Geophysical Research Abstracts
Vol. 15, EGU2013-2161, 2013
EGU General Assembly 2013


# Conversion of medium and low temperature heat to power

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Presently most electricity is produced in power plants which use high temperature heat supplied by coal, oil, gas or nuclear fission and Clausius-Rankine cycles (CRC) with water as working fluid (WF). On the other hand, geo-, solar-, ocean-, and biogenic-heat have medium and low temperatures. At these temperatures, however, the use of other WF and/or other cycles can yield higher efficiencies than those of the water-CRC. For an assessment of the efficiency we model systems which include the heat transfer to and from the WF and the cycle. Optimization criterion is the exergy efficiency defined as the ratio of the net power output to the incoming exergy flow of the heat carrier.

First, for a better understanding we discuss some thermodynamic properties of the WFs: 1) the critical point parameters, 2) the shape of the vapour- liquid coexistence curve in the temperature vs entropy (T,s)–diagram which may be either bell-shaped or overhanging [1,2], and 3) the shape of sub- and supercritical isobars for pure fluids and fluid mixtures.

Second, we show that the problems of a CRC with water at lower temperatures are 1) the shape of the T,s-diagram and 2) the exergy loss during heat transfer to the WF. The first problem can be overcome by using an organic working fluid in the CRC which then is called organic Rankine cycle (ORC). The second problem is reduced by supercritical organic Rankine cycles (sORC) [1,2], trilateral cycles (TLC) and the more general power-flash cycles (PFC) [2], and organic flash cycles (OFC) [3].

Next, selected results for systems with the above mentioned cycles will be presented. The heat carrier inlet temperatures THC range from 120°C to 350°C.The pure working fluids are water, refrigerants, alkanes, aromates and siloxanes and have to be selected to match with THC. It is found that TLC with water have the highest efficiencies but show very large volume flows at lower temperatures. Moreover, expansion machines for TLC and PFC are still under improvement. Presently, the best feasible systems seem to be ORC cycles using WF with a nearly vertical dew line in the T,s-diagram as HFO-1234yf, n-butane or cyclopentane and upper pressures close below or above (sORC) the critical pressure.

Finally, we will consider the above cycles also with mixtures as WF including the Kalina cycle and coupled processes like cascade or multistage processes.

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