# CMap FAQ

**What is CMap?**
CMap is a specialty software designed to predict and analyse performance of centrifugal compressors used in energy/Oil&Gas/Chemical Petrochemical process plants.
CMap 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 (LK/PR/R134a/GERG2008)

**Which are possible applications of CMap?**
Possible applications of the software are:

- Centrifugal compressor Performance analysis
- Efficiency deviation trends (machine performance-based monitoring systems)
- Support to Maintenance schedule
- Advanced anti-surge control systems, Anti-surge valves checks
- Compressor Inspections, Investigations and RCAs
- Compression plant optimization
- Compressor Analyses for zero-flaring
- Support compressor selection
- Support compressor sales/purchase
- Support compression plant engineering
- Support compression plant revamping/debottlenecking

**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 and off design performance predictions.

**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

**How many performance maps I need to configure a compressor in CMap?**
Variable speed compressors configuration requires two performance maps with a minimum of 3 speeds for each map.
User can choose almost freely which maps to use for configuration. Once the data input is complete, CMap automatically selects a calculation algorithm suitable for configuration with received inputs.
In fact, CMap allows to users to configure a compressor using various combinations of performance parameters; this to offer the user maximum flexibility in the configuration process and to allow making the most from the available data. However, user should consider that the "character" of the compressor remains determined by a single pair of parameters used for configuration.

**How to configure single speed compressors in CMap?**
The actual CMap release has not yet embedded a procedure for graphical/numerical digitization of single speed compressor performance. In case single speed compressor configuration can be requested as on-call service to CMap support team. For possible inquiry please see the reference contact point at How to contact CMap assistance team.

**I configured a compressor two times with different map pairs and I obtain different results. How can I explain this?**
If the results of the simulations based on different configurations are distant, it must be concluded that the different configurations used are not equivalent for the purpose of describing the behaviour of the compressor in the CMap.
CMap ensures complete coherence of the results which can always be verified with the following procedure: a configuration (A) is performed, from this the curves of the remaining performance parameters (BA) are generated. Through these we proceed to a new configuration (B), from which we obtain the remaining performance parameters (AB); the curves of all performance parameters will be perfectly superimposed (barring digitization errors), with (A)= (AB).
A further check that can be done consists in using a configuration (Arif) to generate the curves (Bcalc) with CMap and check the difference with the relative reference curves (Brif).
Normally the curves (Bcalc) generated by CMap superimpose very well on the reference ones (Brif).

**I configured a compressor using a pair of maps from reference performance data. Using this configuration, I predicted other performance parameters. Predicted performance are different from reference ones. How can I explain this?**

Accuracy of CMap numerical algorithms is very high and in majority of cases CMap perfectly fits OEM predictions and reference data. CMap calculation accuracy derives from the high precision numerical algorithm used to solve the gas model (thermodynamic properties trough the selected EOS) and the machine aerodynamic model. Gas and machine equation solution are coupled, and overall performance depends on the change of every single gas mix component and are and on changes in input conditions. If some deviation from reference data is observed, normally these can be explained with the following possibilities:

1. different EOS used by OEM and CMap
2. different gas mix
3. errors in the digitization process: the numerical precision of the calculation procedure depends on the pairs of parameters used in the configuration. Based on the combination of maps entered during the configuration phase, the software selects a different calculation algorithm suitable for processing the parameters provided; however, the various algorithms have a different degree of precision, for this reason in some cases the software may warn of a possible loss of precision.
4. any errors or inaccuracies in the reference data
5. difference in the precision of the calculation algorithms: in CMap the degree of precision of the calculations is very high being based on the numerical calculation of the properties of the gases and of the performances of the compressors. In CMap the variation of each individual gas component is reflected on the thermodynamic properties of the gas. Sometimes reference/OEM performance is predicted by considering only the molecular weight of the gas.

**Which are suggestions for an optimal compressor configuration?**

For an optimal compressor configuration, we suggest the following:

-where possible, to use the following combinations of parameters:

Preferred configuration 1):
MapI: P2-Q + MapII: T2-Q
Preferred configuration 2)
MapI: Hp-Q + MapII: Etap-Q

- Check for any inconsistencies in the reference data: Errors in the inputs are transferred directly to the outputs.
- Perform an accurate digitization, using the zoom available in CMap in the graphic digitization window.
- Preferably use the same EOS indicated in the docs. of reference.

**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 compressors may I configure in CMap?**

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

**Is it possible to use isentropic data in CMap compressor configuration process?**

The actual CMap release has not an embedded isentropic to polytropic data converter, but customer with assistance contract active may request an add-on which allows the isentropic to polytropic data conversion.

**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?**
1-Configuration of additional gas:
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.

**How to contact the CMap assistance team?**

For technical support please send an email to the following address
cmapsupport@ipc-eng.com

For commercial request please send an email to the following address
Massimiliano.difebo@ipc-eng.com