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Beyond-Carnot Heat Pump?

Sunoba Pty Ltd today announces details of a heat pump with beyond-Carnot performance.

Heat pumps use work to transfer heat energy from a low-temperature reservoir to a high-temperature reservoir. They are very common in today's world – refrigerators and air conditioners are everyday examples.

The Coefficient of Performance, COP , is a measure of effectiveness for heat pumps. It is defined by

$$COP = \{\text{increase in heat energy}\} / \{\text{work required for the cycle}\}$$

The 2nd law of thermodynamics ensures that the COP of a heat pump operating on a closed-loop cycle will never exceed the Carnot limit

$$COP_{\text{Carnot}} = T_{\text{hot}} / (T_{\text{hot}} - T_{\text{cold}})$$

in which T_{hot} and T_{cold} are the absolute temperatures (Kelvin) of the hot and cold reservoirs.

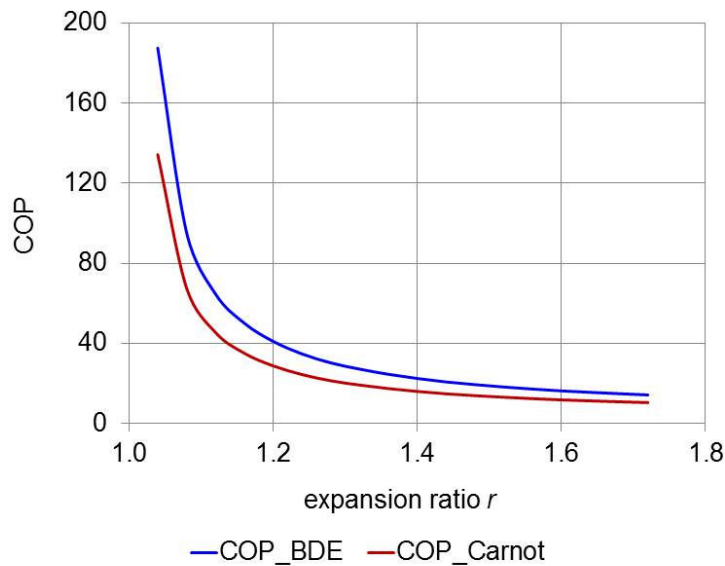
The Barton Drying Engine (BDE) was invented by the founder of Sunoba Pty Ltd in 2004. It operates on a simple cycle:

- mechanically expand moist air beyond dew point, thus causing condensation and releasing latent heat,
- after the expansion is complete, remove the condensed water, and
- re-compress the air to ambient pressure.

Work is required to complete the cycle, and the outlet air is hotter and drier than the inlet air.

Recent work, see Figure below, shows that the COP for the BDE heat pump is superior to the Carnot limit, an apparent contradiction of the 2nd law of thermodynamics.

The paradox is resolved by observing that the BDE heat pump does not operate on a closed-loop cycle. Since condensed water is removed, the state of the engine at the end of the cycle is different to its state at the beginning. The Carnot limit does not apply.



Plots of COP_{BDE} and COP_{Carnot} for the case when the inlet air is at 25°C and saturated. The COP depends on the expansion ratio r .

The BDE heat pump can be built in either piston-cylinder or continuous-flow forms. It exploits the latent heat in moist air, and produces hot dry air for numerous applications such as drying of linen, drying of agricultural and mineral products, de-smogging of public places, and heating of buildings or homes.

The inventor of the BDE heat pump, Noel Barton, says

“These results appear to violate the 2nd law of thermodynamics, but that is not the case. The theory underlying this heat pump was published in peer-reviewed literature in 2008.”

Barton explains the significance of these results:

“Theoretically, the BDE is better than the best heat pump in the world. It will not be difficult to manufacture in piston-cylinder or continuous-flow form, inevitable practical losses can be controlled, and it will have superior operating performance to conventional heat pumps. This will lead to energy savings in numerous applications ranging from domestic to industrial.”

The new heat pump is completely original, worldwide, and is protected by patent applications. The technology is available under licence to manufacturers.

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About Sunoba Pty Ltd and Noel Barton

Noel Barton, founder of Sunoba Pty Ltd, was educated at the University of Western Australia, finishing in 1973 with a PhD in applied mathematics. Prior to becoming a full-time inventor in 2004, he held appointments at the University of New South Wales (1975-81) and CSIRO Australia (1973-74, 1981-2003). Dr Barton's passion is the use of renewable energy for power generation, mineral processing and transport fuels. His work within Sunoba Pty Ltd has concentrated on new heat engines and heat pumps, with a strong emphasis on renewable energy and energy conservation.

Reference

Barton, N.G., "An evaporation heat engine and condensation heat pump", *ANZIAM Journal*, **49** (2008), 503-524.