## Converting kW / ton to COP or EER

### How to convert between kW / ton, COP and EER

The efficiency of chillers depends on the energy consumed. Absorption chillers are rated in fuel consumption per ton cooling. Electric motor driven chillers are rated in kilowatts per ton cooling.

| | | |
|---|---|---|
| KW/ton | = | 12 / EER |
| KW/ton | = | 12 / (COP x 3.412) |
| COP | = | EER / 3.412 |
| COP | = | 12 / (KW/ton) / 3.412 |
| EER | = | 12 / KW/ton |
| EER | = | COP x 3.412 |

If a chillers efficiency is rated at 1 KW/ton, the COP=3.5 and the EER=12

## Cooling Load in - kW / ton

The term kW/ton is common used for large commercial and industrial air-conditioning, heat pump and refrigeration systems.

The term is defined as the ratio of the rate of energy consumption in kW to the rate of heat removal in tons at the rated condition. The lower the kW/ton the more efficient the system.

$kW/ton = P_c / E_r$ (1)

where

$P_c$ = energy consumption (kW)

$E_r$ = heat removed (ton)

## Coefficient of Performance - COP

The Coefficient of Performance - COP - is the basic unit less parameter used to report the efficiency of refrigerant based systems.

The Coefficient of Performance - COP - is the ratio between useful energy acquired and energy applied and can be expressed as:

$COP = E_u / E_a$ (1)

where

$COP$ = coefficient of performance

$E_u$ = useful energy acquired

$E_a$ = energy applied

COP can be used to define both cooling efficiency or heating efficiency as for a heat pump.

- For cooling, COP is defined as the ratio of the rate of heat removal to the rate of energy input to the compressor.
- For heating, COP is defined as the ratio of rate of heat delivered to the rate of energy input to the compressor.

COP can be used to define the efficiency at a single standard or non-standard rated condition or a weighted average seasonal condition. The term may or may not include the energy consumption of auxiliary systems such as indoor or outdoor fans, chilled water pumps, or cooling tower systems. For purposes of comparison, the higher the COP the more efficient the system.

COP can be treated as an efficiency where COP of 2.00 = 200% efficient For unitary heat pumps, ratings at two standard outdoor temperatures of 47°F and 17°F (8.3°C and -8.3°C) are typically used.

## Energy Efficiency Ratio - EER

The Energy Efficiency Ratio - EER - is a term generally used to define the cooling efficiency of unitary air-conditioning and heat pump systems.

The efficiency is determined at a single rated condition specified by the appropriate equipment standard and is defined as the ratio of net cooling capacity - or heat removed in Btu/h - to the total input rate of electric energy applied - in watt hour. The units of EER are Btu/w.h.

$EER = E_c / P_a$ (1)

where

$EER$ = energy efficient ratio (Btu/w.h)

$E_c$ = net cooling capacity (Btu/h)

$P_a$ = applied energy (w.h)

This efficiency term typically includes the energy requirement of auxiliary systems such as the indoor and outdoor fans and the higher the EER the more efficient is the system.