



Research Paper

Steam Power Plant Simulation Using Cycle Tempo: Investigation of Generator Power

M. Fardiansyah Hendratama, Fajri Vidian

Department of Mechanical Engineering, Universitas Sriwijaya

Inderalaya, Sumatra Selatan, Indonesia

Corresponding Author: fajri.vidian@unsri.ac.id

ABSTRACT : *The simulation is a method that is very popular today in predicting the performance of steam power generation systems. In this study, a simulation of a steam power plant system was carried out using the configuration of low-pressure turbine, intermediate pressure turbine and high-pressure turbine. The simulation was done thermodynamically by using cycle tempo software. The simulation results show that the intermediate pressure turbine produces more power than the other turbines. The power generator produced is between 99.9 MW to 129.9 MW.*

KEYWORDS: *Steam, Power Plant, Thermodynamic, Power, Generator*

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I. INTRODUCTION

The steam power plant system is a power generation system that is widely used both in Indonesia and the world. Indonesia uses a lot of steam power plants using coal as fuel, because Indonesia is one of the largest coal producers in the world. The construction of this power plant requires an initial planning in terms of determining the amount of fuel mass flow rate, air mass flow rate, steam mass flow rate and others to get the desired power. In addition, setting up the power system configuration is very necessary before construction. One way to get the required data is through simulation. The most appropriate simulation of the steam power generation system is through thermodynamic simulation. At this time there are many tools that can be used to simulate steam power generation systems. One such tool is the cycle tempo. Through the cycle tempo, we can determine the configuration of the steam power generation system as well as the input parameters to obtain the desired electrical power output.

Several researches on simulation of steam power plants using cycle tempo have been carried out by several researchers. Kumar et al. [1] simulated a steam power plant with coal fuel for three subcritical, supercritical and ultra-supercritical power generation systems to obtain the optimum steam extract. The simulation results show the efficiency of each configuration of 41.4%, 42.48% and 43.03%. Pal et al. [2] conducted a simulation of a conventional 250 MW power plant. The simulation results show the efficiency of the generating system is approximately 32%. Suresh et al. [3] simulated the repowering of a steam power plant with a capacity of 62.5 MWe with a pulverized coal firing system to a pressure pulverized coal firing generating system. The simulation results show that repowering will increase gross plant output by 2.6 times. Wijaya et al. [4] simulated a steam power plant with a capacity of 200 MW using a cycle tempo to see the effect of feedwater heaters operation. The simulation results show an increase in efficiency of 1.37% by improving the feed water heater. Khankari et al. [5] simulated a 500 MWe steam power plant system by adding a kalina cycle to utilize the heat lost using a cycle tempo. The simulation results show an additional 5 MWe of power from the kalina cycle. Jamel et al [6] conducted a simulation of a 200 MW steam power plant using gas fuel using a cycle tempo. The simulation results show that excess water between 5% to 10% does not affect boiler efficiency, but excess water above 10% will reduce boiler efficiency. Darmawan et al. [7] carried out a simulation of a 225 MW steam power plant to see the effect of cooling water temperature on turbine power output, the simulation was carried out using a soft ware cycle tempo. The simulation results showed that any increase in cooling water temperature would decrease the turbine output power. Karmakar et al. [8] simulated a 500 MWe steam power plant using a cycle tempo to see the effect of CO₂ Capture on the efficiency of the power plant. The simulation results show that the use of CO₂ capture will reduce the efficiency of the thermal power plant.

The results of the review show that the use of cycle tempo software to simulate steam power generation systems is very popular, especially considering the influence of operating parameters on power plant performance. In this study, a simulation of the steam power generation system was carried out to see the generator power that could be generated.

II. METHODOLOGY

The simulation is carried out on a steam power plant system with a configuration as shown in Figure 1. Where the generating system has a turbine configuration of each: high pressure turbine, intermediate pressure turbine and low-pressure turbine. The steam power plant system configuration is then made into the steam power plant system block at the cycle tempo as shown in Figure 2. The fuel used is coal with an LHV of 17780 kJ/kg.

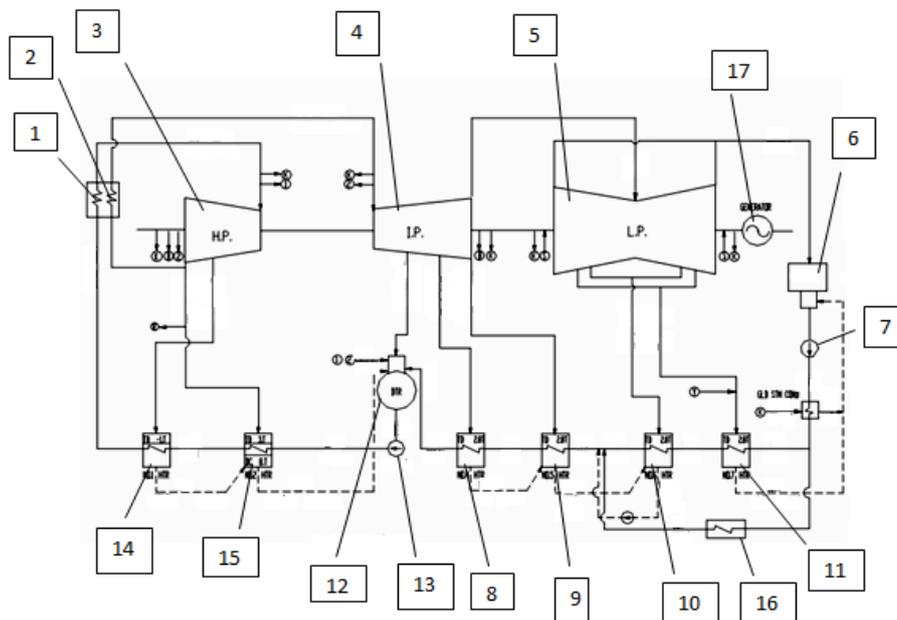


Figure 1. Steam Power Plant Configuration

Power Plant Description:

1. Boiler
2. Reheater
3. High Pressure (HP) Turbine
4. Intermediate Pressure (IP) Turbine
5. Low Pressure (LP) Turbine
6. Condenser
7. Condensate pump
8. Low Pressure Heater No. 4
9. Low Pressure Heater No. 5
10. Low Pressure Heater No. 6
11. Low Pressure Heater No. 7
12. Deaerator
13. Boiler Feed Pump
14. High Pressure Heater No. 1
15. High Pressure Heater No. 2
16. Gland Steam System
17. Generator.

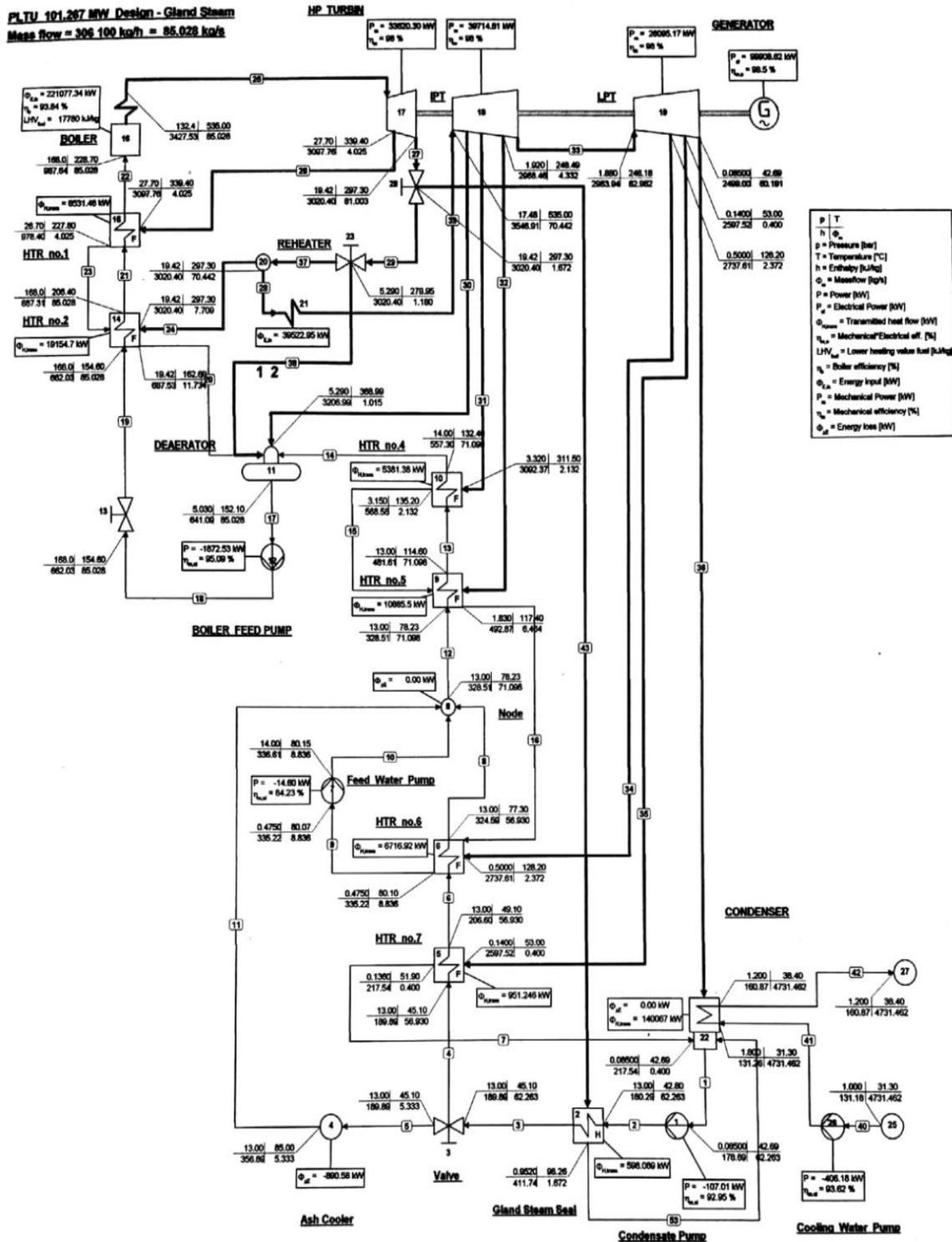


Figure 2. Steam Power Plant Configuration on Cycle Tempo

III. RESULT AND DISCUSSION

Figure 1 shows an increase in the feed water mass flow rate will increase the power of each turbine. The intermediate pressure turbine produces the most power when compared to other turbines. The total power produced by the turbine is 101.4 MW, 107.5 MW, 119.3 MW and 131.2 MW for each feed water mass flow rate of 85.03 kg/s, 90 kg/s, 100 kg/s and 120 kg/s. Furthermore, the power generated by the turbine is converted into generator power as shown in Figure 2. Increasing the mass flow rate of feed water will increase the generator power. The generator power generated for each feed water mass flow rate used is 99.9 MW, 105.9 MW, 117.9 MW and 129.9 MW.

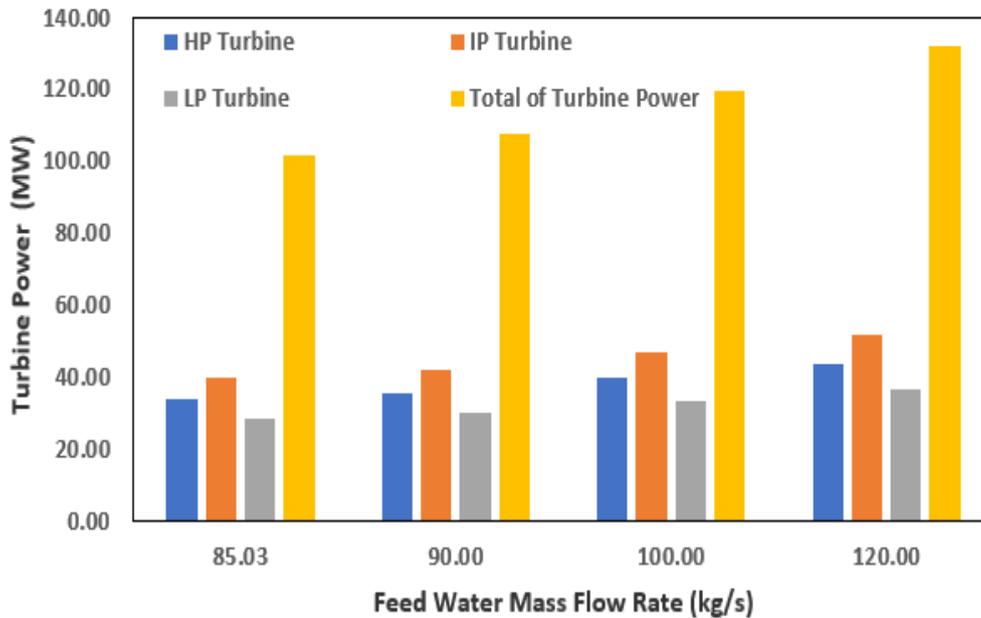


Figure 3. The effect of feed water mass flow rate on Turbine

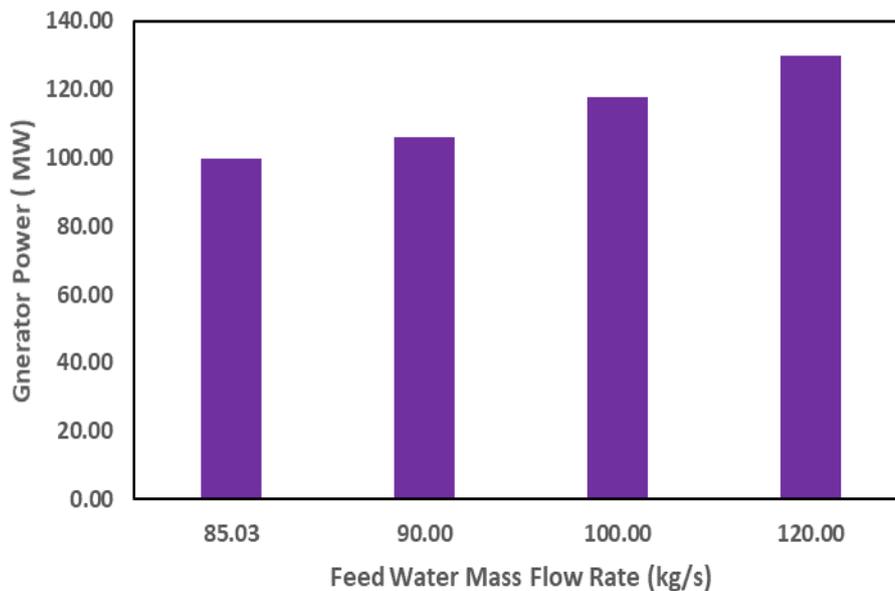


Figure 4. The effect of feed water mass flow rate on Generator Power

IV. CONCLUSION

The simulation results show that an increase in the feed water mass flow rate will increase the power of each turbine. The intermediate pressure turbine produces the greatest power. The losses of power on the process, power transfer and driven of moving auxiliary equipment cause the total turbine power cannot be fully utilized as generator power. The power was generated by the generator ranges from 99.9 MW to 129.9 MW.

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