Low-grade heat driven novel hybrid cooling and power system

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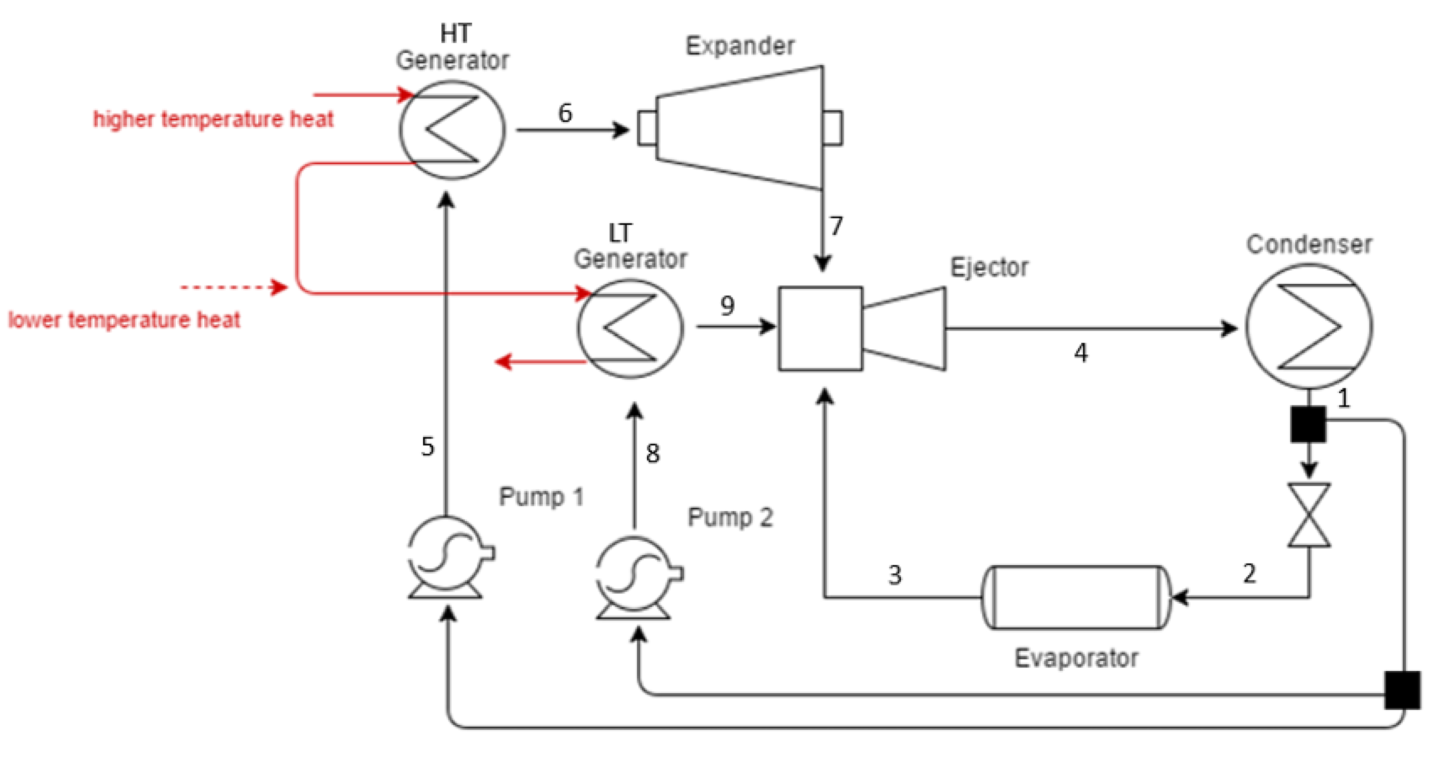
Industry Problem

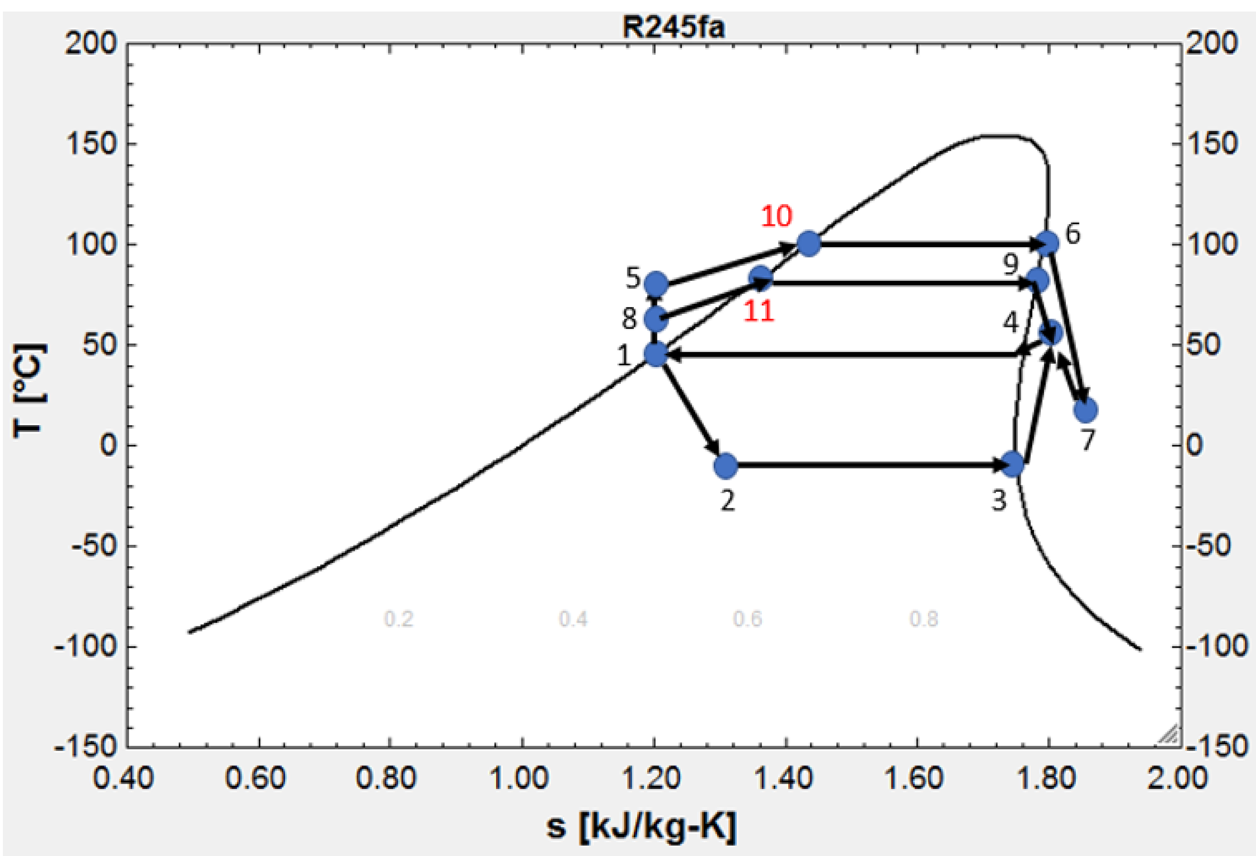
Low-grade thermal energy is abundantly available from many different sources such as waste heat from industrial processes, geothermal and solar energy. Utilizing low-grade waste heat leads to increased energy efficiency and profitability while reducing greenhouse gas emissions. The existing technologies for harnessing waste heat are complex, expensive and can not utilize very low temperature heat (<100ºC) in an effective way. There is a strong need for systems which can utilize this abundantly available very low-grade heat. A combined cooling and power system is desirable because it can be compact, less expensive, efficient, effective and easy-to-operate.

Solution

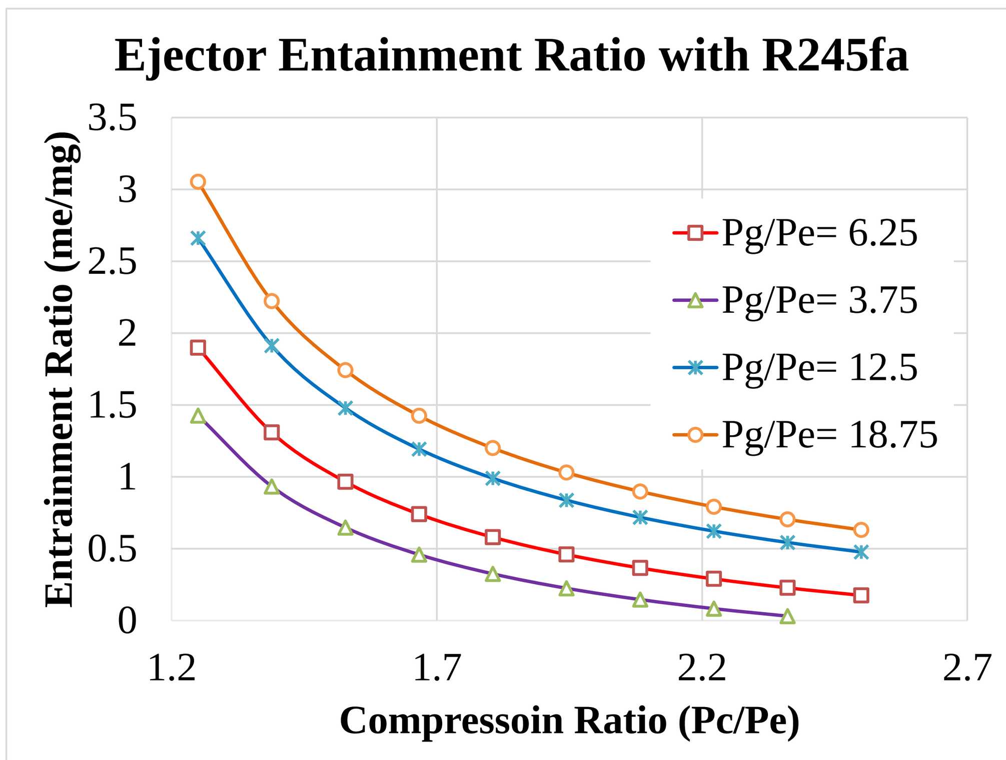
NUS researchers have developed a novel system which can convert low-grade heat into power and cooling. The system configuration utilizes an ejector in a unique way such that the system can extract more energy from waste heat stream. The ejector serves two purposes; (1) reducing the pressure at the exit of turbine for more power generation (2) compression of vapour from low pressure to condenser pressure for producing refrigeration effect. The usage of two vapour generators with different pressures allows more heat extraction form waste heat stream and also makes it possible to use two different waste heat streams available at different temperatures. This novel system is a compact and effective system that can be designed to meet the power and cooling requirements of various users. The NUS team has developed ejector models in FLUENT and EES to be able to optimize the design of ejector for different working conditions. Also, system models have been developed in EES and EBSILON.



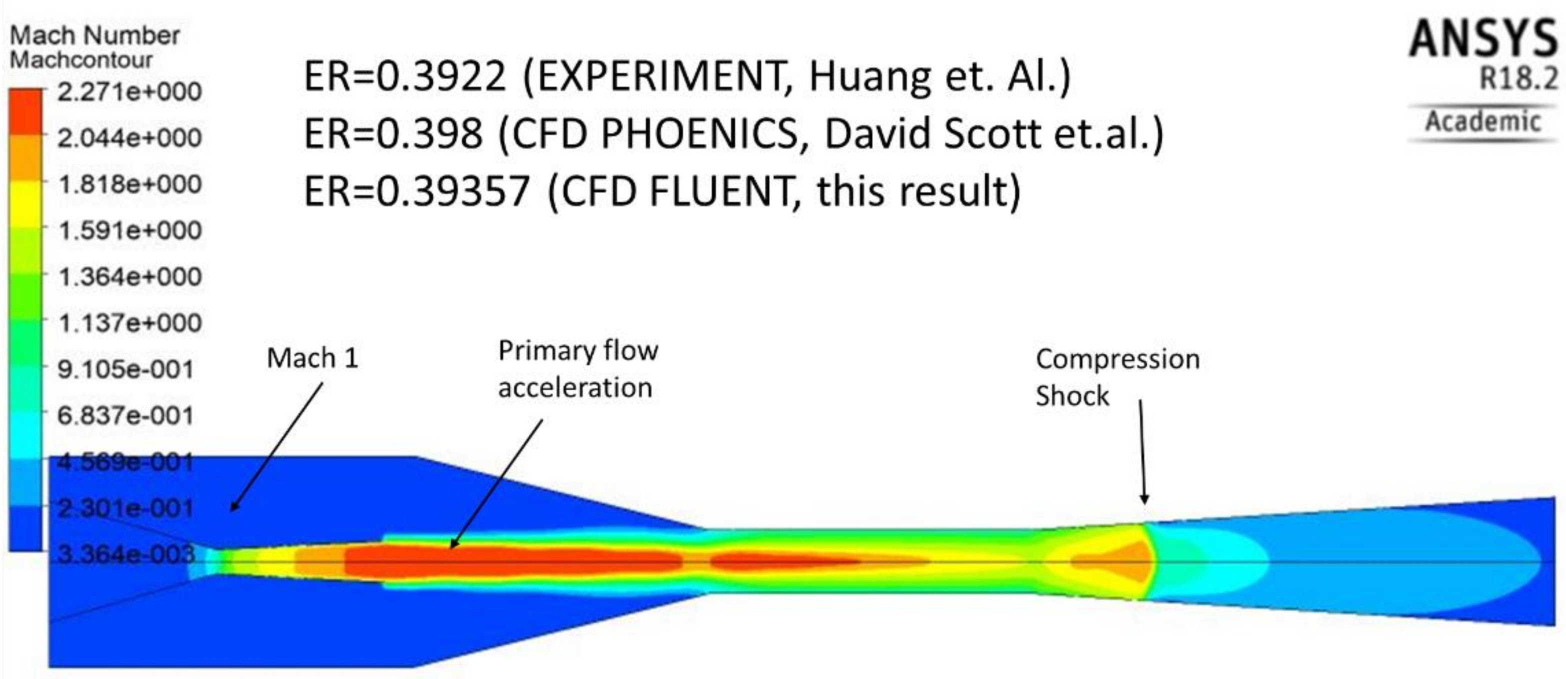
(a) System Schematic



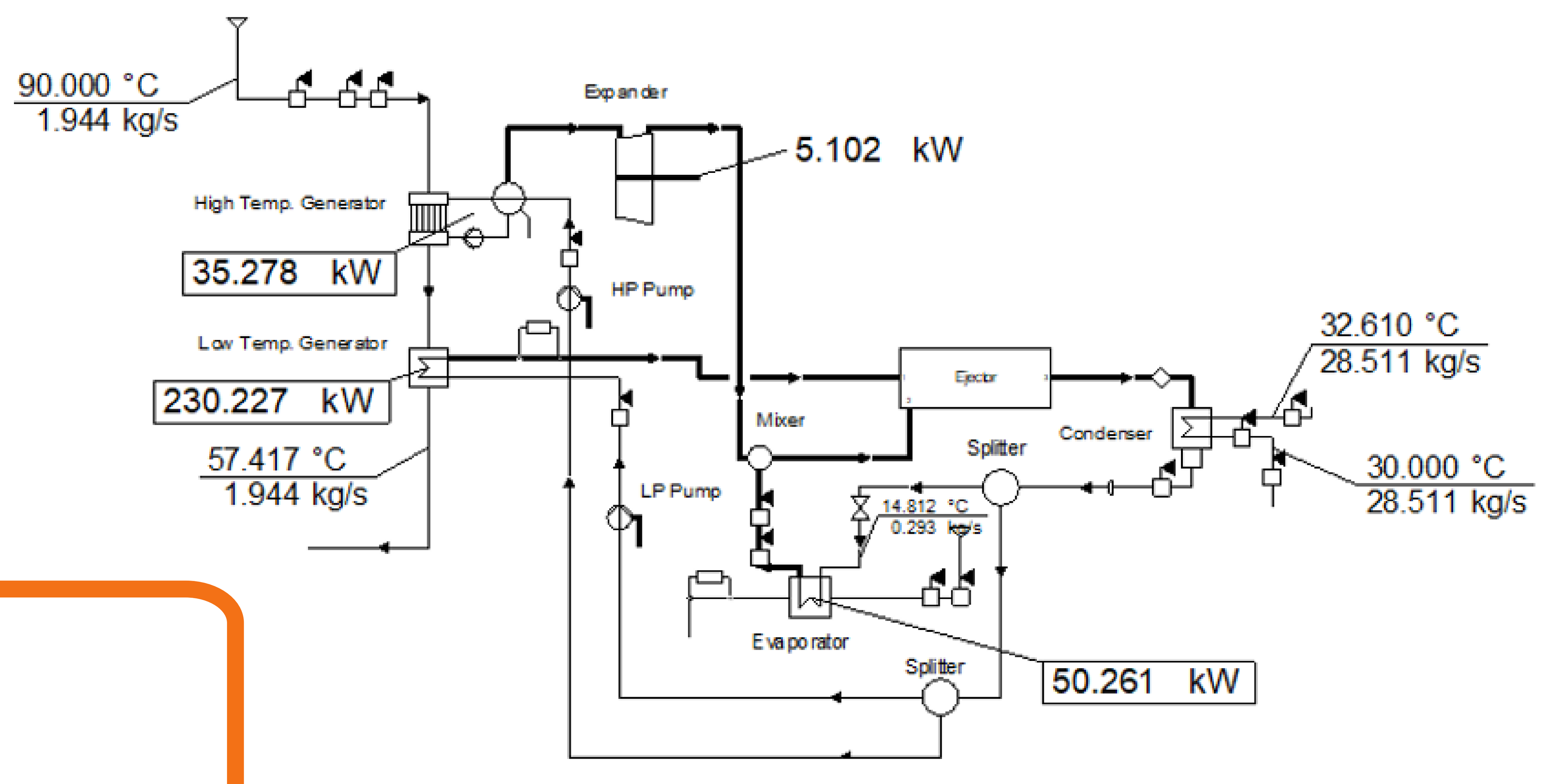
(b) T-s diagram: system modeling in EES



(c) Ejector modeling in EES



(d) Ejector modeling and validation in CFD FLUENT



(e) System design with EBSILON

Value Proposition

- Very low-grade heat utilization
- Combined cooling and power
- Effective system (more heat extraction and more output)
- Compact system (less expensive and easy maintenance)
- Custom design to meet user requirements

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Ref : ID2017-114