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OPTIMIZING THE PERFORMANCE OF CHARGE AIR COOLER (CAC) AS A HEAT TRANSFER MEDIUM TO IMPROVE ENGINE RELIABILITY AT PT PLN NUSANTARA POWER UP ARUN

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ABSTRACT

Equipment performance is one very important thing to be maintained by a company or related agency in order to keep production or work activities running smoothly. Heat Exchanger is a common equipment that we find in many companies and related agencies. Leakage, corrosiveness is common in a heat exchanger or heat exchanger equipment. PT PLN Nusantara Power has a Charge Air Cooler (HE) as a heat exchanger medium between air for the combustion process and cooling water in each engine to help the electricity production process. For this reason, this analysis aims to see the reliability of engines 1 to 10 seen from the ratio of the effectiveness value of the calculation results to the effectiveness value of the commissioning results and compare the operational parameters in the field with the results of the hysys simulation. From the results of the calculation analysis, the highest effectiveness value on engine 3 was 92.759 % which was influenced by the ratio of the actual heat transfer rate value compared to the maximum heat transfer rate value. This result is of course as expected where the effectiveness value of the air cooler charge must be greater than 90%. Similar to engine 3, the other nine engines also have an effectiveness value of > 90%, meaning that in terms of performance the charge air cooler is still able to work optimally. In the input of hysys simulation data, a difference in data between the incoming air temperature data from the data input in hysys and operational data in the field was obtained. This can be caused by the large value of the discharge of the two flows, readings in the field, as well as the need for calibration data in the field for the reading of equipment performance indicators such as flow indications, pressure indicators, temperature indicators, and so on

Keywords : Engine, Corrosion, Heat exchanger, effectiveness, hysys

INTRODUCTION

PT PLN Nusantara Power UP Arun is a national company that uses methane gas as a raw material to produce electrical energy products. The methane gas is converted into electrical energy using gas engine technology. This machine converts the mechanical energy from the combustion of methane gas into electrical energy. This company supplies electricity needs that are prioritized for the Lhokseumawe and Bireun areas. PT PLN Nusantara Power UP Arun has a capacity of 184 MW, has 19 engines with a capacity per engine of 9.73 MW. PT PLN Nusantara Power UP Arun distributes electricity to the Aceh regional system almost 31.8% of the total electricity use in the Aceh region. A company will not produce a maximum product without being supported by adequate equipment and sufficient energy supply. Even though they have tried to produce products well, they still experience obstacles in operation such as operating production machines. This can happen due to natural factors, equipment used factors, and human factors themselves. The company is one of the projects

power plant planned by the Government and PT. PLN to overcome the shortage of power supply in the

Electricity System and support economic growth in Aceh. In supporting the electricity supply process, this company needs water sourced from Deep Wells or drilled wells, where the water is used as an auxiliary material for the process in the factory used in the engine that functions as a cooling water system and for factory consumption. The cooling system plays an important role in the operation of the Engine or engine in the Gas Engine Power Plant. Similar to PLTD, PLTMG UP Arun uses a Close Cycle cooling system to cool the lubricant, air for the combustion process, and a Jacket Cooler. There are several heat exchanger media (Heat Transfer) in the UP Arun unit, one of which is the Charge Air Cooler (CAC). 1 Charge Air Cooler (CAC) is a heat exchange medium between gaseous fluids, namely air as a fluid cooled for the combustion process with cooling water as the coolant. Cooling water & air play a very important role in optimizing engine operation. Fuel quality and cooling water quality play a big role in the engine operating to produce the expected power/load. For this reason, Charge Air coolers are expected to be able to be a medium or intermediary for cooling water and air in maintaining operating temperatures that avoid damage, leakage and unreliability. In 2022, there are several problems that arise with the Charge Air Cooler (CAC), including leaks in the CAC tubing and leaks from the CAC Seal side. This resulted in the engine having to stop operating and not produce electricity. CAC is an important piece of equipment in the operating system to help the engine operate optimally. Repair of damage to the CAC takes 1-2 days to repair. As a result, the electricity demand in the North Sumatra-Aceh area has decreased due to the engine not operating. This greatly affects the performance of UP Arun in the agility to supply electric current when needed at the time needed. On the basis of this problem, the Charge Air Cooler (CAC) needs to be evaluated related to optimizing its performance in helping the engine continue to operate optimally, so that it has an impact on the electricity supply that is not reduced due to the repair time needed to repair the Charge Air Cooler (CAC).

RESEARCH METHOD

Process Equipment Unit

The process equipment unit that will be evaluated for process performance is the Charge Air Cooler (CAC).

Equipment Performance Evaluation Design Plan

Data was taken on 10 different engines with a peak load/power of 8.8 MW.

Table 1. Specification Data of Charge Air Cooler Equipment (CAC)

Component	Data Specifications
Type HE	Shell and Tube
Diameter Tube	8.66 mm
Diameter Shell	96.25 mm
Flow Type	Counter Flow
Effectiveness (Data Commissioning)	>90%
Correction Factors	0,95

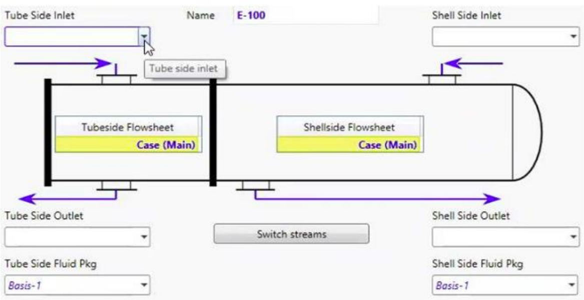

Figure 1. CAC design plan in HYSIS Simulation

Flowsheet or Process Diagram

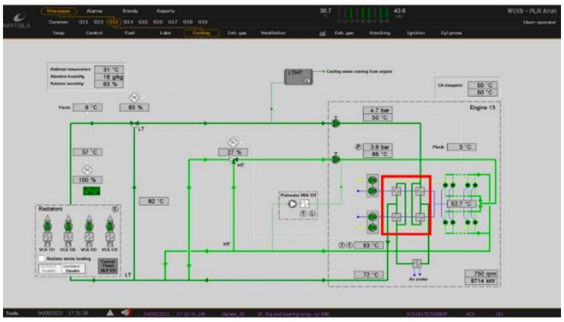

Figure 2. Flowsheet

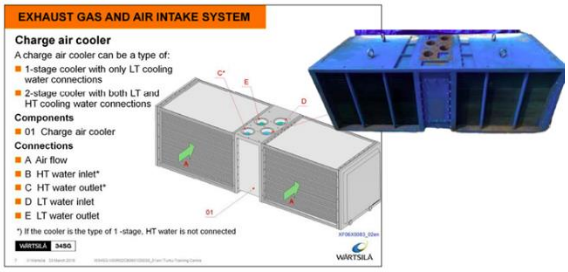

Figure 3. Charge Air Cooler (CAC)

RESULT AND DISCUSSION

Results of Operational Data Analysis

The reliability analysis of the Charge Air Cooler equipment has been completed by calculating several reliability parameters, including calculating the global heat transfer coefficient, calculating the actual heat transfer coefficient, calculating the heat capacity rate, calculating the maximum heat capacity rate, calculating the LMTD, calculating the effectiveness value, and comparing the data that has been obtained with the commissioning data. The reliability analysis of this equipment was carried out on 10 engines at PT PLN Nusantara Power UP Arun which are located in Meuria Paloh Lhokseumawe Village. The analysis data that has been obtained will later be input and suggestions for the arun plant to see the current operational parameters in order to improve engine reliability in the long term.

Table 2. Observation data Engine operation data 1 to 10

ITEM	Udara in °C	Udara Out °C	Coolant in °C	Coolant Out °C	Press Udara in (Bar)	Press Udara out (Bar)	Press Coolant in (Bar)	Press Coolant out (Bar)
ENGINE 01	256	69	51	74	3,73	3,63	4,7	3,9
ENGINE 02	249	69	51	73	3,73	3,63	4,7	3,9
ENGINE 03	231	68	52	72	3,72	3,62	4,7	3,9
ENGINE 04	238	68	51	72	3,73	3,63	4,6	3,8
ENGINE 05	234	70	52	72	3,73	3,63	4,7	3,9
ENGINE 06	233	69	52	72	3,73	3,63	4,7	3,8
ENGINE 07	225	69	52	71	3,72	3,62	4,7	3,9
ENGINE 08	241	69	52	73	3,73	3,63	4,7	3,9
ENGINE 09	238	69	51	72	3,73	3,63	4,7	3,9
ENGINE 10	241	69	52	73	3,73	3,63	4,7	3,9

The table above shows that the operational data differs across each operating engine. This data is taken based on data in the field, namely data in the

Central Control Room (CCR) which is monitored directly by the operator. From the operational data in table 4.1, data processing is carried out to calculate the global heat transfer coefficient, calculate the actual heat transfer coefficient, calculate the heat capacity rate, calculate the maximum heat capacity rate, calculate the LMTD, calculate the effectiveness value, compare the data that has been obtained with the data commissioning, and view the results of data in the field with data input in the hysis software.

Table 3. Field operational data processing

ENGINE	Th_1 (K)	Th_2 (K)	TC_1 (K)	Q_{max} (kW)	Q_{act} (kW)	ϵ (%)	ϵ (Target) (%)	TC_2 K	$\Delta T_{lm,cf}$ K	$\Delta T_{lm,st}$ K	U Kw/m².K
1	529	342	324	249,4235	227,523	91,2195	90,000	347	70,884	67,340	3,379
2	522	342	324	240,9066	219,006	90,9091	90,000	346	69,295	65,830	3,327
3	504	341	325	217,7893	198,322	91,0615	90,000	345	62,274	59,160	3,352
4	511	341	324	227,5229	206,839	90,9091	90,000	345	65,386	62,117	3,330
5	507	343	325	221,439	199,539	90,1099	90,000	345	65,537	62,260	3,205
6	506	342	325	220,2227	199,539	90,6077	90,000	345	64,051	60,849	3,279
7	498	342	325	210,4891	189,805	90,1734	90,000	344	62,167	59,059	3,214
8	514	342	325	229,9563	209,272	91,0053	90,000	346	65,917	62,621	3,342
9	511	342	324	227,5229	205,622	90,3743	90,000	345	66,618	63,287	3,249
10	514	342	325	229,9563	209,272	91,0053	90,000	346	65,917	62,621	3,342

From table 3, it can be seen that the highest effectiveness value obtained through calculation is in engine 1 with an effectiveness value of 91.2195 %. This is greatly influenced by the operational parameters of the engine/engine, especially influenced by the ratio of the actual heat transfer rate value compared to the maximum heat transfer rate value. Antioxidant Test Analysis

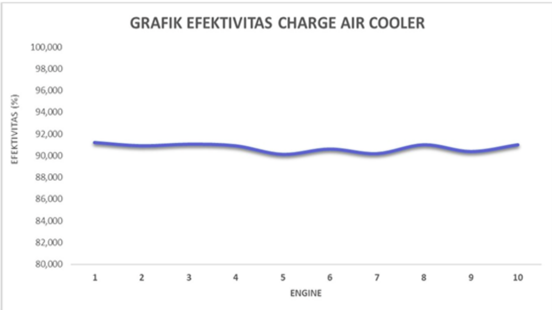

Figure 4. Engine 1 to engine 10 effectiveness graph

From the graph above, it can be seen that the entire engine, namely engines 1 to 10, has an effectiveness value close to the commissioning data, which is above 90%, this means that the ten engines, precisely engines 1 to 10 which are located in engine hall 1, are still considered to be able to work optimally in carrying out their function as a heat exchanger medium between air and water (cooling water).

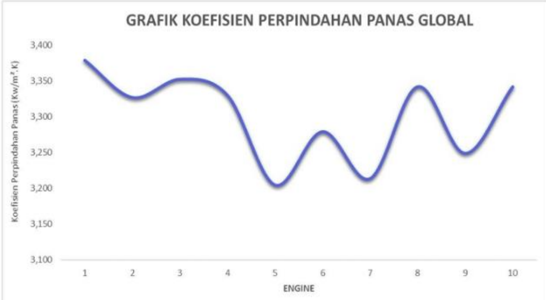

Figure 5. Global heat transfer koef graph of engine 1 to engine 10

Koef graph of global heat transfer engine 1 to engine 10 Directly proportional to effectiveness, the highest global heat transfer coefficient is also in engine 1. This can be seen in figure 5 where the value of the heat transfer coefficient is influenced by the comparison between the actual heat transfer and the average temperature difference. In addition to the calculation method, we also compare the overall operational data of engine 1 to engine 10 with simulations in hysys software. This aims to see the similarities and differences in data in the field with simulations in hysys software. In this case, operational data such as airflow discharge, cooling water discharge, outlet air temperature, cooling water inlet temperature, and 25 cooling water outlet temperatures are displayed in the input in hysys to see the comparison of simulation data with data in the field.

Table 4. Comparison of Hysis data with data in the field

ITEM	Udara in °C	Udara in Hysys °C	Udara Out °C	Coolant in °C	Coolant Out °C	Press Udara in (Bar)	Press Udara out (Bar)	Press Coolant In (Bar)	Press Coolant out (Bar)
ENGINE 01	256	255,6	69	51	74	3,73	3,63	4,7	3,9
ENGINE 02	249	247,6	69	51	73	3,73	3,63	4,7	3,9
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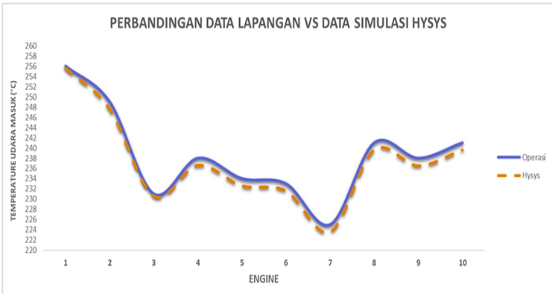

Figure 6. Graph Comparison of inlet air data in the field with hysis simulation

CONCLUSIONS

Based on the analysis of calculations in the field and hysys simulations using operational data in the field, the following conclusions are obtained:

1. The highest Charge Air Cooler (CAC) effectiveness value is in engine 1 (three) with an effectiveness value of 91.2195%. Overall, all ten engines have an effectiveness value above 90% as expected at the beginning of commissioning, which is above 90%.
2. There is a difference in the value of operational parameters between operational data in the field and the data from the hysys simulation, especially in the intake air temperature parameter which can be seen directly in table 4.
3. The performance of the Charge air cooler (CAC) of Engine 1 to 10 is still reliable judging from the calculated effectiveness value and can be seen directly in table 3.

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