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OPTIMIZATION OF COGENT PLANT STEAM SUPPLY INTEGRATED WITH PLC CONTROL SYSTEM IN PT. MNA KUALA TANJUNG

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ABSTRACT

Economic dispatch is often used in general to solve the problem of optimizing the fuel consumption of the electric power system, which focuses on developing optimization methods for a generation system. SCADA/PLC is used so that Economic Dispatch can run in real time on a system. In this research, an automation system will be designed that integrates Economic Dispatch into PLC in a generating system of 3 production boilers operating simultaneously (Cogent System) which aims to ensure that the Economic Dispatch system can run in real time. The simulation results show that the Economic Dispatch program on the PLC can run well. In the simulation of a steam load of 76 MT, the optimal value for boiler 1 is 45 MT and for boiler 3 it is 31 MT while in boiler 2 it is 0 MT, with the opportunity to save boiler fuel use by 16.8% and steam production cost can be reduced by 10% from its initial value.

***Keywords**: Economic Dispatch, PLC Integration, Fuel Optimization.*

INTRODUCTION

Fossil energy is a non-renewable natural resource. Oil, gas and coal mining activities will continue to reduce the availability of these resources (Ir. Wijono Ph.D., Dheo Kristianto., Hadi Suyono, ST., MT., Ph.D 2014). In the end, this condition will lead to an energy crisis which will certainly have an impact on the ability of the economic system to produce products and services and can also increase the cost of energy itself (Kanata 2017). The increase in energy costs in the components of production costs in industry will certainly cause its own problems for companies.

In an effort to prevent this energy crisis, the world has taken anticipatory steps by making several policies(Martha Dewa 2016). One example is the issuance of a standard system that regulates energy management in ISO 50001 (Energy Management System) and ISO 50002 energy audit. Indonesia issued a policy on energy, namely Law no. 30 of 2007 on energy, PP no. 70 of 2009 on energy conservation and the 2014 Government Regulation on National Energy Policy(ESDM 2009)(ESDM 2014)(SKKNI 2015).

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PT. MNA Kuala Tanjung is a company engaged in manufacturing palm oil processing. The company has also implemented ISO 50001 since 2012. In its operation process, the company uses a variety of energy according to the needs of existing equipment. Steam (thermal) and electrical energy are the most significant types of energy use. In 2018 steam energy was used for 76.5% of the total energy used, while electricity was in second place with 20.3% of the total energy. Other energy used, such as fuel oil and biogas, is used only by 3.2%. Calculation of economic operations or Economic Dispatch with iteration method using a computer. This is because the computer is able to speed up the iteration calculation process compared to manual calculations, but the use of Economic Dispatch is limited to research, so that to implement it in a process control system, the role of an operator is needed(Aruan, Siregar, and Sitepu 2013)(P. Marpaung dkk 2017).

A. Economical Operation of Power System Economic

Economic dispatch is very important for the power system to get a return on invested funds. For this reason, efficiency in reducing consumer energy costs and power generation costs is very important. Economic management includes power generation and transmission, which can be divided into two parts. One of them is related to the minimum production cost, which is called Economic Dispatch, and the other is related to the loss of power transmission transmitted to the load(Abidin, Robandi, and Wibowo 2012)(Brännlund et al. 2012).

Economical operation aims to reduce fuel consumption or operating costs by determining the output of each power generation unit under charging system conditions. In a generating unit, the Input-Output characteristics are referred to as a function of fuel consumption or a function of operating costs. thermal power generation unit, the boiler input is fuel and the output is the amount of steam(Syafii and Putri 2018). The value of the generator fuel consumption can be written as MBtu/hour, the fuel cost ratio can be written as \$/hour, and the generator output can be written as P_G(Yoshimi, Swarup, and Izui 1993).

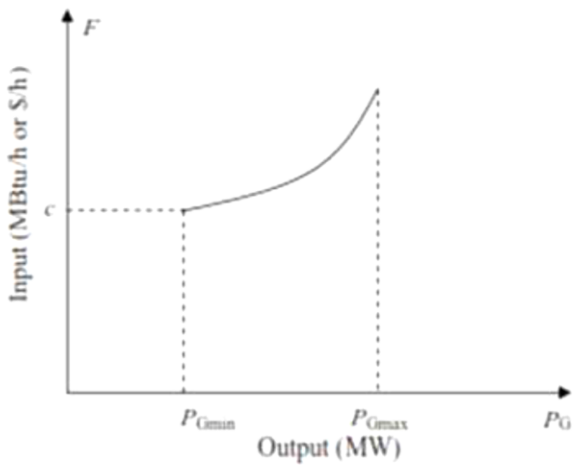

Figure 1. Input-output characteristics of the generating unit

Figure 1 describes the relationship between input and the output at the power plant shows that the fuel function is proportional to the amount of generator production with generator limits from PGMIN to P_{GMAX}. Then the value will fulfill the following equation:

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$$P_{Gmin} \leq P_G \leq P_{Gmax} \quad (1)$$

The characteristics of the input-output curve are non-linear with the following equation:

$$F = \gamma P_G^2 + \beta P_G + \alpha \quad (2)$$

Where , and are coefficient value of the input-output characteristics. The value of is the value of the fuel consumption of the generating unit without output power(Costanza and Rivadeneira 2015)(Komsiyah 2012).

B. Boiler

The boiler steam boiler or steam generator is a device used to create steam by applying heat energy to water. Although the definition is somewhat flexible, we can say that older steam generators have been called boilers and operate at low to moderate pressures (7- 2,000 kPa or 1-290 psi)(Ryashentseva et al. 2015).

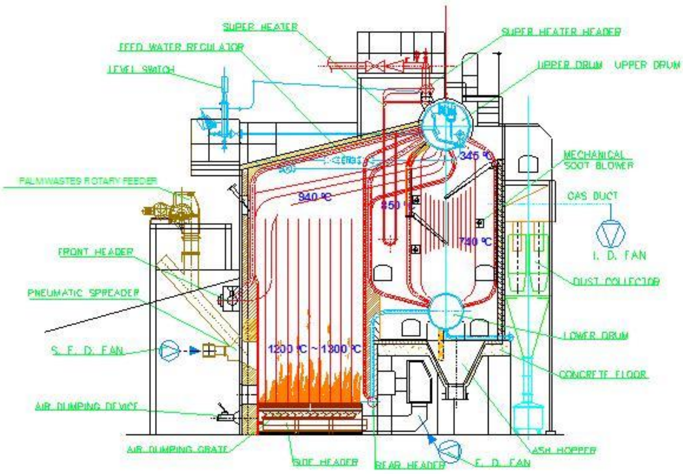

Figure 2. Illustration of Boiler – Steam Boiler

Cogent Plant System is the generation of electricity and other energy carried out simultaneously. Cogent in fuel is the use of fuel to produce heat more efficiently, because otherwise the wasted heat from power plants can be used for productive use. More thermally efficient in fuel use than standard energy production, which only produces unusable process heat, cogeneration makes better use of the heat energy generated in addition to the electricity generated.

C. PLC (Programmable Logic Controller)

A programmable logic controller (PLC) is simply a special computer device used in industrial control systems. It is used in many industries such as oil refineries, production lines and transportation systems. Whenever you need to control a device, PLCs provide a flexible way of "software linking" components(Almuhtarom and Sasmoko 2015). This research uses PLC GE Versamax Micro IC200UDR005 and HMI Simplity in Figure 3.

Figure 3. PLC GE Versamax Micro IC200UDR005

EXPERIMENTAL SECTION

Design of Economic Dispatch Boiler System

Figure 4. seen 3 boiler units that have different characteristics from one another. These three boilers use biomass fuel in the form of palm shells. These three boilers are used to carry the steam load of the system. In distribution, the steam load is divided into 2 systems, namely the 13 bar system and the 3 bar system. A PRV is used which serves to lower the steam pressure level to the desired level so that both systems can be met, at the same time this PRV can also regulate the amount of steam flow to the load. And the next step is to make a design scheme implementation of research that is integrated into the PLC. Figure 5 is an Economic Dispatch design for the Steam boiler system

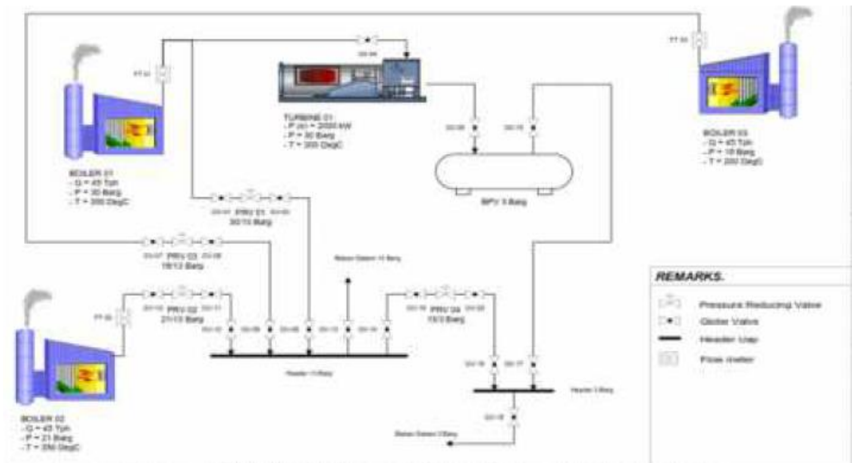

Figure 4. Economic Dispatch of the Steam Boiler system

Where :

F1, F2 & F3 : Fuel used for boilers 1, 2 and 3

B1, B2 & B3 : Steam produced by boilers 1, 2 and 3

BD : Total amount of steam load from the system

Materials and work tools.

Tools and materials used in this study are described in table 1 as follows:

Table 3. Components of tools and materials

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Names of tools and components	Function
PLC function GE Versamax Micro IC200UDR005	Tools used to integrate the economic dispatch method in the PLC
PLC GE Fanuc 2.0 Software	Software to incorporate the economic dispatch method into the PLC programming
Human Machinery Interface (HMI) cimply 7.0 Edition Software	Creating an automation system by integrating Economic Dispatch into the General Electric (GE) PLC system to see opportunities for fuel efficiency and economic aspects

Procedure

Sampling Locations And Points

The research location was conducted by PT. Multimas Nabati Asahan with the address: Access Road Inalum, Kuala Tanjung village, Batubara Regency. With a sample of bio-mass fuel in the form of palm shells and steam production for each boiler during the period July 1, 2017 to June 30, 2018

Method

The method used in this study uses the lambda iteration method to calculate the value of fuel savings and operational cost savings and integrates the PLC programming language and then simulates it into the HMI Software.

Data analysis

Data analysis was carried out using the Ms. application. Excel to get the results of the lambda method of 3 fuel usage from the boiler. And simulate in graphical form to get the values of y1, y2, and y3 on the boiler

RESULTS AND DISCUSSION

A. Results of Fuel Data and Production Data

Results of fuel data and production data after ratio analysis and data cutting which is not active in the three boilers and is re-tested after cutting the correct data seen in Table 2 :

Tabel 2. Data Production And Fuel

Boiler 1		Boiler 2		Boiler 3	
MT	**Fuel (Kg)**	**MT**	**Fuel (Kg)**	**MT**	**Fuel (Kg)**
2	726	3	1,681	9	2,318
8	1,795	8	4,476	14	3,749

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13	2,842	13	4,512	19	4,360
18	3,010	18	5,246	23	4,343
23	3,864	23	5,998	28	4,883
29	3,858	28	7,125	32	5,238
33	4,371	33	7,757	37	5,536
38	4,562	37	8,780	42	5,616
41	5,374	41	9,415	42	5,649

B. Formulation of boiler input-output curve

To obtain efficiency values and curves for boilers in table 1 It can be described in the form of input-output curve in Figure 6 :

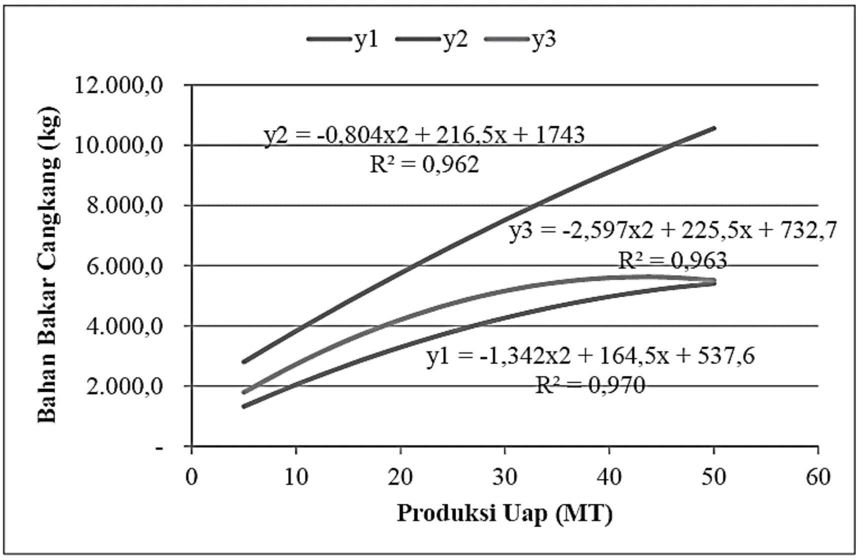

Figure 6. Input-output 3 Steam boiler

Explanation of Figure 6. In terms of efficiency, boiler no. 1 is the best, followed by steam boiler no. 3 and the last is steam boiler no. 2. And obtained the following equation:

$y_1 = -1.342x^2 + 164.5x + 537.6$

$y_2 = -0.804x^2 + 216.5x + 1743$

$y_3 = -2.597x^2 + 225.5x + 732,7$

Based on Figure 6, it is also found that the R2 values for y_1, y_2 and y_3 respectively are 0.970, 0.962 and 0.963, where this value shows the equation of each input-output curve is valid.

C. Economic Dispatch dalam PLC

Integrate Economic Dispatch formula in PLC system. PLC is divided into 2 types of programs, namely PLC programming and HMI programming. PLC programming, the programming technique chosen is to use *a ladder diagram.* Figure 7 is a form of ladder diagram programming on a PLC

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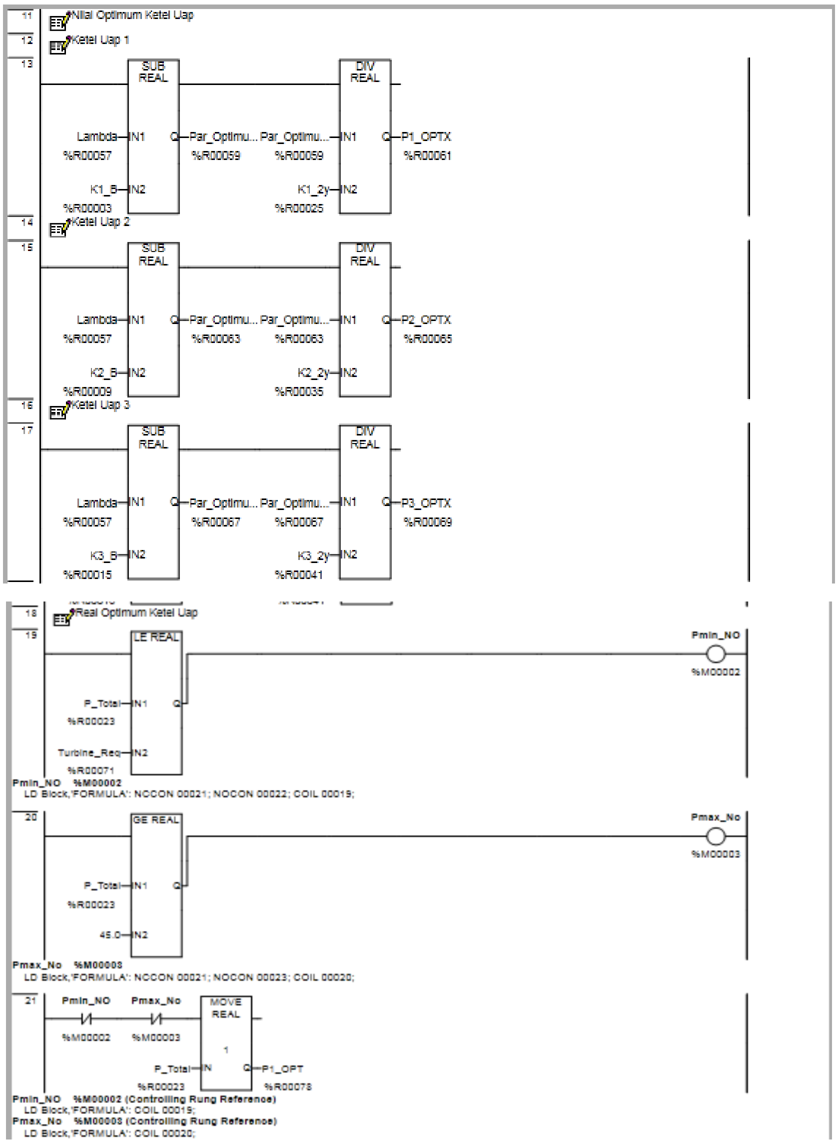

Figure 7. The ladder diagram section for the optimum value of the boiler output. The

HMI programming used for this research is a control system of a process for controlling the boiler output flow. HMI programming on this boiler system is shown in Figure 8.

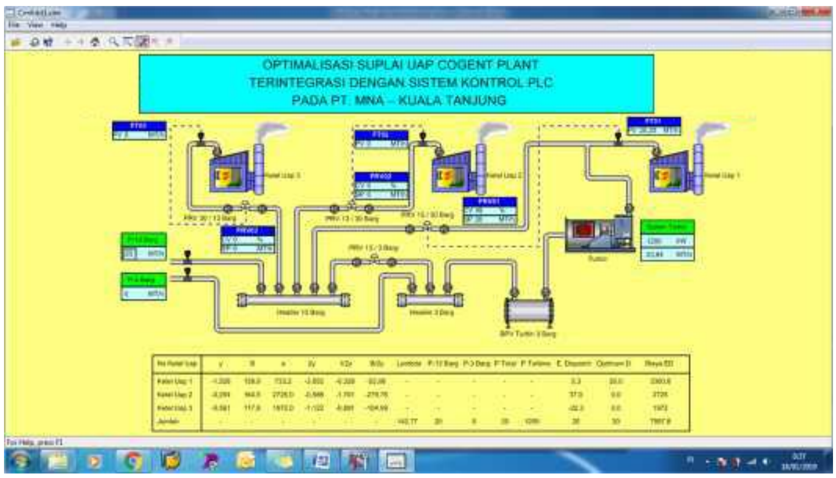

Figure 8. HMI of the steam supply system

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D. Analysis of Fuel Use

Analysis is carried out by comparing the actual value with the calculated value of Economic The Dispatch analysis carried out took data from the last 12 months in tabel 3.

Tabel 3. Perbandingan Nilai Actual Dengan Economic Dispatch Periode Juli 2017-jun 2018

Date	Boiler Production (MT)	Fuel (KG)	Ratio (KG/MT)	Fuel (KG)	Ratio (KG/MT)	Effenciency Of Fuel (kg)
Jul-17	40,888	6,668,390	166.3	6,146,554	153.3	521,836
Aug-17	49,408	7,210,350	145.9	8,051,595	163.0	(841,245)
Sept-17	30,357	5,492,770	180.9	5,234,331	172.4	258,439
Okt-17	45,273	7,886,190	174.2	7,481,764	165.3	404,426
Nov-17	48,541	8,620,710	177.6	7,792,473	160.5	828,237
Des-17	30,452	6,782,630	222.7	5,571,898	183.0	1,210,732
Jan-18	29,836	7,396,700	247.9	5,459,186	183.0	1,937,514
Feb-18	37,604	7,371,920	196.0	5,392,881	143.4	1,979,039
Mar-18	32,109	6,830,550	212.7	5,656,832	176.2	1,173,718
Apr-18	41,087	10,810,700	263.1	6,789,776	165.3	4,020,924
Mei-18	40,318	9,189,660	227.9	6,492,885	161.0	2,696,775
Jun-18	48,119	9,134,030	189.8	7,587,590	157.7	1,546,440
Total	**473,192**	**93,394,600**		**77,657,762**		**15,736,838**
Average	**39,433**	**7,782,883**		**6,471,480**		**1,311,403**
				Effessiency		**16,8%**

E. Economic Analysis of Economic Dispatch Implementation Economic

Analysis of Economic Dispatch Implementation was carried out from the last 12 months (July 2017 – June 20180) which is shown in table 4.

Tabel 4. Perbandingan Biaya Untuk Periode Jul 2017 - Juni 2018

Item	Aktual	ED	Effeciency
Biomass Fuel	93,394,600	77,657,762	15,736,838
Cost	46,697,300,000	38,828,880,976	7,868,419,024

The explanation of table 3 shows the total fuel cost for the three boilers is Rp. 46,697,300,000,- down to Rp. 38,828,880,976, - so the chance of saving is Rp. 7,868,419,024,-. In terms of the cost of steam production, there is also a decrease in costs in terms of fuel costs. The fuel cost based on field data is 100% per MT of steam. After optimization, the fuel cost fell to 90% per MT

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CONCLUSION

1. The simulation results with PLC, obtained the optimal value of each steam boiler when carrying a load. system steam of 76 MT is P_1 = 45 MT, P_2 = 0 and P_3 = 31 MT with a lambda value of 137.61 kg/MT while without Economic Dispatch is P_1 = 32 MT, P_2 = 16 MT and P_3 = 29 MT. Besides that, the simulation can also run in real time by changing the load value steam system.
2. With Economic Dispatch, there is an equivalent 16.8% fuel saving opportunity with 15,736,838 kg during the period July 2017 – June 2018, where previously used 93,394,600 kg of shells but decreased to 77,657,762 kg of shells for the same period.
3. Economically, there is an opportunity for fuel savings of Rp. 7,868,419,024, - for the period July 2017 – June 2018, where the cost before being optimized was Rp. 46,697.300.000,- and decreased to Rp.38,828,880,976,- after optimization. With thus the cost of steam production can be reduced by 10.0%.

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