

Compressor Efficiency Definitions: Summary

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There are many different compressor efficiency definitions in use by the compressor industry, which can cause confusion when comparing compressors. For positive displacement compressors (non-dynamic), there are two major types of efficiency. One characterizes flow (mass flow or volume flow) and is called volumetric efficiency. The other characterizes power, and comes in a wide variety of forms: adiabatic, isothermal, mechanical, overall, and system, to name a few.

Vairex has adopted the following definitions to satisfy industry convention and theoretical standards. Below are brief descriptions of the volumetric efficiency, specific overall adiabatic efficiency, and system efficiency, which Vairex currently uses in specifications. For a more complete explanation of these efficiencies and their derivation, please see our more comprehensive document on the subject [[LINK](#)].

Volumetric Efficiency

$$\eta_{V,e} = \frac{\dot{m}_e}{\dot{m}_S} = \frac{(ACFM)_e}{\dot{V}_S}$$

Here and throughout, \dot{m}_e is the experimentally measured discharge mass flow rate, \dot{m}_S is the theoretical swept-volume mass flow rate, $(ACFM)_e$ is the experimentally measured volume flow rate in actual cubic feet per minute, and \dot{V}_S is the theoretical swept-volume flow rate. The former definition (\dot{m}_e/\dot{m}_S) is preferred, but in the absence of mass-flow meters, the latter is acceptable. We note that both swept-volume rates are functions of only compressor geometry.

Specific Overall Adiabatic Efficiency

$$\bar{\eta}_{overall,ad} = \frac{\left(\begin{array}{c} \text{Specific Theoretical Adiabatic} \\ \text{Compression Work} \end{array} \right)}{\left(\text{Specific Experimental Shaft Power} \right)} = \frac{\dot{m}_e c_p T_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]}{\dot{W}_{shaft,e}}$$

In this efficiency, c_p is the specific heat of air at constant pressure evaluated at T_1 , T_1 is the theoretical (standard) inlet temperature, P_2/P_1 is the theoretical pressure ratio, and $\dot{W}_{shaft,e}$ is the experimentally measured shaft power.

System Efficiency

$$\eta_{sys} = \bar{\eta}_{overall,ad} \cdot \eta_{motor} \cdot \eta_{controller} \cdot \eta_{auxiliary}$$

where η_{motor} , $\eta_{controller}$, and $\eta_{auxiliary}$ denote efficiencies of the compressor motor, controller, and auxiliary device, respectively. This efficiency is the product of all component efficiencies.