

from full capacity down to 40 percent of flow. Below that, the compressor operates in load/unload mode or by modulating the inlet valve as previously described (Figure 4, pg. 60).

Variable speed drive control

A variable speed drive controls compressor speed to match output with demand. As system pressure rises above the set point, the drive reduces compressor speed by changing the frequency supplied to the motor. The efficiency loss across the drive is typically between two to four percent.

Compressor displacement is directly proportional to speed. By controlling displacement via speed and not restricting inlet flow, the compression ratio remains constant. This results in relatively good part-load efficiencies.

Rotary screw air-end compressor efficiency is a function of rotor tip speed. Operating the rotor at any tip speed other than the designed optimum speed increases specific power (kW/100 cfm) and reduces overall compressor efficiency. Adjusting compressor rpm and, therefore, rotor tip speed to match system demand results in less than optimum operating efficiency at most load settings.

When running fully loaded, most VSD factory packages operate the air-end above optimum rotor tip speeds. This allows the air-end to operate at a more efficient rotor tip speed at part load; however, less than maximum air-end efficiency is realized at full load.

Typically, VSD-controlled rotary screw compressors improve efficiency at reduced flows. The best energy savings come from applications in which most system demand is in the low- to mid-capacity range. VSD typically can regulate compressor output down to 40 percent of full load—and in some cases, as low as 20 percent. When operating below the VSD range, capacity is controlled in either the load/unload or start/stop modes (Figure 5).

Multiple compressor systems

When operating a facility with multiple compressors, an efficient overall control scheme should focus on three items:

- Shut off unneeded compressors.
- Delay bringing additional compressors on line until absolutely needed.

Collaborative effort

The Compressed Air Challenge (CAC), a non-profit corporation, began in 1997 as a collaboration of public, non-profit and private organizations dedicated to increasing the understanding and improving the efficiency of compressed air systems within the U.S. industry.

The purpose of the CAC is to provide a solutions-neutral environment for educating both suppliers and users of industrial compressed air systems on the benefits of taking a "systems approach."

The CAC has developed two levels of training for plant engineers: "Fundamentals of Compressed Air Systems" and "Advanced Management of Compressed Air Systems." Other educational products include publications, such as the Sourcebook. Other materials are under development. For more information, call 800-862-2086 or visit www.knowpressure.org.

