Pollution Engineering

Comparing Compressor Efficiency

What you need to know to get the most for your money

By Harold Wagner

Compressed performance and overall efficiency is critical to every end user, and can be influenced by many factors. An increased focus on compressed air as a fourth utility has helped raise awareness industry-wide, and has provided excellent information on everything from installation basics and design to state-of-the-art, self-monitoring systems. Few can dispute the benefits of a comprehensive audit, correctly applied controls, leak repair and routine maintenance. However, the compressor itself is the heart of any system. When upgrading or designing a new system, end users should start with the core component by selecting the right compressor for the application. air system

Model ASD 30 screw air compressors are shown here.

Rotary screw compressors are the choice for many end users in a variety of applications. While many associate these compressors with heavy manufacturing, these quiet, energy-efficient compressors are also ideal for light industrial and laboratory use. But even within this category of air compressor, there are choices in technology and function.

CAGI data sheets for reliable performance comparison

Short of putting two units side-by-side to measure kW input and CFM output, the best way to compare performance is to use the compressors' CAGI data sheets. The Compressed Air and Gas Institute (CAGI), is a non-profit organization of competitive companies that manufacture air and gas compressors and related equipment. The institute seeks to educate end users and provide helpful, hands-on tools and techniques to improve compressed air system knowledge and best practices.

CAGI member companies have implemented standards that measure compressors and their productivity based on a standard testing procedure and reporting criteria. End users can view comparisons between like systems with rated performance based on CAGI/PNEUROP standards. The following sample CAGI data sheet and line-by-line explanation details how to compare units when making a buying decision.

Line-by-line explanation

Line 1: Name of the manufacturer

Line 2: General description of compressor type

Air-cooled – Data should include power

KAESER COMPRESSORS

COMPRESSOR DATA SHEET

Rotary Screw Compressor

MODEL DATA - FOR COMPRESSED AIR			
1	Manufacturer: **Kaeser Compressors, Inc.**	Date: **6/6/2005**	
2	Model Number: **ASD 25 - 125 psig** [**X**] Air-cooled [ ] Water-cooled [**X**] Oil-injected [ ] Oil-free	# of Stages: **1** VALUE	UNIT
3	Rated Capacity at Full Load Operating Pressure[a,f]	**115**	acfm[a,f]
4	Full Load Operating Pressure[b]	**115**	psig[b]
5	Maximum Full Flow Operating Pressure[c]	**125**	psig[c]
6	Drive Motor Nameplate Rating	**25**	hp
7	Drive Motor Nameplate Efficiency	**91**	percent
8	Fan Motor Nameplate Rating (if applicable)	**0.75**	hp
9	Fan Motor Nameplate Efficiency	**67**	percent
10	Total Package Input Power at Zero Flow[e]	**5.6**	kW[e]
11	Total Package Power Input at Rated Capacity and Full Load Operating Pressure[d]	**22.0**	kW[d]
12	Specific Package Input Power at Rated Capacity and Full Load Operating Pressure[g]	**19.2**	kW/100 cfm[g]

NOTES:

a. Measured at the discharge terminal point of the compressor package in accordance with the CAGI/PNEUROP PN2CPTC2 Test Code (Annex C to ISO 1217); acfm is actual cubic feet per minute at inlet conditions.

b. The operating pressure at which the Capacity (item 3) and Electrical Consumption (item 10) were measured for this data sheet.

c. Maximum pressure attainable at full flow, usually the unload pressure setting for load/no load control or the maximum pressure attainable before capacity control begins. May require additional power.

d. Total package input power at other than reported operating points will vary with control strategy.

e. Tolerance is specified in the CAGI/PNEUROP PN2CPTC2 Test Code (Annex C to ISO 1217)

f., g. Tolerance is specified in the CAGI/PNEUROP PN2CPTC2 Test Code (Annex C to ISO 1217) as follows:

Member:

COMPRESSED AIR AND GAS INSTITUTE® CAGI

Volume Flow Rate at specified conditions		Volume Flow Rate[f]	Specific Energy Consumption[g]
m^3/min	ft^3/min	%	%
Below 0.5	Below 15	+/-7	+/- 8
0.5 to 1.5	15 to 50	+/- 6	+/- 7
1.5 to 15	50 to 500	+/- 5	+/- 6
Above 15	Above 500	+/- 4	+/- 5

This form was developed by the Compressed Air and Gas Institute for the use of its members.
CAGI has not independently verified the reported data.

Form Number ROT 030 Rev 4 1-05

Typical CAGI form filled out by Kaeser Commpressor Inc.

Air Compressor Selection Factors

When selecting an air compressor, the most important factors are quality and reliability. Reflected in quality and reliability are overall costs, efficiency and easy maintenance. The most cost-effective unit may not be the lowest priced. Components to evaluate in a compressor include:

Cooling systems: Coolers and fans must be sized to provide low discharge temperatures in high ambient temperatures. In air-cooled units, low noise radial fans generally provide better cooling while using less electricity than axial fans. The ability to easily duct air in and out of the compressor package can add to the compressor's overall efficiency. Topside exhaust often simplifies ducting and reduces footprint while allowing the waste heat to be recovered for other uses.

Drive systems: Drive efficiency and simplicity are important. True direct drive units – ones without gear connections – offer the best efficiency with no loss in transmission efficiency and require no maintenance. Belt drives require only simple maintenance and offer advantages such as flexibility in pressure selection. Automatic belt-tensioning devices are a must to ensure transmission efficiency and protect bearings from excess stress.

Operator interface: The control panel must be reliable, readable and run the compressor efficiently. It should indicate operational status as well as offer maintenance interval reminders, diagnostic information and external communications capability for remote monitoring and control.

Interconnecting piping: Look for rigid piping with flexible connections and high-quality fittings to eliminate leaks.

Vibration isolation: Vibrations can loosen fluid and air fittings as well as electrical connections. Some compressors mount the motor and airend on vibration isolators to eliminate this source of stress. Additional isolators under the compressor package offer another layer vibration protection, and for most rotary screw compressors, these isolators eliminate the need for special foundations.

Motor: Motor efficiency affects electrical consumption. End users should make sure that their compressor motors meet or exceed Energy Policy Act standards. TEFC motors offer much better protection from airborne dirt and dust than ODP motors.

Sound enclosures: A soundproof enclosure can reduce compressor noise emissions well below safety limits, eliminating the need for a separate compressor room. This can save thousands of dollars in site preparation costs.

required by cooling fan
Water-cooled – No cooling fan power required, but may require cabinet fan
Oil-injected – Also referred to as fluid injected or fluid cooled.
Oil-free – Yes or no
Number of stages – Single or multistage

Line 3: Rated Capacity at Full Load Operating Pressure –The air volume, in CFM, measured at the terminal point of the package, at an agreed-upon set of standard inlet conditions with the compressor operating at the rated pressure (again, measured at the terminal point of the package) stated on Line 4. This takes into account all package air losses and pressure drops.

Line 4: Full Load Operating Pressure – The pressure at the terminal point of the package where the flow and power were measured.

Line 5: Maximum Full Flow Operating Pressure –The maximum pressure at which full flow can be maintained with a given package. It is usually the unload pressure set point for load/unload controls or the pressure at which modulation or other capacity control begins for other control schemes.

Line 6: Drive Motor Nameplate Rating – A nominal horsepower rating applied by the motor manufacturer. This number is not the maximum design capability for the motor. To determine the maximum power output that can be continuously sustained for a motor, multiply the nominal horsepower rating by the service factor. Sustained loads beyond this maximum will shorten the design life of the motor.

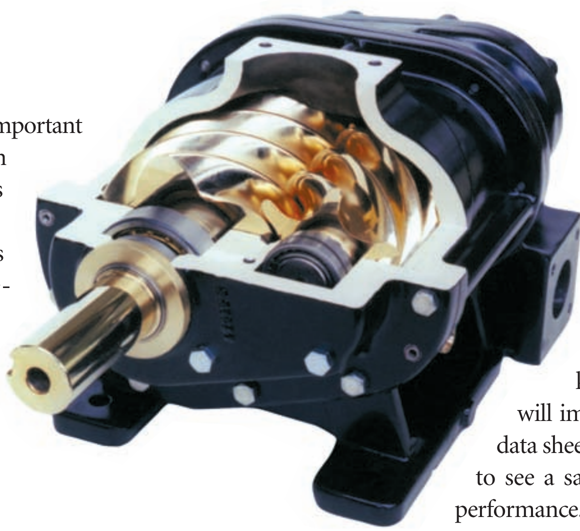
Line 7: Drive Motor Nameplate Efficiency – The efficiency of the motor at the nameplate rating.

Line 8: Fan Motor Nameplate Rating (if applicable) – A nominal horsepower rating applied by the motor manufacturer. This applies to all cooler and cabinet fans.

Line 9: Fan Motor Nameplate Efficiency (if applicable) – The efficiency of the motor at the nameplate rating.

Line 10: Total Package Power at Zero Flow – This is input power requirement, in kW, of the total compressor package when the unit is idling. This is the power that the customer will have to provide – and pay for – to operate the compressor even when there is no compressed air being produced.

Line 11: Total Package Power Input at Rated Capacity and Full Load Operating Pressure. This is the complete input power requirement, in kW, of the compressor package when the compressor is running at the rated capacity listed in Line 3 and the full load operating pressure listed in Line 4. This is the power that the customer will have to provide – and pay for – to operate the compressor package at the rated capacity and flow. It includes all efficiency, power factor and accessory losses. When comparing these numbers between manufacturers, it is important to make certain that power consumption of the remote cooler packages is included. Some manufacturers may not count remote cooling packages in this number. This may include remote-mounted air-cooled coolers and closed-loop water-cooling systems. Also, power should be measured on the supply side of remote-mounted variable frequency drive controls.



The Sigma Airend. Photograph supplied by Kaeser Compressor Inc.

Line 12: Specific Package Input Power at Rated Capacity and Full Load Operating Pressure Package Input Power is the measure of how efficiently a compressor package produces compressed air. It is the power input divided by the flow in units of 100 CFM. A 563-cfm machine that requires 91.58 kW at the rated pressure would have a specific power of 16.3 (91.58 / 5.63 = 16.3). Comparing specific power ratings allows users to determine which compressor delivers air at the lowest cost per CFM.

Getting it right from the start

Qualified air system professionals can offer experience in sizing and overall system design, but knowing what to ask for in compressor performance will improve the process. End users should ask for CAGI data sheets if they are not provided in the proposal – and ask to see a sample of competitive sheets to verify anticipated performance. This information should be offered and provided freely since most manufacturers offer the sheets on their websites. Remember that while there are many aspects to overall system efficiency, starting with an efficient compressor is key. **PE**

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