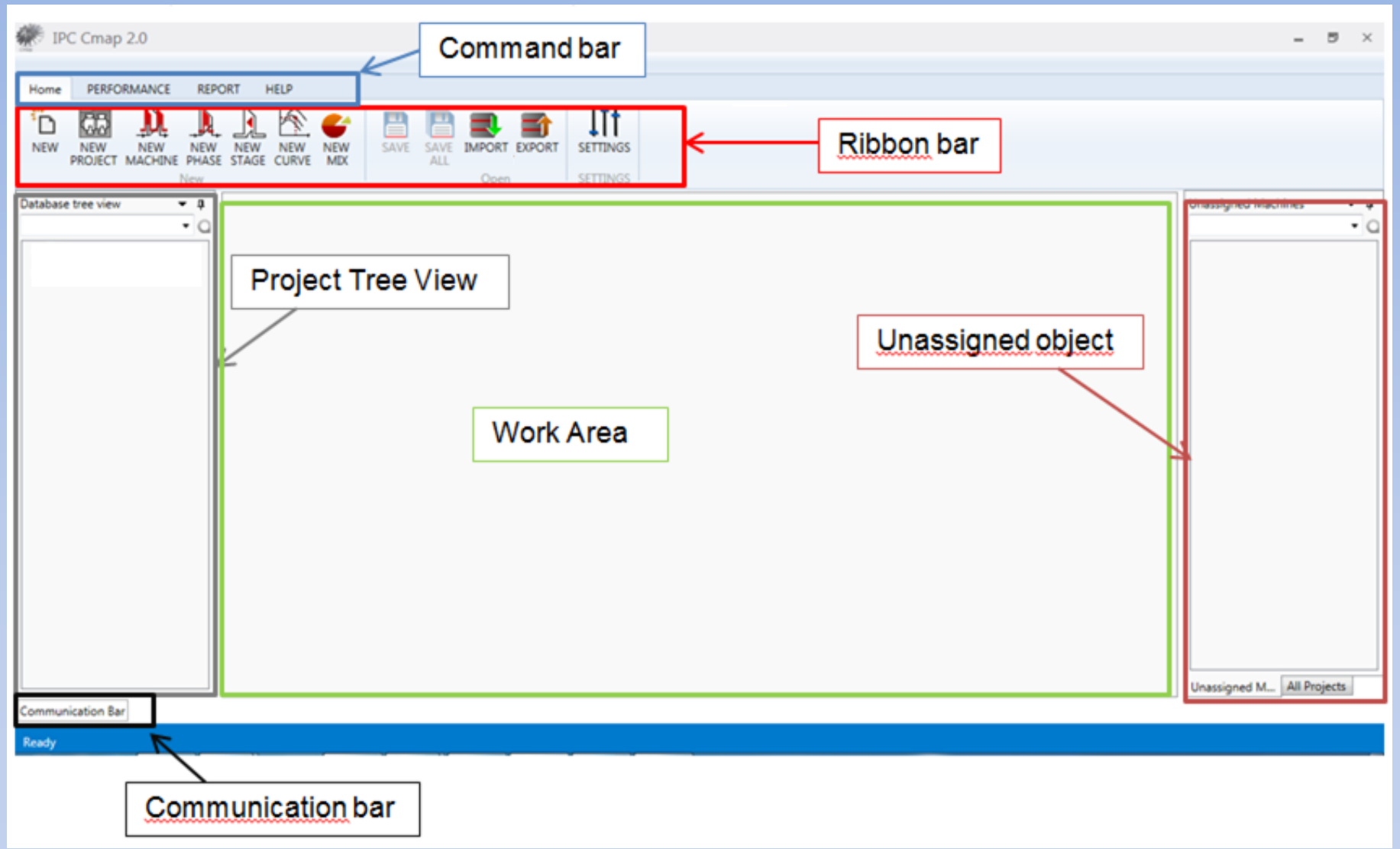
Curve 

- is a couple of reference performance maps to configure the stage

Mix 

- Is the lowest level
- To create the gas mixture
- Will be assigned to a Curve

4. GUI of Cmap 2.0



5. Centrifugal compressor configuration

The Input process in Cmap is made of the following steps:

1 Creation of a project

2 Inside a project, configuration a machine and lower levels (phase, stage, curve, mix)

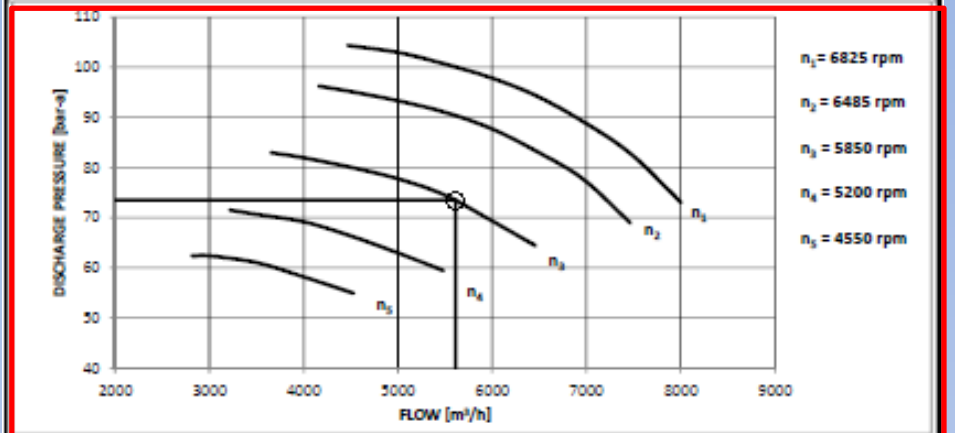
3 Performance calculations and analysis

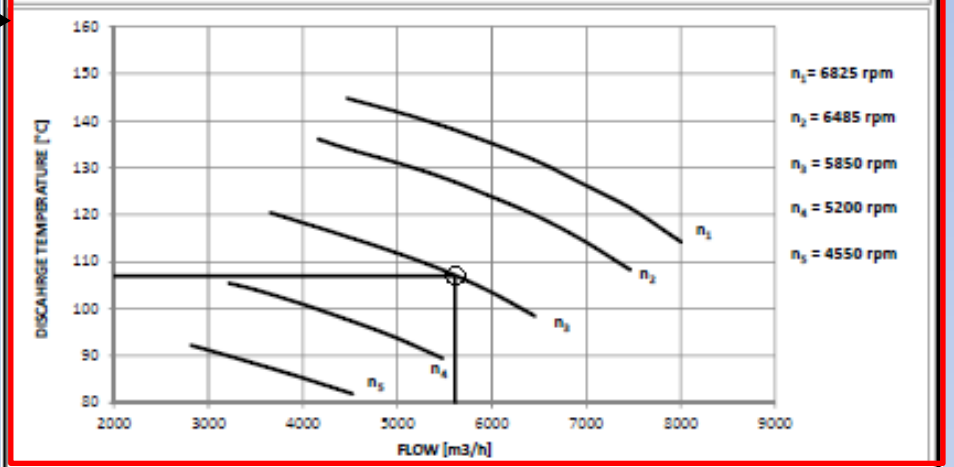
Now we are going to show all the steps of a tutorial project from the creation of machine until gas mixture and then Cmap calculations through Performance Analysis.

Tutorial Datasheet

TUTORIAL CENTRIFUGAL COMPRESSOR - MAPS

DESIGN CURVES





DESIGN INLET CONDITIONS

Gas mix composition		
Methane (CH4)	80 %	p1 = 40,2 bar-a
Ethane (C2H6)	15 %	T1 = 50 °C
Propane (C3H8)	5 %	Mw = 19,55 g/mol

Q1 = 5613 m3/h	
p2 = 73,5 bar-a	
T2 = 107 °C	
N = 5850 rpm	

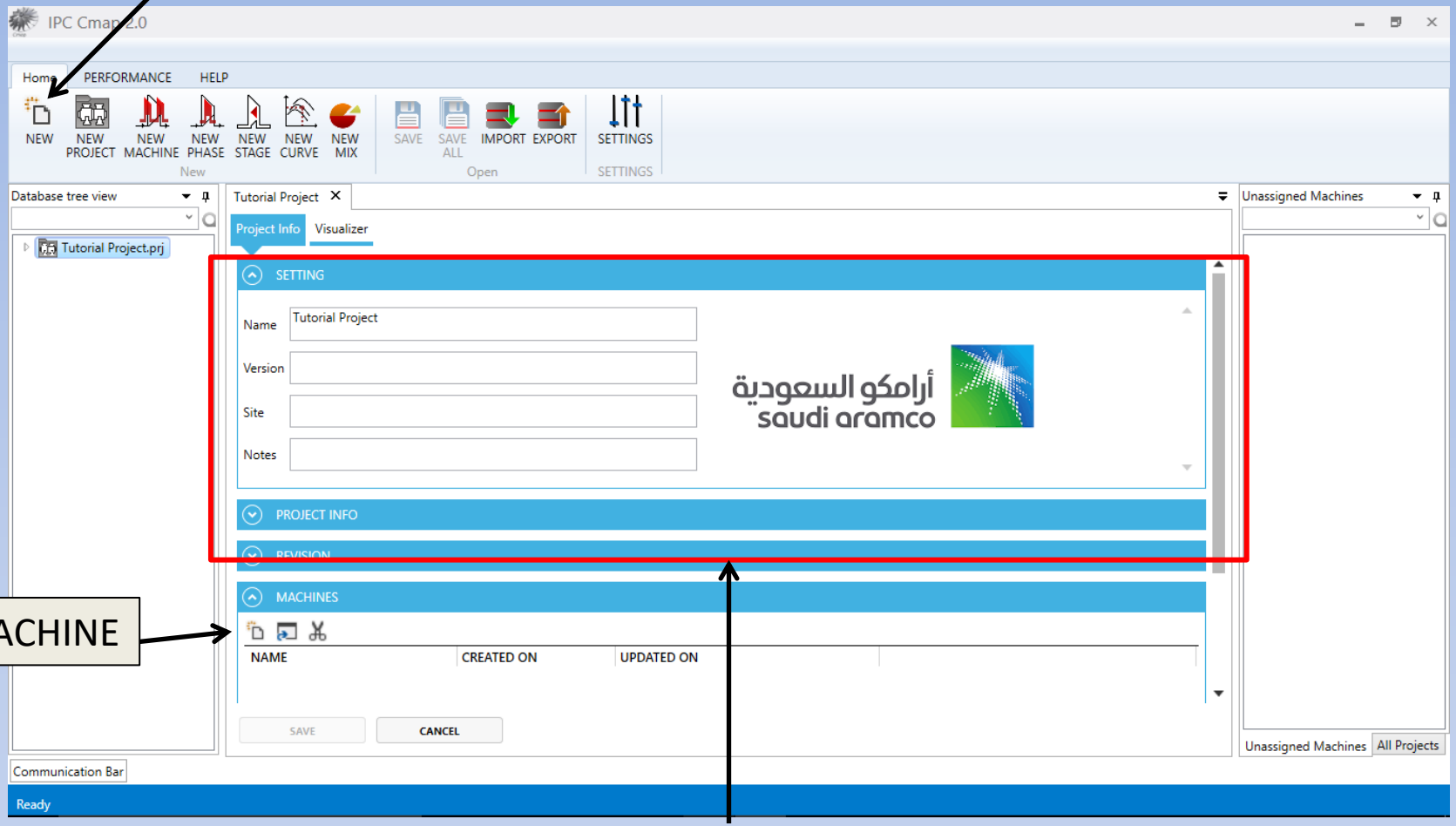
Performance maps:
p_2 vs Q_1
T_2 vs Q_1

Reference inlet conditions

Operating point

5.1 Creation of project: *Tutorial Project*

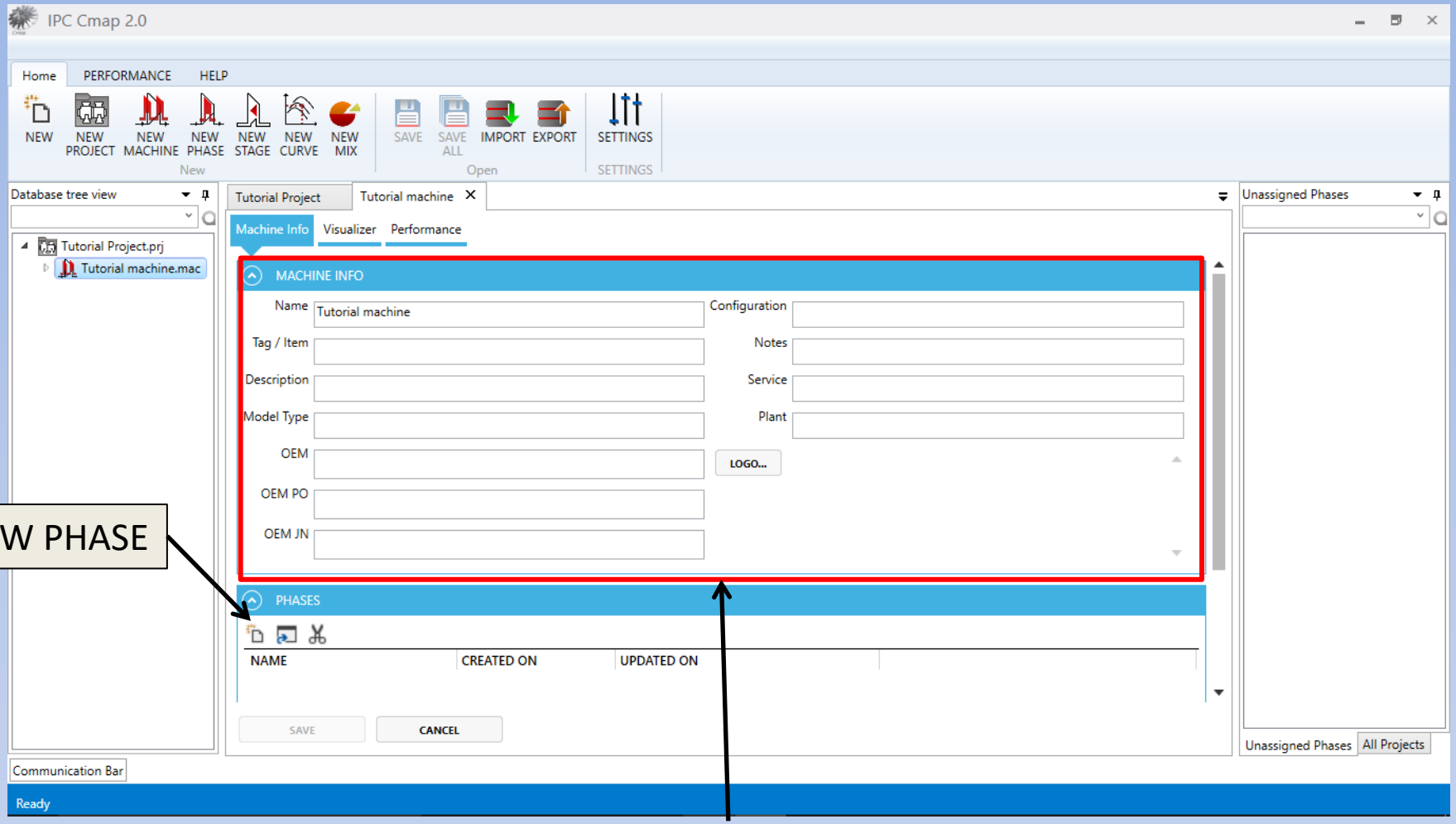
Click NEW PROJECT on the Ribbon Bar



NEW MACHINE

AREA INFO: Name, Version, Site, Notes, Customer, Job Number, Plant, Service, Logo

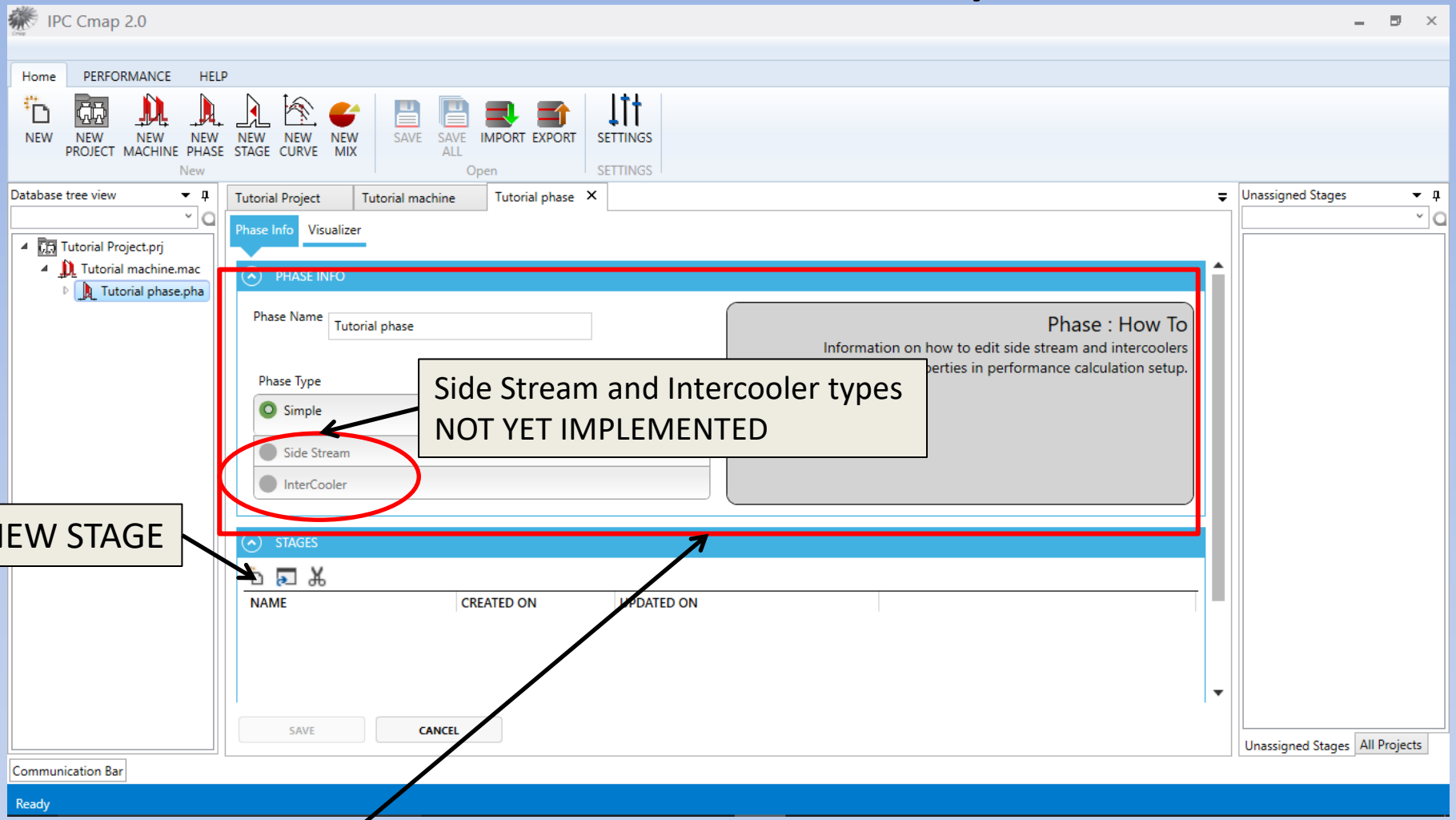
5.2 Creation of Machine: *Tutorial machine*



NEW PHASE

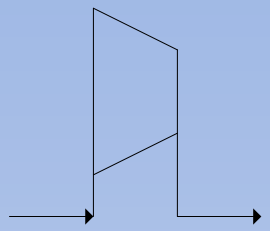
AREA INFO: Name, Version, Site, Notes, description, Job Number

5.3 Creation of Phase: *Tutorial phase*

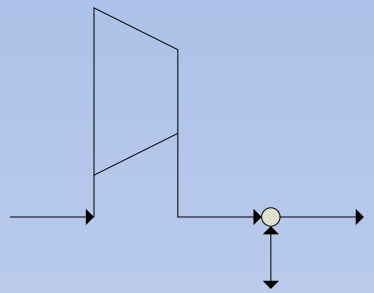


AREA INFO: Name and Type

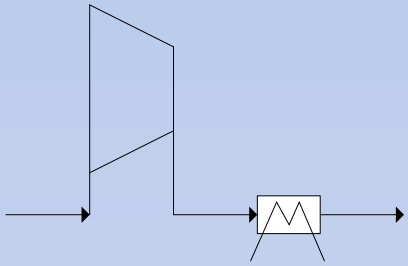
Phase Symbology



Simple Phase

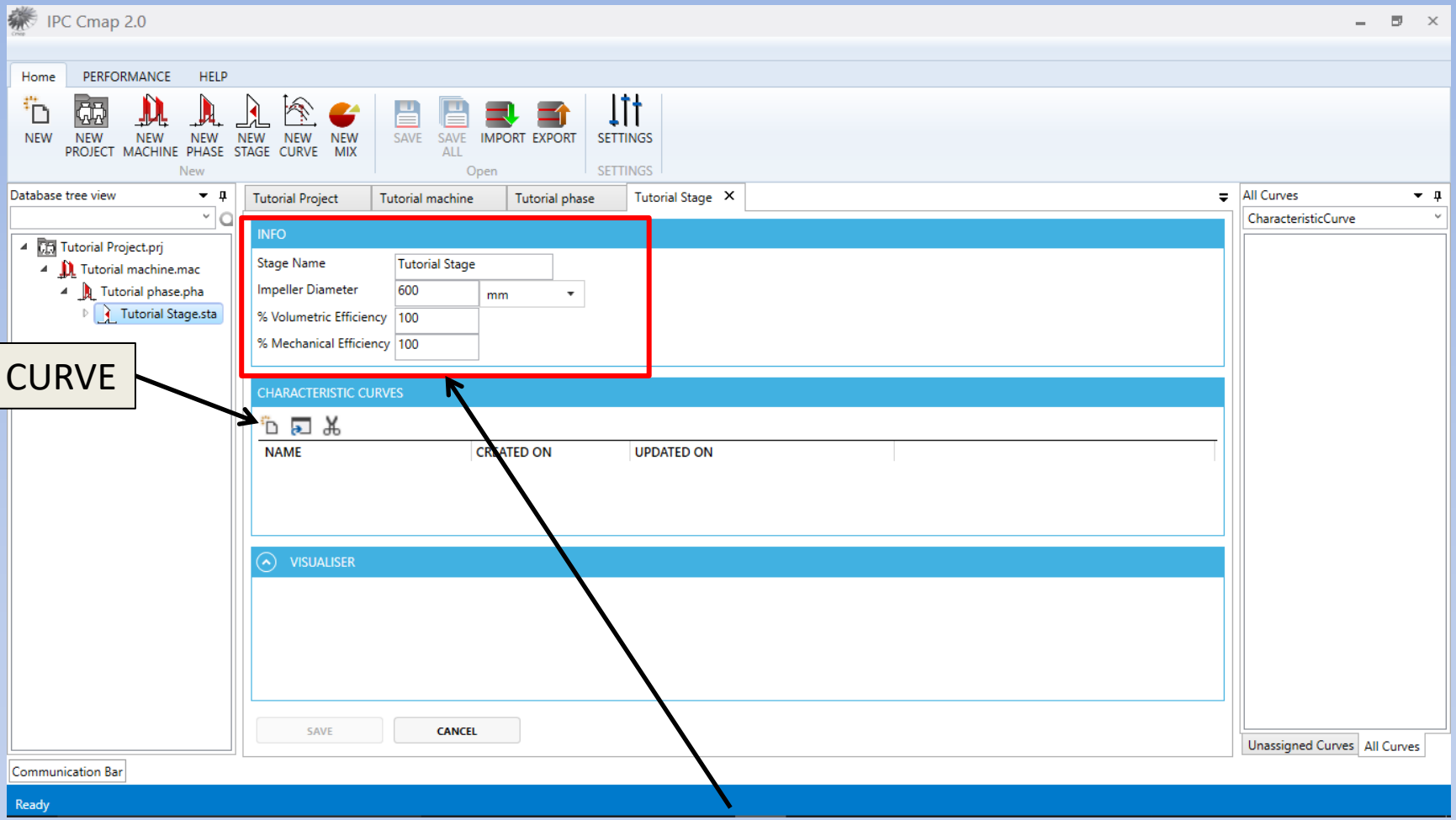


Side Stream Phase



Intercooler Phase

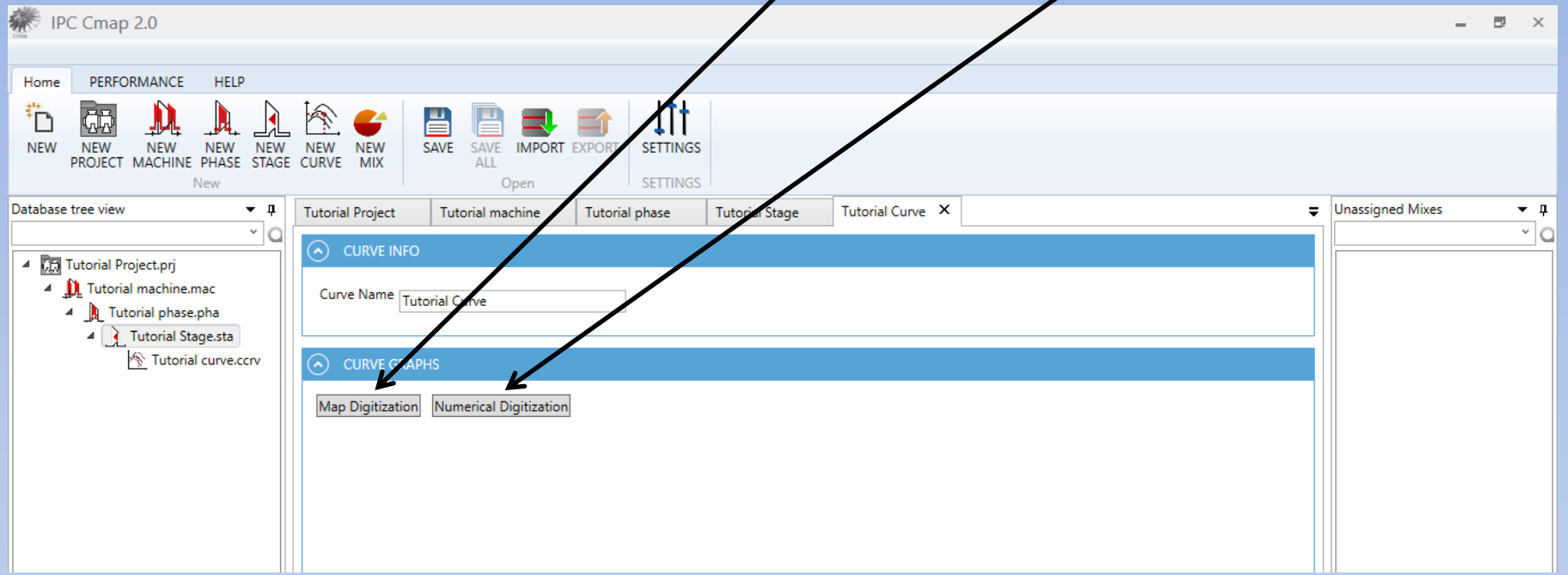
5.4 Creation of Stage: *Tutorial Stage*



AREA INFO: impeller diameter , volumetric and mechanical efficiency

5.5 Creation of Curve: *Tutorial curves*

2 ways to upload reference maps: Map or Numerical Digitization

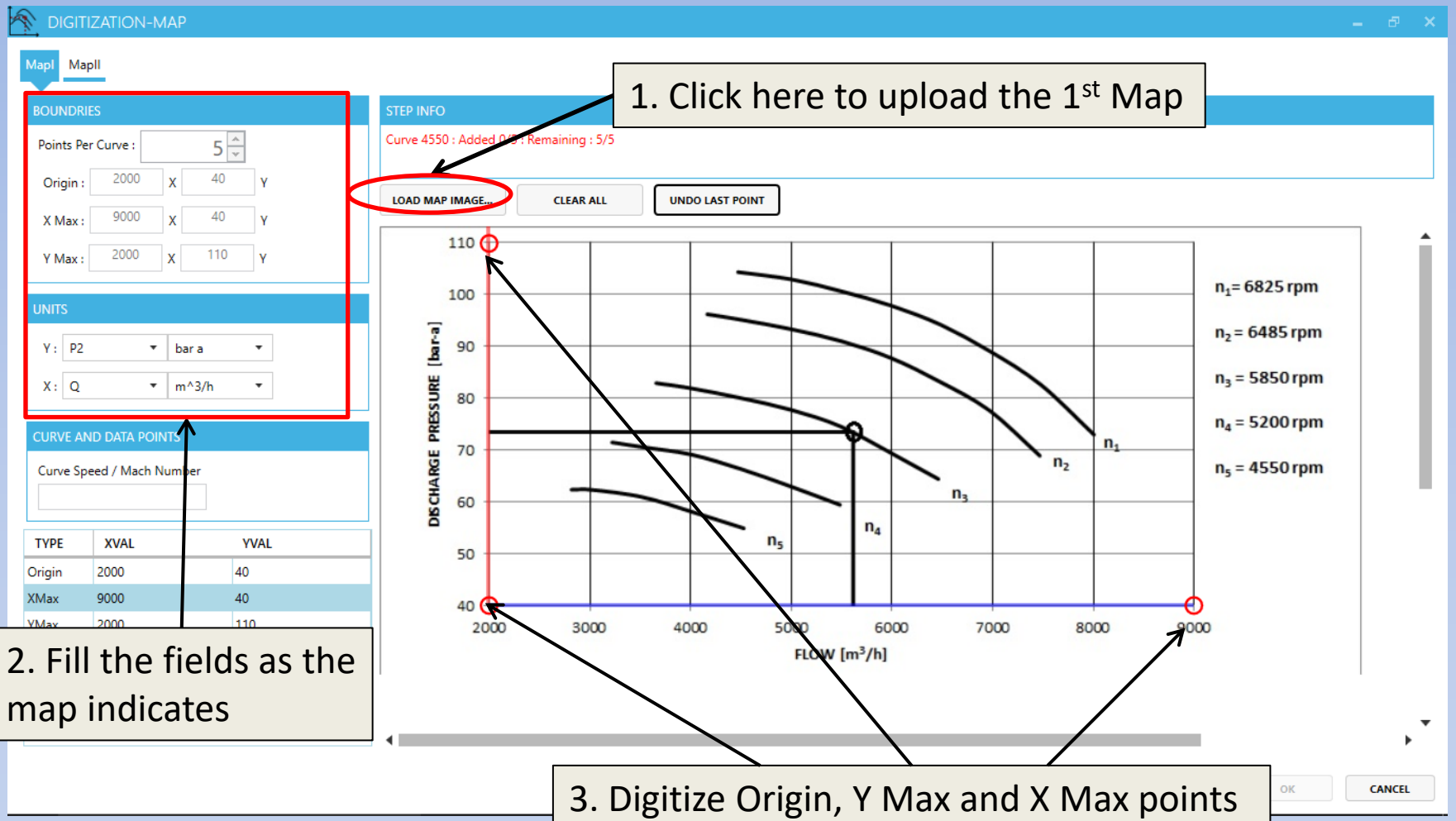


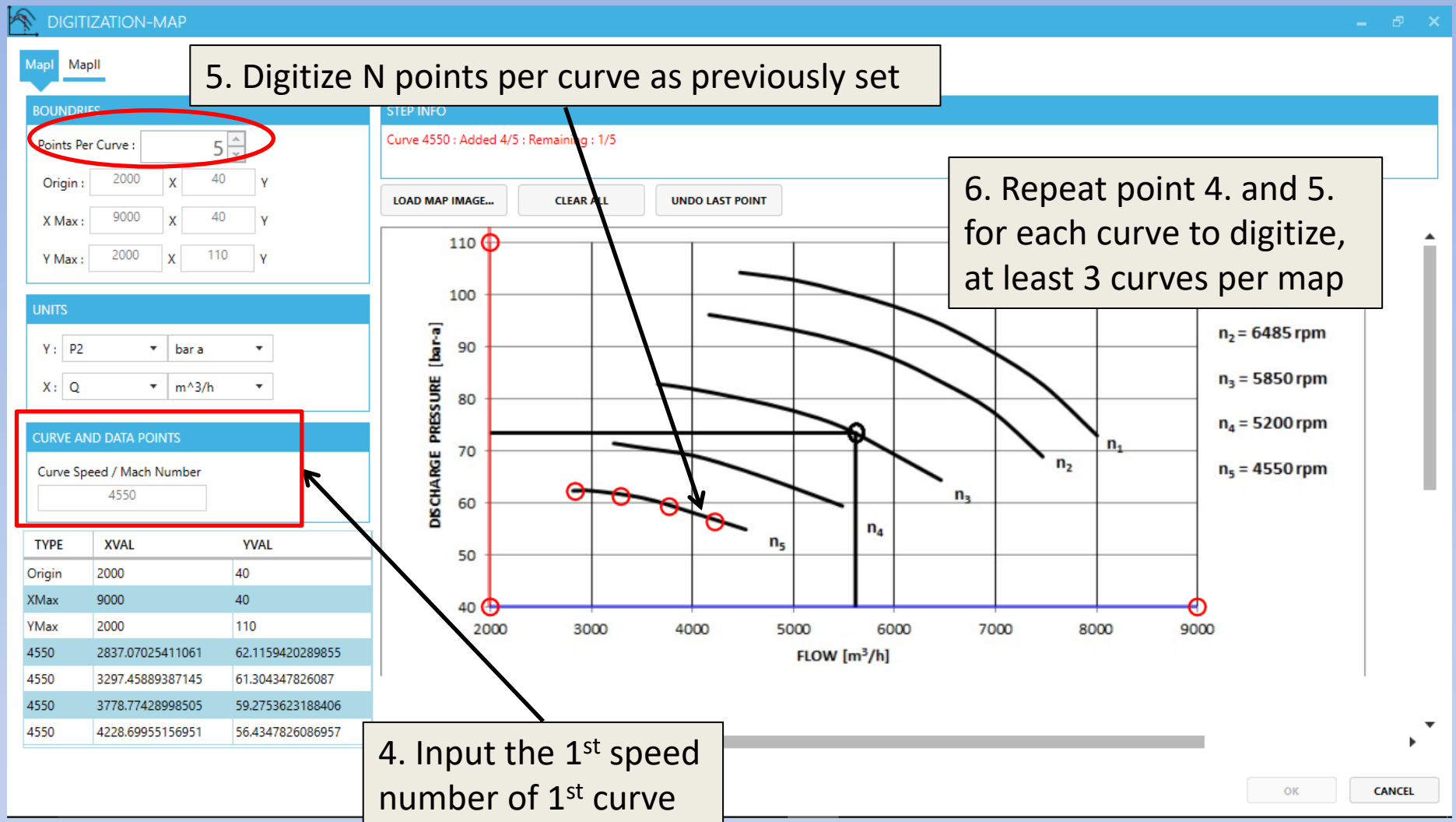
From Tutorial Compressor Datasheet, the available performance maps to set centrifugal compressor in Cmap are:

- Map 1 ➔ Discharge Pressure (p_2) vs Suction Volume Flow (Q_1)
- Map 2 ➔ Discharge Temperature (T_2) vs Suction Volume Flow (Q_1)

MAP DIGITIZATION PROCEDURE (graphically)

Cmap is able to upload the maps as BMP, JPEG, GIF, TIFF, PNG files.



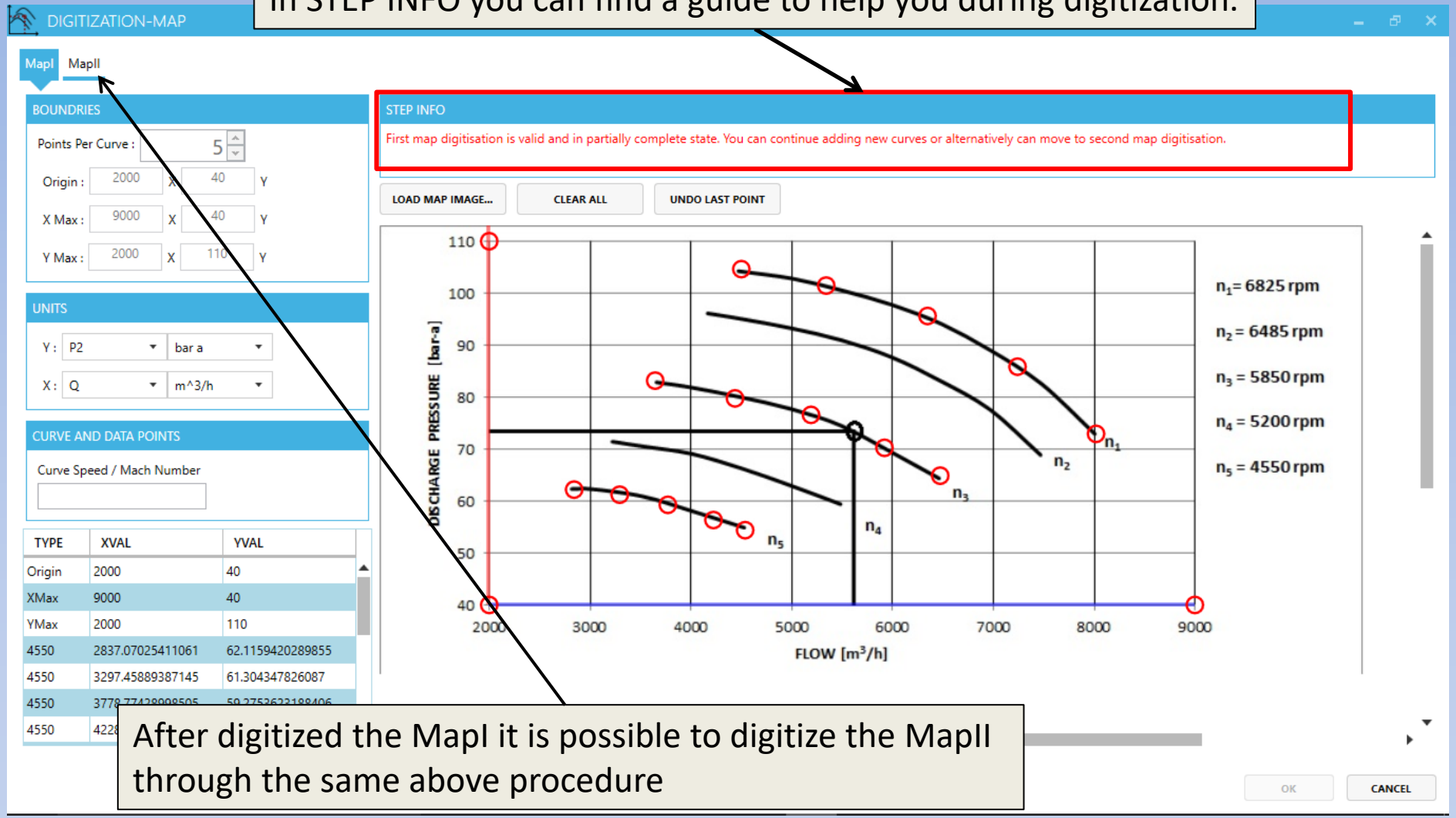


5. Digitize N points per curve as previously set

6. Repeat point 4. and 5. for each curve to digitize, at least 3 curves per map

4. Input the 1st speed number of 1st curve to digitize

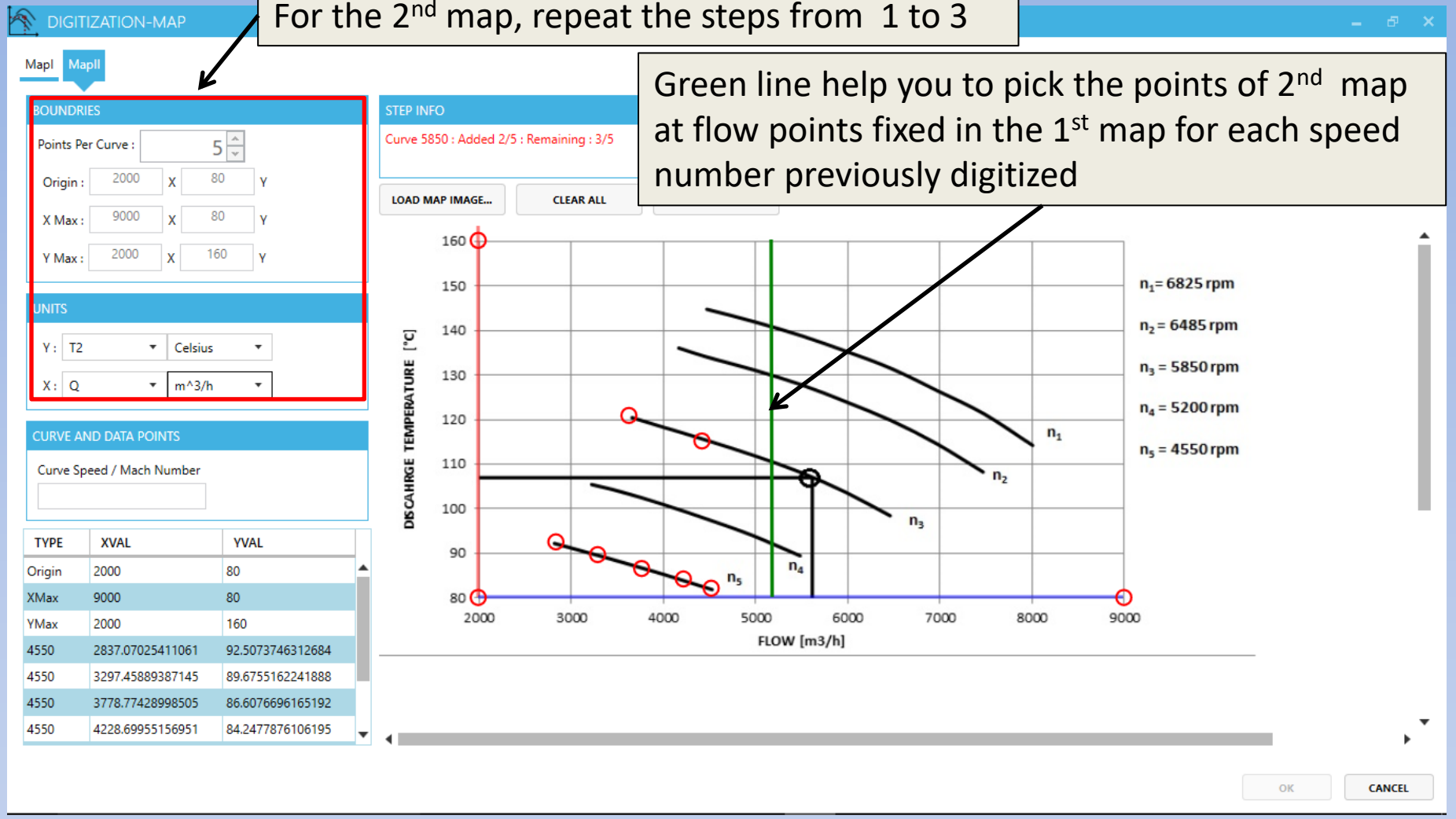
In STEP INFO you can find a guide to help you during digitization.



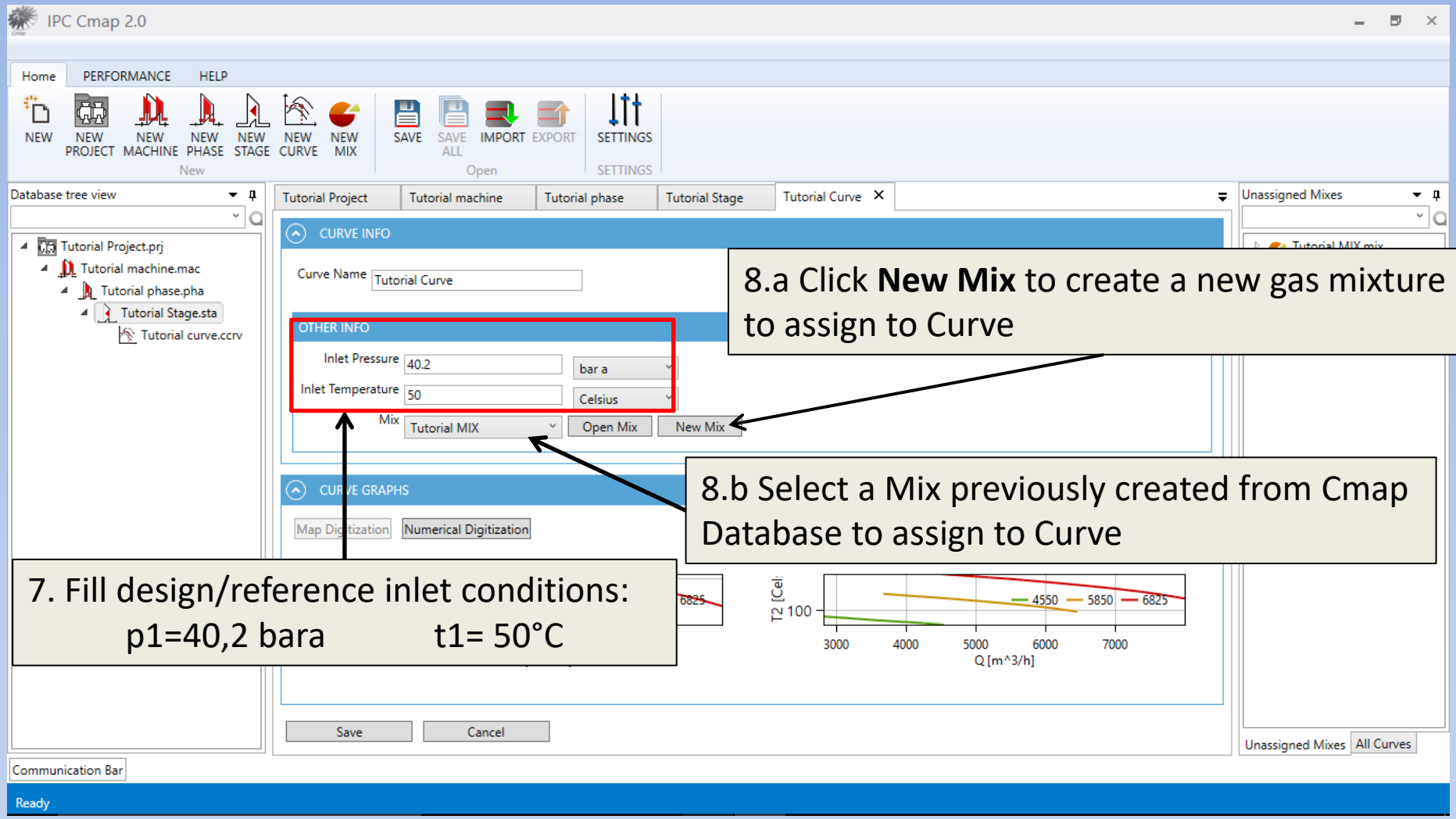
After digitized the MapI it is possible to digitize the MapII through the same above procedure

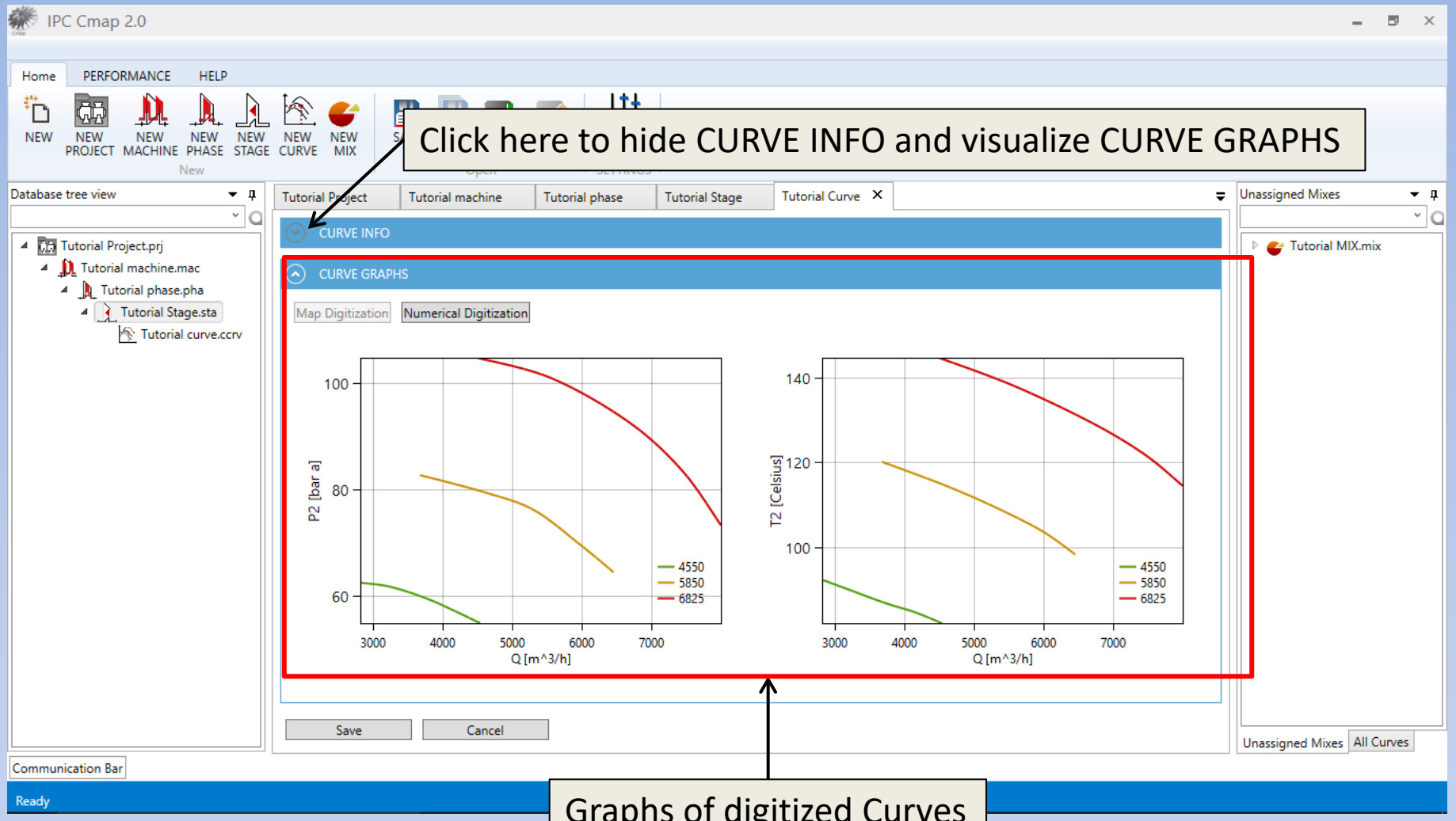
For the 2nd map, repeat the steps from 1 to 3

Green line help you to pick the points of 2nd map at flow points fixed in the 1st map for each speed number previously digitized

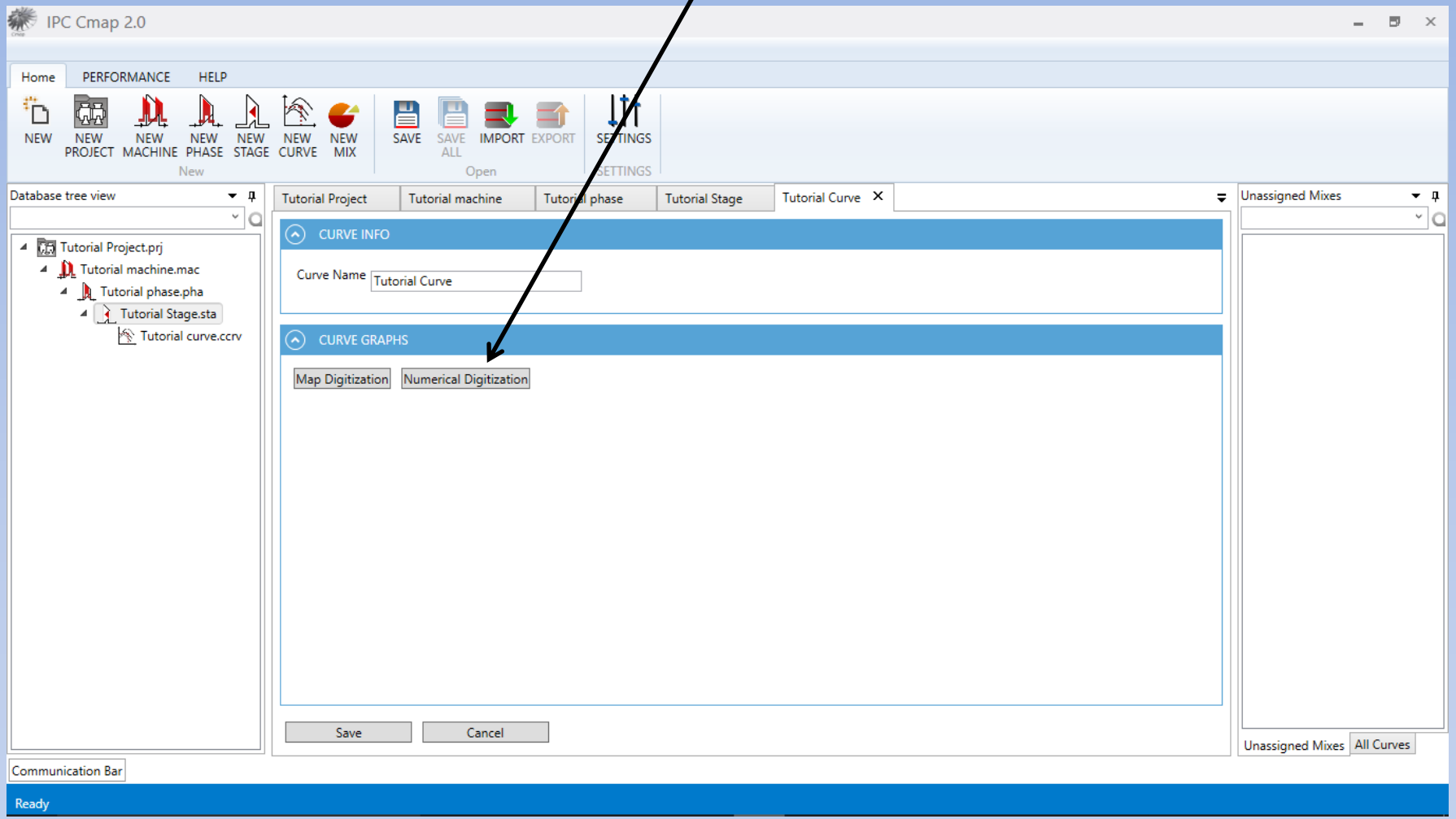


After digitization of the curves, it need to input the reference inlet condition: pressure (p1), temperature (T1) and gas mixture

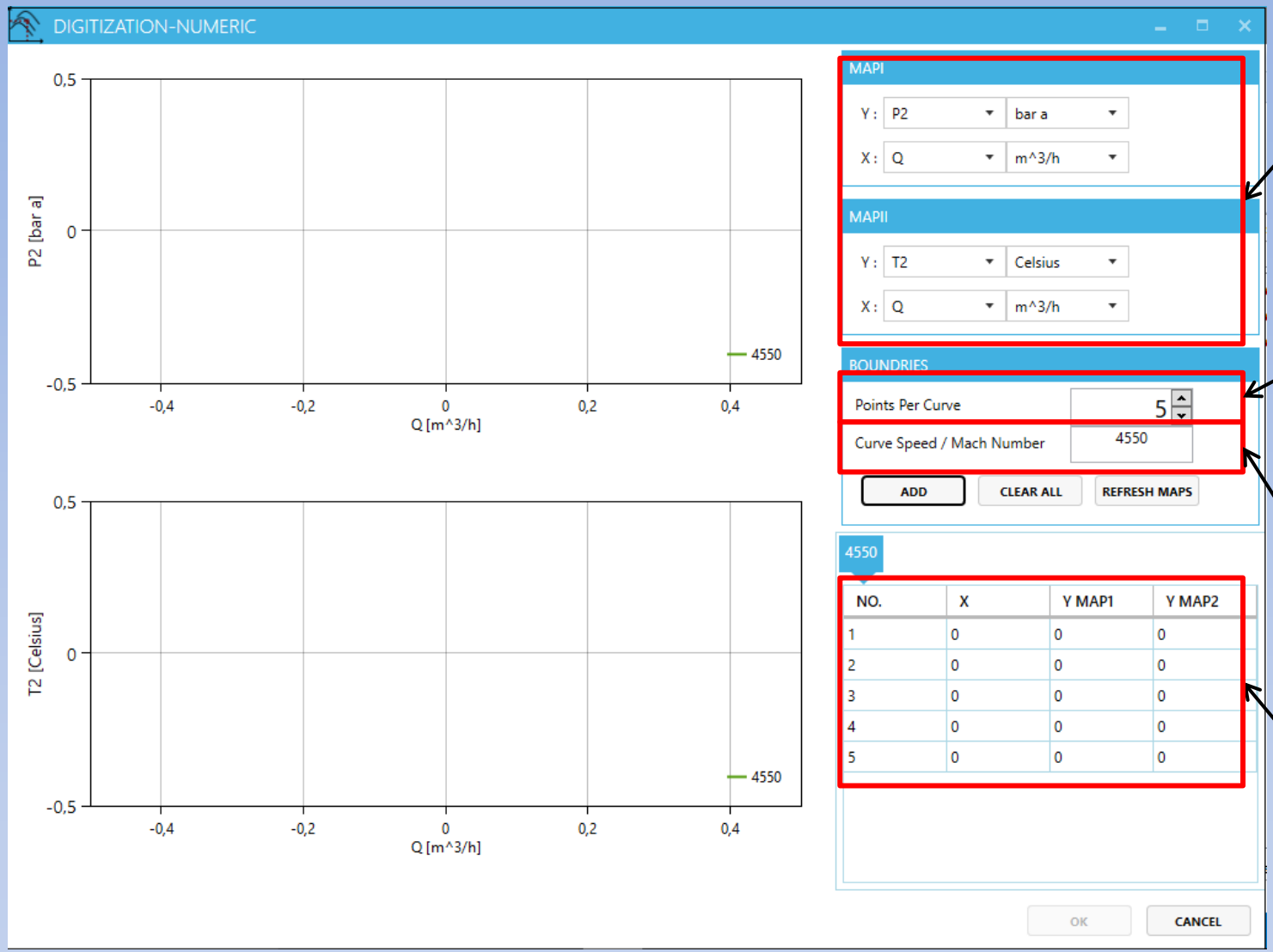

IPC Cmap 2.0
Home
PERFORMANCE
HELP
NEW
NEW PROJECT
NEW MACHINE
NEW PHASE
NEW STAGE
NEW CURVE
NEW MIX
SAVE
SAVE ALL
IMPORT
EXPORT
SETTINGS
New
Open
SETTINGS
Database tree view
Tutorial Project.prj
Tutorial machine.mac
Tutorial phase.pha
Tutorial Stage.sta
Tutorial curve.ccrv
Tutorial Project
Tutorial machine
Tutorial phase
Tutorial Stage
Tutorial Curve
CURVE INFO
Curve Name
Tutorial Curve
OTHER INFO
Inlet Pressure
40.2
bar a
Inlet Temperature
50
Celsius
Mix
Tutorial MIX
Open Mix
New Mix
CURVE GRAPHS
Map Digitization
Numerical Digitization
T2 [Cel
100
4550
5850
6825
3000
4000
5000
6000
7000
Q [m^3/h]
Save
Cancel
Unassigned Mixes
Tutorial MIX.mix
Unassigned Mixes
All Curves
Communication Bar
Ready
8.a Click New Mix to create a new gas mixture to assign to Curve
8.b Select a Mix previously created from Cmap Database to assign to Curve
7. Fill design/reference inlet conditions:
p1=40,2 bara
t1= 50°C


IPC Cmap 2.0
Home
PERFORMANCE
HELP
NEW
NEW PROJECT
NEW MACHINE
NEW PHASE
NEW STAGE
NEW CURVE
NEW MIX
New
Click here to hide CURVE INFO and visualize CURVE GRAPHS
Database tree view
Tutorial Project.prj
Tutorial machine.mac
Tutorial phase.pha
Tutorial Stage.sta
Tutorial curve.ccrv
Tutorial Project
Tutorial machine
Tutorial phase
Tutorial Stage
Tutorial Curve
CURVE INFO
CURVE GRAPHS
Map Digitization
Numerical Digitization
P2 [bar a]
100
80
60
3000
4000
5000
6000
7000
Q [m^3/h]
4550
5850
6825
T2 [Celsius]
140
120
100
Unassigned Mixes
Tutorial MIX.mix
Unassigned Mixes
All Curves
Save
Cancel
Communication Bar
Ready
Graphs of digitized Curves

NUMERICAL DIGITIZATION PROCEDURE



Cmap User guide

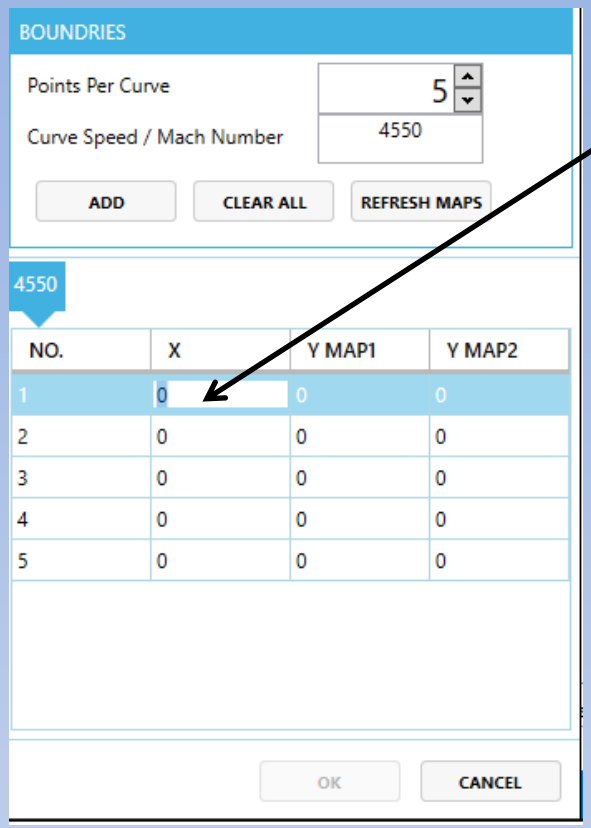


1. Fill the fields to set X and Y axis for 1st and 2nd map

2. How many points to digitize?

3. Input 1st speed number of maps

4. Click **ADD** to enter values at current speed



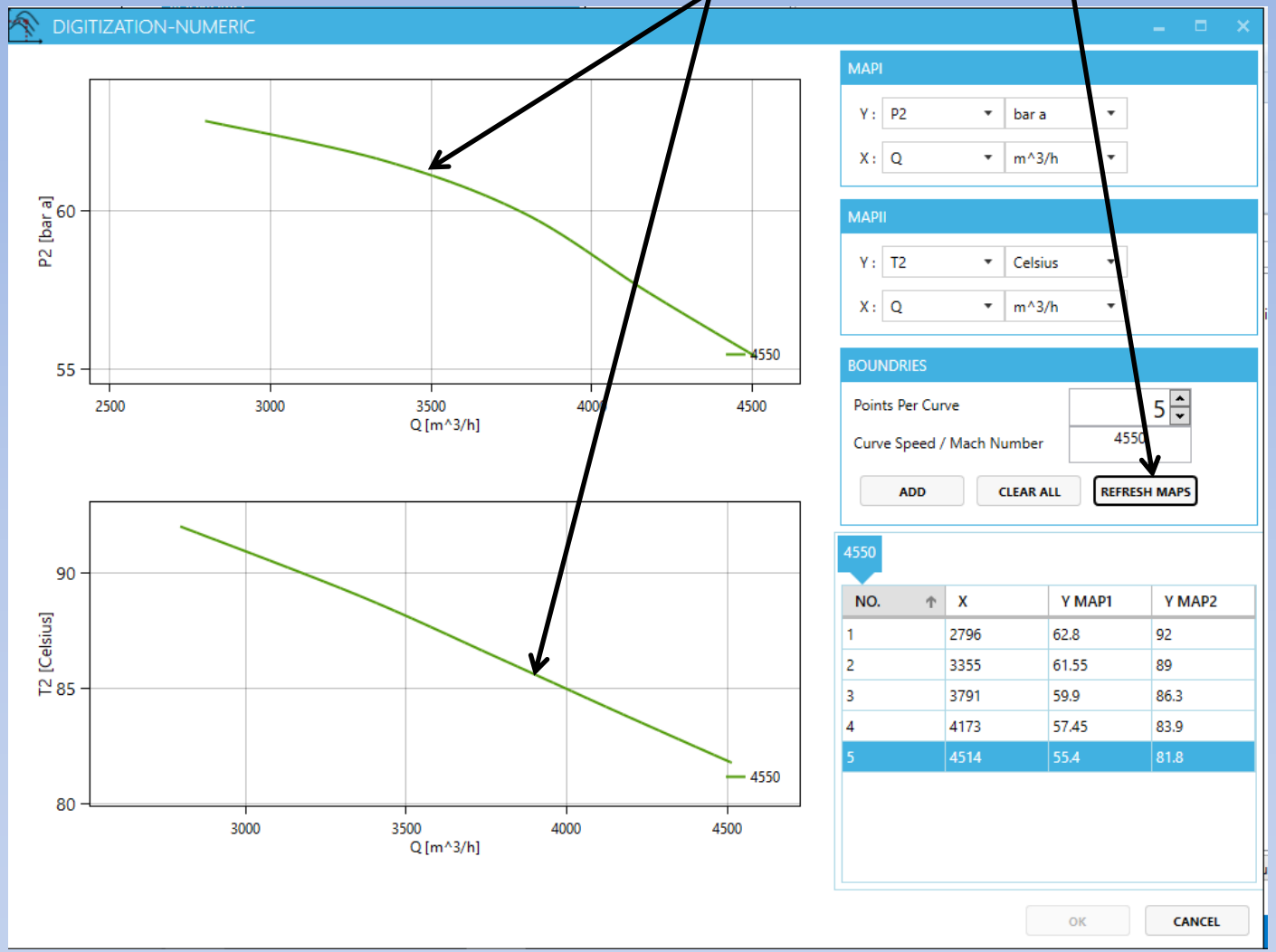
5. Double Click in the box and enter the value

6. Q_1 in X column P_2 in Y1 column T_2 in Y2 column

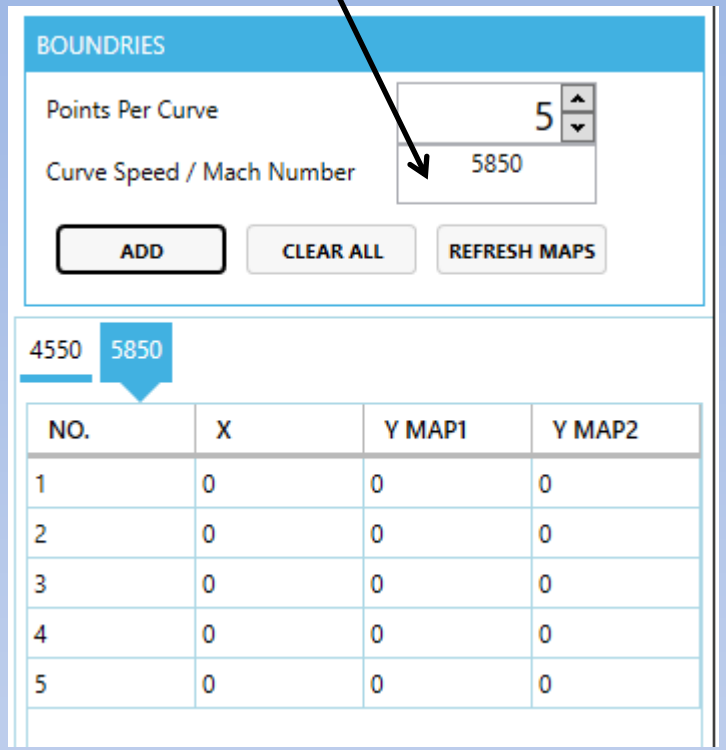
4550

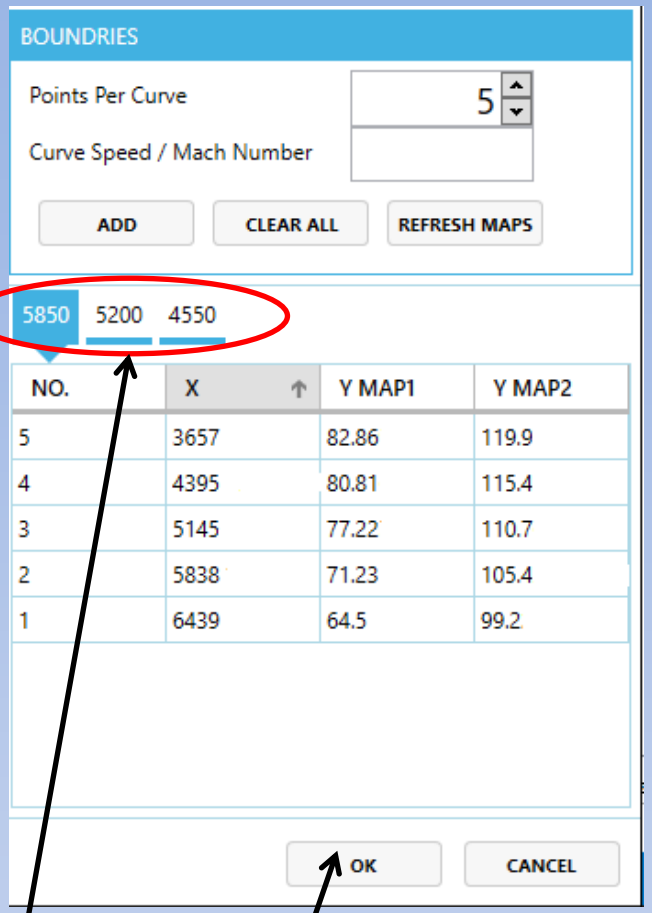
NO.	X	Y MAP1	Y MAP2
1	4514	55.4	81.8
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0

7. Click **REFRESH MAPS** to visualize as the curves are building



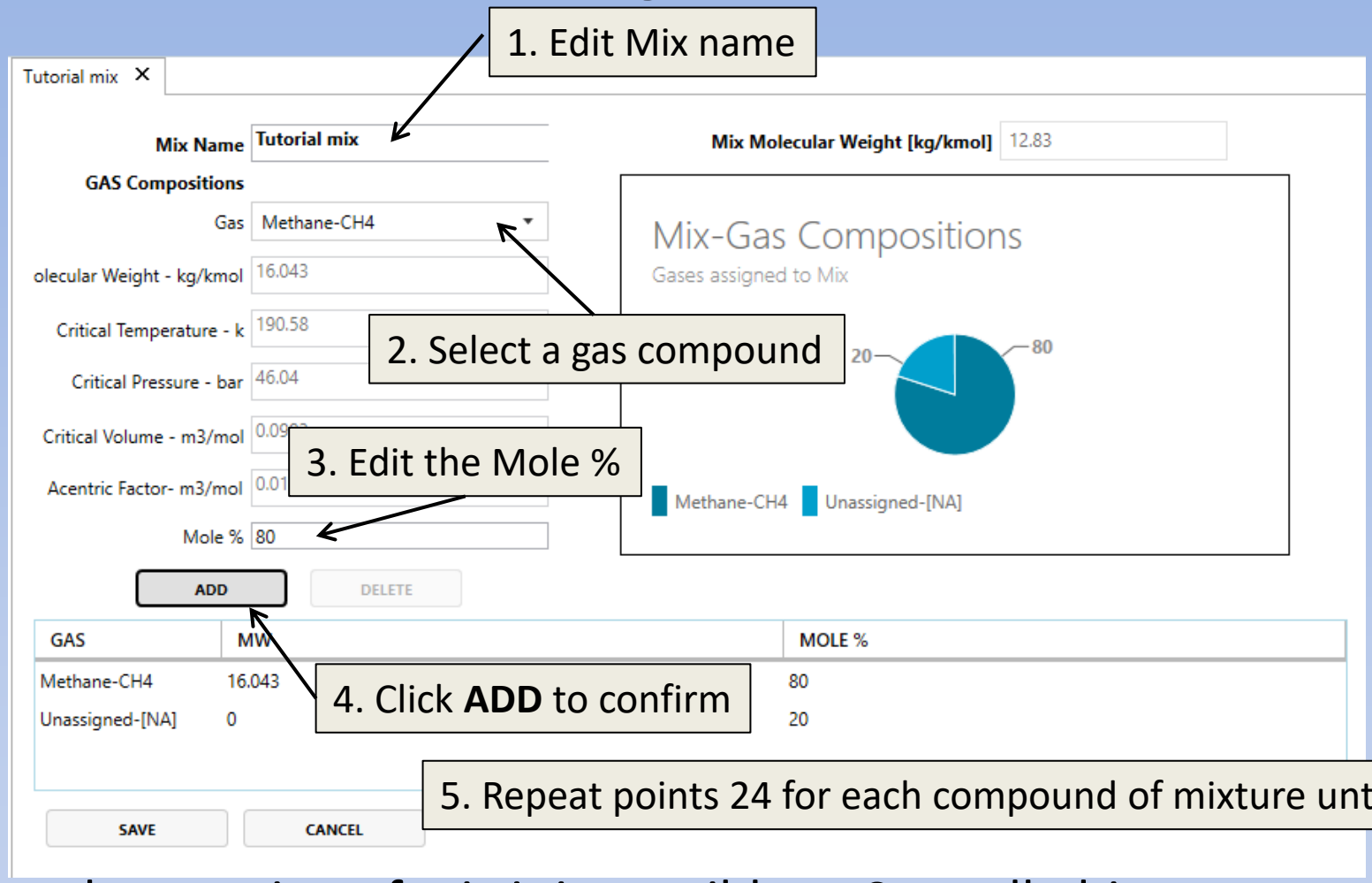
8. Input 2nd speed number of maps and repeat the steps from 4 to 6





9. You need at least 3 curves to set correctly a centrifugal compressor, then it's possible to save the MAPS clicking **OK**

5.6 Creation of gas mix: *Tutorial Mix*



After the creation of mix it is possible to Save all objects:
Mix, Curve, Stage, Phase, Machine, Project

6. Performance evaluation

In order to execute a compressor performance prediction, it's necessary:

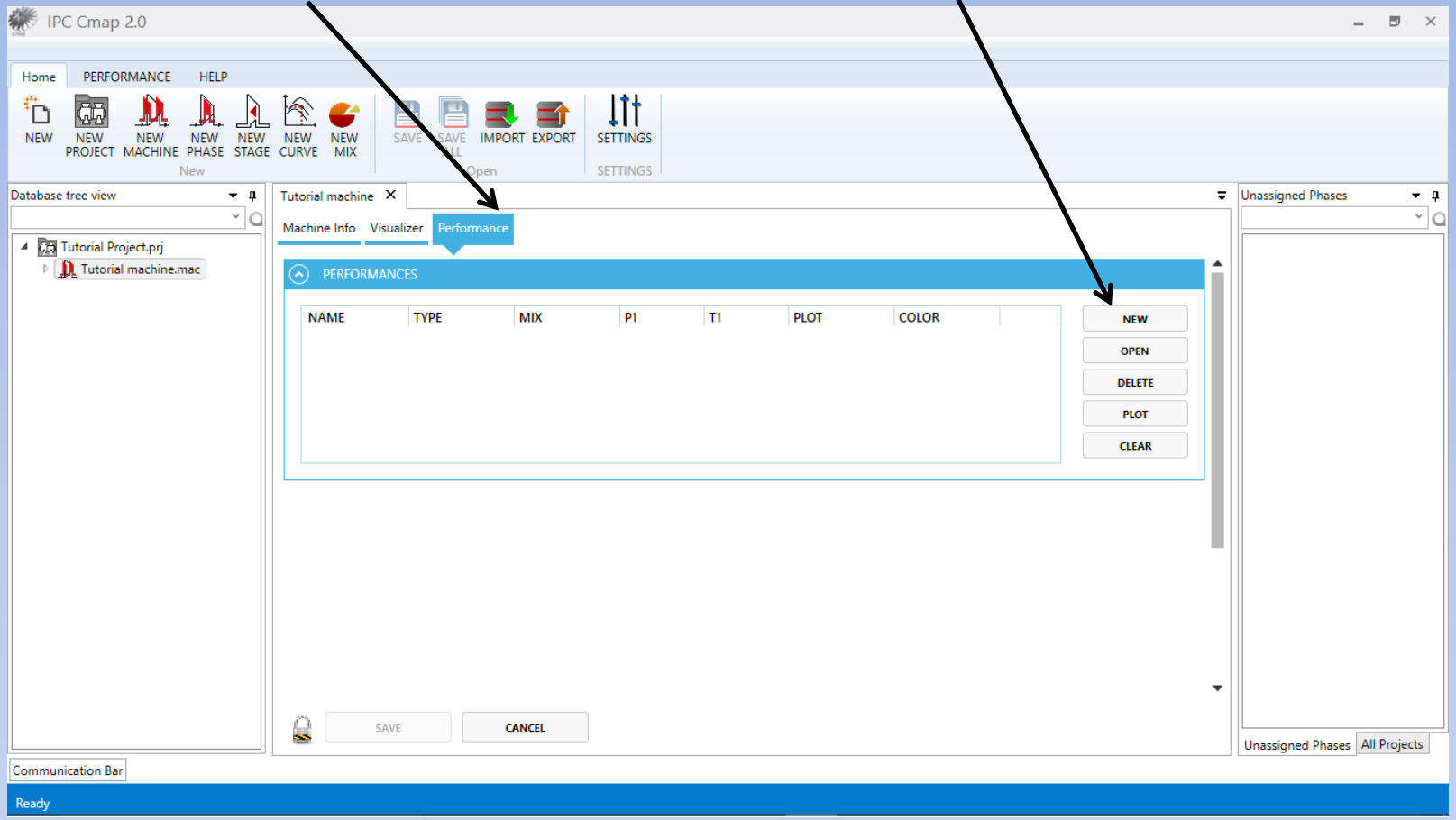
1. Define a gas mix (as seen in 5.6)

2. Launch the calculation tool

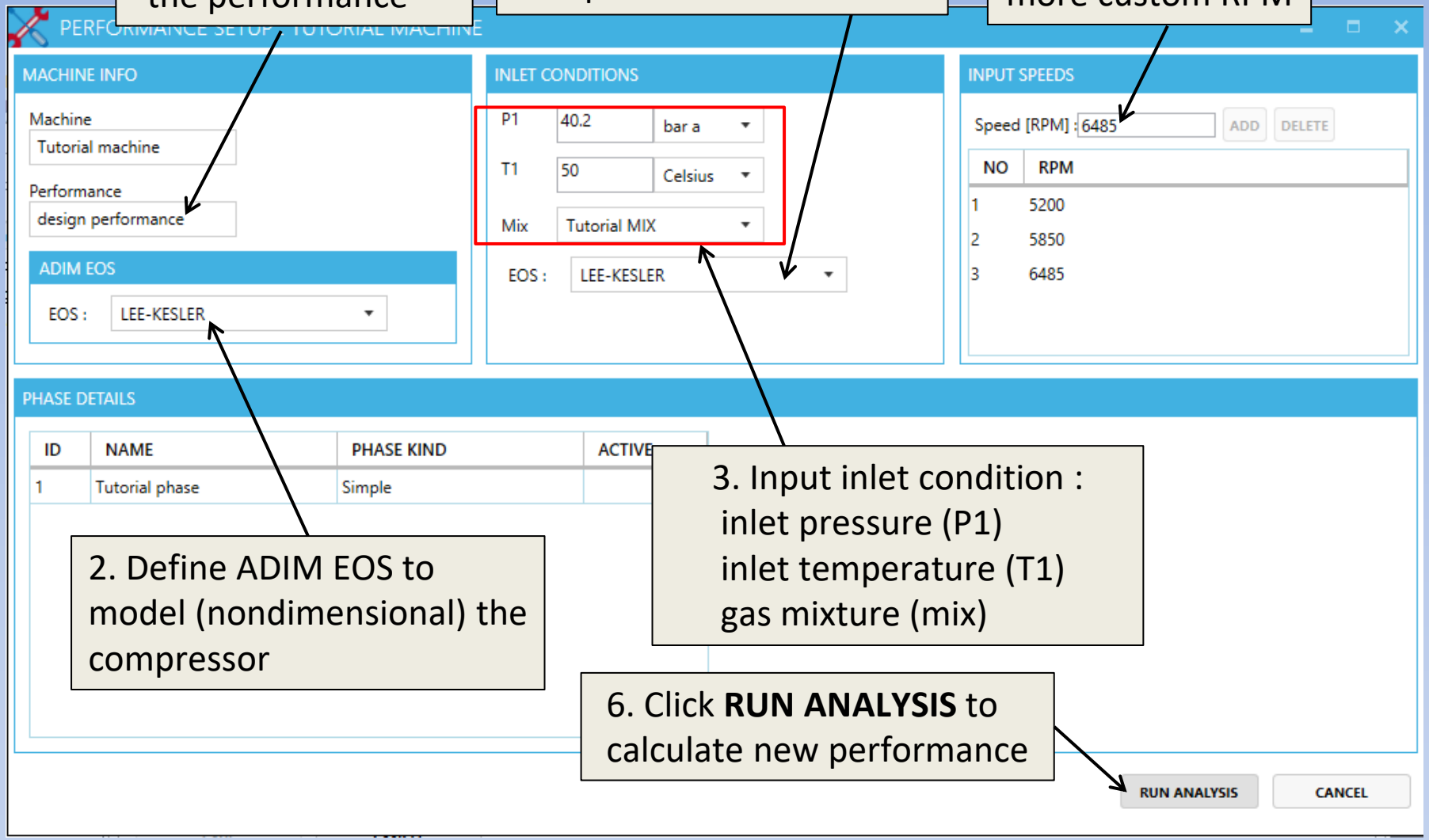
These steps will be shown in the next slides

6.1 Launch calculation

Open the machine “*Tutorial machine*”
click “**Performance**” tab and click button “**NEW**”



The Performance setup form will be opened


1. Edit the name of the performance
4. Define EOS to calculate the performance
5. Input one or more custom RPM
MACHINE INFO
Machine
Tutorial machine
Performance
design performance
ADIM EOS
EOS :
LEE-KESLER
INLET CONDITIONS
P1
40.2
bar a
T1
50
Celsius
Mix
Tutorial MIX
EOS :
LEE-KESLER
INPUT SPEEDS
Speed [RPM] :
6485
ADD
DELETE
NO
RPM
1
5200
2
5850
3
6485
PHASE DETAILS
ID
NAME
PHASE KIND
ACTIVE
1
Tutorial phase
Simple
2. Define ADIM EOS to model (nondimensional) the compressor
3. Input inlet condition :
inlet pressure (P1)
inlet temperature (T1)
gas mixture (mix)
6. Click RUN ANALYSIS to calculate new performance
RUN ANALYSIS
CANCEL

ADIM EOS

This EOS is linked to **design mix**

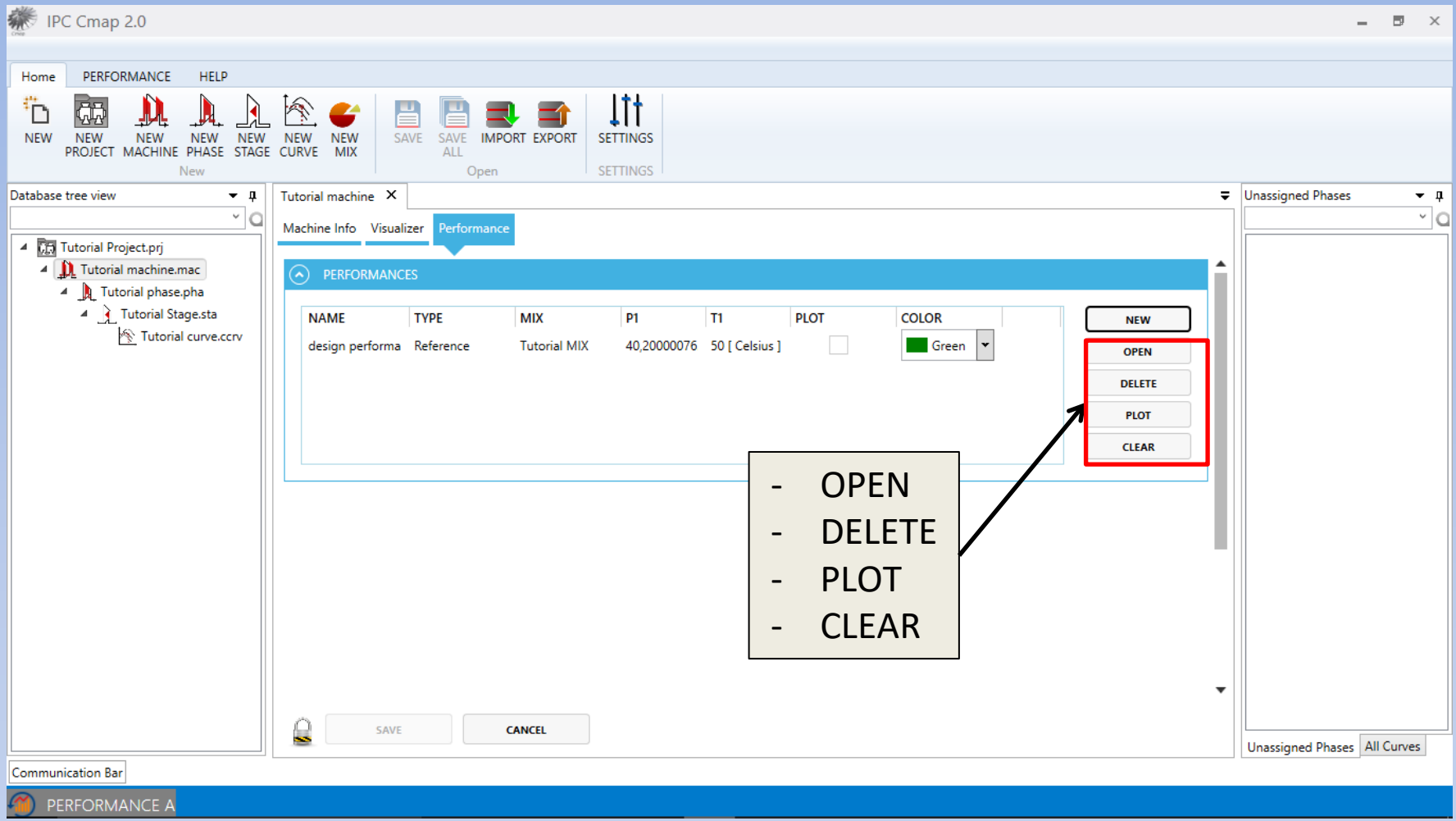
- **if design mix is a Hydrocarbon mixture you have to select LeeKesler or Peng Robinson EOS.**
- **if design mix is Freon R134a you have to select R134a EOS**

EOS (INLET CONDITION)

This EOS is linked to **off design mix**.

- **if off design mix is a Hydrocarbon mixture you have to select LeeKesler or Peng Robinson EOS**
- **if off design mix is Freon R134a, the software selects automatically R134a EOS**

6.2 Performance section



Through **OPEN** button you can open the PERFORMANCE ANALYSIS (see 7.) for selected performance
Through **DELETE** button you can delete the selected performance from database

Cmap User guide

Through **PLOT** button you can see the Performance in terms of:

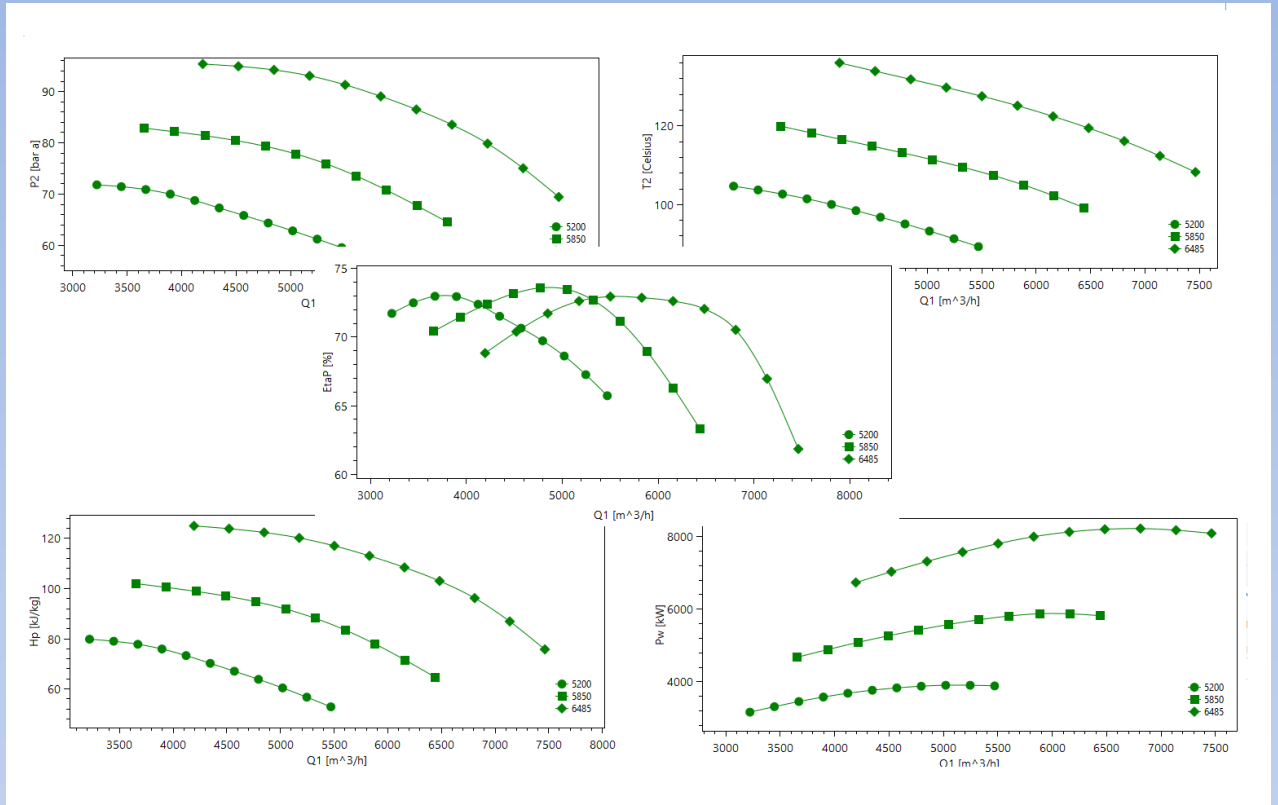
Discharge Pressure (p2)

Discharge Temperature (T2)

Polytropic Efficiency (Etap)

Polytropic Head (Hp)

Gas Power (Pw)



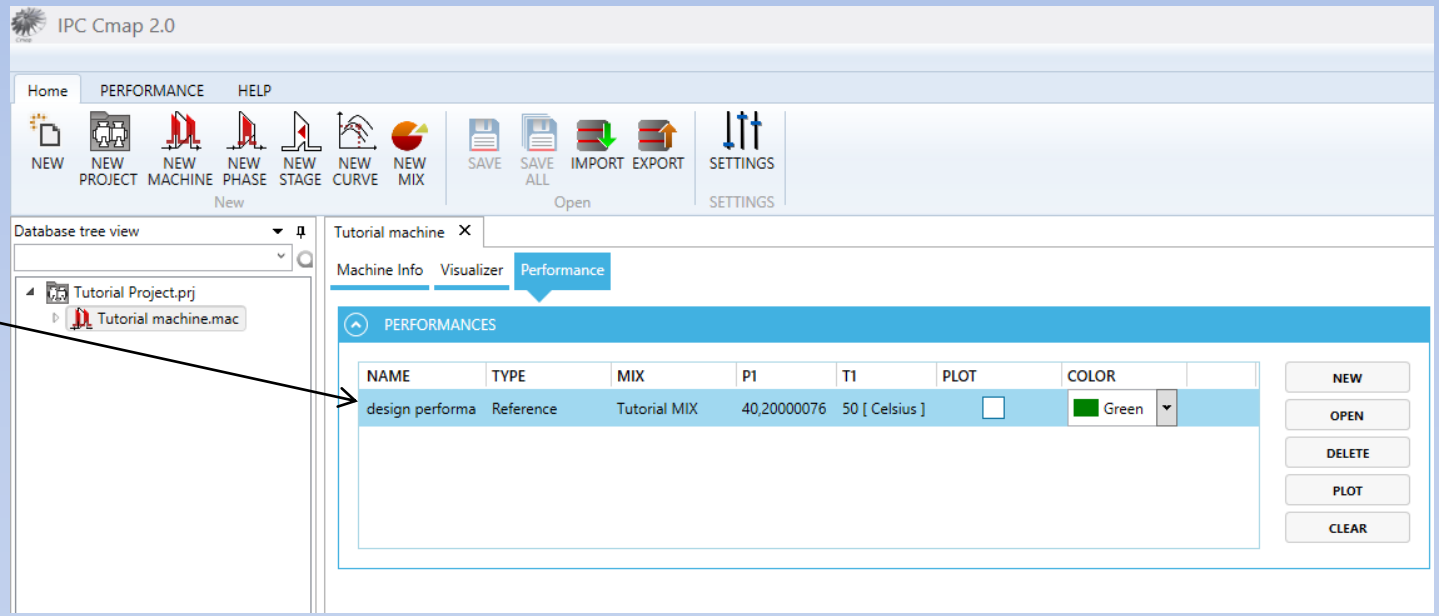
Through **CLEAR** button you can clean all performance maps (previously plotted).

7. Peformance Analysis

For each calculation developed, Cmap can provide a detailed analysis. The analysis tool allows to:

- make a detailed performance analysis, comparing real measured values with expected ones (from calculation)
- Check all compressor operative parameters in the considered specific inlet conditions for the calculation

To perform this task, select the performance curve and click Open or double click



After the analysis command, the Analysis setup form will be opened:

1. Select speed

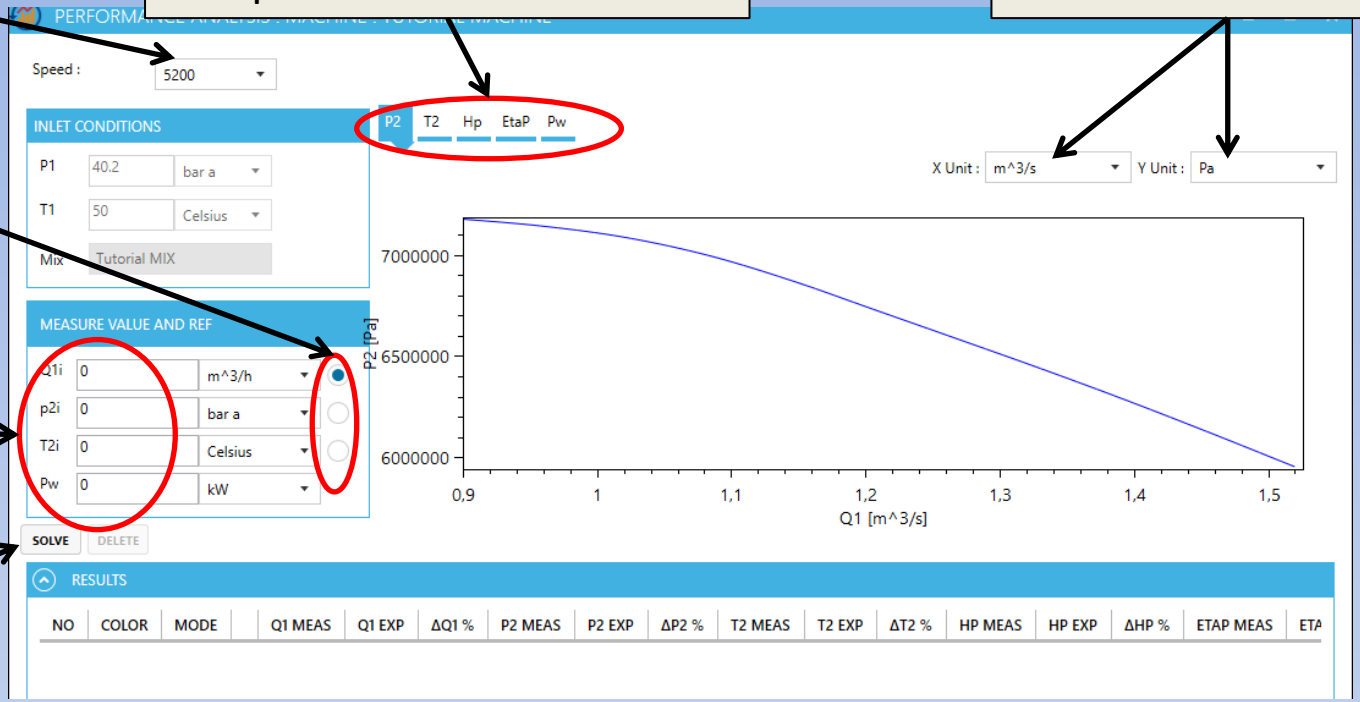
Select to visualize different performance curves

Select different units for X and Y axis

3. Select Reference Measurement(*)

2. Input data from field

4. **SOLVE** to start calculation



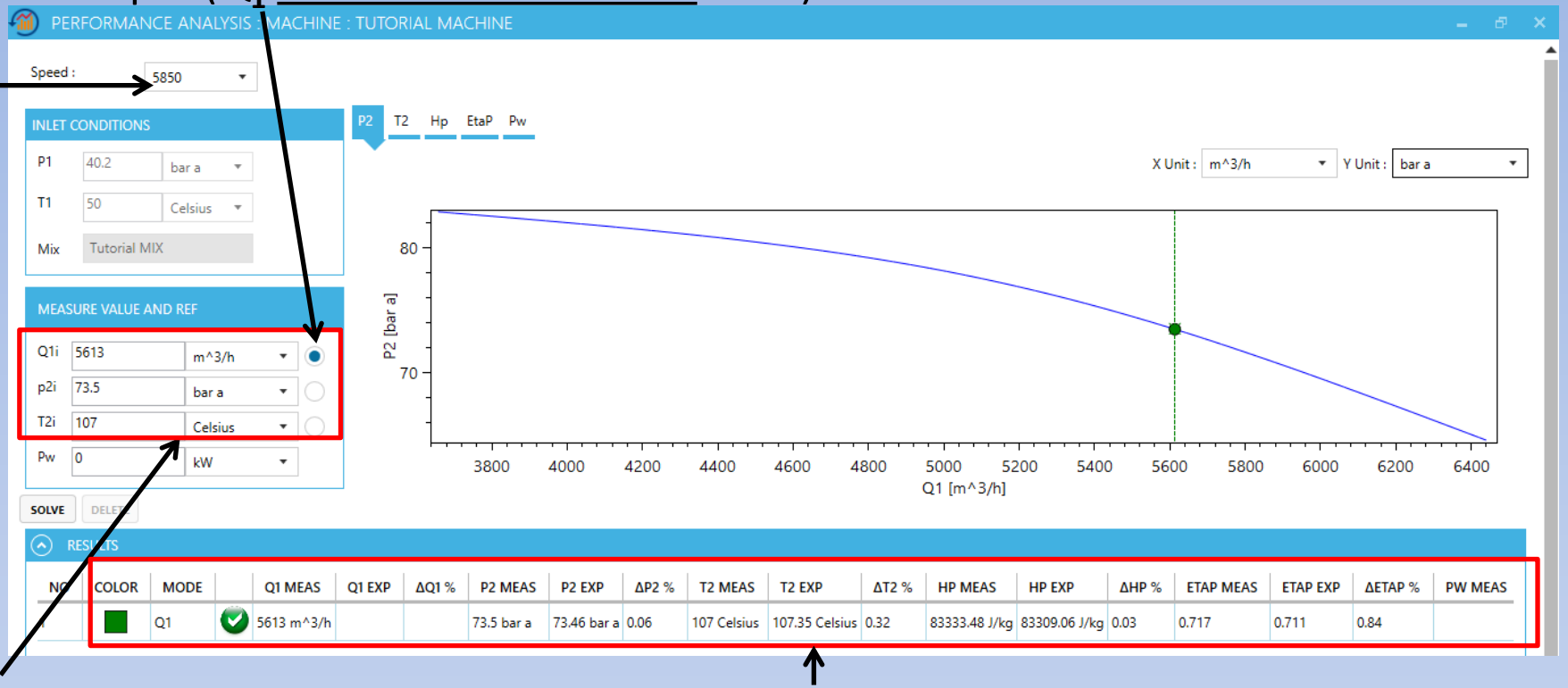
(*)Reference Measurement: the software offers the possibility to use as reference value Q_{1meas} or p_{2meas} or T_{2meas}

- if Q_{1meas}= Ref ➔ Q_1 will be used to extract the expected values of p_2, T_2, H_p, Eta_p and P_w
- if p_{2meas} = Ref ➔ p_2 will be used to extract the expected value of Q_{1exp}; then expected values of T_2, H_p, Eta_p and P_w will be calculated from Q_{1exp}
- if T_{2meas} = Ref ➔ T_2 will be used to extract the expected value of Q_{1exp}, then expected values of p_2, H_p, Eta_p and P_w will be calculated from Q_{1exp}

Example for Design case:

p_1=40,2 bara T_1 = 50°C Gas mixture = Tutorial (M_w = 19,55 kg/kmol)

n = 5850 rpm (Q_1 as reference measurement)



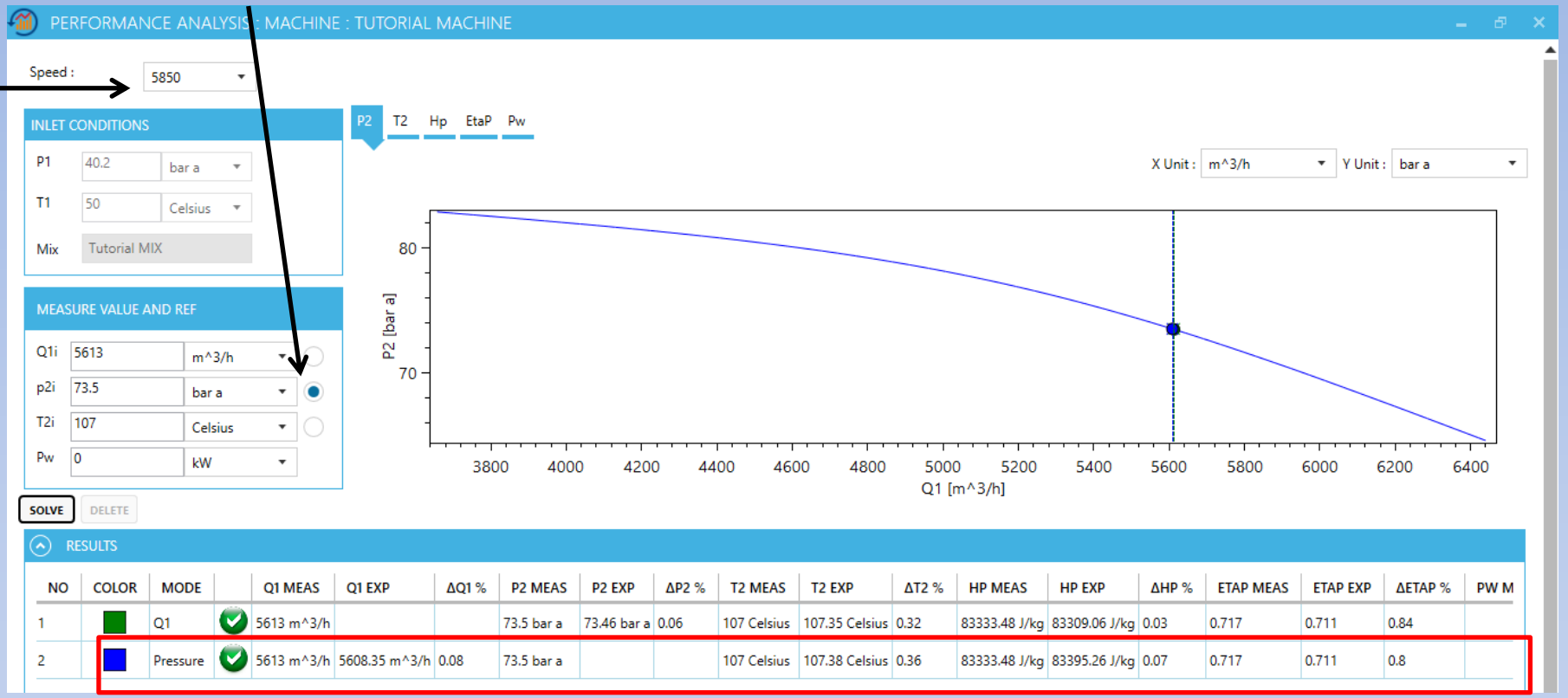
Q_1 =5613 m^3/h
p_2 = 73,5 bara
T_2 = 107 °C

The results are listed in this Area: there are both measured values (from field or datasheet) and expected values from Cmap calculations (p_2, T_2, H_p, Eta_p and P_w) and also the deviations between them (deviations are very low for all performances).

Example for Design case:

p_1=40,2 bara T_1 = 50°C Gas mixture = Tutorial (M_w = 19,55 kg/kmol)

n = 5850 rpm (**p_2** as reference measurement)



NO	COLOR	MODE		Q1 MEAS	Q1 EXP	ΔQ1 %	P2 MEAS	P2 EXP	ΔP2 %	T2 MEAS	T2 EXP	ΔT2 %	HP MEAS	HP EXP	ΔHP %	ETAP MEAS	ETAP EXP	ΔETAP %	PW M
1		Q1		5613 m^3/h			73.5 bar a	73.46 bar a	0.06	107 Celsius	107.35 Celsius	0.32	83333.48 J/kg	83309.06 J/kg	0.03	0.717	0.711	0.84	
2		Pressure		5613 m^3/h	5608.35 m^3/h	0.08	73.5 bar a			107 Celsius	107.38 Celsius	0.36	83333.48 J/kg	83395.26 J/kg	0.07	0.717	0.711	0.8	

Also in this case the deviations between expected and datasheet values are very low (<0,1%).

Example for Design case:

p_1=40,2 bara T_1 = 50°C Gas mixture = Tutorial (M_w = 19,55 kg/kmol)

n = 5850 rpm (T_2 as reference measurement)



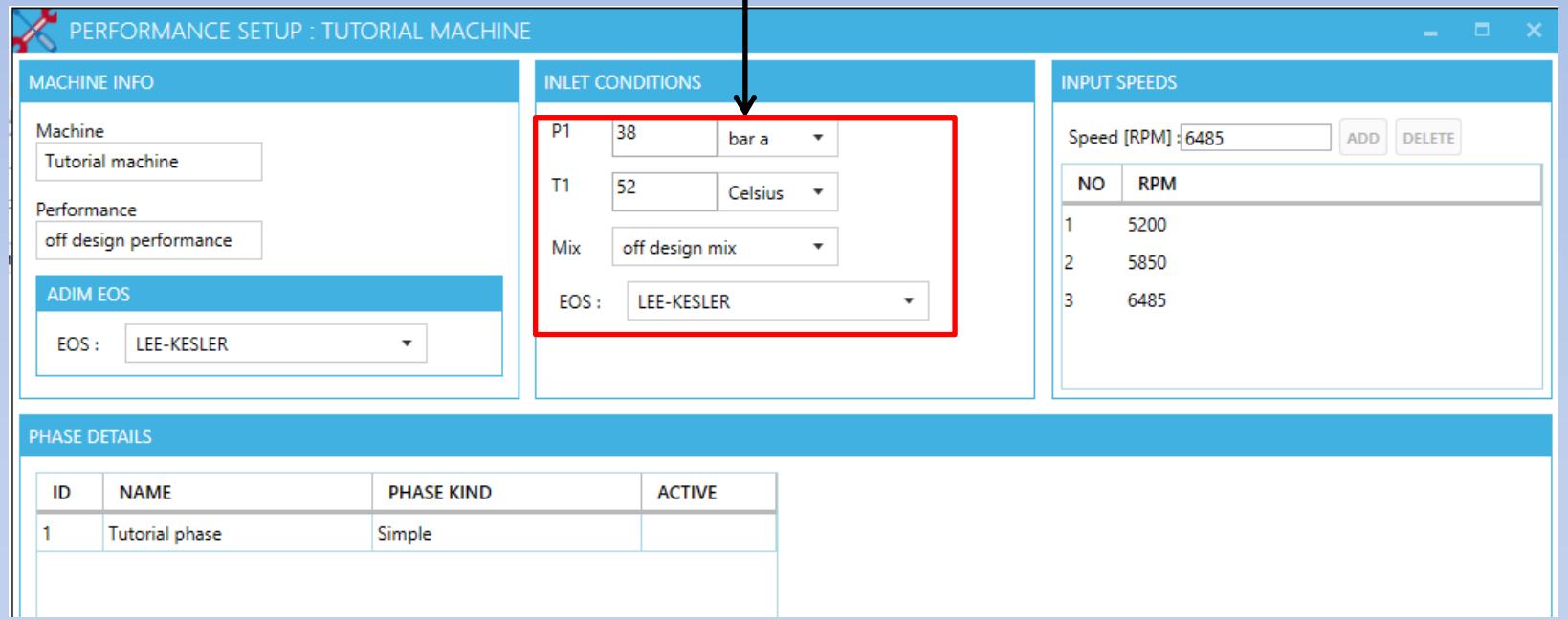
NO	COLOR	MODE		Q1 MEAS	Q1 EXP	ΔQ1 %	P2 MEAS	P2 EXP	ΔP2 %	T2 MEAS	T2 EXP	ΔT2 %	HP MEAS	HP EXP	ΔHP %	ETAP MEAS	ETAP EXP	ΔETAP %	PW
1		Q1		5613 m^3/h			73.5 bar a	73.46 bar a	0.06	107 Celsius	107.35 Celsius	0.32	83333.48 J/kg	83309.06 J/kg	0.03	0.717	0.711	0.84	
2		Pressure		5613 m^3/h	5608.35 m^3/h	0.08	73.5 bar a			107 Celsius	107.38 Celsius	0.36	83333.48 J/kg	83395.26 J/kg	0.07	0.717	0.711	0.8	
3		Temperature		5613 m^3/h	5655.55 m^3/h	0.75	73.5 bar a	73.05 bar a	0.61	107 Celsius			83333.48 J/kg	82509.08 J/kg	1	0.717	0.708	1.26	

Example for OffDesign case:

Now we consider an offdesign case where all the inlet conditions change from design/reference ones:

OFF DESIGN INLET CONDITIONS

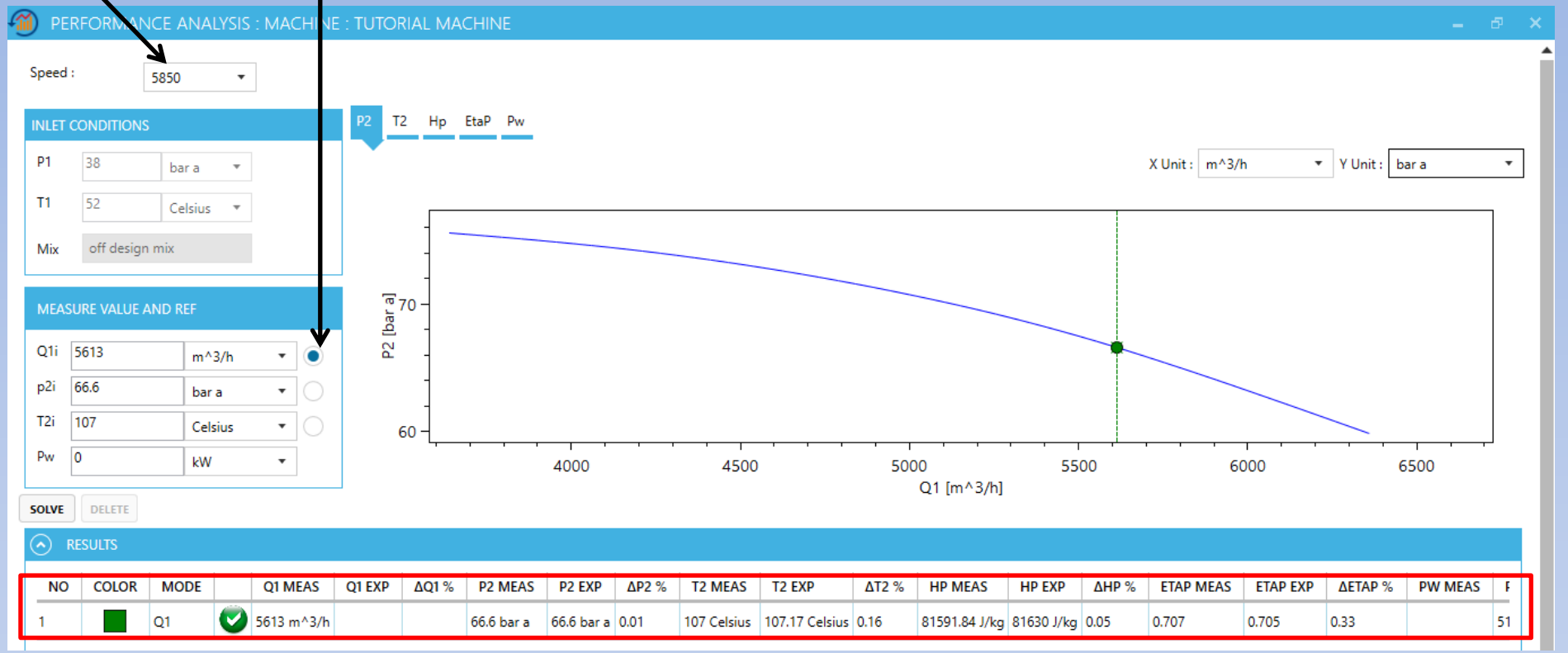
Gas mix composition		p_1 = 38 bar-a	Q_1 = 5613 m3/h
Methane (CH4)	80 %	T_1 = 52 °C	p_2 = 66,6 bar-a
Ethane (C2H6)	20 %	Mw = 18,85 g/mol	T_2 = 107 °C
			N = 5850 rpm



* It is necessary to create offdesign mix before to run the performance

Example for OffDesign case:

n = 5850 rpm (Q_1 as reference measurement)

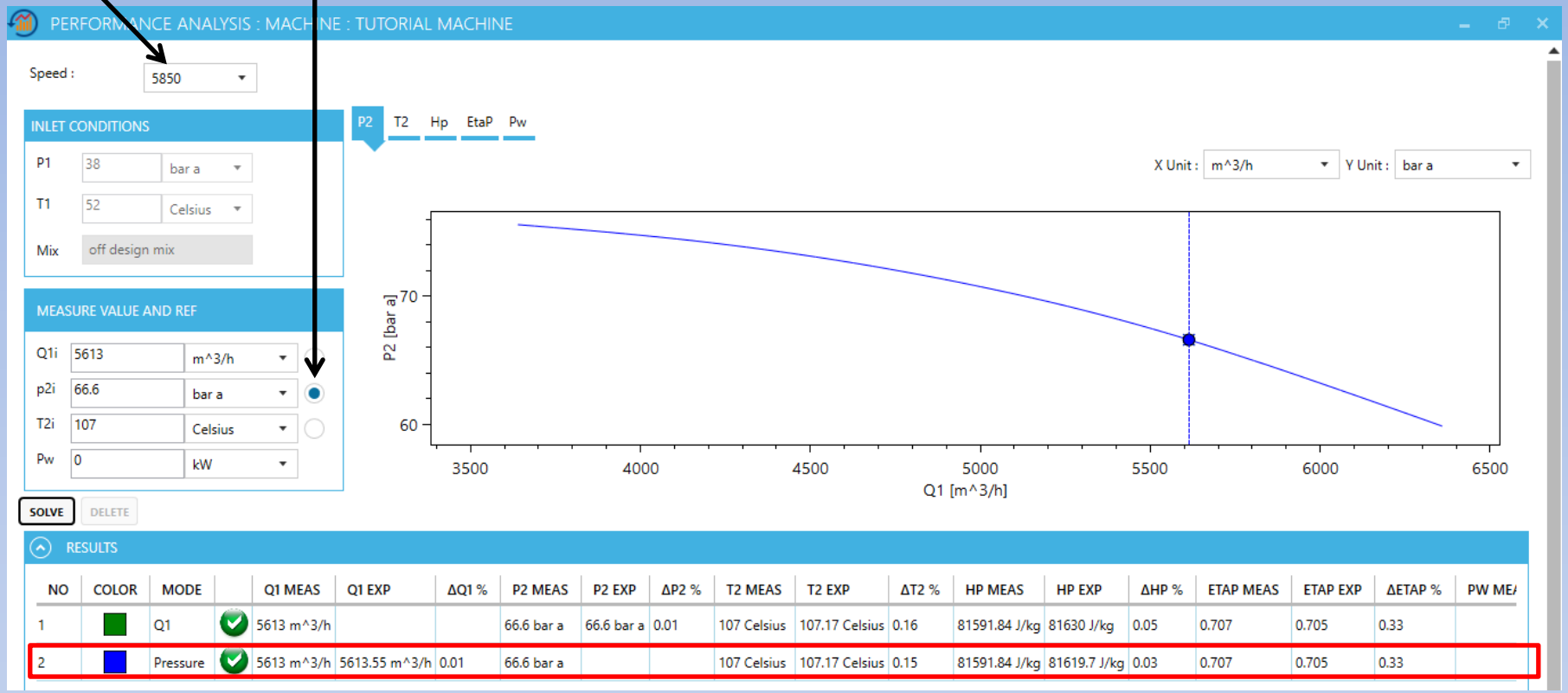


NO	COLOR	MODE		Q1 MEAS	Q1 EXP	ΔQ1 %	P2 MEAS	P2 EXP	ΔP2 %	T2 MEAS	T2 EXP	ΔT2 %	HP MEAS	HP EXP	ΔHP %	ETAP MEAS	ETAP EXP	ΔETAP %	PW MEAS	
1		Q1		5613 m^3/h			66.6 bar a	66.6 bar a	0.01	107 Celsius	107.17 Celsius	0.16	81591.84 J/kg	81630 J/kg	0.05	0.707	0.705	0.33		51

Cmap provides the performance calculations in every offdesign inlet conditions.
The results show negligible deviations.

Example for OffDesign case:

n = 5850 rpm (p_2 as reference measurement)



NO	COLOR	MODE		Q1 MEAS	Q1 EXP	ΔQ1 %	P2 MEAS	P2 EXP	ΔP2 %	T2 MEAS	T2 EXP	ΔT2 %	HP MEAS	HP EXP	ΔHP %	ETAP MEAS	ETAP EXP	ΔETAP %	PW MEA
1		Q1		5613 m^3/h			66.6 bar a	66.6 bar a	0.01	107 Celsius	107.17 Celsius	0.16	81591.84 J/kg	81630 J/kg	0.05	0.707	0.705	0.33	
2		Pressure		5613 m^3/h	5613.55 m^3/h	0.01	66.6 bar a			107 Celsius	107.17 Celsius	0.15	81591.84 J/kg	81619.7 J/kg	0.03	0.707	0.705	0.33	

Cmap provides the performance calculations in every offdesign inlet conditions.
The results show negligible deviations.

Example for OffDesign case:

n = 5850 rpm (T_2 as reference measurement)



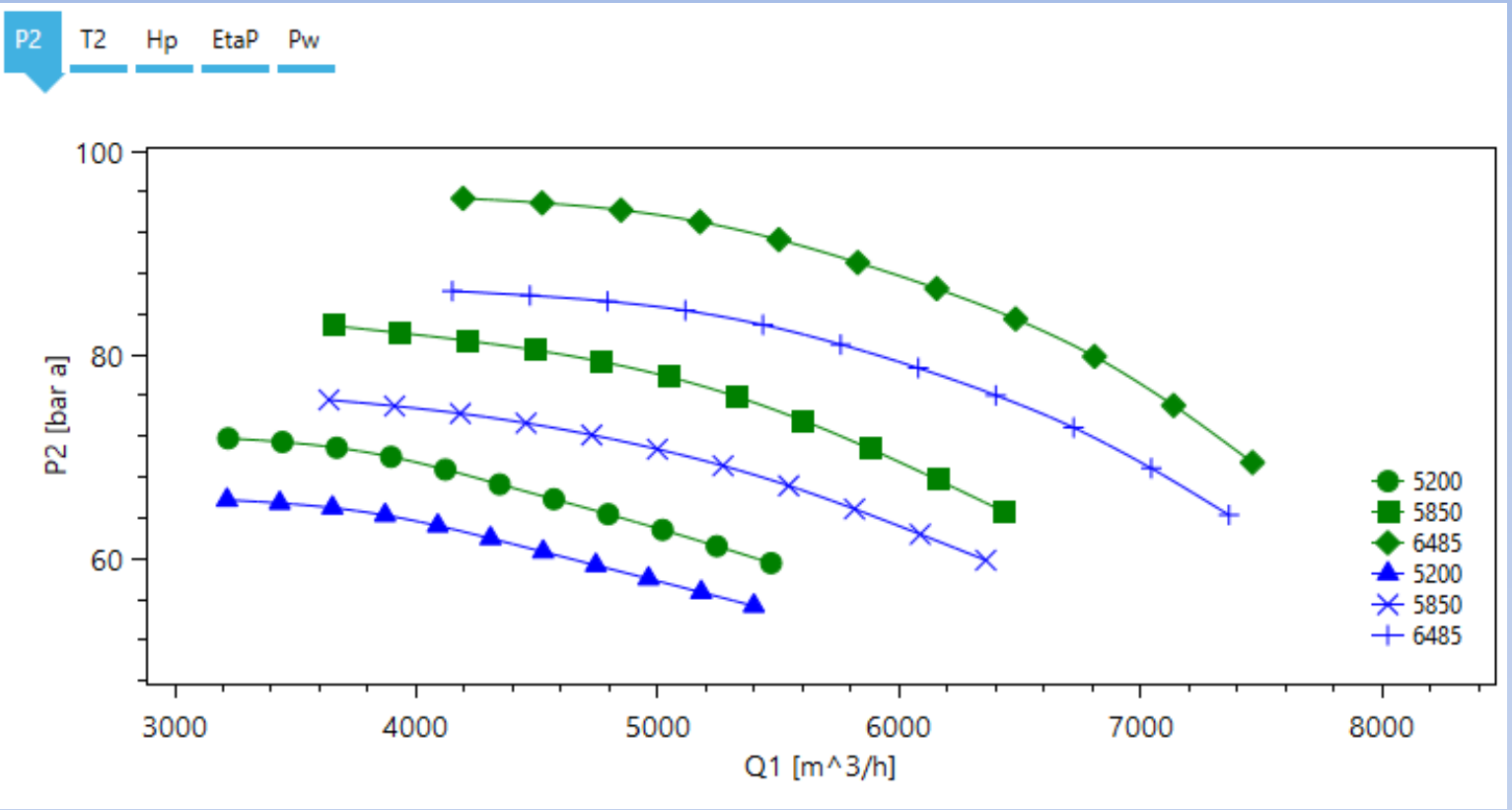
NO	COLOR	MODE		Q1 MEAS	Q1 EXP	ΔQ1 %	P2 MEAS	P2 EXP	ΔP2 %	T2 MEAS	T2 EXP	ΔT2 %	HP MEAS	HP EXP	ΔHP %	ETAP MEAS	ETAP EXP	ΔETAP %	PW
1		Q1		5613 m^3/h			66.6 bar a	66.6 bar a	0.01	107 Celsius	107.17 Celsius	0.16	81591.84 J/kg	81630 J/kg	0.05	0.707	0.705	0.33	
2		Pressure		5613 m^3/h	5613.55 m^3/h	0.01	66.6 bar a			107 Celsius	107.17 Celsius	0.15	81591.84 J/kg	81619.7 J/kg	0.03	0.707	0.705	0.33	
3		Temperature		5613 m^3/h	5633.88 m^3/h	0.37	66.6 bar a	66.43 bar a	0.25	107 Celsius			81591.84 J/kg	81236.39 J/kg	0.44	0.707	0.704	0.53	

Cmap provides the performance calculations in every offdesign inlet conditions.
The results show negligible deviations.

Graphical Comparison

Cmap2 is able to compare 2 or more performance curves (or maps) in different inlet conditions.

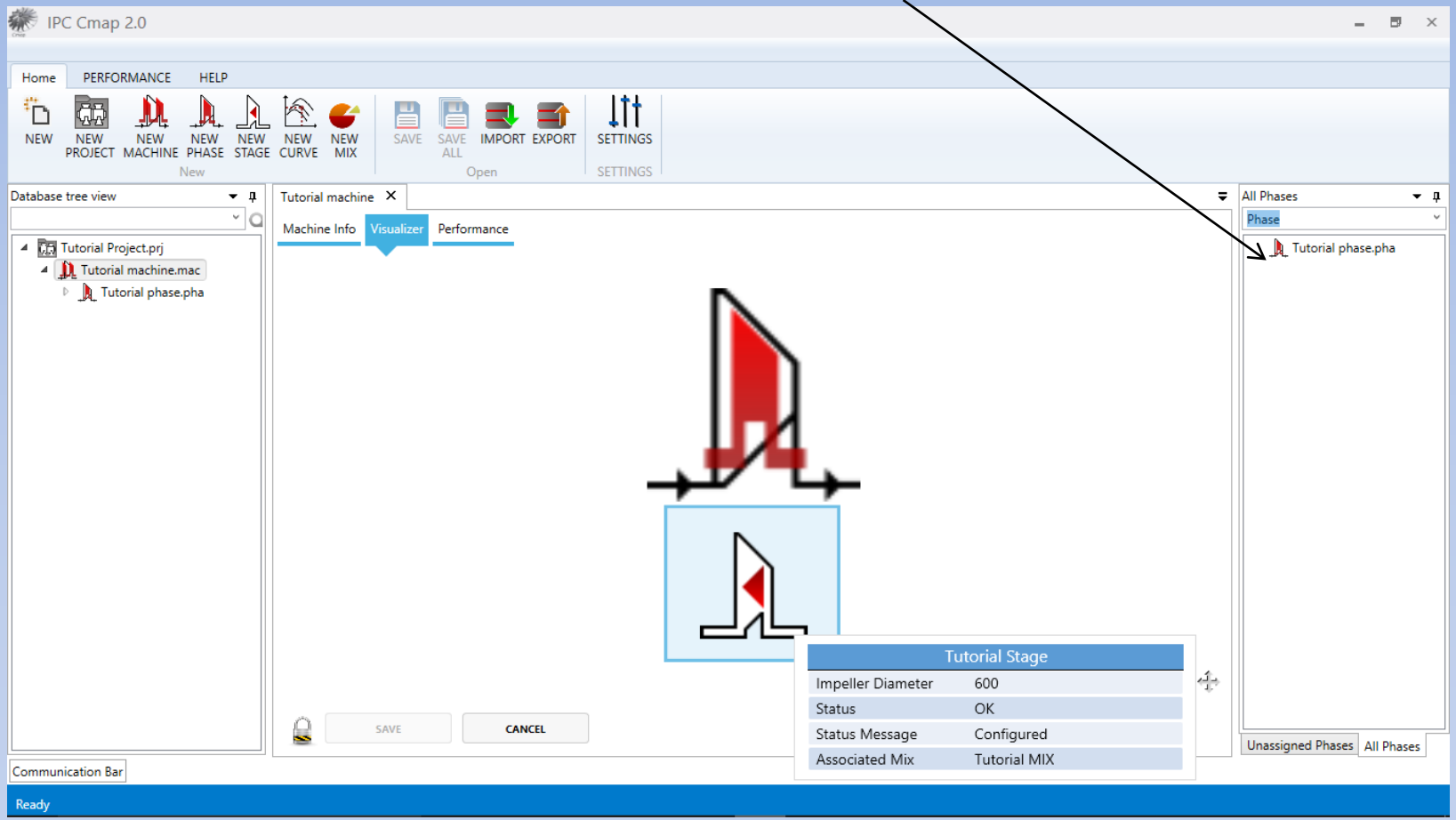
Design case vs Offdesign case



8. Additional Functions

8.1 Drag & Drop

In section Visualizer of each Object it's possible to drag and drop one or more lower level objects from database (**unassigned object**)



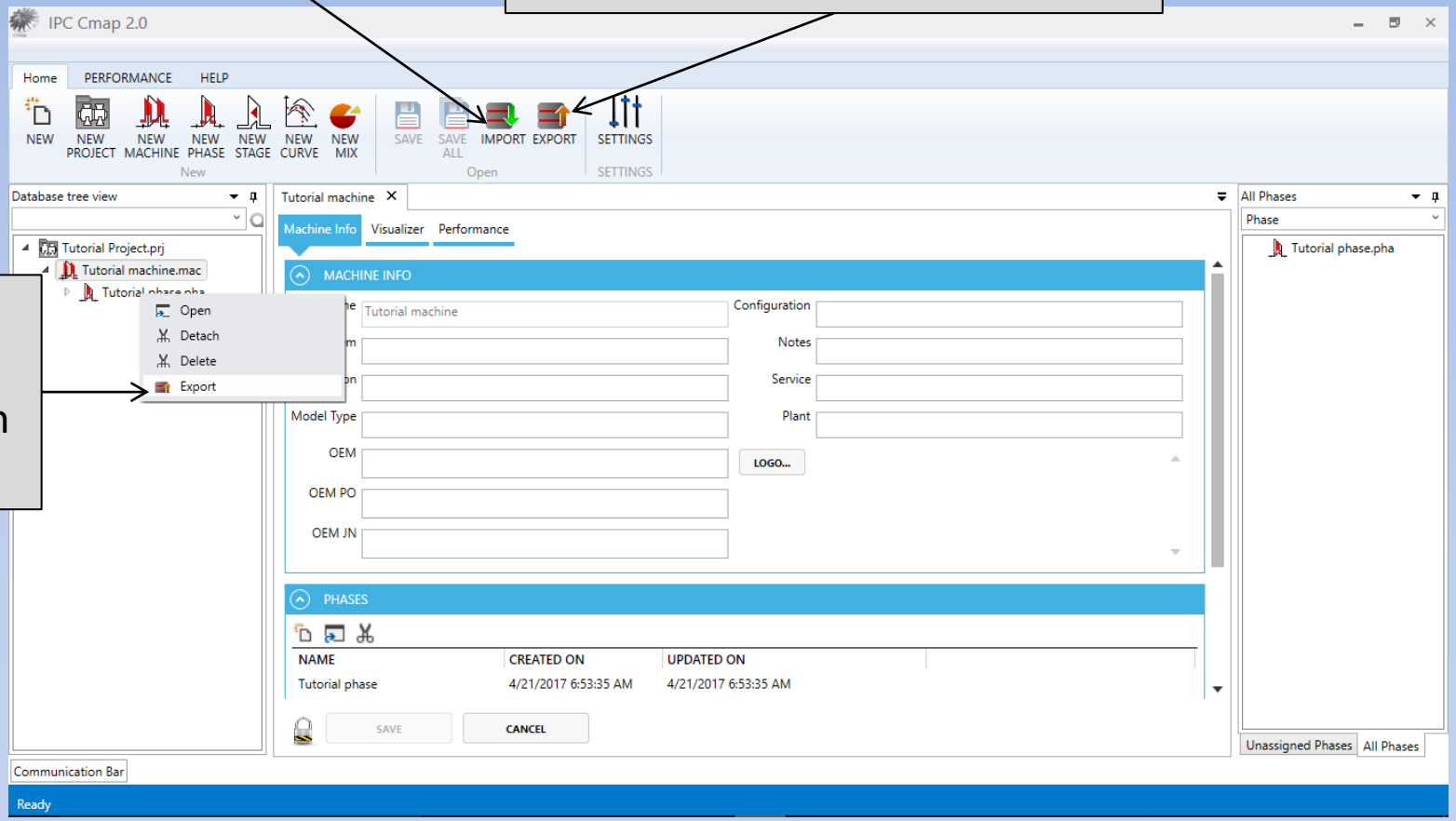
8.2 Import/Export

It is possible to export and import every object (item) from *Project* to *Mix*

IMPORT

EXPORT (1)
The active object in main window will be exported clicking here

EXPORT (2)
Right click of the object then click export

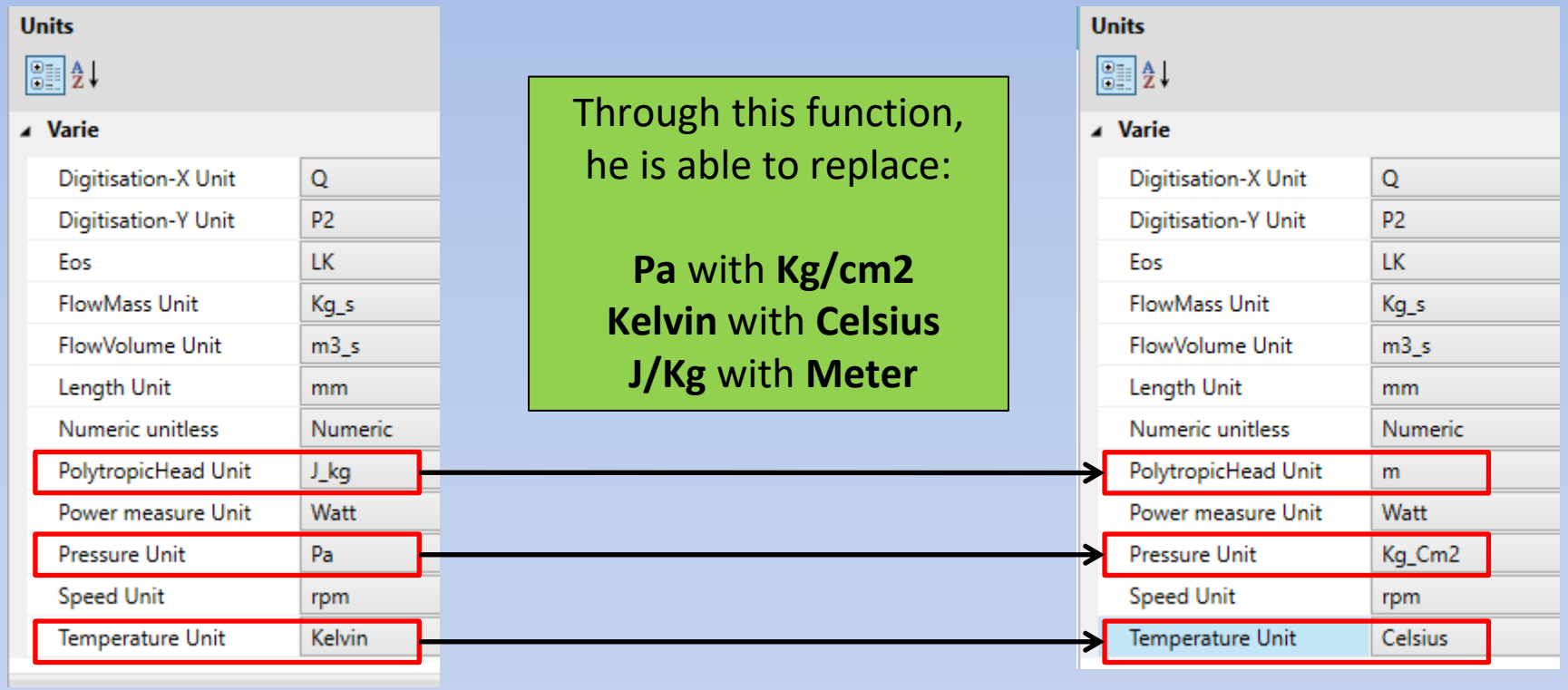


8.3 Units

It is possible to set the favorite units as default units (**SETTINGS➔ Units**)

Example: analyst/user use usually:

- Kg/cm^2 for Pressure
- Celsius for Temperature
- Meter for Polytropic Head



9. PDF Report

Filed	Value	Filed	Value
Name	803-K-001	Configuration	
Tag	803K001	Notes	HYDROCRACKER
Description		Service	recycle gas compressor
Model Type	20MH10	Plant	SINAIS REFINERY
OEM	ELLIOTT NUARA	OEM PO	
OEM JN			

Section No	Section Name	Stages
1	803-K-001 phase	1 803-K-001 stage

Stage 1. 803-K-001 stage	
Impeller Diameter	600 (mm)
% Volumetric Efficiency	100
% Mechanical Efficiency	100

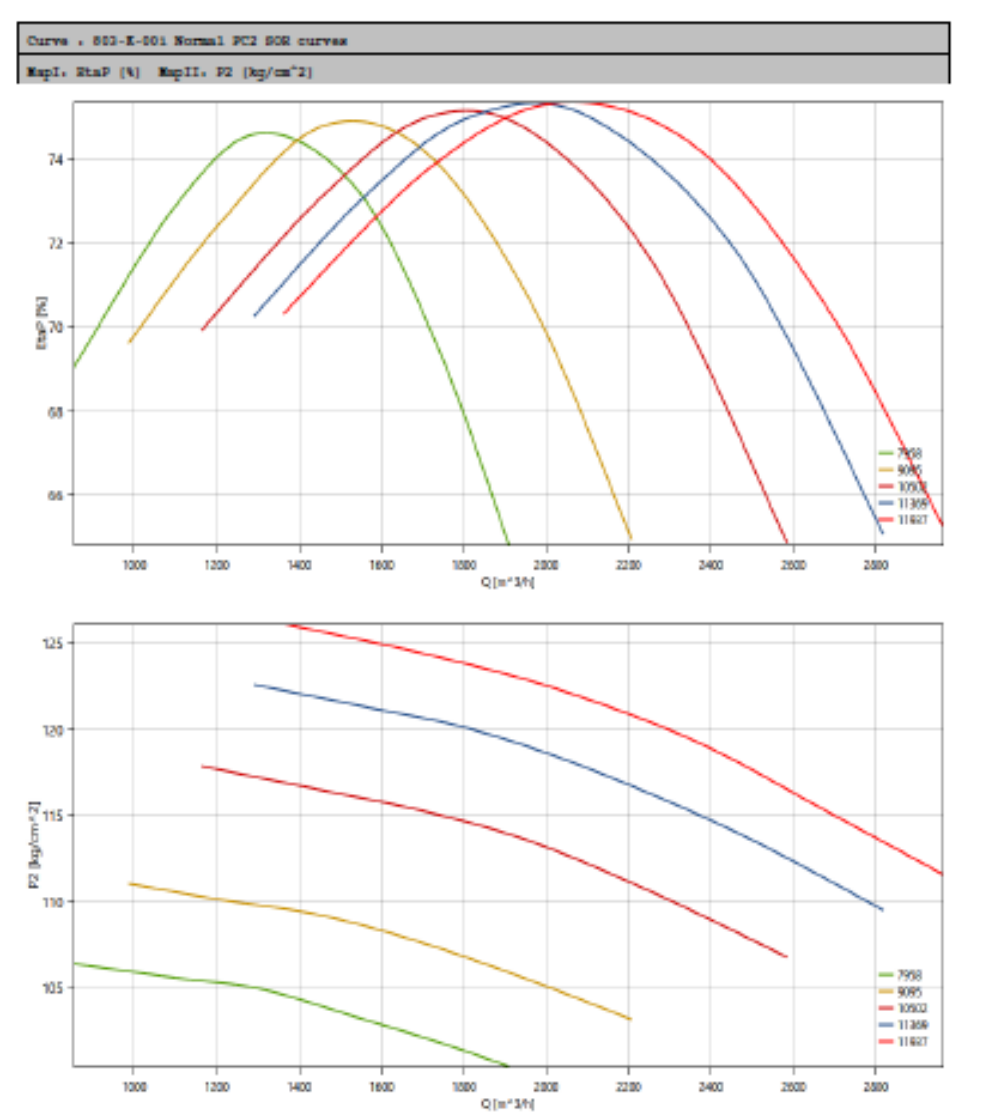
REFERENCE CONDITIONS

Mix Name.	803-K-001 PC2 SOR normal
Gas	Mole Fraction
Water-H2O	0,0019
Hydrogen Sulfide-H2S	0,023
Hydrogen-H2	0,9431
Methane-CH4	0,0218
Ethane-C2H6	0,0027
Propane-C3H8	0,0031
i-butane-i-C4H10	0,0013
n-Butane-n-C4H10	0,0008
i-pentane-i-C5H12	0,0006
n-Pentane-n-C5H12	0,0002
n-Hexane-n-C6H14	0,0005

INLET PRESSURE (P1)	91,9 Kg_Cm2
INLET TEMPERATURE (T1)	57 Celsius
MIX MOLECULAR WEIGHT	3,54 kg/kmol

It’s possible to create a pdf REPORT wich resume all information about analyzed Machine.

Gas Mixture



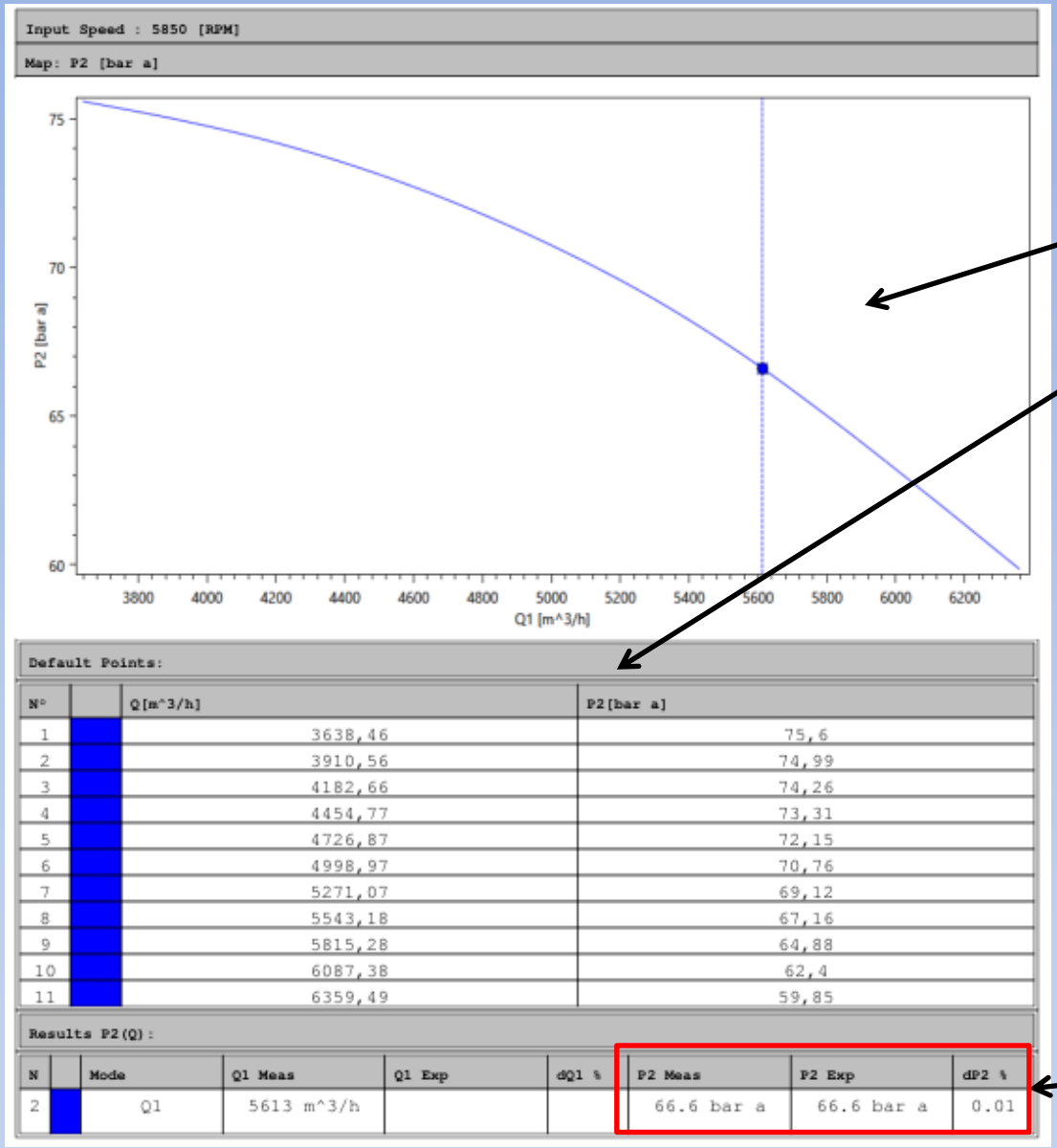
Reference Curves used to set the centrifugal compressor

PERFORMANCE CONDITIONS	
Mix Name:	803-K-001 PCL NOR normal
Gas	Mole Fraction
Water-H2O	0,0019
Hydrogen Sulfide-H2S	0,0238
Hydrogen-H2	0,8929
Methane-CH4	0,0613
Ethane-C2H6	0,0107
Propane-C3H8	0,0048
i-butane-i-C4H10	0,0016
n-Butane-n-C4H10	0,0012
i-pentane-i-C5H12	0,0008
n-Pentane-n-C5H12	0,0003
n-Hexane-n-C6H14	0,0003
n-Octane-n-C8H18	0,0004

INLET PRESSURE (P1)	51,9 Kg_Cm2
INLET TEMPERATURE (T1)	57 Celsius
MIX MOLECULAR WEIGHT	4,48 kg/kmol

Performance condition

Cmap User guide



Default Points:

N°		Q[m^3/h]	P2[bar a]
1		3638,46	75,6
2		3910,56	74,99
3		4182,66	74,26
4		4454,77	73,31
5		4726,87	72,15
6		4998,97	70,76
7		5271,07	69,12
8		5543,18	67,16
9		5815,28	64,88
10		6087,38	62,4
11		6359,49	59,85

Results P2(Q):

N		Mode	Q1 Meas	Q1 Exp	dQ1 %	P2 Meas	P2 Exp	dP2 %
2		Q1	5613 m^3/h			66.6 bar a	66.6 bar a	0.01

Performance Curves from Cmap calculations are plotted both:

- graphical
- numerical

for each speed number required in PERFORMANCE ANALYSIS in terms of:

- p_2
- T_2
- H_p
- Eta_p
- P_w

- Measured value (analyst)
- Expected value (Cmap)
- Deviation

10. XLS Report

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

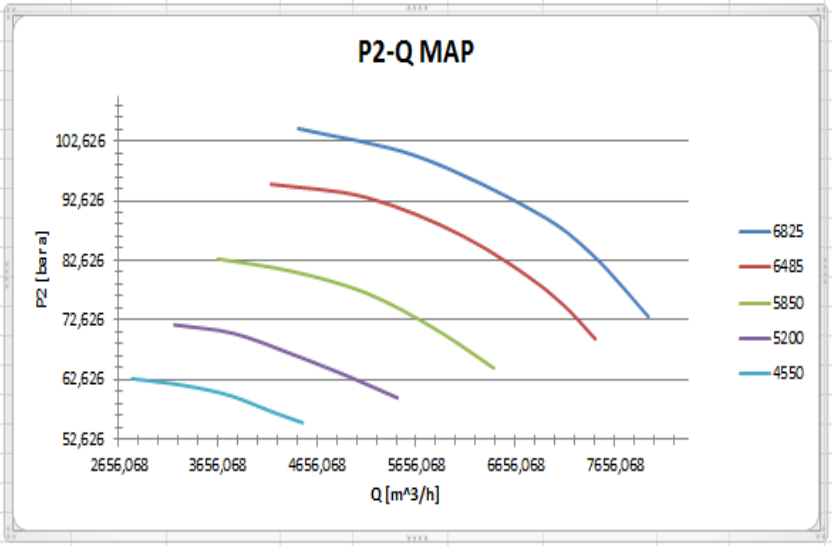
Sheet 2 "Reference Condition", includes

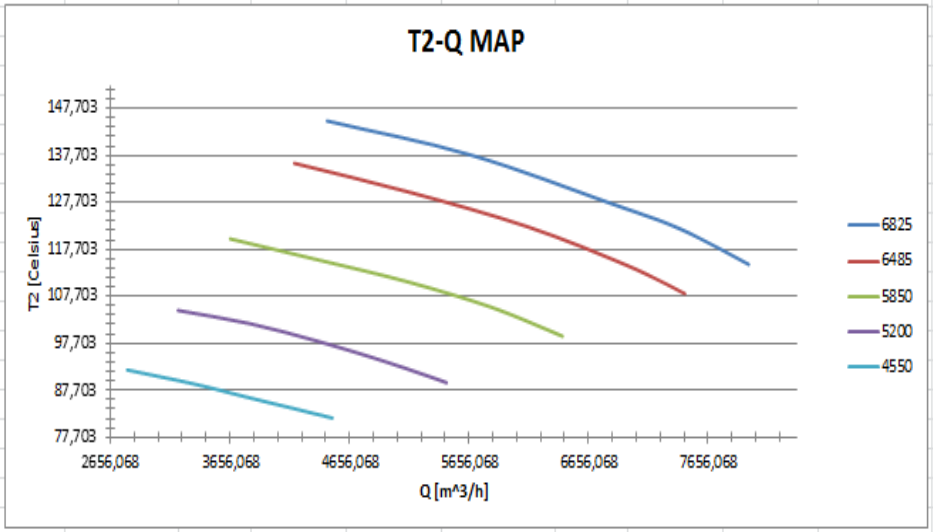
the reference inlet conditions (p1, T1, Gas mixture, Mw)

	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



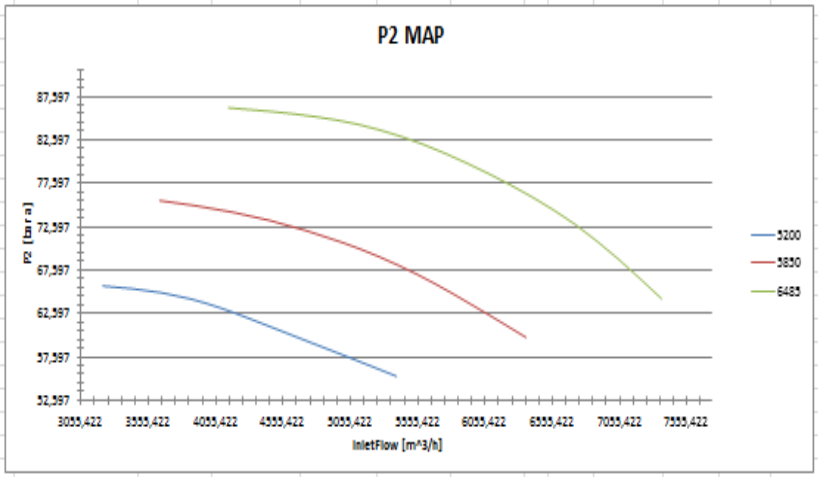


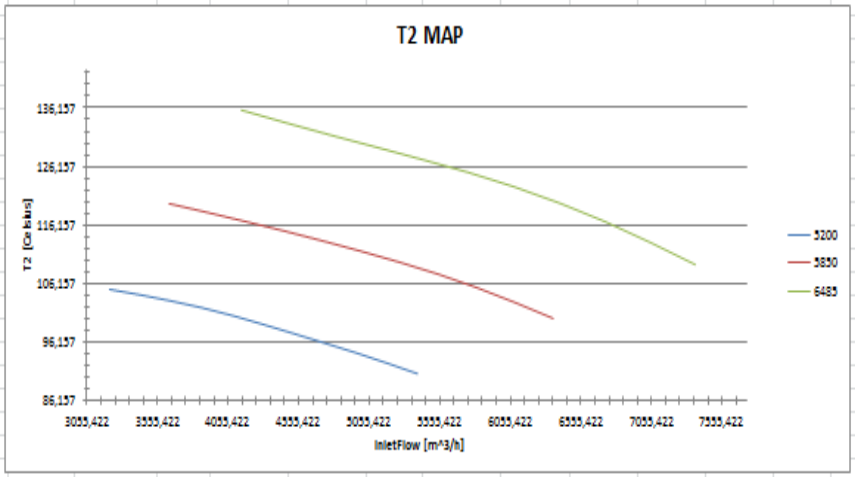
Sheet 3 "Performance condition", includes:

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





	Speed 1: 5200					
N°	nletFlow [m^3/h	P2 [bar a	T2 [Celsius	Hp [kJ/kg	ΞtaP [0-1	Pw [kW]
1	3216,233652	65,766582	105,1252641	79,521804	0,7165349	2821,9089
2	3434,442931	65,456296	104,1791684	78,713391	0,7241576	2950,6862
3	3652,65221	64,995222	103,1558427	77,563315	0,7294286	3070,8416
4	3870,86149	64,270555	101,9866939	75,806931	0,7304734	3175,9741
5	4089,070769	63,239391	100,6241003	73,324541	0,7263294	3263,3961
6	4307,280048	61,992063	99,10975803	70,303834	0,7180929	3333,8649
7	4525,489328	60,67802	97,53037877	67,074098	0,7078237	3390,1333
8	4743,698607	59,353438	95,92544635	63,766445	0,6963053	3434,7577
9	4961,907886	58,032787	94,28142359	60,4083	0,6839833	3465,1695
#	5180,117166	56,703684	92,52933861	56,950919	0,6712683	3472,3012
11	5398,326445	55,365714	90,69187459	53,418181	0,6584085	3462,5752

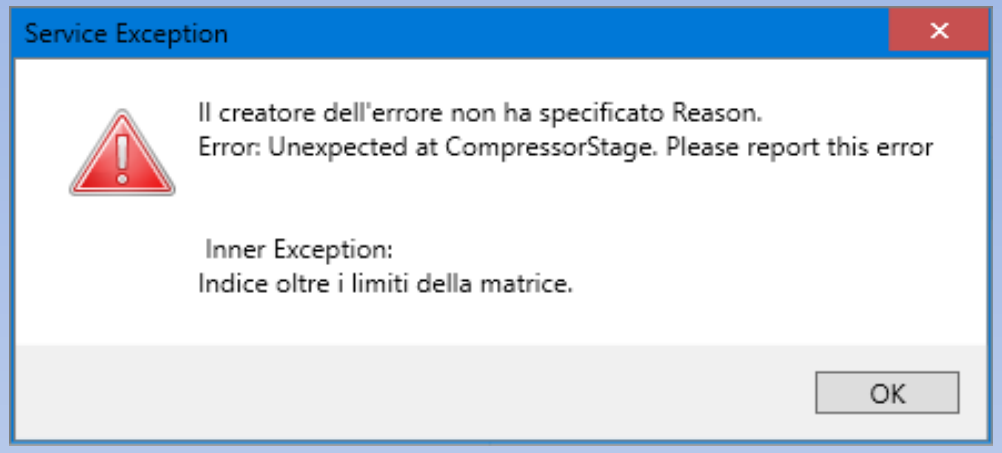
	Speed 2: 5850					
N°	nletFlow [m^3/h	P2 [bar a	T2 [Celsius	Hp [kJ/kg	ΞtaP [0-1	Pw [kW]
1	3638,456665	75,599451	119,7944413	101,98886	0,7104506	4129,3586
2	3910,559635	74,992612	118,2619171	100,54494	0,7192281	4320,5564
3	4182,662606	74,258416	116,7078596	98,844176	0,7262692	4500,7972

Results																				
N°	Mode	Q1 Meas	Q1 Exp	ΔQ1%	P2 Meas	P2 Exp	ΔP2%	T2 Meas	T2 Exp	ΔT2 %	Hp Meas	Hp Exp	ΔHp %	ΞtaP Meas	ΞtaP Exp	ΔΞtaP %	Pw Meas	Pw Exp	ΔPw %	
1	Q1	5600 m^3/h			65 bar a	66.71 bar a	2,56	107 Celsius	107.28 Celsius	0,26	78101.22 J/kg	81872.61 J/kg	4,61	0,67	0,706	5,01	5136.37 kW		Mecha	

General Data | Reference Condition | Performance Condition

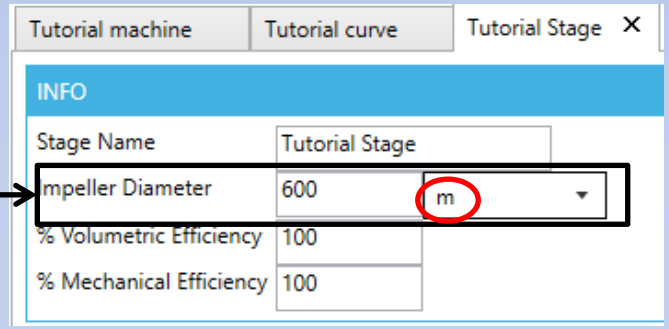
11. FAQ & TROUBLESHOOTING

a) **Service exception 1:** if you find these Warning Message

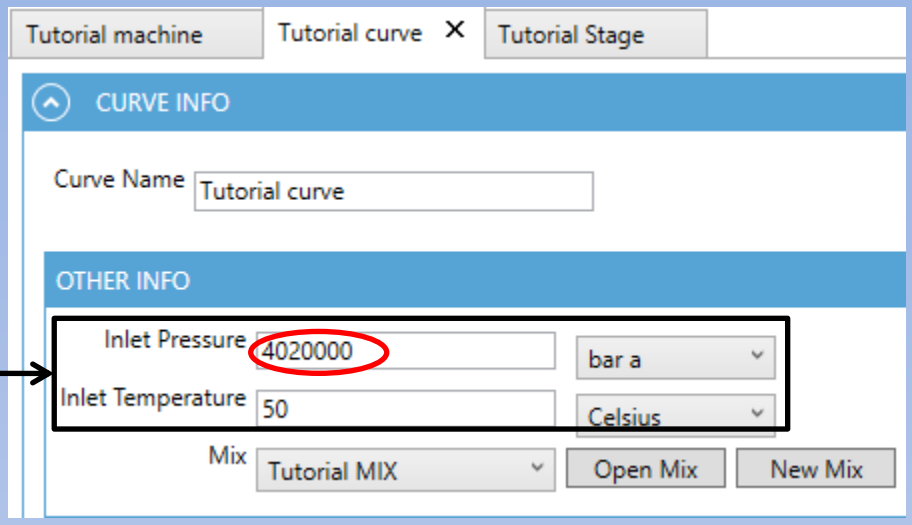


Causes: invalid value for

I_d in Stage Tab



P_1 or T_1 in Curve Tab

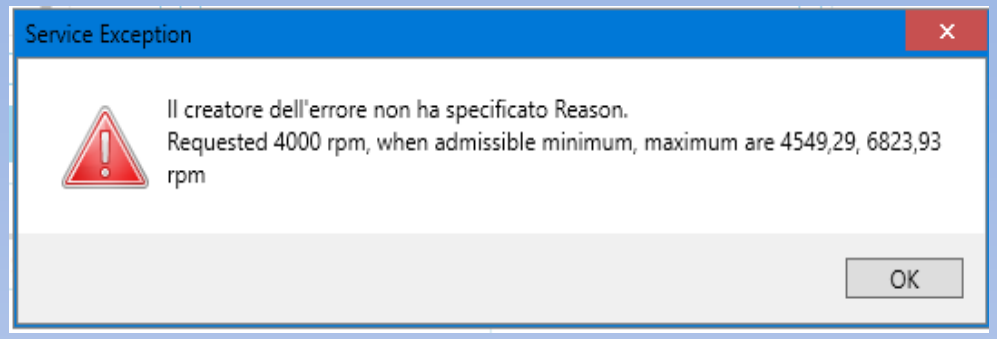




P_1 or T_1 in Performance setup

Solution: verify both values and units for these fields

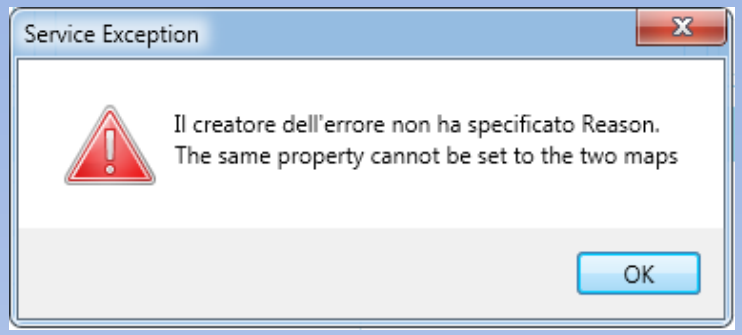
b) Service exception 2: if you find this Warning Message



Causes: requested speed number is out of allowable range

Solution: enter valid speed number ($N_{min} < N < N_{max}$)

c) **Service exception 3:** if you find this Warning Message



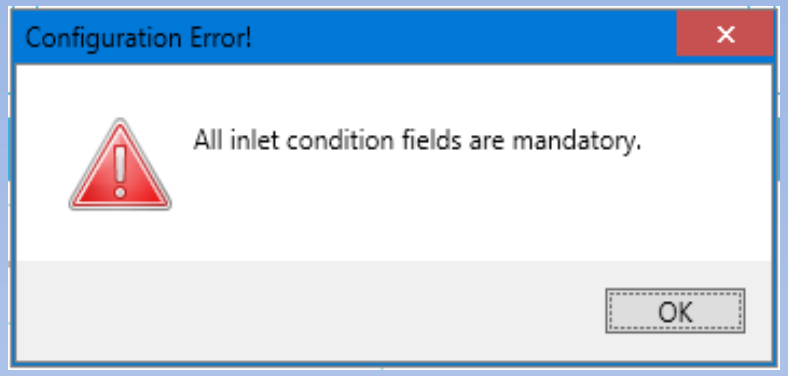
Causes: the maps have been defined through the same performance

Uploaded maps are equal



Solution: come back to digitization and modify the axis settings

d) **Configuration error 1**: if you find this Warning Message

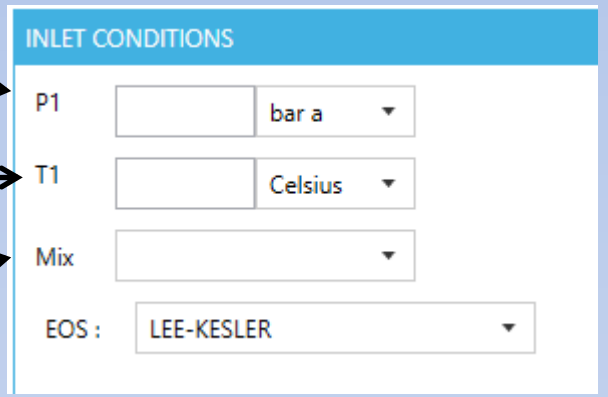


Causes: one or more data are missing

p_1 field not yet filled

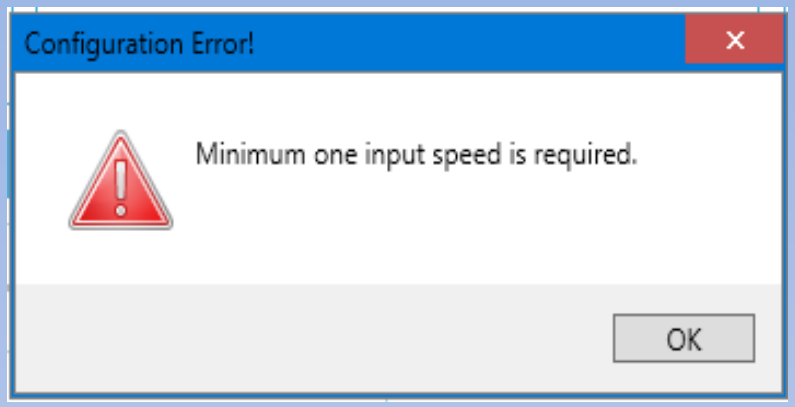
T_1 field not yet filled

No Mix has been selected

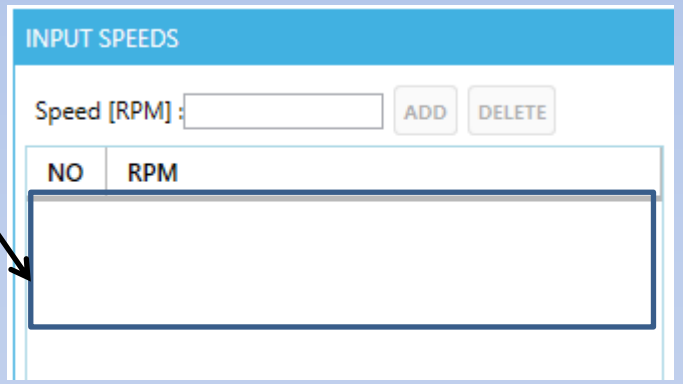


Solution: enter all the mandatory fields

e) **Configuraton error 2:** if you find this Warning Message



Cause: no speed has been entered



Solution: enter at least one speed number

http://www.compressormap.com

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