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THE BRIEF REVIEW ON THE VARIOUS THERMODYNAMIC CYCLES

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ABSTRACT

The organic Rankine cycle and the super critical Rankine cycle for the conversion of low heat to electricity are discussed in this paper, as well as the collection of possible workflow parameters, the screening of 35 workflow fluids for two cycles, and an overview of fluid characteristics output on the loop. Thermodynamic and physical characteristics, durability, environmental consequences, protection and compatibility, supply and prices are all important considerations when choosing an operating liquid. The kinds of working fluids, the effect of latent heat, density, and actual heat, and the overheating efficiency are all covered in this article.. Superheating is needed for moist fluids in organic Rankine cycles. In the case of dry fluids, superheat may have a detrimental impact on cycle efficacy. Fluids with low critical temperatures and pressures are good candidates for the supercritical Rankine cycle.

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

INTRODUCTION

A thermodynamic cycle is a connected series of thermodynamic processes that include the movement of heat and work into and out of a system while changing pressure, temperature, and other state variables, and that ultimately restores the system to its original condition. The working fluid (system) may function as a heat engine by converting heat from a heated source into productive work and disposing of the leftover heat to a cool sink while going through a cycle.

The cycle may also be reversed, with labor being used to transport heat from a cold source to a warm sink, thus functioning as a heat pump. The system is in thermodynamic equilibrium at all times throughout the cycle, making it reversible (its entropy change is zero, as entropy is a state function).Part of the world's energy demand will be met by renewable energy sources such as thermal and geothermal energy sources, as well as a large amount of industrial waste heat. Traditional ways of generating electrical power, on the other hand, are unable to efficiently convert the moderate temperature heat generated by these sources, resulting in huge quantities of moderate temperature heat being wasted [1]. In this instance, research into how to convert this low-quality heat source into energy is of great importance.

The organic Rankine cycle, the supercritical Rankine cycle, the Kalina cycle, the Go swami cycle, and the three-way flash cycle are among the thermodynamic cycles suggested and studied for converting low-quality heat sources into electricity[2]. Despite widespread claims that Kalina cycles have 15 to 50 percent higher heat induction than organic Rankine cycles, data shows that the difference in efficiency for the Kalina loop is only three percent in real operating cycles and simulations under the same atmospheric temperature and cooling system conditions. The biological Rankine cycle, on the other hand, is much less complicated and needs less maintenance [3].The Figure 1 shows the sketch of the Rankine cycle.

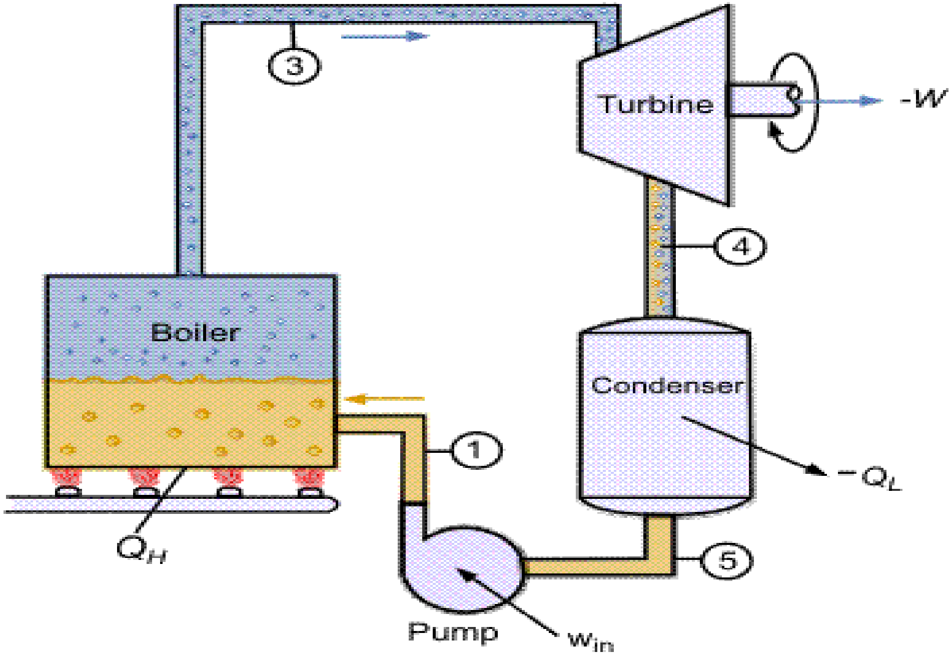

Figure 1:Rankine Cycle[4]

The fundamental working cycle of all power plants is the Rankine cycle, in which the operating fluid continually evaporates and condenses [5]. The working fluid used is mainly determined by the temperature range available. Pressure-enthalpies (p-h) and temperature-entropy (t-e) are used to depict this loop (T-s). The Rankine cycle operates in the following stages:

Isobaric Heat Transfer 1-2-3 The feed pump delivers high-pressured liquid that has been heated to saturation temperature. More energy is incorporated into the liquid, allowing it to evaporate before being fully transformed to saturated steam.

Expansion 3-4 Isentropic. In the turbine, the steam is expanded to produce work that may be converted to electricity. As the process moves into the two-phases region, the expansion is limited by the temperature of the coolant medium and the corrosion of the turbine blades caused by the liquid training in the vapour flux. The quality of the exit vapour should be more than 90%.

4-5 Isobaric Heat Rejection The vapor-liquid combination left by the turbine (4) is condensed at a low pressure in a surface condenser, usually with cooling water. In properly-built and operated condensers, the vapour pressure is far below ambient pressure.

Isentropic compression of 5-1. The condensate pressure in the feed pump has been increased. Pump effort is generally low due to the tiny real volume of liquids, therefore thus is often ignored in thermodynamic measurements.

Many application cycles have previously been discovered after the researchers developed and tested variants of the Rankine heat transfer cycles into electricity. However, there is still more to be learned in terms of improving output and lowering prices. This is a side-by-side comparison of the two periods.

Organic Rankine Cycle: The organic rankine cycle (BRC) is based on the steam rankine cycle principle, but it recovers heat using organic working fluids with low boiling temperatures. In a T-s diagram, an ORC structure and operations are shown. The loop includes an expansion turbine, a condenser, a pump, a boiler, and a superheater. Superheat is required. Pure working fluids such as HCFC123 (CHCl2CF3), PF5050(CF3(CF2)3CF3), HFC-245,fa (CH3CH2CHF2), HFC-245,ca, isobutene, n-pentane, and flavored hydrocarbons (CH3), isobutene ((CH3) 2C55H2) [6]. Fluid mixes were also proposed for organic rankin cycles[7].

Water characteristics are prevalent in chemical job fluids. The slope of the job fluid saturation curve in a T-s graph may be positive (e.g. isopentane), positive (e.g. R22), or vertical (e.g. R11), indicating that the fluids are warm, dry, and isentropic. Wet fluids, such as water, are often overheated, while many dry or isentropic organic fluids do not need to be. Another advantage of organic fluids is that the ORC turbine often only needs a single phase expander, resulting in a smoother, less expensive approach[8].

Supercritical Rankine Cycle: To achieve a better thermal balance with the supply of heat, working fluids with low critical temperatures and pressures should be compressed at supercritical pressures and heated till expansion. The T–s diagram depicts the structure and process of the CO2 supercritical Rankine cycle. The supercritical rank-in process isn't as straightforward as a two-phase area. The Rankine organic cycle produces a tighter thermal fit with less irreversibility. The supercritical Rankine cycle R143a and the standard organic Rankine cycle R152a both have the same thermal limit[9].

By establishing a set of assumptions, thermodynamic cycles may be utilized to simulate actual devices and systems. It is often essential to simplify assumptions in order to reduce an issue to a more manageable size. For example, a gas turbine or jet engine may be represented as a Brayton cycle, as illustrated in the diagram. The device itself is made up of a number of steps, each of which is represented as an idealized thermodynamic process in its own right. Despite the fact that each stage that interacts with the working fluid is a complicated actual device, it is possible to describe it as an idealized process that approximates its real behavior. If energy is provided by methods other than combustion, it is assumed that the exhaust gases will be transferred from the exhaust to a heat exchanger, which will sink the waste heat to the environment and reuse the working gas at the intake stage.

It's possible that the gap between an idealized cycle and real performance is substantial. The following Figure 2, for example, show the discrepancies in work output predicted by an ideal Stirling cycle and real Stirling engine performance:

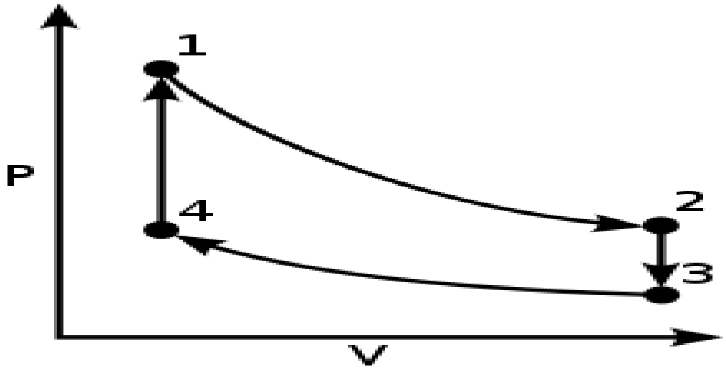

Figure 2: Deal Stirling Cycle

LITERATURE REVIEW

For variable temperature thermal sources, there is no one-size-fits-all fluid. Choices must be taken while selecting fluids. The critical temperature and the fluid's j value are important characteristics that indicate the time and working temperature of the fluid that can be supplied by the fluid, according to the authors [10].

DISCUSSION

For variable temperature thermal sources, there is no one-size-fits-all fluid. Choices must be taken while selecting fluids. The critical temperature and the j value of the fluid, according to the authors, are important characteristics that indicate the time and working temperature of the fluid that can be supplied by the fluid.Among the thermodynamic cycles proposed and researched for converting low-quality heat sources into electricity are the organic Rankine cycle, the supercritical Rankine cycle, the Kalina cycle, the Go swami cycle, and the three-way flash cycle[3]. Despite widespread claims that Kalina cycles have 15 to 50 percent higher heat induction than organic Rankine cycles, data shows that in real operating cycles and simulations under the same atmospheric temperature and cooling system conditions, the difference in efficiency for the Kalina loop is only three percent. The biological Rankine cycle, on the other hand, is simpler and requires less upkeep . The organic rankine cycle (BRC) uses organic working fluids with low boiling temperatures to recover heat, similar to the steam rankine cycle.

An ORC structure and operations are illustrated in a T-s diagram. An expansion turbine, a condenser, a pump, a boiler, and a superheater are all part of the loop. It is necessary to use superheated water. HCFC123 (CHCl2CF3), PF5050 (CF3(CF2)3CF3), HFC-245,fa (CH3CH2CHF2), HFC-245,ca, isobutene, n-pentane, and flavored hydrocarbons (CH3), isobutene((CH3)2C55H2)[6]. For organic rankin cycles, fluid mixtures were also suggested.

Chemical work fluids have a lot of water properties.In a T-s graph, the slope of the job fluid saturation curve may be positive (e.g. isopentane), positive (e.g. R22), or vertical (e.g. R11), signifying warm, dry, and isentropic fluids. Water and other wet fluids are often overheated, while many dry or isentropic chemical fluids are not. Organic fluids also have the benefit of just requiring a single phase expander in the ORC turbine, resulting in a smoother, less costly approach.

Working fluids with low critical temperatures and pressures should be compressed at supercritical pressures and heated till expansion to create a better thermal balance with heat supply. The structure and operation of the CO2 supercritical Rankine cycle are shown in the T–s diagram. The supercritical rank-in process is more complicated than that of a two-phase area. With reduced irreversibility, the Rankine organic cycle provides a tighter thermal fit. The temperature limit of both the supercritical Rankine cycle R143a and the conventional organic Rankine cycle R152a is the same.

CONCLUSION

Organic rankine cycles and supercritical rankine cycles were explored for low-grade heat conversion to fuel. Organic Rankine cycles are not in compliance with the thermal sources, unlike an overly critical Rankine cycle, although the supercritical Rankine cycle usually requires greater operating pressures. The efficiency of the cycle is greatly influenced by the functional fluids. Thermodynamic and physical characteristics, durability, environmental implications, protection and performance, as well as availability and cost, are all aspects to consider when selecting a working fluid. Types of work fluids, latent heat effects, density and actual heat, and the effectiveness of superheating are all discussed in detail. Turbines with high-density working fluids and latent high heat have a high work performance. The study also discovered that isentropical and dry fluids are preferred in organic rankine cycles. Superheating is needed for moist fluids in organic Rankine cycles. In the case of dry fluids, superheat may have a detrimental impact on cycle efficacy. Fluids with low critical temperatures and pressures are good candidates for the supercritical Rankine cycle.

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