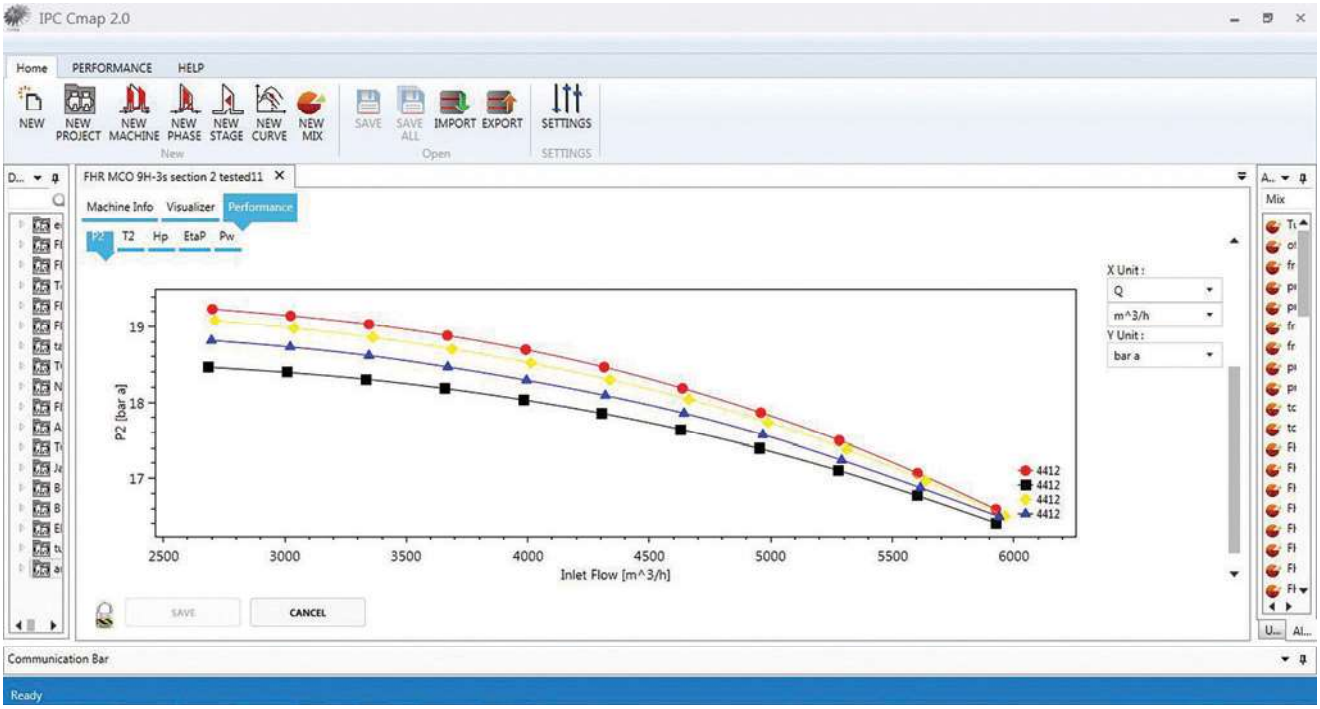



Cmap screen shot

# RAISING PERFORMANCE

## HOW GAS MIXTURES AFFECT THE PERFORMANCE OF CENTRIFUGAL COMPRESSORS

**BY MASSIMILIANO DI FEBO & PASQUALE PAGANINI**

Assuring the availability of centrifugal compressors is one of the primary tasks for maintenance teams. Quantitatively evaluating machine performance plays a key role in understanding if a compressor is working as expected. Software tools, such as Cmap, allow the user to predict compressor performance and obtain a quantitative indication of deviating parameters.

Compressor performance depends on gas composition and the operating inlet pressure and inlet temperature. Gas composition affects the way gas moves through the compressor.

Any assessment of compressor performance, therefore, requires the ability to predict pressure, temperature and gas composition. Computational models must incorporate compressor aeromechanics and compressed gas thermodynamics.

Field inlet conditions are sometimes different than the conditions given in machine specifications. An adjustment of design performance maps to actual operative conditions, then, is necessary to quantitatively assess the performance.

This approach to numerical analysis results shows how variations of individual gas mixture components effect compressor condition and can aid in performance prediction. All numerical evaluations were developed using the most recent thermodynamic theories and machine aero-mechanical models. These were done according to the prescriptions of the ASME PTC10 (Performance Test Code on Compressors and Exhausters) standard.

The starting point is the reference centrifugal compressor performance map. This can be taken from OEM datasheets or from "as tested" maps. The software combines the gas mix composition, pressure and temperature parameters with available reference performance maps to perform complex automated calculations to predict compressor performance.

That makes it possible to determine the consequence of each variation in gas components with regard to overall compressor performance. The study also looked at machine performance for gas mixes with the same molecular weight but with a different gas composition.

Four different variations of gas mixtures were considered (Figure 1). Inlet conditions were kept constant as follows:

- Gas mix MW (kg/kmole) – 42.09
- Inlet pressure (bar a) – 15.5
- Inlet temperature (°C) – 49.2

This analysis obtained the expected performance for the compressor in each of the

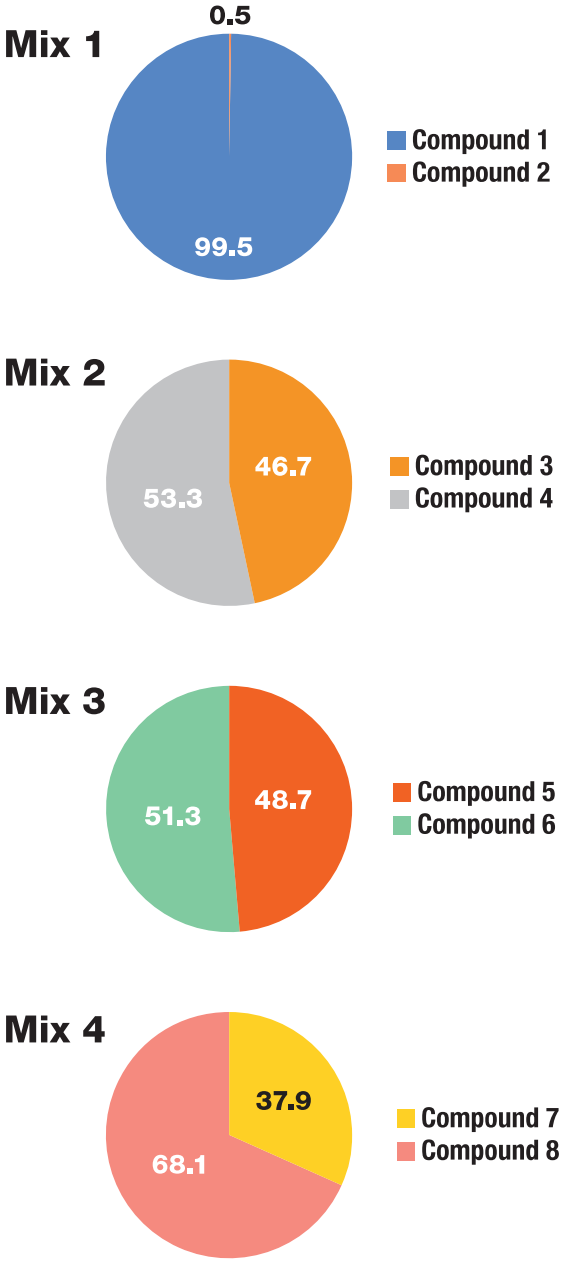



**Figure 1: Gas mixtures modelled as part of compressor performance modelling**

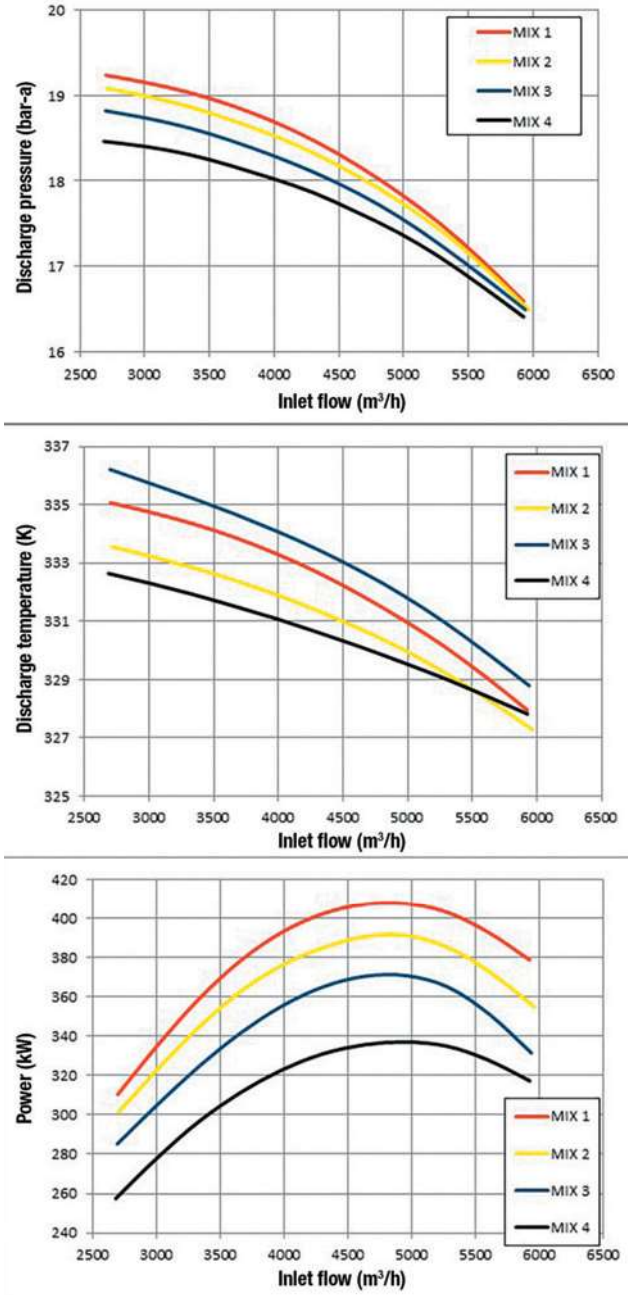



**Figure 2: Performance maps under different gas compositions**

four off-design conditions considered. Performance changes were mapped against discharge pressure, discharge temperature and power (Figure 2). These charts are also useful in noting shifts in the surge line.

It is possible using advanced computational tools, therefore, to accurately determine centrifugal compressor performance under varying inlet conditions. These performance curves aligned well with field measurements of real world equipment and conditions.

This method of predicting performance maps for a centrifugal compressor in off-design conditions, therefore, has been found to be accurate even at high pressures. It enables engineers to predict adjustments based on inlet pressure, temperatures and gas composition to implement advanced protection from surge. It also can be used for early identification of machinery trouble before other indicators, such as vibration or other mechanical parameters, appear. ■





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