



# Packaged Compressor Efficiency Ratings



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## Compressed Air Systems Fact Sheet #8

Evaluating and comparing industrial air compressor capacities and efficiencies can be a daunting task. Standards exist for testing the performance of a compressor, but they have not always been applied in a consistent manner, and performance test results and efficiency ratings are not always published in consistent, standard formats. The result is that purchasers of air compressors can find it difficult to compare the equipment performance.

The Compressed Air and Gas Institute (CAGI), the primary compressed air industry trade association, has developed performance testing standards. CAGI, in conjunction with its European counterpart PNEUROP, has developed simplified performance testing standards which have been incorporated as addenda in International Standards Organization (ISO) Standard ISO 1217, Displacement Compressors Acceptance Tests. These Simplified Test Codes were adopted by the membership of CAGI and will be reflected in performance data published in manufacturers' literature. Some CAGI members also have ISO 9001 Certification which requires documentation of compliance with published performance and procedures.

Compressed air system users should be aware that not all manufacturers marketing compressors in the United States are members of CAGI, and some may test their compressors using different standards.

The following standards have been developed for measuring air compressor performance:

- CAGI/PNEUROP - Acceptance Test Code for Bare Displacement Air Compressors (PN2CPTC1)
- CAGI/PNEUROP - Acceptance Test Code for Electrically-Driven Packaged Displacement Air Compressors (PN2CPTC2)
- CAGI/PNEUROP - Acceptance Test Code for I.C. Engine-Driven Packaged Displacement Air Compressors (PN2CPTC3)
- American Society of Mechanical Engineers (ASME) - Power Test Code 9, Displacement Compressors, Vacuum Pumps, and Blowers
- International Standards Organization (ISO) - ISO 1217 Displacement

## Compressors Acceptance Tests [distributed in the United States by the American National Standards Institute (ANSI)]

The revised ISO 1217 with Simplified Test Codes will likely be the most commonly used standard in the future. CAGI is also currently developing Data Sheets outlining a common format and style for reporting compressor performance, including efficiency. For more information on CAGI Data Sheets, see Appendix B of this Sourcebook.

The industry norm for comparison of compressor efficiency is given in terms of bhp/100 acfm (brake horse power per actual cubic feet per minute) at a compressor discharge pressure of 100 psig. A typical single-stage lubricant-injected rotary screw compressor will have a rating of approximately 22 bhp/100 acfm (referenced to standard inlet conditions). Users need to remember that performance at site conditions will be different from test data because of differences in factors such as ambient temperature, pressure, and humidity.

Even when accurate, consistent efficiency information is available, it may only be specified for full-load operation (i.e., full capacity and specified full-load discharge pressure). Since most systems operate at part-load much of the time, it is also important to compare part-load efficiencies when evaluating the performance of different compressors. The variety of control methods can, however, make this difficult.

When gathering information on compressor performance and comparing different models, users should make sure the compressors have been tested using the same standard, at the same conditions, and that the data is being reported in a consistent manner. Some situations can lead to "apples and oranges" comparisons. For example:

- Manufacturers may test their compressors under different "standard" conditions. Standard conditions should be at 14.5 psia (1 bar); 68F (20C) and dry (0% relative humidity).
- The actual full-load power required by a typical air compressor package will exceed the nominal nameplate rating of the main drive electric motor. Such motors have a continuous service factor, usually 15%, which allows continuous operation at 15% above the nominal rating. Most manufacturers use up to two thirds of the available service factor, so that full-load power will be 10% above the nominal motor rating. It is therefore important to use the bhp rating, not the motor nameplate hp rating, when comparing efficiency ratings in hp/acfm. To include the motor efficiency and all package accessories and losses, use a rating in total kW input per acfm to provide more precise data.

- Manufacturers may use a flange-to-flange rating that does not include inlet, discharge, and other package losses. This can affect overall efficiency by 5% or more.
- Energy consumption for accessory components, such as cooling fan motors, may not be treated consistently.
- Manufacturers may apply ranges or tolerances to performance data.
- Performance is usually based on perfect intercooling, which may not be realized under actual operating conditions. Perfect intercooling requires the air inlet temperature at each stage to be the same, requiring a cooling water temperature approximately 15F below the ambient air temperature. Poor intercooling will adversely affect compressor performance.

As the revised ISO standard and CAGI Compressor Data Sheets become more commonly used, these equipment comparison problems should become less significant.