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Rapid Engineering of Turboexpanders

An essential component of an air separation plant, which separates process fluids into pure gases or pure liquids in order to make them commercially available to the end user, is the turboexpander. The turboexpander consists of rotating assembly with expander and brake (usually compressor) located on two ends of a rotating shaft, housings, flanges, skid, subsystems to deliver seal gas and oil into the vicinity of the rotating assembly, interfaces with plant cold boxes, and junction outlets to interface with customer utilities. The rotating assembly, together with its surrounding stationary housings, is called the cartridge as shown in Figure 1.

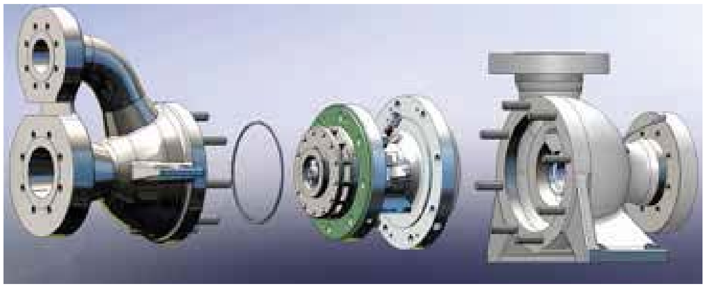

Figure 1

Industrial gas producers have changing thermal process conditions and varying plant output capacity. Therefore, suppliers of expanders are expected to satisfy needs which include low cost, high performance, high reliability, continuous operation over long periods of time, simplicity of installation, and ease of replacement and maintenance in order not to interrupt plant production.

The customer has full control over turboexpander function and output capacity because, due to electronic communication channels between plant and machine, the turboexpander function self-adjusts to match plant cold production needs. Also, because plant continuous operation is essential, ease of assembly and disassembly is required and, therefore, the cartridge is designed as an integrated unit separate from the expander and compressor housings. This allows for simple and fast cartridge replacement and/or repair, without hindering the entire plant cold production capacity for long.

ACD has, over the past 50 years, placed in operation over 1000 turboexpanders utilizing:

1. Many standard components such as inlet and outlet flanges, shafts, bearings, and expander variable-area vaned-nozzles;
2. Differentiated frame sizes in order to match customer process conditions; and
3. Aerodynamic design parameters to optimize cartridge function, reliability, and performance.

The rotating assembly is engineered using in-house test performance data, and achieving high expander and compressor efficiencies is critical. Typical expander efficiencies are in the 85% to 90% range, and typical compressor efficiencies are in the 75% to 85% range.

ACD developed proprietary computer code which selects, from among the nearly 1000 production units, the most suitable frame size. Figure 2 shows ACD's frame size series chart for compressor-loaded expanders which, depending on the process conditions (at design and off-design operating conditions), yield

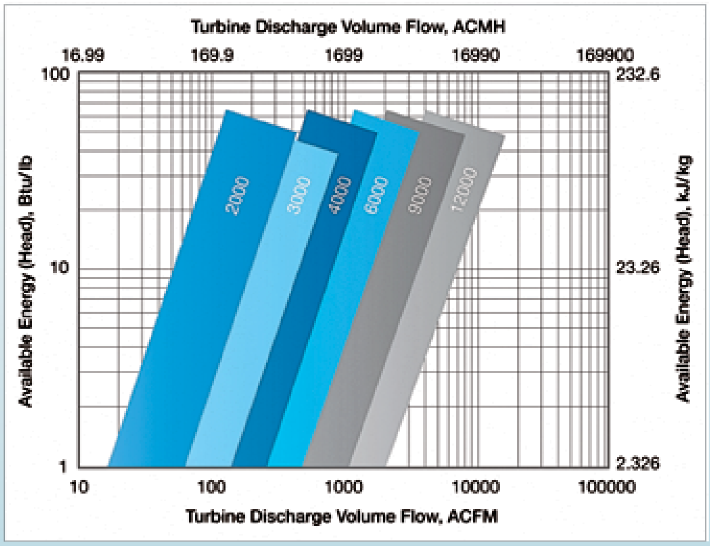

Figure 2

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the most suitable frame size, ranging from small low-power 2000-frame to large high-power 12000-frame. Benefits of the code, which utilizes actual cryogenic test database, include:

1. High-speed simulation;
2. Determines optimum configuration;
3. Accurate performance prediction with less than 1% error;
4. Predicts future replacement cartridge performance for potential increase in cold production; and
5. Guarantees aerodynamic, thermal, and structural parameters are within acceptable ranges.

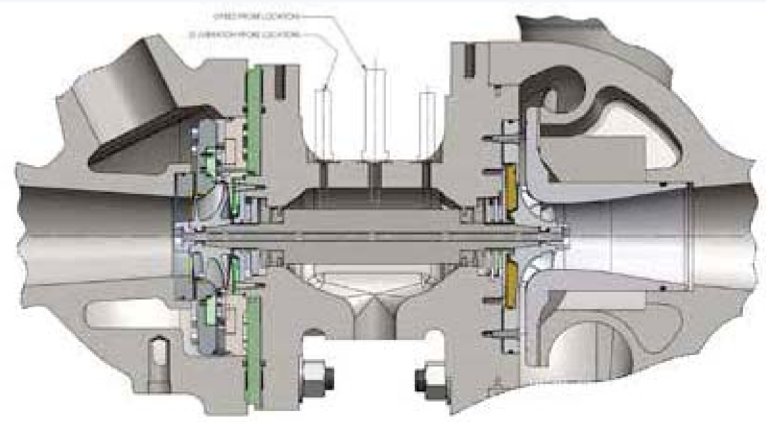

Figure 3

After the initial sizing; detailed analysis of aerodynamics, stress, vibrations, rotor dynamics, heat transfer, material selection, thrust, bearings, seal gas flows, and computational fluid dynamics (CFD) are performed. Figure 3 shows 3-D model of a turboexpander cartridge.

During operation oil is continuously supplied (and subsequently cooled) in order to cool the bearings. ACD utilizes the most common-and-reliable bearings type, the tilt pad journal-and-thrust hydrodynamic bearings which can withstand up to 500 psi load capacity. The oil flow pathways are separate from process gas and seal gas flow pathways. At no time during operation would the oil mix with the process gas on either the expander or the compressor side. This is achieved by utilizing a complex pressure-driven seal gas flow structure.

Over the past 50 years, in order to be able to select an optimum expander configuration, ACD had developed precise relationships between expander cryogenic test performance and fundamental design parameters such as the specific speed, as shown in Figure 4.

In summary; ACD produces high-performance turboexpanders at low cost and rapid delivery, by utilizing:

(a) As many standard components as possible;

(b) Production cartridge designs with excellent performance;

(c) Bearings, shafts, and seal gas subsystems with proven performance and reliability;

(d) Cryogenic test performance database;

(e) Proprietary computer code for process conditions simulation; and

(f) Designs which allow for ease of repair, replacement, and integration into air separation plant.

For more information, visit acdcom.com.

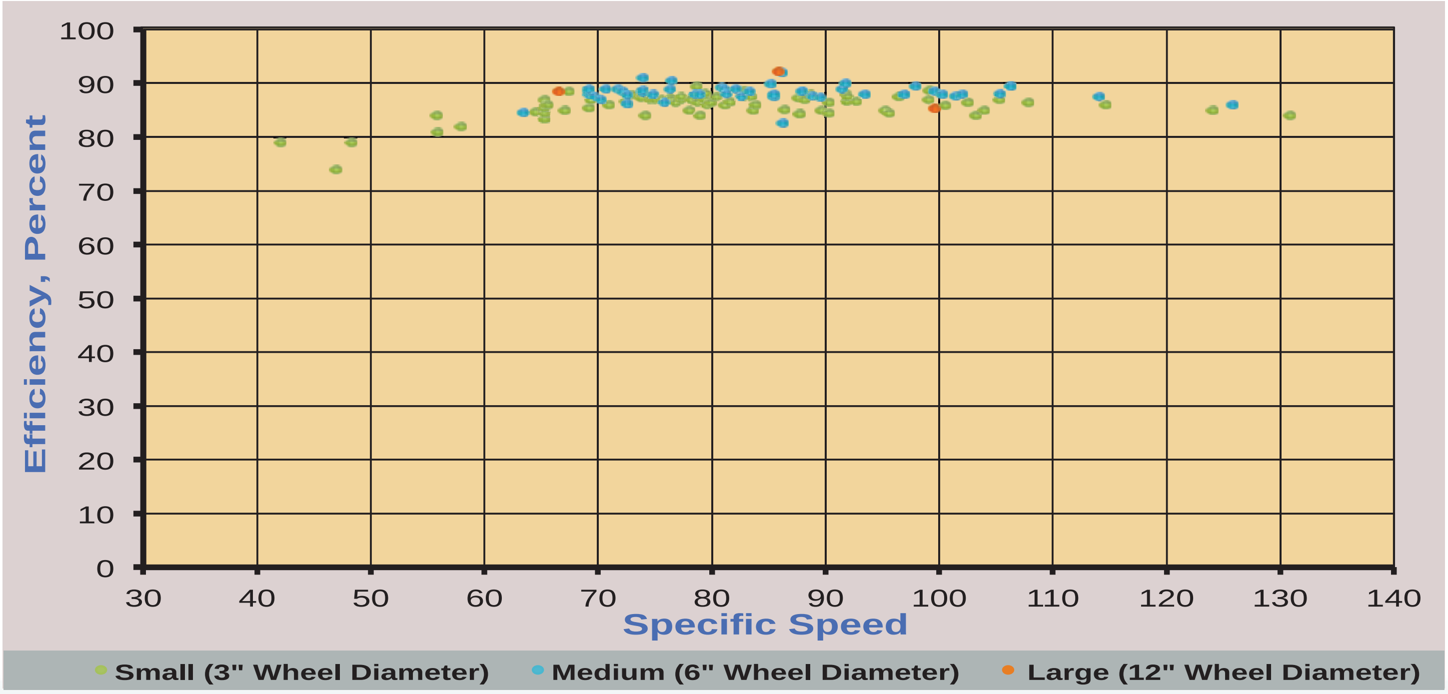

Figure 4