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ANALYSIS OF STEAM POWER PLANT RANKINE CYCLE EFFICIENCY ANALYSIS AT PT. PG RAJAWALI II JATITUJUH UNIT

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Abstract
Rankine cycle efficiency and rankine cycle work process at PT. PG Rajawali II Jati Tujuh Unit Adding knowledge to students about Rankine cycle in steam power generation system. To determine efficiency based on operational data. To know and understand the process of the Rankine cycle. It can be a reference and input for PT, PG Rajawali II Unit Jati Tujuh to see its efficiency. Before going into the field, we must prepare our theory according to the title such as boiler, turbine, condenser, pump example. This is a direct observation of the conditions at PT. PG Rajawali II Unit Jati Tujuh. This step is carried out to find out information about the conditions in the field and the situation where the practical work is carried out. Fractional pressure will not occur in the boiler and condenser, if the working fluid flows through the various components of a simple steam power cycle without irreversibility, and the working fluid will flow through the components at constant pressure. Dry water vapor from the boiler enters the turbine and undergoes a process isentropic expansion of the energy stored in the water vapor is converted into motion energy in the turbine. The water vapor is converted into liquid again so that it can be reused in the cycle process, PT. PG Rajawali II Unit Jati Tujuh on October 11, 2020 had the highest efficiency of 25.20%. October 22, 2020 has the lowest efficiency, which is 22.99%. Before going to the work process of the Rankine cycle, we must really understand the components related to the Rankine cycle, starting from the boiler, turbine, condenser, and pump so that we can understand and understand what the Rankine cycle is. In processing data using a help system, namely with Microsoft Excel with engineering applications, we have to ask those who know better so that in processing data with Microsoft Excel it can be actually clear in calculating it to get the values of pressure and temperature and their efficiency.

Keywords: *Rankine Cycle, Efficiency, Microsoft Excel (Engineering application)*

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Introduction

Steam Power Plant (PLTU) is the most widely used power plant in Indonesia because of its various advantages, namely it can be operated with various types of fuel, can be built with various capacities, can be operated with various construction operations, and has continuity of operation and a relatively long service life. .

In thermodynamics, a cycle means a series of thermodynamic processes involving the transfer of heat and work, followed by changes in pressure, temperature, volume, entropy and other state variables, at the end of which the system returns to its initial state. The power cycle that was first noticed was the one often used by the electric power generation industry, the power cycles were operated in such a way that the working fluid underwent a phase change from liquid to vapor. The simplest steam power cycle is the Rankine cycle. This Rankine cycle is a theoretical cycle that underlies the work cycle of a steam power plant.

The efficiency of the generator will affect the performance of the PLTU system. The greater the generator efficiency, the better the system reliability. During the 5 years of operation, it is estimated that the efficiency of the generator has decreased due to several factors such as frequent derating or tripping (unit shutdown), length of maintenance, errors in operation and maintenance and other factors. Therefore it is necessary to analyze the efficiency of the generator whether the generator is still within the limits of a reliable condition or not.

Research Method

This research was carried out in a systematic and structured manner with research procedures as shown in Figure 2.1

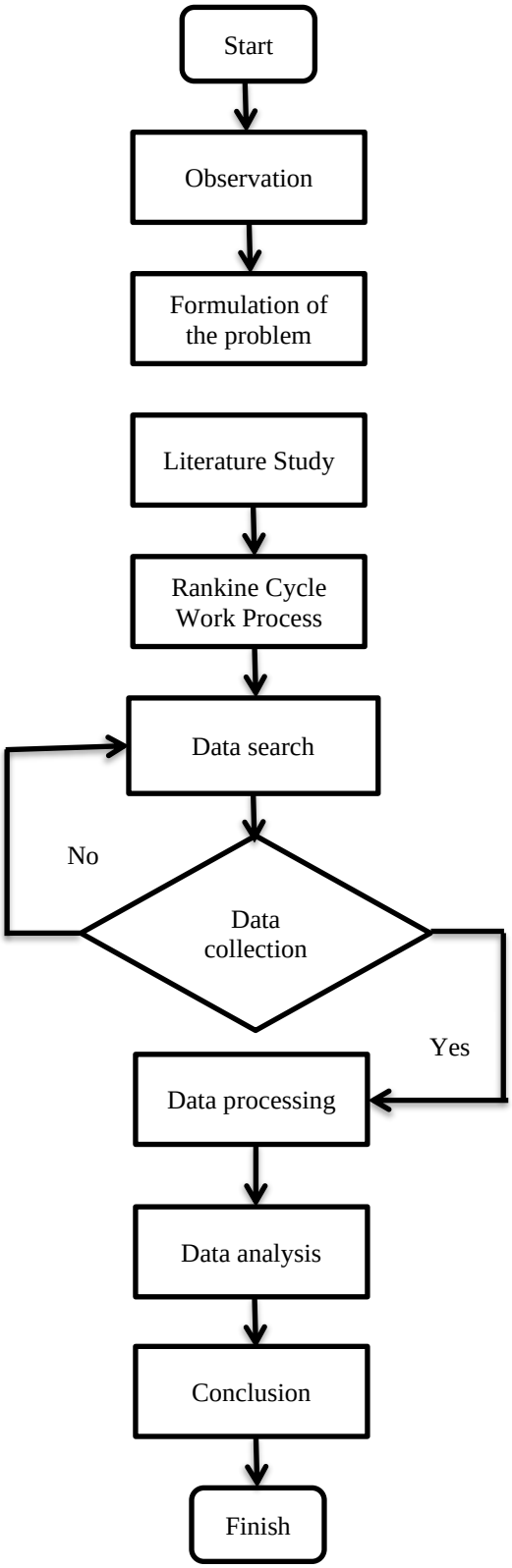

Figure 1. Research Flowchart

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Results and Discussion

3.1. Rankine cycle

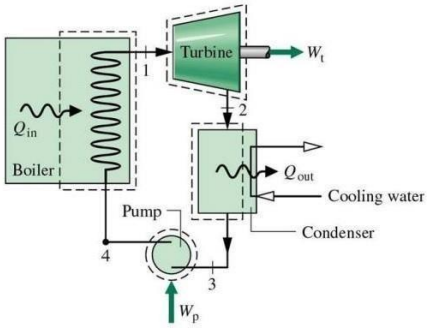

Figure 2. Steam Power Plant Cycle

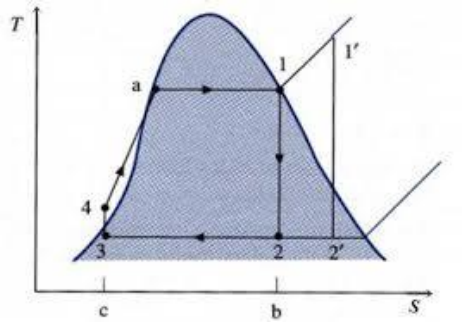

Figure 3. Ideal Rankine Cycle Diagram

The Rankine cycle is a thermodynamic cycle that converts heat into work energy. The Rankine cycle is the theoretical cycle that underlies the cyclic process in steam power plants. This Rankine cycle is not the same as the existing air cycle. This can be seen in the fluid that works in it, namely the process of evaporation and condensation. Therefore what is produced from this Rankine cycle must be steam.

Boilers

Boiler (Steam Kettle) Boiler or steam boiler is a machine device that converts water into steam. The process of changing water into steam occurs by heating the water in the pipes by utilizing the heat from the combustion of fuel.

Figure 4. Boiler engine

Steam turbine

Steam Turbine Turbine is equipment that converts heat energy in high pressure steam to rotate the shaft leading to the generator. With the kinetic energy of the steam used directly to turn the turbine.

Figure 5. Steam Turbine Engine

Condenser

The condenser is a device for changing the vapor phase into a liquid phase where in the generator it is used to convert the steam that has turned the turbine into water by means of a condensation system, the results of the condensation are accommodated in a hotwell and then pumped back to the boiler again by means of a heater. The condensation process, that is, steam is condensed into water again, so this system is usually called a closed system or closed loop.

Figure 6. Condenser Machine

Pump

Pump is equipment to flow fluid from low pressure to high pressure.

Figure 7. Pump Engine

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Data collection

Data obtained from PT. PG Rajawali II Jatipuh Unit as follows:

Table 1. Factory Data

CHECK TEKANAN	CHECK TEMPERATUR	Feed Water
New Vapor	New Vapor	Temperature °C
(Kg/Cm²)	(°C)	(°C)
20 Bar	289°C	90°C

Data processing

Factory standard efficiency and normal efficiency carried out on 1-27 October 2020 at PT. PG Rajawali II Jatipuh Unit are as follows:

Factory Operation Standard

Efficiency (η)

23,71%

Table 2. Efficiency Value

Operasi Normal	
Date	**Efisiensi (η)**
01/10/2020	23,33%
02/10/2020	24,32%
03/10/2020	24,49%
04/10/2020	24,79%
05/10/2020	24,63%
06/10/2020	24,48%
07/10/2020	24,41%
08/10/2020	24,1%
09/10/2020	24,84%
10/10/2020	24,89%
11/10/2020	25,2%
12/10/2020	25,06%
13/10/2020	24,57%
14/10/2020	25,06%
15/10/2020	24,57%
16/10/2020	24,05%

17/10/2020	23,53%
18/10/2020	23,65%
19/10/2020	23,42%
20/10/2020	23,83%
21/10/2020	23,51
22/10/2020	22,92
23/10/2020	23,68
24/10/2020	23,69
25/10/2020	24,16
26/10/2020	24
27/10/2020	24,09

After all efficiency values are obtained, the average efficiency value is 24.21% from 1-27 October 2020 at PT. PG Rajawali II Unit Jatipuh.

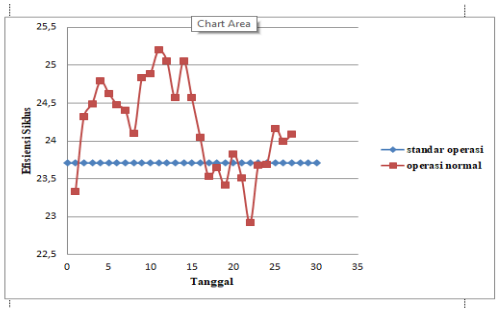

Figure 8. Efficiency Graph

The lowest efficiency at PT. PG Rajawali II Jatipuh Unit on October 22, 2020, namely η = 22.99% obtained from the new steam pressure of 24 bar or (2353.598), new steam temperature of 292°, temperature of 98° C. PT. PG Rajawali II Jatipuh Unit on October 11 2020, namely η = 25.20% obtained from a new steam pressure of 24 bar (2353.598), new steam temperature of 283°, temperature of 84° C. With an average efficiency value of 24 .21%.

Conclusion

Pressure fractionally will not occur in the boiler and condenser, if the working fluid flows through the various components of a simple steam power cycle without irreversibility, and the working fluid will flow through the components at constant pressure. Dry steam from the boiler enters the turbine and undergoes a process. Expansion isentropically the energy stored in the water vapor is converted into motion energy in the turbine. The water vapor is changed its phase to become liquid again so that it can be used again in the cycle process,

PT. PG Rajawali II Jatipuh Unit on October 11 2020 has the highest efficiency, namely η = 25.20%. October 22 2020 has the lowest efficiency, namely η = 22.99% with an average of 24.21%.

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