REHOS Cycle vs Perpetual-Motion Machine of the 2nd Kind

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Abstract:

The REHOS thermodynamic power cycle consist of two distinctly different sub-cycles, combined regeneratively, namely an Absorption Heat Transformer (AHT) type heat pump, pumping low-grade heat from an external waste heat source, up to higher temperature, and a simple Organic Rankine Cycle (ORC) utilizing the pumped, higher temperature heat to power a turbine.

Due to the complete regeneration of the ORC-rejected heat, the REHOS cycle efficiency is extremely high. It also ensure that the only heat loss from the system comes from conduction and radiation of heat from the working surfaces due to imperfect thermal insulation.

The high efficiency obtained, however, force a perception among scientists and engineers of having designed a "perpetual motion machine", and papers and publications written to describe the REHOS Cycle are therefore regarded as "another nut case ramblings" even before it is read. This negative perceptions have a resulting mental block among people who are not prepared to read the technical detail of the disclosures in the required detail to see the difference.

This paper highlight how the REHOS Cycle design avoid all the limitations placed on a heat engine driven heatpump not to violate the 2nd Law of thermodynamics, and actually achieve a very realistic, but exceptionally high thermodynamic efficiency.

When you have seen that the REHOS Cycle is not a perpetual-motion machine and you want to know more about this energy revolution, use the link to my website, where some 20 different publications (pdf-files) may be downloaded from.

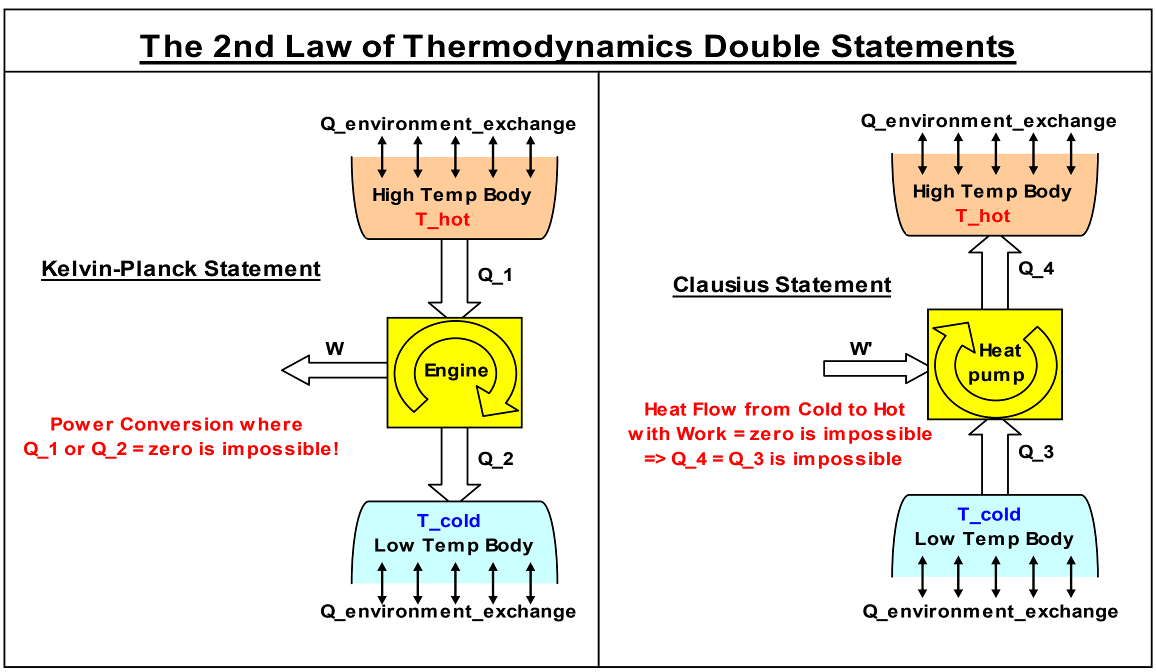
The 2nd Law of Thermodynamics

The 1st Law of Thermodynamics state that energy cannot be created or destroyed; the total quantity of energy in the universe stays the same.

The 2nd Law of thermodynamics is about the quality of energy. Every process where energy is transformed or transferred, waste a portion of the energy, degrading the quality to make it less available to perform work. This law also states that there is a natural tendency of any isolated system to degenerate into a more disordered state. This lead to the two equivalent statements summarizing the 2nd Law of thermodynamics: the **Kelvin-Planck statement** and the **Clausius statement**.

The Kelvin-Planck statement: It is impossible to construct a device that will operate in a cycle and produce no effect other than producing power and the exchange of heat with a single reservoir. In effect, it states that it is impossible to construct a heat engine that operates in a cycle, receives a given amount of heat from a high-temperature body, and does an equal amount of work. The only alternative is that some heat must be transferred from the working fluid at a lower temperature to a low-temperature body. Thus, work can be done by the transfer of heat only if there are two temperature levels, and heat is transferred from the high-temperature body to the heat engine and also from the heat engine to the low-temperature body. This implies that it is impossible to build a heat engine that has a thermal efficiency of 100%. Refer to the left-hand sketch of figure 1, below.

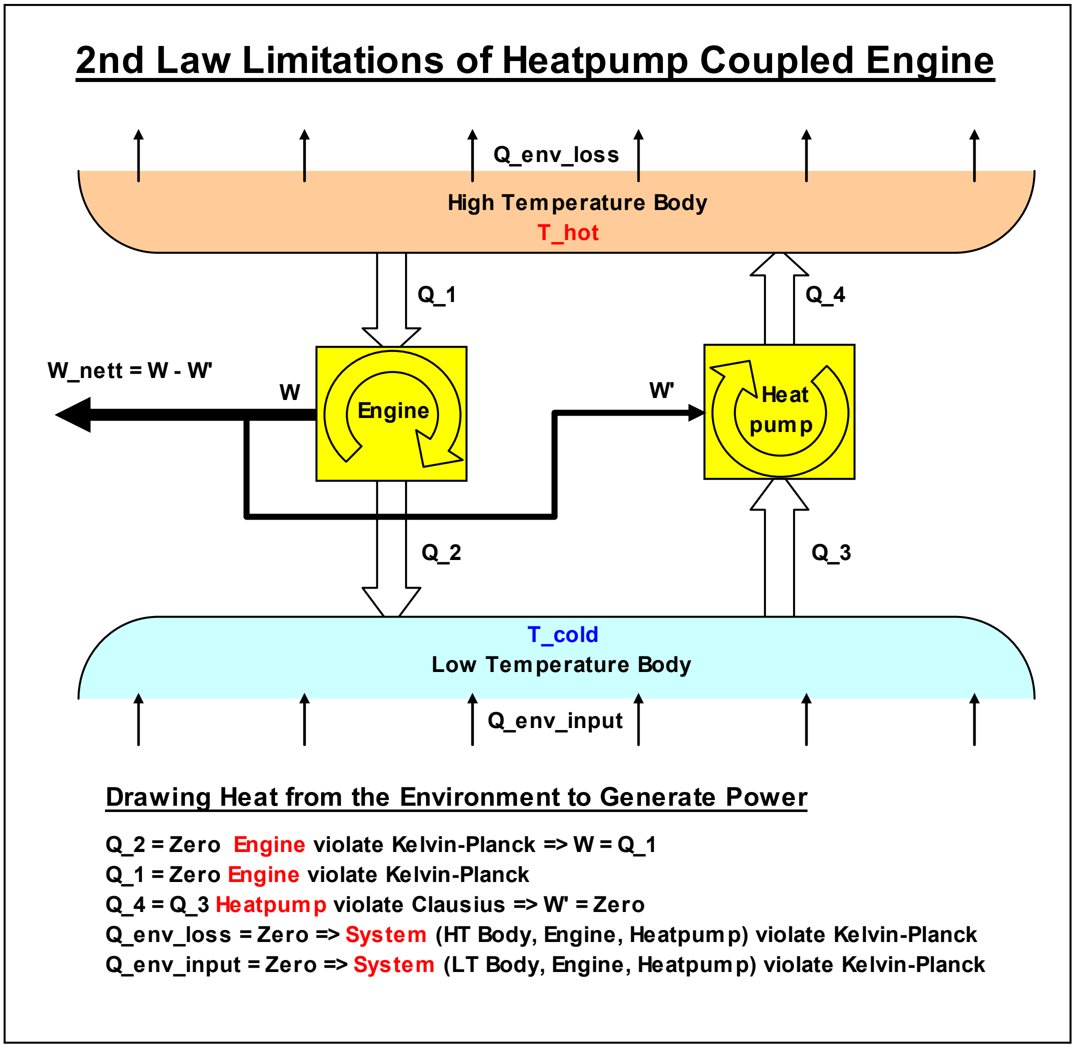
Figure 1



The Clausius statement: It is impossible to construct a device that operates in a cycle and produces no effect other than the transfer of heat from a cooler body to a warmer body. See the right-hand sketch of figure 1, above. This statement is related to the refrigerator or heat pump. In effect, it states that it is impossible to construct a refrigerator that operates without an input of work. This also implies that the COP is always less than infinity.

Should we look at a heatpump, coupled with a heat engine for the purpose of extracting low grade heat from the environment to use for the generation of power, we should be aware of the limitations of designing a system like this. These limitations are listed below, as part of the sketch of figure 2.

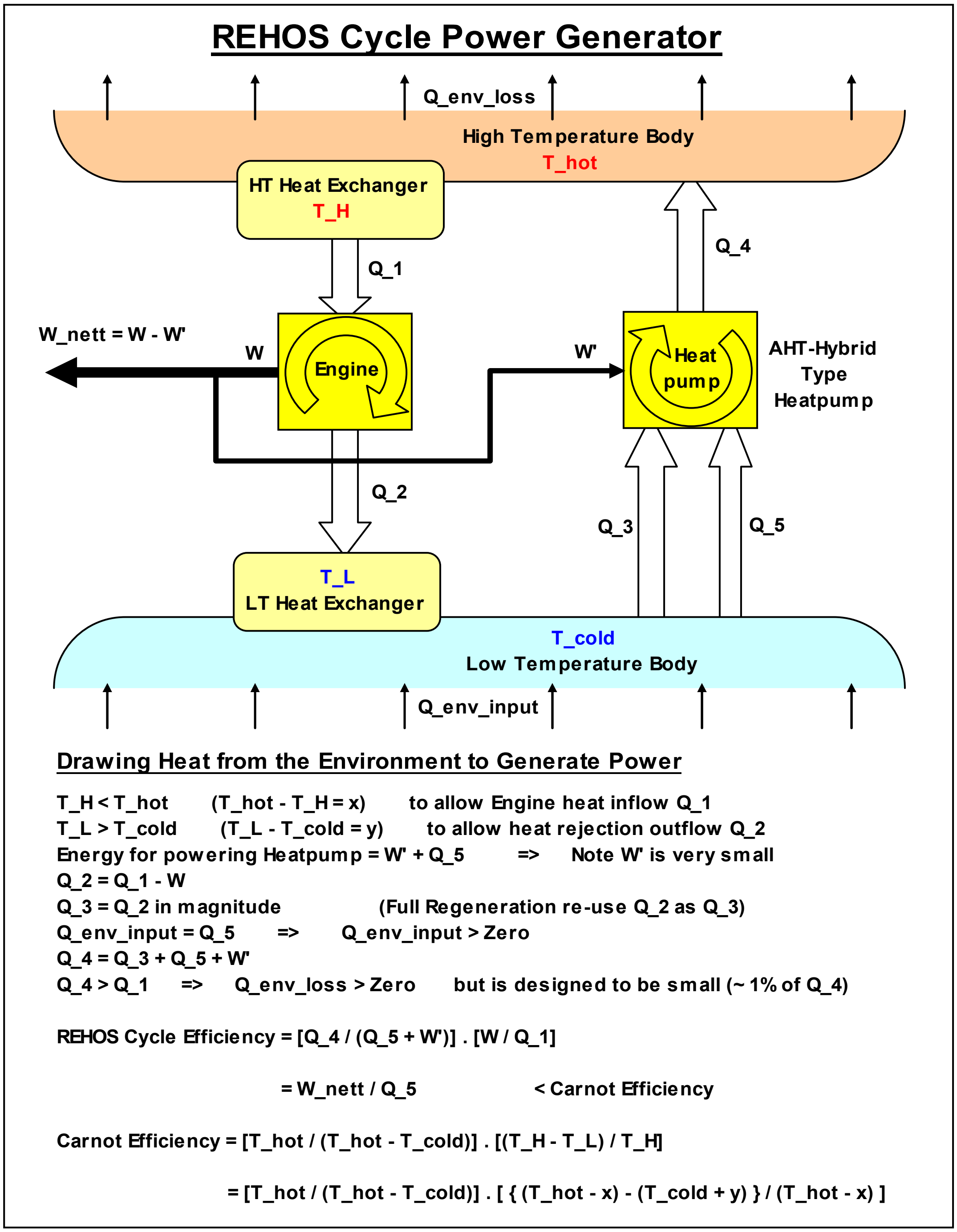
Figure 2



From a thermodynamic handbook [2] some extracts: The 2nd law of thermodynamics has been stated as the impossibility of constructing a perpetual-motion machine of the second kind. A perpetual-motion machine of the first kind would create work from nothing or create mass or energy, thus violating the first law. A perpetual-motion machine of the second kind would extract heat from a source and then convert this heat completely into other forms of energy, thus violating the second law. The limitations on a system designed to use environmental heat, but does not violate the 2nd Law, are summarised in figure 2, above. A perpetual-motion machine of the third kind would have no friction, and thus would run indefinitely but produce no work.

Figure 3, below, show a sketch of the REHOS Cycle, drawn very similar to the sketch in figure 2, but showing how all the limitations mentioned that would violate the 2nd Law, are carefully, but practically avoided and circumvented, resulting in a very practical environmental heat to power converter able to achieve high thermal to power conversion efficiency.

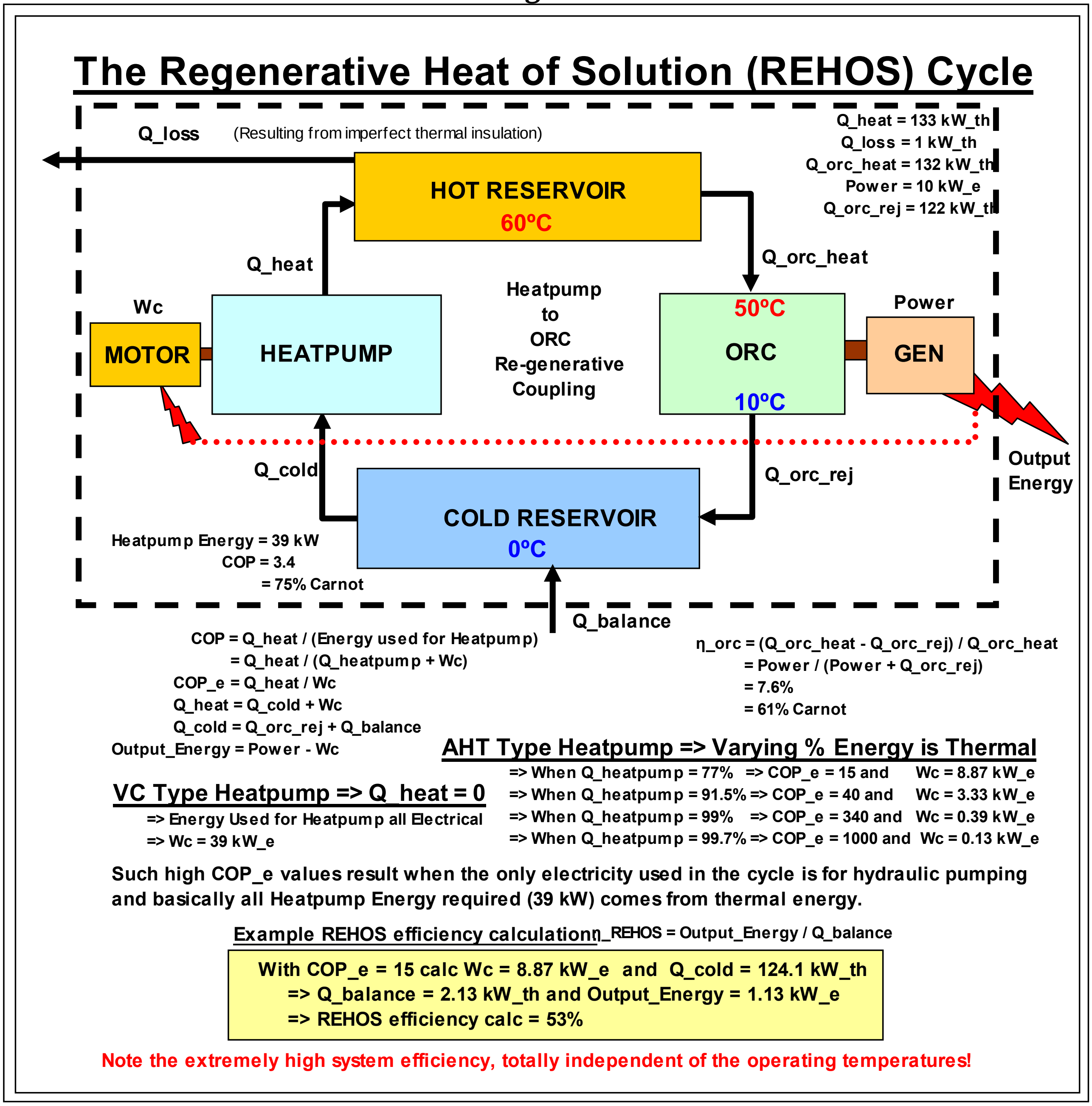
Figure 3



In another paper I have written, the REHOS Cycle efficiency calculated to 80,1%, while the Carnot efficiency was 90,1% with the system high temperature (T_hot = 80°C) and the system low temperature (T_cold = -5°C) extracting heat from a liquid reservoir at ambient (22°C).

Figure 4, below represent a "At a Glance" overview of the REHOS Cycle with some real temperatures added into the sketch.

Figure 4



It should be clear that the REHOS Cycle is a practical, real waste heat recovery power generation cycle, and does not violate any thermodynamic laws!

References:

All aspects of the REHOS Cycle, it's development and applications have been emphatically described and published on my website (referenced below). It is therefore not repeated here.

Each paper published on my website can stand on it's own, with all references, external sources as well as my own previous publications on the subject included on each individual paper.

1. Website for Heat Recovery Micro Systems where the above publications are available from: www.heatrecovery.co.za

2. Thermodynamics Handbook: Fundamentals of Thermodynamics, 8th Edition. Claus Borgnakke and Richard E. Sonntag, University of Michigan. A Wiley publication Copyright (C) 2013, 2009, 2002, 1998 John Wiley & Sons, Inc.