# SYNERGY EFFECT IN THE HYBRID ORC POWER PLANT DRIVEN BY TWO LOW ENTHALPY HEAT SOURCES

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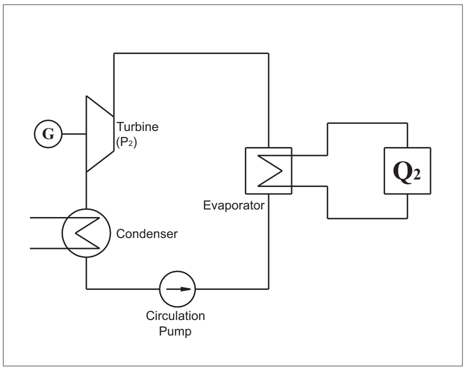
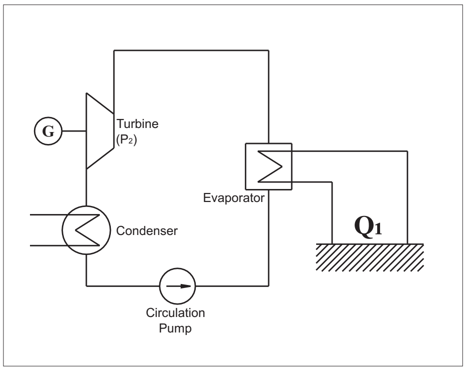
**Abstract:** Organic Rankine Cycles (ORC) are used in an increasing number of applications in the field of the distributed electricity generation. There is also a tendency to convert heat of lower and lower temperature, i.e. such as 100ºC and below that value. However, the thermodynamic efficiency of the energy conversion is very low at this temperature level. To overcome that situation several hybrid systems were considered within which the low temperature heat would be in various ways coupled with additional high temperature heat. Irrespectively from the energy conversion efficiency in those systems (the high temperature heat source requires application of the conversion technology that is different from ORC) this kind of approach calls for a high temperature heat source to be provided at the location of the existing low temperature heat source, which in most cases might be not feasible. Now, a requested positive effect in the efficiency of the energy conversion results when two low temperature heat sources (of different temperature values) are engaged in one hybrid ORC system, and the cycle generates saturated vapour to drive the turbine. An example discussed in the presentation refers to the case of low enthalpy geothermal water (with the temperature of, say, 70ºC) and heat delivered by a biomass fired water boiler (water output at 100 – 120ºC). It appears that, with properly adjusted heat streams of those two heat sources, the power output of such hybrid ORC system is up to 40 % greater than the sum of the power outputs of the two ORC units utilizing the respective individual heat sources at the equivalent heat stream capacities. The synergy effect comes from a thermodynamically better utilization of the upper heat source.

## Assumption:

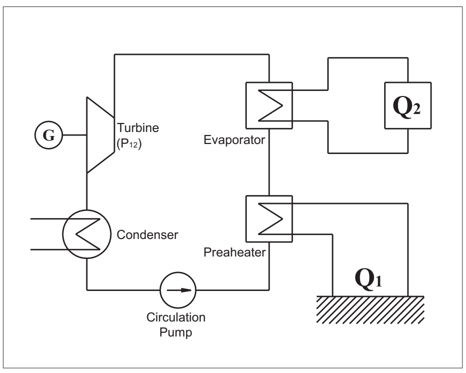
Two heat sources with different temperatures are given. The lower temperature heat source is of geothermal type (the heat leaving the heat exchanger cannot be recuperated in the cycle).



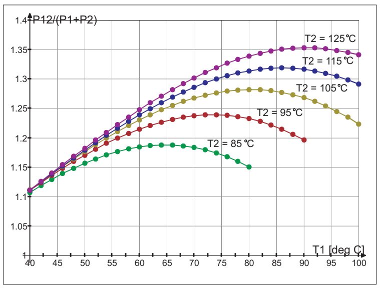

ORC cycle powered by the heat source $Q_1$ (higher temperature)



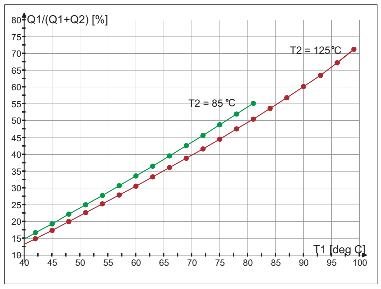

ORC cycle powered by the heat source of geothermal type $Q_2$ (lower temperature)



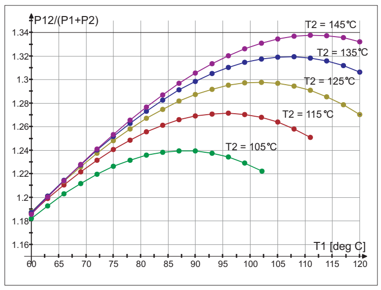

Hybrid ORC cycle powered by the both head sources $Q_1$ and $Q_2$



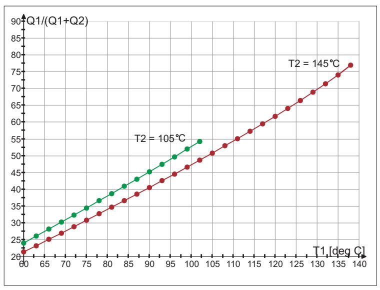

The ratio of electrical power of the hybrid cycle and the sum of electrical powers generated by the independent cycles vs. the lower heat source temperature. Different curves for different temperatures of the second heat sources are presented. ***Working fluid - R227ea.***




The amount of heat of the source Q2 with respect to the sum of the heat of sources Q1 and Q2 vs. the lower heat source temperature. Two curves are presented corresponding to different higher heat source temperature. ***Working fluid - R227ea.***




The ratio of electrical power of the hybrid cycle and the sum of electrical powers generated by the independent cycles vs. the lower heat source temperature. Different curves for different temperatures of the second heat sources are presented. ***Working fluid - R236ea.***




The amount of heat of the source Q2 with respect to the sum of the heat of sources Q1 and Q2 vs. the lower heat source temperature. Two curves are presented corresponding to different higher heat source temperature. ***Working fluid - R236ea.***

## Conclusion

Production of electricity even from very low enthalpy heat sources can be justified. Application of hybrid cycles for certain combinations of heat sources yields significant efficiency benefits

***Literature:***

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