Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 9, September 2019

THERMODYNAMIC CYCLE: A REVIEW

Mr. Sri Krishna Baskar Rao
Department of Mechanical Engineering, Faculty of Engineering and Technology
JAIN (Deemed-to-be University), Karnataka - 562112
Email Id: srikrishna.rao@jainuniversity.ac.in

Abstract

This paper discusses the organic cycle of Rankine and the super critical cycle of Rankine for the transfer of low heat to electricity as well as collection of possible workflows parameters, screening 35 workflow fluids for two cycles and an overview of fluid characteristics output on the loop. One of the key factors when considering an operating liquid is it's thermodynamically and physical properties, durability, environmental implications, protection and compatibility, supply and costs. The paper examines the types of working fluids, the impact of latent heat, density, and real heat and the overheating efficiency.

Keywords*: Organic Rankine cycle, Rankine, Renewable energy source, Supercritical Rankine cycle.*

I. INTRODUCTION

Renewable energy sources, such as thermal and geothermal energy sources and a significant volume of industrial waste heat will, in part, satisfy world energy demand. Nevertheless, traditional methods of generation electrical power cannot effectively transform the moderate temperature heat from these sources and simply waste vast amounts of moderate temperature heat[1]. Research into how this low-quality heat supply can be turned into energy is of considerable interest in this case. Several thermodynamic cycles were proposed and researched for transformation of low-quality heat sources into electricity, such as the organic Rankine cycle, the supercritical Rankine cycle, the Kalina cycle, the Go swami cycle and the three-way flash cycle[2]. Though wide claims for the same heat induction in Kalina cycles are 15 to 50 percent higher than organic Rankine cycles, data are available difference in efficiency is just three percent for the Kalina loop, seen from real operating cycles and simulations under equal atmospheric temperature and cooling systems conditions. But the biological Rankine cycle is considerably less complex and requires less upkeep.

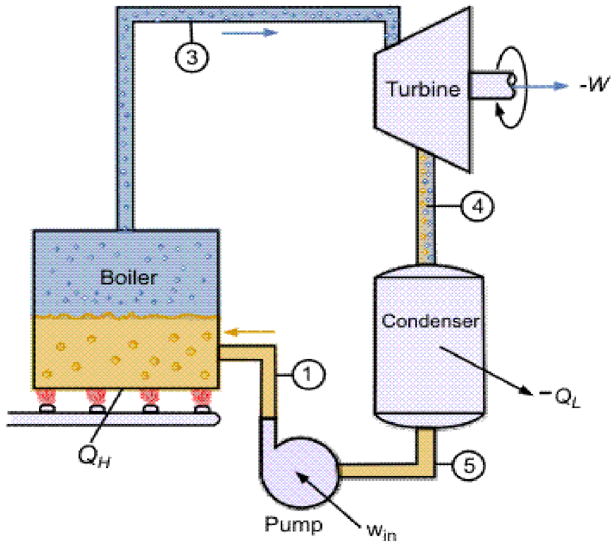

Fig. 1:Rankine Cycle[3]

The Rankine cycle is the basic operating cycle of all power plants in which the operating fluid evaporates and condenses continuously[4]. The choice of operating fluid primarily depends on the temperature range available. This loop is diagramed with pressure-enenthalpia (p-h) and temperature-entropy (T-s). In the following stages, the Rankine cycle works:

A. 1-2-3 Heat Transfer Isobaric:- Heated at saturation temperature, high pressurized liquid reaches the boiler from the feed pump. Further energy incorporation allows the liquid to evaporate before completely converted into saturated steam.

B. Expansion 3-4 Isentropic: - The steam is expanded to generate work that can be turned into electricity in the turbine. The expansion is constrained in operation, as the process proceeds into the two-phase area by the temperature of the coolant medium and by corrosion of the turbine blades by the liquid training in the vapour flux. The quality of exit vapour should be above 90%.

C. 4-5 Rejection of Isobaric Heat: - The vapor-liquid mixture left by the turbine (4) is condensed at a low pressure, typically using cooling water in a surface condenser. The vapour pressure is well below ambient pressure in condensers that are well built and operated.

D. 5-1 compression isentropic: - The condensate pressure in the feed pump is increased. The pump work is comparatively limited and frequently ignored in thermodynamic measurements because of the low real volume of liquids.

The researchers have suggested and tested modifications of the Rankine heat transfer cycles into electricity and several cycles of applications have already been discovered. Yet a lot still needs to be learned to change Production and expense decline. This is an analysis of these periods.

Organic Rankine Cycle: The organic rankine cycle (BRC) applies the steam rankine cycle theory but uses organic working fluids with low boiling points for heat recovery. Displays an ORC structure and processes in a diagram with a T-s. A expansion turbine, a condenser, a pump, a boiler and a superheater is given for the loop. It's needed superheat. Pure working fluids, such as HCFC123 (CHCl2CF3)-, PF5050(CF3(CF2)3CF3) used in organic ranchin cycles were studied, HFC-245,fa (CH3CH2CHF2) , HFC-245,ca, isobutene, n-pentane and flavorful hydrocarbons (CH3), isobutene((CH3)2C55H2)[5]. For organic rankin cycles, fluid mixtures were also suggested. Chemical job fluids have several common water properties. In a T-s graph, the slope of the job fluid saturation curve can be positive (e.g. isopentane), positive (e.g. R22) or vertical (e.g. R11) and the fluids can then be called warm, dry, and isentropic. Wet fluids such as water are typically overheated, whereas much of the dry or isentropic organic fluids do not have to be overheated. Another benefit of organic fluids is that the ORC turbine usually only requires a one phase expander, which leads to a smoother, cheaper method.

E. **Supercritical Rankine Cycle:-** Working fluids with comparatively low critical temperatures and pressure should be immediately compressed at their supercritical pressures and heated until expansion to ensure a better thermal balance with the source of heat. The CO2 supercritical Rankine cycle structure and mechanism in the T–s diagram. The supercritical rank-in process is not as classic as a separate two-phase area. The organic cycle of Rankine leads to a stronger thermal fit with lower irreversibility. Specific R152a thermal fits with the normal organic Rankine cycle, and the supercritical Rankine cycle R143a with the same limit.

No best fluid fits all requirements for varying temperature thermal sources. When choosing fluids, choices must be made. The authors note that the critical temperature and the j value of the fluid are essential parameters that show the form of period and the working temperature of the fluid that can be served by the fluid[6].

II. DISCUSSION

No best fluid fits all requirements for varying temperature thermal sources. When choosing fluids, choices must be made. The authors note that the critical temperature and the j value of the fluid are essential parameters that show the form of period and the working temperature of the fluid that can be served by the fluid.

III. CONCLUSION

For low-grade heat conversion to fuel, organic rankine cycles and supercritical rankine cycles were investigated. Unlike an excessively critical Rankine cycle, Organic Rankine cycles are not in compliance with the thermal sources, but the supercritical Rankine cycle typically demands higher operating pressures. The functional fluids play an important role in the efficiency of the cycle. One of the factors in choosing a working fluid is thermodynamic and physical properties, durability, environmental consequences, protection and performance as well as availability and cost. Detailed discussion of types of work fluids, latent heat influences, density and real heat, and the efficacy of superheating. High-density working fluids and latent high heat have high work performance for turbines. The analysis also found that in organic rankine cycles isentropical and dry fluids are favoured. For wet fluids in organic Rankine cycles, superheating is required. Superheat may therefore play a negative role in cycle effectiveness for dry fluids. Supercritical Rankine cycle candidates are fluids with low critical temperatures and pressures.

IV. REFERENCES

[1] I. Renewable Energy Agency, "Renewable Power Generation Costs in 2017," International Renewable Energy Agency, 2018.
[2] T. C. Hung, "Waste heat recovery of organic Rankine cycle using dry fluids," Energy Conversion and Management, 2001, doi: 10.1016/S0196-8904(00)00081-9.
[3] "RANKINE CYCLE," thermopedia. .
[4] B. Saleh, G. Koglbauer, M. Wendland, and J. Fischer, "Working fluids for low-temperature organic Rankine cycles," Energy, 2007, doi: 10.1016/j.energy.2006.07.001.
[5] J. Sarkar, "Review and future trends of supercritical CO2 Rankine cycle for low-grade heat conversion," Renewable and Sustainable Energy Reviews. 2015, doi: 10.1016/j.rser.2015.04.039.
[6] H. Chen, D. Y. Goswami, and E. K. Stefanakos, "A review of thermodynamic cycles and working fluids for the conversion of low-grade heat," Renewable and Sustainable Energy Reviews. 2010, doi: 10.1016/j.rser.2010.07.006.