

CASE STUDY: Evaluating Compressor Operating Risks

Reciprocating gas compressors usually operate across a range of suction pressures, discharge pressures, and flow rates. This operating flexibility is one of the benefits of reciprocating machinery.

Achieving this operating flexibility requires problem-free operation over the entire operating envelope. Too often this is not the case; it is common to find a compressor system that works well at a few conditions, but not at others. As outlined below, these problems are easily avoided.

Compressor Selection Using a Few Design Points

Engineers often select a compressor based on a few points. The goal is to ensure the compressor will meet the required capacity and pressures. For example, these five points were used on a recent project to size a 4500 HP compressor (Figure 1). The figure shows the 2D and 3D view of the compressor's operating map, illustrates the range of suction and discharge pressures, and the required loads steps (3D view, vertical axis).

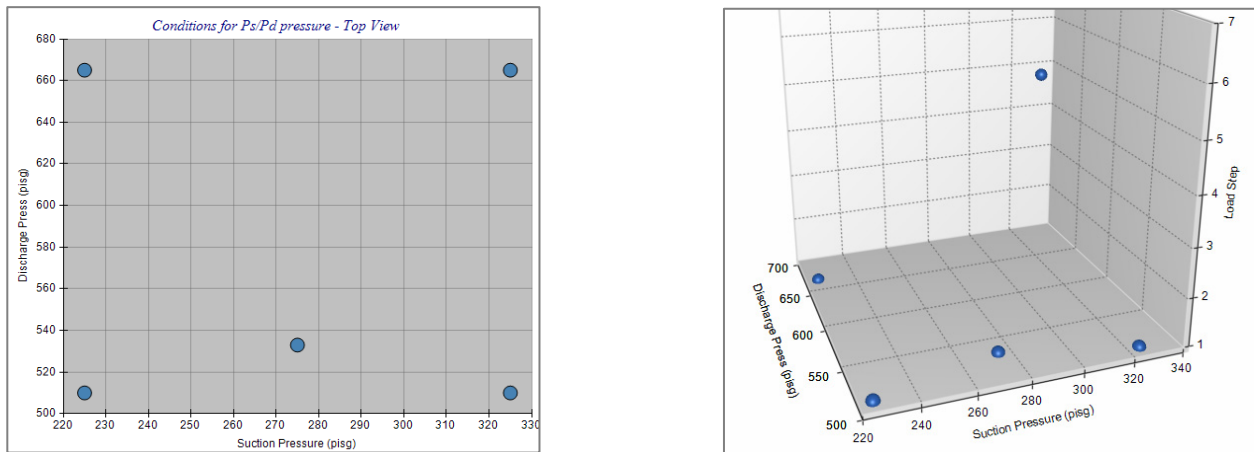


Figure 1: Operating Map (suction vs. discharge pressure vs. load step). Left, 2D View, Right, 3D View

Vibration Varies Across the Operating Map

Traditionally, these few design points are used to analyze pulsation and vibration risks and provide a vibration solution including pulsation control. Figure 2a shows these five points. The green circle indicates that pulsation forces have been reduced below the API 618 guideline.

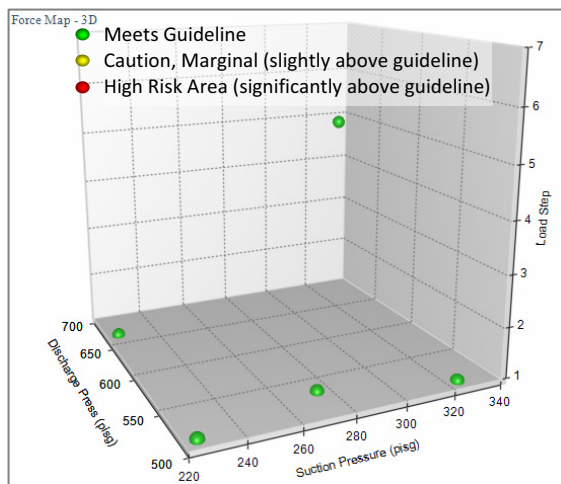


Figure 2a: Pulsation Force Map for 5 Points

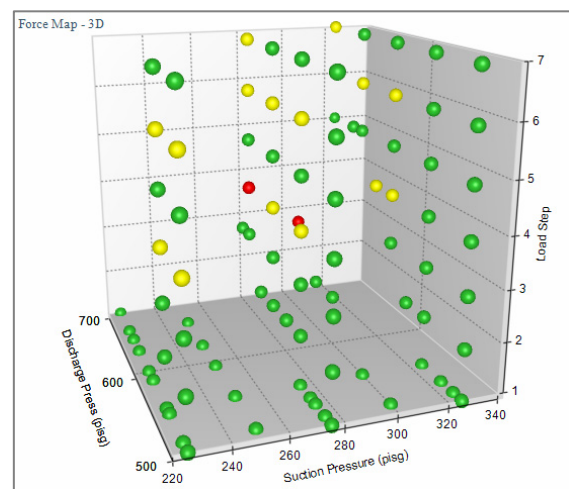


Figure 2b: Pulsation Force Map over the Entire Operating Range

The problem is that at other operating conditions, vibration problems may occur. For this project, Beta Machinery Analysis (BETA) evaluated 100 conditions across the operating map. Figure 2b illustrates the pulsation forces – and as you can see, there are many conditions where pulsation forces are marginally above guideline (yellow), or significantly above guideline (red). By evaluating the overall map, BETA is able to design a more reliable vibration solution for their customers.

The key point is that the vibration risk varies widely across the compressor operating map. Therefore, a vibration study should not be limited to only the few points used to size the compressor.

BETA DataMiner Toolkit - A New Approach to Evaluating Operational Risks

Evaluating the complex vibration information can be a daunting task. For a typical report, there can be over 300 pages of plots to document the pulsations and other operational data across the piping system, when you consider the frequency range, compressor speed, and operating parameters.

Many consultants will only evaluate a few conditions to avoid the complexities associated with a thorough analysis.

BETA has developed a proprietary modelling toolkit called DataMiner. This allows BETA to easily (and cost effectively) evaluate the overall operating map – from 20 to 1000 operating conditions. This evaluation is now popular with complex compressor installations including gas storage, pipeline, and other situations which require a wide range of operation (Figure 3).

DataMiner can produce a wide variety of 2D and 3D plots illustrating how these variables change over the operating map: Some examples include:

- Pressure Pulsation Map
- Pulsation Force Map
- Cylinder Gas Force Map
- Performance Map (capacity, load, etc.).
- Pressure Drop Map

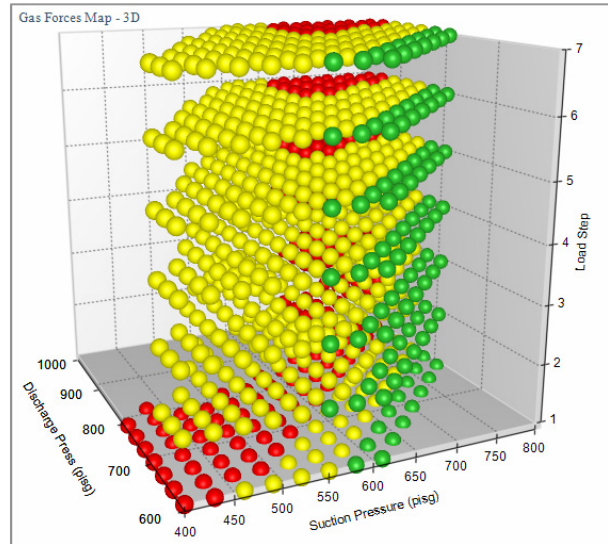


Figure 3: Cylinder Gas Force Map. Over 800 conditions assessed for this existing compressor installation. BETA's Force Map is a valuable tool for identifying excitation forces and resolving vibration problems.

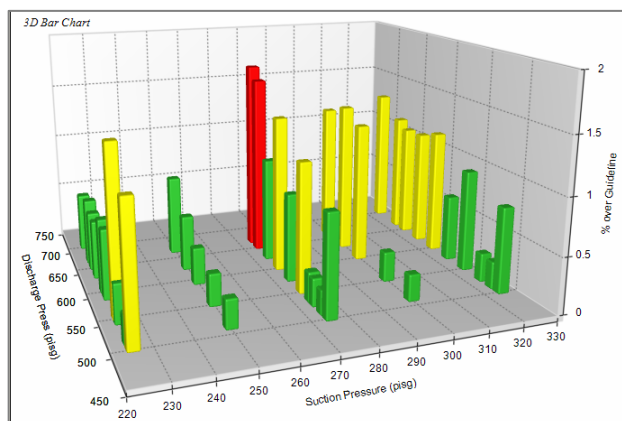
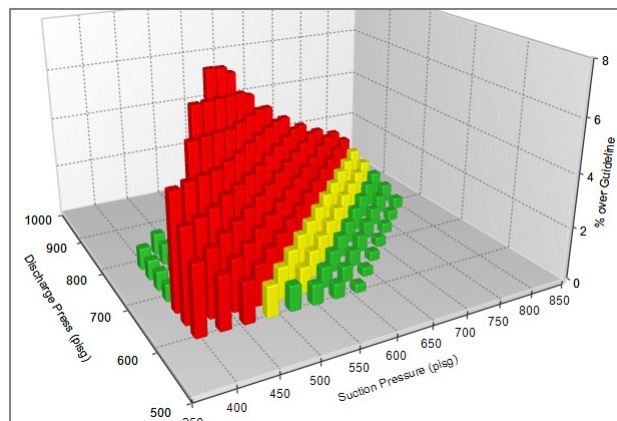


Figure 4: Examples of other DataMiner plots used by customers to assess their compressors.

Contact BETA for your next project, info@betamachinery.com.