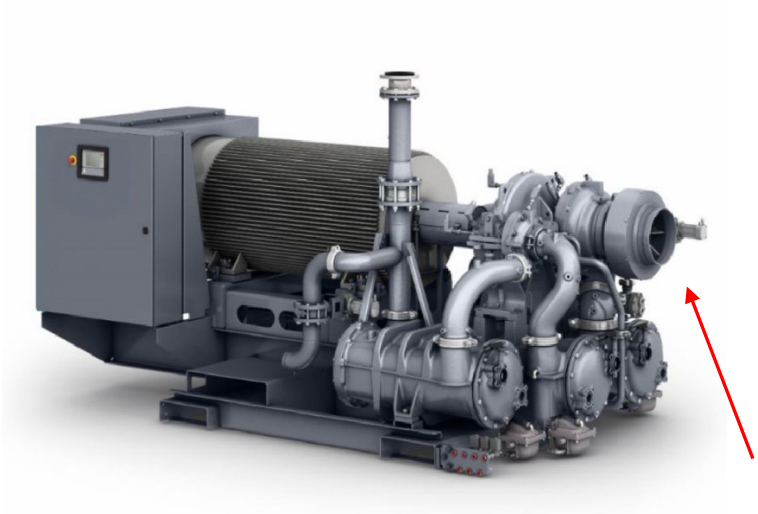
Demystifying the Myths of Centrifugal Compressors

Centrifugal compressors are used in many industries to provide clean, dry compressed air for various applications. Despite their wide use and general reliability, there are several myths and misconceptions about centrifugal compressors that have persisted over the years. In this article, we will demystify some of the most common myths about centrifugal compressors. Specifically, we explain how centrifugal compressors can handle varying air demands, we debunk the belief that surge causes failures, and we remove the stigma that centrifugal technology is just too complicated. This article provides you with the facts to help you make informed decisions about using centrifugal compressors.

Myth #1: Centrifugal compressors cannot handle varying capacity loads.

A common myth about centrifugal compressors is that they are not suitable for systems that have a fluctuating demand. Positive displacement compressors often use variable speed drives (VSDs) to adjust the speed of the compressor to deliver a variable flow to match the changing demand. VSDs are not typically applied with dynamic (centrifugal) compressors. Rather, modern centrifugal compressors are designed with advanced control systems that enable them to handle varying capacity loads and fluctuating system demand. Most centrifugal compressors use inlet guide vanes (IGV) to efficiently throttle the flow rate of the air entering the first stage of the compressor.



Inlet guide vanes on first stage inlet

By adjusting the position of the guide vanes, the compressor can maintain optimal efficiency at different flow rates. To provide additional control of the flow and pressure delivered to the system, there is typically a by-pass or unloading valve.

To optimize these control systems, newer centrifugal compressors are also equipped with microprocessor controllers that utilize advanced algorithms that enable the compressor to adapt to changes in system demand in real-time. These algorithms may use a variety of data inputs, including process variables, temperature, and pressure, to optimize compressor performance and meet the needs of the system.

By using these sophisticated control systems, centrifugal compressors provide an effective turndown range that can effectively handle the fluctuating demands of many industrial processes, making them a reliable and versatile option for many applications.

Myth #2: Surges cause failures in centrifugal compressors.

The performance of a centrifugal compressor follows a curve where flow and pressure are inversely related. Whenever the discharge pressure exceeds the pressure on the performance curve for any given flow, the flow through the compressor will stall and or reverse . . . resulting in surge. Surge presents as a loud noise, which can be alarming, but the main surge concerns are vibration, due to the turbulence created internally by the flow reversal, and a temperature rise through the machine, which can be significant. Occasional surge events, while not ideal, are not harmful to the compressor as this robust equipment is designed to handle such events without damage. However, frequent, prolonged surge events can be detrimental to the long-term reliability of a unit, as well as reducing its efficiency and increasing energy consumption.

The causes of surge are several: operating the compressor at a pressure higher than it can make for a given flow, too high inlet air temperature, too high cooling water temperature, attempting to throttle the machine too much, or any combination of the above. Realizing the many variables that can precipitate a surge condition, manufacturers have designed their compressors to include sophisticated controls that handle and or avoid surge.

Advanced microprocessor controls minimize surge events

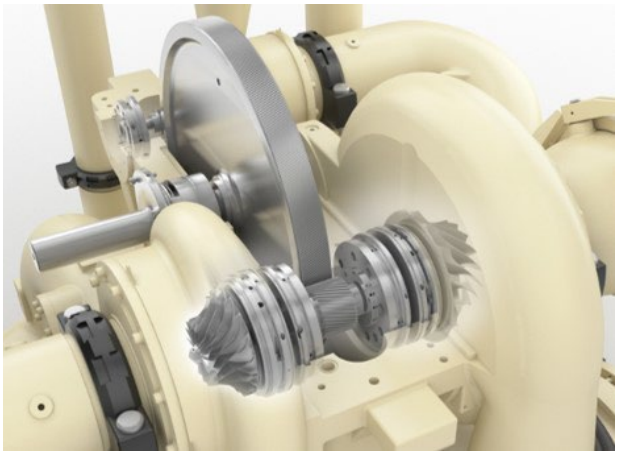
One of the biggest causes for surge is operating a centrifugal compressor in a system where the compressor is grossly oversized, and it operates deeply throttled. The more it is throttled, the closer the compressor gets to its surge point. A properly sized compressor and a controlled air system are the most important factors in mitigating any potential conditions that might precipitate surge. The best way to

assure that centrifugal compressor selection and sizing decisions are based upon real data is to have a trained compressor specialist perform an air audit and full system assessment prior to equipment purchase. Armed with this data, operators can select a properly sized centrifugal compressor that is equipped with advanced control systems that monitor the operating conditions of the compressor and adjust its performance to prevent surge from occurring.

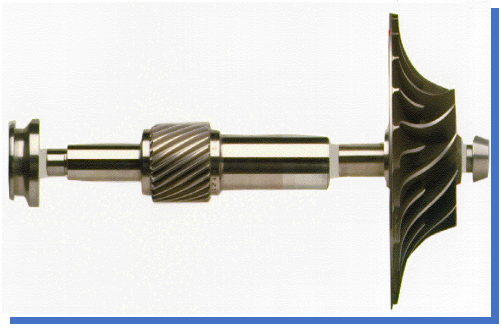
Performance adjustments are accomplished by changing the airflow into the first stage of the compressor through the use of inlet guide vanes. Blow-off or unloading valves function to alleviate surge whenever system demand is below the turndown range of the inlet guide vanes. These control systems use algorithms that take into account a variety of factors, including inlet flow, discharge pressure, temperature, and system demand, to make real-time compressor adjustments that maintain stable compressor operation and prevent conditions that allow surge to occur.

Myth #3: Centrifugal compressors are complicated.

While centrifugal compressors are highly engineered and robust pieces of equipment, they are not overly complicated. By design, centrifugal compressors have very few moving parts compared to other compressor technologies. The key centrifugal components consist of a large drive gear, commonly referred to as a Bull Gear, that powers the bearing mounted rotor assemblies for each stage. The rotor assemblies include the impellers that generate the required flow and pressure.

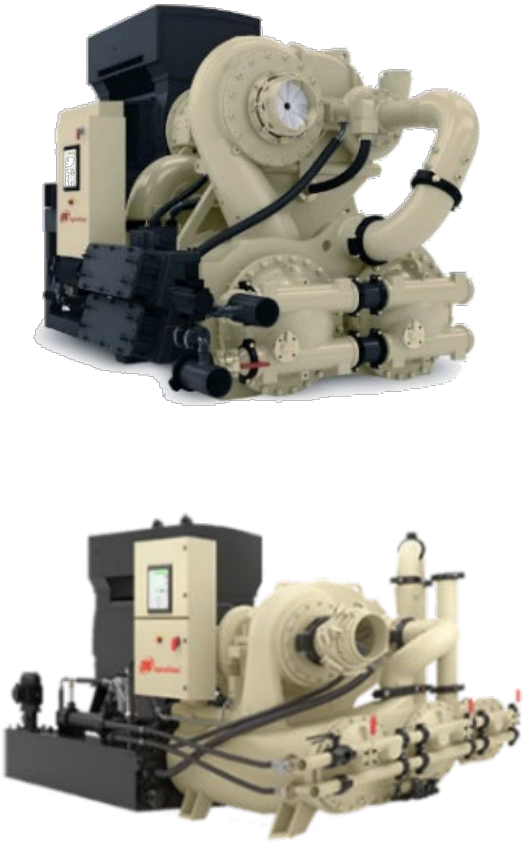


Bull gear driving first stage rotor assembly



Rotor assembly: thrust collar, pinion gear and shaft, impeller

Centrifugal components are typically easily disassembled and reassembled for maintenance and repair. With the proper equipment and training, maintenance personnel will find that maintaining and operating centrifugal compressors can be extremely simple. Additionally, centrifugal compressors are designed with user-friendly, microprocessor interfaces that allow operators to easily monitor and control the compressor.



Three stage centrifugal air compressor

In conclusion, centrifugal compressors are versatile and reliable machines that can handle a wide range of applications. Despite common myths about the inability to handle varying capacity loads, surge events, and being complicated, centrifugal compressors are a great option for many compressed air systems. By understanding the capabilities and limitations of centrifugal compressors, users can select the right centrifugal compressor for their system and realize some of the lowest cost of ownership to produce compressed air for their application.

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