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Turbine Output Power Settings Analysis on the Performance of Steam Power Plants

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Abstract---*Performance of a power plant to be more effective and efficient, the turbine output power regulation must be able to be operated with normal pressure control or sliding pressure control operating methods.*

This research was obtained by conducting two analytical calculations, namely thermodynamic analysis and direct method analysis. Process parameters needed are feed water flow, coal flow, steam flow, steam temperature, inlet pressure, HHV and SFC. The study was also accompanied by a regression analysis test to determine the significance level of the effect of parameters on the heat rate and also the thermal efficiency that was achieved.

Keywords---*Turbine output power, process parameters, thermal efficiency, heat rate.*

I. INTRODUCTION

Steam turbine as a generator drive must be controlled at a constant rotation even though the generator load changes. Turbine rotation that varies will produce the frequency of electricity from the generator varies. One indicator of a good quality of electrical energy is a stable frequency, for that it is necessary to adjust the turbine so that the rotation remains constant.

More effective turbine output power settings must also be operated with normal pressure control or sliding pressure control operating methods. Steam pressure increases with increasing load, when the load reaches 90%, the pressure reaches the rated value, at this time the system must operate on the normal pressure control method. The turbine valve must be fully opened or the turbine controller must be operated to accept the target load command.

The sliding pressure method is actually one type of the combined pressure variable operating method during low load, the unit operates with a fixed value under low pressure ie when the load is between 25% to 90%. In the turbine output power regulation system in the Ombilin power plant there is an increase in the value of the heat rate and a decrease in efficiency when the regulatory system is changed to a sliding pressure control method. This makes the operating system of PLTU units ineffective.

This final project research is to evaluate the performance (heat rate and efficiency) of each application of the two methods of regulating the output power of the turbine, the factors that influence the values of the operating parameters of the power plant unit installation. The results of this study are expected to be input for the turbine output power regulation system and the process parameters of a Ombilin steam power plant (PLTU) and other power plants in order to improve performance in the operating process.

II. LITERATURE REVIEW

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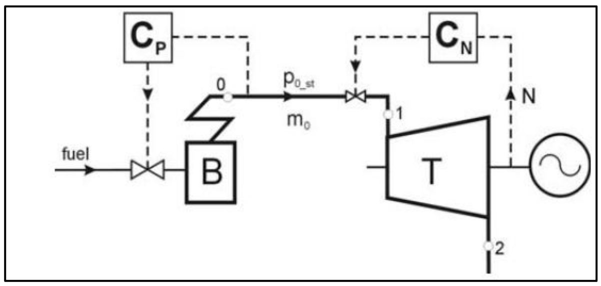
Steam turbine as a generator drive must be controlled at a constant rotation even though the load of the generator changes, there are two methods in regulating the turbine rotation, which are normal pressure control and sliding pressure control mode. Here's how to adjust the rotation of the steam turbine:

a. Normal / constant pressure control mode

The governor valve serves to regulate the amount of steam entering the turbine. The amount of steam that enters the turbine is proportional to the electric power generated by the generator if the turbine works at a constant pressure and temperature.

Steam flow rate through several valves that open simultaneously. Steam pressure control in the boiler is kept at a fixed condition. The turbine rotation control mechanism can be seen in the following figure:



Gambar 1. *Normal pressure control*

In the normal pressure control method has two control units. The first is the control of the CN turbine power which adjusts the steam flow pressure to the load demand by adjusting the governor valve opening. And the second is the Cp control to keep the pressure constant after the boiler (po, st) and adjust it to the demand for steam that will enter the turbine.

a. Sliding Pressure control method.

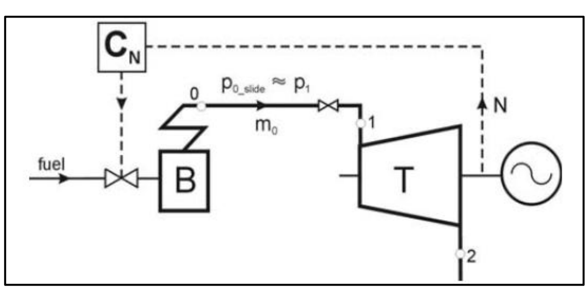
Another method used to regulate the turbine rotation is the method of regulation with a sliding pressure operation. There are two different methods in this operation, namely:

1. Adjust the turbine output power by regulating the inlet vapor pressure and the governor valve open in a fixed position.
2. Adjust the turbine output power by regulating the incoming steam pressure and adjusting the governor valve opening.

The vapor pressure before entering the turbine blade (p1) changes according to the principle of flow capacity. In the sliding pressure control method unit has only one control, namely CN, in the absence of pressure control the steam pressure after the boiler is the same as the pressure before entering the turbine blade (except for

losses caused by obstacles in the pipe). CN power control measures turbine power and works directly by adjusting fuel flow. The turbine will consume directly the amount of steam produced by the boiler.

Steam pressure in a boiler varies according to the efficiency of the steam it produces. At the same time temperature control will keep the temperature of the steam stable.



Gambar 2. *Sliding pressure control.*

Steam pressure increases with increasing load, when the load reaches 90%, the pressure reaches the rate value, at this time the operating system must be moved at constant / normal pressure. The turbine valve must be wide open or the turbine controller must be operated to receive the target load command.

Power System Performance Indicators

The power plant performance indicator is the energy (input) needed to produce one unit of electrical power output.

These performance indicators are known as:

1. Heat rate (kcal / kWh; or kJ / kWh)

There are 2 heat rate test methods, namely:

a. Input-Output Method

The input-output method is a simple, fast and inexpensive method, because it only measures the amount of coal fuel input energy consumed during the test time, which is then divided by the amount of electrical energy produced.

There are two types of Heat rate measurements, namely:

1) Gross (Gross Plant Heat Rate-GPHR): Namely the heat rate calculated using the power output in the form of kWh measured at the generator output terminal of the generator.

GPHR = Heat input / kW output (kcal / kWh).

2) Net Plant Heat Rate (NPHR): Namely the heat rate calculated using the power output in the form of kWh net measured after the generator's own use.

NPHR = Heat input / Net kW output (kcal / kWh).

b. Energy-Balance Method.

The energy-balance method requires a lot of measurement of the energy conversion process and losses arising in each part of the plant, then a complicated calculation process is carried out. But the process also has benefits that are not obtained if we carry out testing with the input-output method.

III. RESEARCH METHODOLOGY

This Final Project Research. The method in collecting data in the field is as follows.

a. Observation Method

This method is done by observing directly to the field about the object of the Ombilin Padang PLTU, in order to get a real picture of the processes that occur and obtain accurate data.

b. Interview Method

This technique is done by direct interview with the supervisor or technician in order to get a clearer and specific picture about the material to be studied.

c. Literature Study Methods

Data collection techniques by reading and studying all the literature relating to the issues discussed.

IV. DISCUSSION

A. Testing the power plant conversion system.

In this study two test methods are used to determine the performance of a power plant, namely the thermodynamic analysis method and the input and output method (direct method).

1. Thermodynamic analysis of PLTU systems

In theoretically determining the performance of a power plant, system thermodynamic analysis is needed. In determining the thermodynamic analysis required various energy conversion machine process parameters, in the appendix there are various process parameters for the PLTU system units 1 and 2. The thermodynamic analysis calculation formula is as follows:

Tabel 1. Rumus perhitungan analisa termodinamika mode sliding pressure dengan beban bruto 49,58 MW

No.	Mesin konversi energi	Rumus	Daya (MW)
1	Boiler	$Q_b = m_{16} \times (h_1 - h_{16})$	138,467
2	High pressure heater 5 (hph5)	$Q_{hph5} = m_{uap} \times (h_{17} - h_{18}) = m_{air} \times Cp_{air} \times (T_{air-in} - T_{air-out})$	3,931
3	High pressure heater 4 (hph4)	$Q_{hph4} = m_{uap} \times (h_{19} - h_{20}) = m_{air} \times Cp_{air} \times (T_{air-in} - T_{air-out})$	10,260
4	Deaerator (lph3)	$Q_{lph3} = m_{uap} \times (h_{21} - h_{21a}) = m_{air} \times Cp_{air} \times (T_{air-in} - T_{air-out})$	9,351
5	Low pressure heater 2 (lph2)	$Q_{lph2} = m_{uap} \times (h_{22} - h_{23}) = m_{air} \times Cp_{air} \times (T_{air-in} - T_{air-out})$	8,283
6	Low pressure heater 1 (lph1)	$Q_{lph1} = m_{uap} \times (h_{24} - h_{25}) = m_{air} \times Cp_{air} \times (T_{air-in} - T_{air-out})$	2,672
7	Gland steam condenser (GSC)	$Q_{GSC} = m_{uap} \times (h_{26} - h_{27}) = m_{air} \times Cp_{air} \times (T_{air-in} - T_{air-out})$	0,524
8	Kondensor	$Q_{kond} = m_7 \times (h_7 - h_8)$	54,710
9	* Turbin keluar extact 1	$W_{t1} = m_1 \times (h_1 - h_2)$	17,557
	* Turbin keluar extact 2	$W_{t2} = (m_1 - m_2) \times (h_2 - h_3)$	3,082
	* Turbin keluar extact 3	$W_{t3} = (m_1 - m_2 - m_3) \times (h_3 - h_4)$	6,897
	* Turbin keluar extact 4	$W_{t4} = (m_1 - m_2 - m_3 - m_4) \times (h_4 - h_5)$	4,198
	* Turbin keluar extact 5	$W_{t5} = (m_1 - m_2 - m_3 - m_4 - m_5) \times (h_5 - h_6)$	4,809
	* Turbin keluar extact 6	$W_{t6} = (m_1 - m_2 - m_3 - m_4 - m_5 - m_6) \times (h_6 - h_7)$	2,271
	Daya turbin total	$Wtt = W_{t1} + W_{t2} + W_{t3} + W_{t4} + W_{t5} + W_{t6}$	38,893
10	* Pompa 1	$W_{p1} = m_8 \times (h_9 - h_8)$	0,232
	* Pompa 1	$W_{p2} = m_{13} \times (h_{14} - h_{13})$	2,621
	Daya pompa total	$W_{pt} = W_{p1} + W_{p2}$	2,853
11	Daya turbin netto	$W_{tnet} = W_{tt} - AuxialaryPower$	34,563

No.	Kinerja sistem PLTU	Rumus	Satuan
1	Efisiensi konversi	$\eta_{siklus} = \frac{W_{tnet}}{Q_b} \times 100\%$	25,970%
2	Net plant heat rate (NPHR)	$NPHR = \frac{860}{\eta_{siklus}}$	3311,43 k cal/kWh

1. Analisa metode input-output (metode langsung)

Performance is the ability of an equipment in an operating system, the ability we can know from the Current / electric current used in its operation, the power generated and the efficiency of the equipment. To find out the performance of a Steam Power Plant, we can see from the Boiler's efficiency, the efficiency of the turbine-generator, the heat rate / heat and SFC. The methods used to determine performance include using the direct method

Tabel 2. Rumus perhitungan metode input output mode sliding pressure beban bruto 49,58 MW

No.	Kinerja sistem PLTU	Rumus	Satuan
1	Efisiensi boiler	$\frac{W_s * h_{main\ steam} - h_{feed\ water}}{W_f * HHV}$	76,240%
2	NPHR	$\frac{\{(\text{pemakain batubara} \times \text{HHV}) + (\text{pemakaian HSD} \times \text{nilai kalor HSD})\}}{(\text{produksi listrik bruto - pemakaian sentral})}$	3330,65 k cal/kWh
2	SFC	$\frac{\text{Jumlah b. bakar pada suatu periode waktu (kg)}}{\text{produksi kWh generator pada suatu periode waktu}} (\text{kg/kWh})$	0,52 kg/kwh
3	Effisiensi thermal siklus	$\eta_{siklus} = \frac{860}{\text{NPHR}} \times 100\,\%$	25,82%

A. Discussion of the results of thermodynamic calculations and analysis

Based on the process parameter data and the results of the previous thermodynamic analysis calculations, tables and graphs a

Table 3. Data from the thermodynamic calculation of sliding pressured mode applications and normal pressure Ombilin unit 2 power plant system

No.	Tanggal	Daya Bruto teoritik	Daya Netto teoritik	Heat Rate teoritik	Steam flow	Temp Steam	Inlet Pressure	Coal Flow	Flow HSD	Feed Water Flow	vacuum	PS (MW)	Effisiensi Siklus (%)
1	12/01/2017	38,81	33,44	3311	180	512	50	25	6861	188	117,00	5,37	25,97
2	30/01/2017	42,34	37,09	3229	195	516	50	27	0	194	118,00	5,25	33,93
3	27/01/2017	38,69	33,44	3641	175	521	50	26	0	197	117,00	5,25	23,62
4	26/01/2017	38,17	32,84	3290	179	512	50	25	0	179	117,00	5,33	26,14
5	21/02/2017	40,76	35,47	3481	179	508	50	26	0	194	110,00	5,29	22,16
6	25/01/2017	37,21	31,88	3769	178	516	50	25	0	197	115,00	5,33	22,82
7	16/02/2017	41,42	36,17	3247	186	514	63	27	146	194	94,00	5,25	26,49
8	13/01/2017	38,38	32,92	3411	187	502	50	30	0	191	117,00	5,46	25,21
9	10/02/2017	45,54	40,00	3017	182	493	52	29	1508	200	109,00	5,54	28,51
10	24/01/2017	41,16	35,57	3522	188	501	52	28	0	204	118,00	5,58	22,57
11	17/02/2017	59,15	53,40	2920	225	511	70	32	729	237	99,00	5,25	29,45
12	18/02/2017	58,40	52,48	2798	230	508	83	31	426	238	102,00	5,92	30,74
13	28/02/2017	57,21	51,42	3000	221	520	83	33	0	243	99,00	5,79	28,67
14	26/02/2017	61,45	55,62	2867	239	514	84	34	464	253	95,00	5,83	30,00
15	16/03/2017	58,68	52,72	3186	230	514	84	37	0	260	100,00	5,96	26,99
16	04/04/2017	56,87	51,16	3251	227	515	96	32	193	260	100,00	5,71	26,45
17	01/03/2017	57,42	51,54	2986	224	517	83	31	0	243	98,00	5,88	28,80
18	04/03/2017	59,43	53,56	3039	232	513	83	38	0	254	94,00	5,88	28,30
19	03/03/2017	63,87	57,96	2695	242	516	84	39	0	242	100,00	5,92	31,91
20	05/03/2017	58,28	52,37	3057	227	516	83	39	0	251	96,00	5,92	28,13
21	02/09/2016	73,43	67,47	2280	296	489	69	39	0	248	120,00	5,96	37,72
22	24/02/2017	65,62	65,62	2781	278	511	85	37	608	287	100,00	6,13	30,93
23	09/11/2016	99,80	93,88	2348	387	518	90	45	47	355	133,00	5,92	36,63
24	07/11/2016	94,31	87,86	2604	386	501	91	49	0	394	132,00	6,45	33,02
25	06/11/2016	86,34	79,72	2709	361	502	91	47	0	361	130,00	6,63	31,75
Average		**56,51**	**51,02**	**3057,51**	**233**	**510**	**71**	**33**	**439**	**243**	**109,20**	**5,71**	**28,68**
Normal pressure		103,21	97,29	2329	375	510	100	39	0	386	90,50	5,54	36,93

B. Pembahasan hasil perhitungan dan analisa metode langsung.

Based on the process parameter data and the results of direct method analysis calculations previously obtained data tables and graphs to analyze the performance of the application of sliding
pressure mode at the Ombilin power plant unit 2.

Table 4. Process parameter data and the results of direct method calculation in the sliding pressure mode and normal pressure system of the Ombilin power plant unit 2

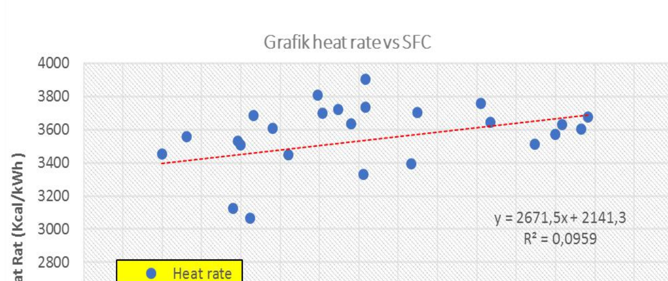
No.	Tanggal	Beban Bruto (MW)	Beban Netto (MW)	NPHR kcal/kWh	Coal Flow ton/h	Flow HSD liter	Effisiensi silks (%)	SFC kg/kWh	PS (MW)	η boiler (%)	HHV BB kcal/kg	HHV HSD kcal/liter
1	12/01/2017	49,58	44,21	3331	25	6861	25,82	0,52	5,37	76,24	5700	9000
2	30/01/2017	50,30	45,00	3703	25	0	23,22	0,53	5,25	71,37	6200	9000
3	27/01/2017	50,50	45,21	3810	26	0	22,57	0,51	5,25	59,94	6700	9000
4	26/01/2017	51,10	45,79	3688	25	0	23,31	0,49	5,33	64,41	6700	9000
5	21/02/2017	51,20	45,92	3610	26	0	23,82	0,50	5,29	66,17	6500	9000
6	25/01/2017	51,62	46,29	3558	25	0	24,17	0,48	5,33	65,91	6700	9000
7	16/02/2017	51,90	46,67	3721	27	146	23,11	0,51	5,25	65,32	6500	9000
8	13/01/2017	52,10	46,67	3395	30	0	25,33	0,53	5,46	71,10	5700	9000
9	10/02/2017	53,00	47,46	3646	29	1508	23,58	0,55	5,54	64,35	5900	9000
10	29/03/2017	53,29	47,71	3903	28	0	22,03	0,52	5,58	61,23	6700	9000
11	17/02/2017	62,00	56,25	3736	32	729	23,01	0,52	5,25	62,27	6500	9000
12	18/02/2017	63,50	57,58	3511	31	426	24,49	0,49	5,92	68,08	6500	9000
13	28/02/2017	65,04	59,25	3699	33	0	23,24	0,51	5,79	60,78	6600	9000
14	26/02/2017	65,54	59,71	3638	34	464	23,63	0,52	5,83	65,74	6400	9000
15	16/03/2017	65,60	59,63	3573	37	0	24,07	0,57	5,96	64,79	5700	9000
16	04/04/2017	65,90	60,17	3534	32	193	24,33	0,49	5,71	63,48	6600	9000
17	01/03/2017	66,30	60,46	3454	31	0	24,89	0,47	5,88	64,26	6700	9000
18	04/03/2017	66,40	60,50	3679	38	0	23,37	0,58	5,88	62,52	5800	9000
19	03/03/2017	67,10	61,17	3603	39	0	23,86	0,58	5,92	66,91	5700	9000
20	05/03/2017	67,50	61,58	3634	39	0	23,66	0,57	5,92	61,01	5800	9000
21	02/09/2016	70,90	64,99	3759	39	0	22,88	0,55	5,96	69,77	6250	9000
22	24/02/2017	73,70	67,58	3449	37	608	24,93	0,50	6,13	70,82	6300	9000
23	09/11/2016	92,75	86,83	3127	45	47	27,50	0,49	5,92	85,21	6000	9000
24	07/11/2016	94,30	87,82	3515	49	0	24,46	0,56	6,45	73,86	5800	9000
25	06/11/2016	95,80	89,13	3067	47	0	28,04	0,49	6,63	76,06	5800	9000
Average		**63,88**	**58,14**	**3574**	**33**	**439**	**24,13**	**0,52**	**5,71**	**67,26**	**6230**	**9000**
Normal pressure		103,21	97,29	2329	39	0	36,93	0,50	5,54	78, 97	6876	9000

Based on the analysis of the calculation results and discussion of the turbine output power settings that use sliding pressure and normal pressure modes, then to simplify the explanation, two summary tables of correlation between various process parameters and performance performance in unit 2 of the Ombilin Sawah lunto Padang power plant are made.

Abjad	Variabel (x)	Variabel (y)	Persamaan regresi linier y = a + b X	Nilai b	Koefisien korelasi (R^2)	Hubungan antar variabel	Nilai Korelasi kedua variabel
a	Feed water flow	Steam flow	y = 1,0549x-22,908	(+)	0,9376	searah	Signifikan
b	Feed water flow	Daya bruto	y = 0,302x – 16,63	(+)	0,9317	searah	Signifikan
c	Feed water flow	Daya netto	y = 0,2997x – 21,541	(+)	0,9327	searah	Signifikan
d	Feed water flow	Inlet pressure	y = 0,2363 + 14,189	(+)	0,6686	searah	Signifikan
e	Feed water flow	Temperature steam	y = -0,012x + 513,36	(-)	0,0087	berlawanan	Tidak signifikan
f	Feed water flow	Coal flow	y = 0,1001x + 8,296	(+)	0,7920	searah	Signifikan
g	Coal flow	Steam flow	y = 0,1001x + 8,296	(+)	0,8053	searah	Signifikan
h	Coal flow	Daya bruto	y = 2,4289x – 23,481	(+)	0,7810	searah	Signifikan
i	Coal flow	Daya netto	y = 2,4289x – 23,481	(+)	0,7810	searah	Signifikan
j	Coal flow	Heat rate	y = -41,688x + 4446,8	(-)	0,6350	berlawanan	Signifikan
k	Feed water flow	Heat rate	y = -4,7554x + 4214,2	(-)	0,5666	berlawanan	Signifikan

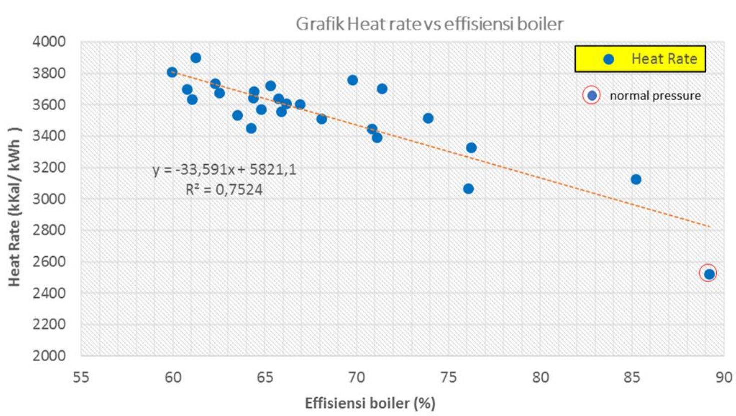
Tabel 6 Data ringkasan hasil perhitungan analisa metode langsung aplikasi mode sliding pressure sistem PLTU Ombilin 100 MW

Abjad	Variabel (x)	Variabel (y)	Persamaan regresi linier y = a + b X	Nilai b	Koefisien korelasi (R^2)	Hubungan antar variabel	Nilai Korelasi kedua variabel
a	Coal flow	Beban bruto	y = 1,9582x – 0,0111	(+)	0,7953	searah	Signifikan
b	Coal flow	Beban netto	y = 1,9105x – 4,1603	(+)	0,7878	searah	Signifikan
c	Coal flow	Heat rate	y = -17,118x + 4105,1	(-)	0,1860	berlawanan	Tidak signifikan
d	HHV	SFC	y = -6E-05x + 0,8664	(-)	0,4767	berlawanan	Tidak signifikan
e	Heat rate	SFC	y = 2671,5x + 2141,3	(+)	0,0959	searah	Tidak signifikan
f	Heat rate	Effisiensi boiler	y= -33,591x + 5821,1	(-)	0,7524	berlawanan	Signifikan



Example 1. Analysis of the graph between Heat rate vs. SFC, From the figure it is known that the linear regression equation that is formed is the value of b is always positive (+), namely: y = 2671.5x + 2141.3, from the equation shows a direct relationship that is the greater the value of SFC (specific fuel consumption) or the use of specific fuels in the combustion process in the boiler it will further increase the value of the heat rate of an ombilin power plant. Value correlation coefficient (R2) = 0.0959 indicates a weak (not significant) relationship between the two variables, meaning that the use of specific fuels in sliding pressure mode applications hardly affects the heat value of the ratio.

The SFC value in normal pressure applications is 0.50 kg / kwh which is almost the same as the SFC value of sliding pressure applications that is 0.52 kg / kwh.

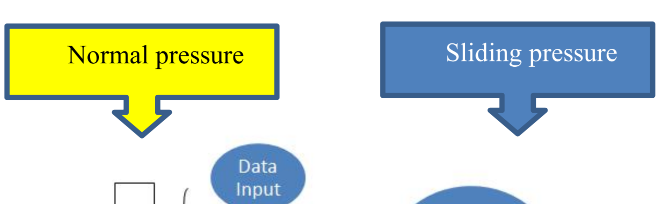


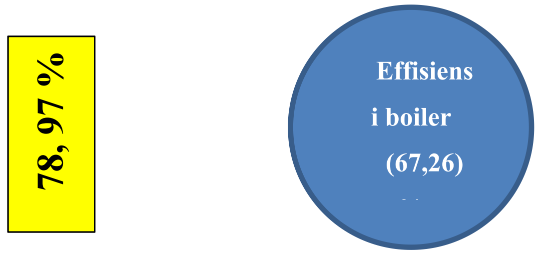
Gambar 4. Grafik *Heat rate* vs effisiensi boiler

Example 2. Analysis of the graph of the relationship between Heat vs. boiler efficiency, from the figure it is known that the linear regression equation formed is the value of b is always negative (-), namely: y = -33,591x + 5821.1

From the equation shows the opposite relationship that is increasing boiler efficiency in the PLTU system will further reduce the value of the heat rate, and vice versa. With the value of the correlation coefficient (R2) = 0.7524 shows a fairly strong relationship between the two variables.

Basically boiler efficiency is a parameter of boiler work performance in each generation, many factors affect boiler efficiency, and will be discussed in the figure and analysis below





Gambar 5. Effisiensi boiler pada saat kondisi normal pressure dan sliding pressure

1. The efficiency of boiler unit 2 decreases by 12% when the output power setting mode is changed from sliding pressure to normal pressure mode. This reduction is said to be very large because when viewed from the commissioning conditions in 1996 the efficiency of this boiler could reach 89.19%. This decrease can also be caused by many things, here are the factors that influence the reduction in the efficiency of the boiler.
2. 1. The rate of clean air supplied through the air heater. Boilers must be operated with an air flow rate that is more than the theoretical air requirements calculated based on a flue gas analysis. But too much excess air will also result in losses due to the taking up of heat by the excess air to be carried with the exhaust gas.
3. 2. Burner factor, the function of the burner is to mix the fuel and air with the proportions appropriate for the ignition of the fire and to maintain a continuous combustion condition that is running well. Incorrectly set burners will result in improper mixing of air and fuel and at each loading rate will increase the need for excess air and waste fuel so the boiler efficiency will decrease.

4. The combustion air temperature is also a factor that affects the efficiency of the boiler, combustion air temperature can be increased by utilizing high exhaust gas temperatures through the air heater.

5. Fouling is a major factor affecting boiler efficiency. Fouling is the occurrence of deposits or crust on the surface of heat transfer which can result in inefficiency of the combustion results resulting in high exhaust gas temperatures.

6. Slagging occurs in the coldest part of the boiler. On that surface, inorganic volatile condensate will stick and form a deposit. In addition, the particles that melt will cool and form deposits on the coldest surface of the boiler

7. Blowdown also influences boiler efficiency.

8. Sediment formed in the tube wall on the water side can reduce efficiency and even crust can damage the tube due to over heating. These deposits are caused by high concentrations of suspended solids and dissolved solids, which can also cause foam formation to cause carry over. Therefore the concentration of solids must be maintained under certain conditions, and this is done by a blowdown process, where the water is discharged out and immediately replaced by boiler feed water. Because blowdown is water that is released in a high temperature state, this is a heat dissipator which results in a decrease in efficiency.

9. The next factor is the use of condensate, if water vapor provides thermal energy into a process system, the heat absorbed by the process is generally its latent heat, while the condensate that still carries heat.

Based on the results of analysis, calculations and industry visits in the field, to improve the performance of the Ombilin power plant system it is recommended:

1. Periodic checks on the specification of the instrument (instrument) both on the boiler component and turbine-generator will be able to help in achieving better thermal efficiency. Because with regular checks will make it easier to find problems that will then be quickly resolved.

2. Minimizing various causes of boiler efficiency decline by carrying out routine maintenance and periodic repairs so that boiler efficiency is maintained and the boiler's performance can work optimally in producing steam

3. The need for further research on the performance of the boiler by applying the indirect method (Indirect Method) in order to find out the cause of the lower system efficiency by calculating the heat loss in each boiler component.

V. CONCLUSIONS

1. Based on the analysis of the calculation results and discussion of the turbine output power settings using sliding pressure and normal pressure modes, it can be concluded that:
2. Ombilin Power Plant has applied the turbine output power control application with both modes, namely sliding pressure mode which is actually one type of combined-pressure operating mode during low load, ie between the gross load of 49.58 MW - 95.80 MW , then switches to normal pressure mode when the pressure reaches the rated value, and the gross load is 103, 21 MW.
3. 3. There is an increase in the NPHR (net positive heat rate) value if the system setting is changed from normal mode prssure to sliding mode prssure.
4. 4. Process parameters that affect the decreasing heat rate due to the sliding pressure mode application are the increased flow rate of coal fuel. This increase was caused by several factors including the increased consumption of feed water flow. The heat energy obtained from the combustion is then transferred to the feed water in the boler to produce steam.
5. Based on the direct method analysis table data (input-output method) above it can be concluded that:
6. 1. An increase in the value of the heat rate of 1245 kcal / kwh when changing the turbine output power system from the normal pressure mode to the sliding pressure mode, this decrease is caused by several factors including the unpreparedness of the boiler unit in applying the sliding pressure mode by showing a 12% reduction in efficiency. this decrease can be caused by many things such as:
7. The rate of clean air supplied through the air heater
8. Burner factor in the boiler unit
9. Combustion air temperature
10. Oul Fouling factor
11. Slagging factor

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