

Carnot Cycle

The Carnot Cycle is the fundamental theory/limit of heat pump operation (cooling or heating) is:

$$COP = \frac{T_h + T_z}{T_h - T_l} = \frac{\text{Heat Output}}{\text{Electrical Input}}$$

COP = is a measure of how good the device is operating - big numbers are good.

T_h = is the temperature of the hot side of heat pump.

T_l = is the temperature of the cold side of the heat pump.

T_z = is temperature above absolute zero for the temperature scale you are using – a constant

The temperature scale (C or F) doesn't matter as long as all temperature units are the same. For user's of Celsius $T_z=273$, for Fahrenheit user's $T_z= 451$ degrees.

What does it mean?

In a heating system T_l will be ambient temperature for air sourced pumps or the brine temperature from the ground source. T_h will be the hot water temperature to the radiators. The key takeaway from the equation is that COP is really sensitive to the temperature difference between the hot and cold sides.

The Carnot Cycle COP is a theoretical heat pump performance. Studying the operating data from a few heat pump data sheets it seems that the performance is 30% – 50% of the theory and does vary a slightly across the operating range of input and output temperatures. These

A good way of manufacturers providing meaningful information would be to state the percentage of the theoretical COP their product achieves. Marketing departments won't be too keen on the numbers!