











In terms of overhaul interval, the use of gas turbines 9E3 series is more profitable than the old technology (MS9001E gas turbines type PG9161E). Where the old technology must be overhauled every 8000 hours of operation and also produces more waste. While the new technology overhaul only every 32000 hours. Refer simply to the reference number, as in [9].

### C. Heat Rate

Reference [10] mentioned that heat rate is the amount of energy used to produce 1 kilowatt hour of electricity. The heat rate is calculated by equation 8.

$$HR (BTU/kWH) = \frac{\text{Input Energy (BTU/hr)}}{\text{output power (kW)}} \quad (8)$$

Reference [11] mentioned that the input energy is calculated by using equation 9.

$$\text{Input Energy (BTU/h)} = \text{Fuel flow (lb/hr)} \times \text{Fuel heating value (BTU/lb)} \quad (9)$$

Reference [8] mentioned input energy from the data obtained, the 9E3 (Advanced Extendor Combustor and Advanced Gas Path) gas turbines are 52187 Lb / hr and fuel heating value (LHV) of 20719 BTU / Lb. So the input energy can be calculated by using equation 9.

$$\begin{aligned} \text{Input Energy (BTU/h)} &= \text{Fuel flow (lb/hr)} \times \text{Fuel heating value (BTU/lb)} \\ &= 52187 \text{ (lb/hr)} \times 20719 \text{ (BTU/lb)} \\ &= 1.081.262.453 \text{ BTU/hr} \end{aligned}$$

The amount of input energy is 1,081,262,453 BTU /hr, and the heat rate can be found using equation 8. Where the output of gas turbine 9E3 series (Advanced Extendor Combustor and Advanced Gas Path) is 106,913 kW.

$$\begin{aligned} HR (BTU/kWH) &= \frac{\text{Input Energy (BTU/hr)}}{\text{output power (kW)}} \\ &= \frac{1.081.262.453 \text{ (BTU/hr)}}{106.913 \text{ (kW)}} \\ &= 10.113 \text{ (BTU/kWH)} \end{aligned}$$

Based on the calculation, the heat rate was obtained using a series of 9E3 (Advanced Extendor Combustor and Advanced Gas Path) gas turbines of 10.113 (BTU / kWh). While the heat rate of the data obtained using the MS9001E type PG9161E gas turbine is 10.854 BTU / kWh. The heat rate results obtained using gas turbines (old technology) are greater than gas turbines (new technology).

Reference [12] mentioned that further the simulation which has been performed previously has shown that the

combustion process in new technology results more than the previous technology.

## V. CONCLUSION

1. The gas turbine series 9E3 (Advanced Extendor Combustion and Advanced Gas Path) produces a larger output of 16,306 kW, than using gas turbine type MS9001E.
2. The gas turbines in series 9E3 (Advanced Extendor Combustor and Advanced Gas Path) can reduce the maintenance interval to once every 32.000 hours. While the use of gas turbine MS9001E standard type of maintenance is carried out once every 8000 hours and will also produce more waste.
3. Within 12 years the maintenance duration of turbine gas (PG9161E) type requires 204 days.
4. Within 12 years the maintenance duration of turbine gas 9E3 series only takes 87 days.
5. In terms of heat rate, it was found that the heat rate of using a gas turbine type MS9001E was greater compared to the 9E3 series turbine gas.

## SUGGESTIONS

For the next research are expected to be able to calculate gas turbine efficiency before and after overhaul of the 9E3 series turbine gas.

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