Review of: "The Thomson-Clausius synthesis revisited: Why “conversion” of heat to work is a misnomer?"

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In this work the author brings us to our attention a fundamental difference between heat and work, that related to the asymmetry of their transformation: all work can be transformed into heat, whereas at best (under reversible conditions) only a fraction of heat can end up as work at the end of a heat transfer-work production process. This much was known from long time, namely from the work of Carnot, which the author brings often to our attention. In fact, he uses the Carnot cycle as his primary tool to explain this asymmetry. In particular, he is using a cleverly introduced two Carnot cycles composition to illustrate how the heat exchanged in one can be visualized as the driving force for the apparent conversion of the other heat stream into work. This example brings up the true generating the work force, the entropy difference (1/T2 – 1/T1)*Q1 also called within the paper as “entropy generating potential” (EGP). Along with this new term, the author reminds us some of the key works that led to our current understanding of thermodynamics and entropy.

This is a carefully worded work on a difficult subject that has been often led to confusing interpretations. As such, I recommend its publication and only have some secondary comments to make (see detailed remarks below) that can potentially lead to a better presentation of the material.

Detailed remarks

1. Starting with the title, if “conversion of heat to work” is a misnomer, (and of course we need to keep in mind that when we are talking for conversion is always a partial conversion that we are talking about) the author does not clearly come up with a better alternative. I feel that the one term mentioned a lot “interventionist-causation” although it helps to understand why the conversion is partial (connected with “thermodynamic processes of unnatural direction”---meaning non-spontaneous transitions) it cannot possibly be used to express phenomenologically the connection. I therefore feel that the word “conversion” is not that inappropriate; what is important is to always have in mind that there is a thermodynamic limitation to the maximum conversion that one can get. In this respect, the best is to use a weight for every heat exchange so that, when introduced, it allows for a full conversion of the weighted product to work to be realized. This weight is none else than the Carnot efficiency factor, as for example used in exergy balance evaluations, with the temperature of the environment used as the reference reservoir temperature. This makes the exergy dependent on that temperature (and therefore strictly limited to open processes allowing for heat exchanges to the environment, and this is correctly mentioned also here by the author) but this is really the only inconveniency in a term and an approach that has found wide usage in energy conversion calculations. I feel therefore that some additional reference to exergy will be nice to be made-

--a couple of pertinent works, one classic, one more recent, are to be found at the end of the present review [1,2]. Similar corrections are to be found in equilibrium thermodynamic calculations (such as related to the use of Gibbs free energy in chemical reactions as opposed to the internal energy) in order to accommodate entropy-related effects.

2. Some editorial comments

a. Page 4, line 9: "belong" should be "belonging"

b. Page 11, line 2 of section 3, "for" should be capitalized.

c. In Figure 3, it would have been helpful to also draw (perhaps with dotted lines) the continuation of the corresponding isotherms for the relevant temperatures T2, T1, T through the whole usable parameter space range.

d. In Figures 3-6, an arrow would have been better if it was used to indicate the Q1 exchange.

e. In page 17, first line after section 3.2, the reference for "A Treatise" is missing.

f. In a number of occasions (for example, page 10, lines 4 and last in second paragraph; page 11, line 4 from the end; Page 14, lines 7 and 1 from the end; Page 15, line 4; page 17 first line after Eq. (5); Page 19, lines 3,4 before the end; etc.) the Arabic numerals are used instead of the roman numerals for the reference citation.

References

[1] T.J. Kotas, 'The Exergy Method of Thermal Plant Analysis', 1st Ed. Updated, Exergon Publishing Co., UK, London, 2012.

[2] Yasar Demirel, Vincent Gerbaud, Nonequilibrium Thermodynamics, 4th Ed., Elsevier, 2018.