Converting Fuel Oil to Gas in Combustion System for CO_2 Emission Mitigation at PT. PJB UP Gresik

Rita Anitasari, Rizki Fitriani, Erna Triastutik, Alief Makmuri Hartono, Totok R. Biyanto

Abstract*— In environmental point of view, natural gas is the cleanest of the fossil fuels. The combustion of natural gas releases virtually no sulphur dioxide and ash or particulate matter, and very small amounts of nitrogen oxides. Natural gas emits 22% less carbon dioxide than oil and 40% less than coal. NOx is reduced by more than 90% and SOx by more than 95%. This paper will describes the effort of PT. PJB UP Gresik as the owner of the bigest steam power plant in Indonesia to reduce the CO_2 emission by converting fuel oil to gas at existing steam power plant fuel system. In order to achive operating conditions that assure mass, energy and momentum balances, some plant modifications and new installation were performed in combustion system area. The effort was performed succesfully. The evidents were compare with the same powerplant in the world. In term of CO2 emission, PT. PJB UP Gressik lay at the best ten compared to others power plant performance in America. It is shown PT. PJB UP Gresik have been performing best green practice especially in reducing CO2 emmision in the steam power plant by utilize fuel gas.

***Index Terms*—CO_2 Emission, Mitigation, Combustion System, Converting Fuel Oil to Gas**

I. INTRODUCTION

Nowaday, becoming green is a matter of responding to the expectations and demands of our world, country, community, stockholders, customers, employees and competitors as well as a matter of compliance with regulations. These issues create tremendous pressure for companies to carry out their activities in a more environmental friendly [1].

Being green requires the best engineering minds and commitment from the entire organization. Engineering is all about practicality finding solutions to improve the conditions. Perform practical solutions that have a large impact to society, i.e. air pollution, carbon capture and storage, CO2 emissions and renewable energy. Develop and apply the new processes that reduced waste and vent streams, reduced energy consumption, minimized environmental impact, etc. One of the practice converting fuel oil to gas in power plant's combustion sysmtem [1]. It is well known that different fuels emit different amounts of carbon dioxide (CO_2) when burned. Pounds of CO2 emitted per million British thermal units (Btu) of energy for various fuels, such as diesel fuel oil and natural gas (gas) emit 161.3 and 117.0 pound of CO_2, respectively [2].

The amount of CO_2 produced by a fuel is mainly determined by the carbon (C) and hydrogen (H) content of the fuel. Heat is produced when C and H combine with oxygen (O) during combustion. Natural gas is primarily methane (CH_4), which has a higher energy content relative to other fuels, and thus, it has a relatively lower CO_2 to energy ratio. Water and various elements, such as sulfur and noncombustible elements in some fuels reduce their heating values and increase their CO_2 to heat ratio of contents [2].

Converting a combustion engine to operate on gaseous fuel improves fuel efficiency in three ways i.e natural gas burns efficiently due to highest energy content fossil fuel, Natural gas burns cleanly, hence– it provides lower maintenance costs and emissions (reduced fees, carbon finance), and it is attractively priced that produced more power for the same money [3]

In environmental point of view, natural gas is the cleanest of the fossil fuels. The combustion of natural gas releases virtually no sulphur dioxide and ash or particulate matter, and very small amounts of nitrogen oxides. Natural gas emits 22% less carbon dioxide than oil and 40% less than coal. NOx is reduced by more than 90% and SOx by more than 95% [4].

Frankly speaking, compliance with environmental regulations is one of main drivers for converting fuel to gas operation. In order to acchive the aims, retrofitting of existing fuel oil into gas operation are increasingly being looked into in the steam power plants [5],

This paper will describes the effort of PT. PJB UP Gresik as the owner of the bigest steam power plant in Indonesia to reduce the CO2 emission by converting fuel oil to gas at existing steam power plant fuel system.

II. THEORY

A. Heating Value

The fuel heating value is an amount of produced heat, when the complete combustion of a unit quantity of fuel are cooled to the initial temperature (298 K) of the air and fuel. Since the heating value of fuel increases, the delivered heat content to the burner increases. The heat of combustion of a fuel is also called its potential heat.

If a fuel is burned in oxygen saturated with water vapor, the

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quantity of heat released is known as the high heating value (HHV) or gross calorific value (GCV) of fuel. When the latent heat of water vapor contained in the combustion fuels is subtracted from the HHV, It obtains the low heating value (LHV) or net calorific value (NCV) of fuel. In the laboratories, the HHVs of solid and liquid fuels are determined at constant volume. In another hand, the HHVs of the gaseous fuels are determined at constant pressure. Combustion in a furnace, however, takes place at constant pressure [6].

III. METHODOLOGY

In order to achive operating conditions that assure mass, energy and momentum balances, some plant modifications and new installation were performed in combustion system area, as follows;

1. Replace 6 conventional burners with Radially Stratified Flame Core (RSFC) burners
2. Modify valves and piping system
3. Install burner management system
4. Install gas receiving and measuring system
5. Replace Force Draft Fan (FDF)
6. Modify fire protection system
7. Modify Automatic Boiler Control (ABC) and Automatic Burner System (ABS)

The P&D of modifiedd plant is shown in Figure 1.

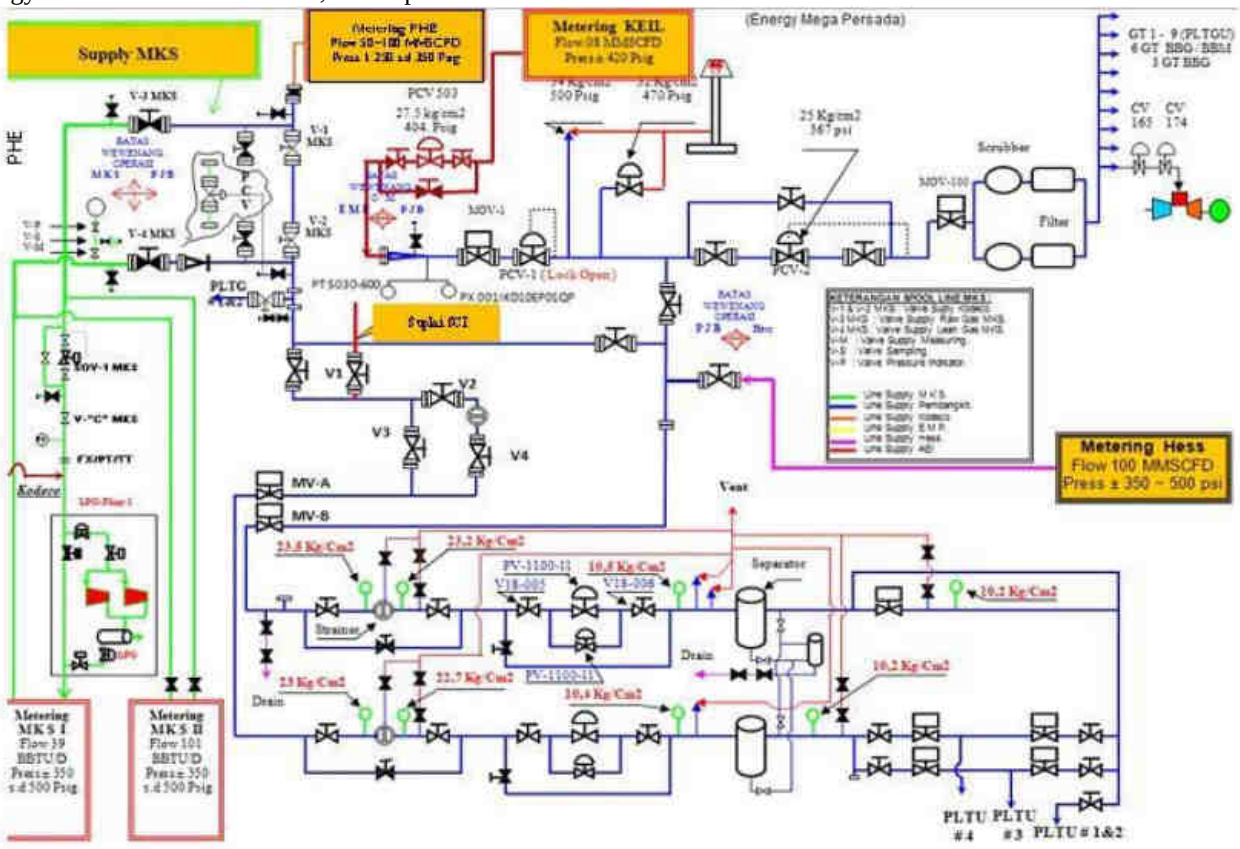

Fig. 1. Modifed fuel cumbustion system

IV. RESULTS

Emision reduction performances due tto converting fuel oil to gas can be obtain by flue gas visual observation at stack outlet and inside heat transfer equipmemnts such as boiler, More acurrate evident can be obtained by emision measuremeent using online instrument or laboratory testing. The flue gas condition after reftofitiing using flue gas can be seen in Figure 2. The performance of combustion in the boiler can be exhibited by the cleanless of the tube, as shown in Figure 3..

Qualty of power plant flue gas using fuel gas has good performance, except SOx ontnete that out of allowable emission contin from goverment. After utilizing fuel gas, all quality parameters of flue gas not exceed the maximum limit from goverment

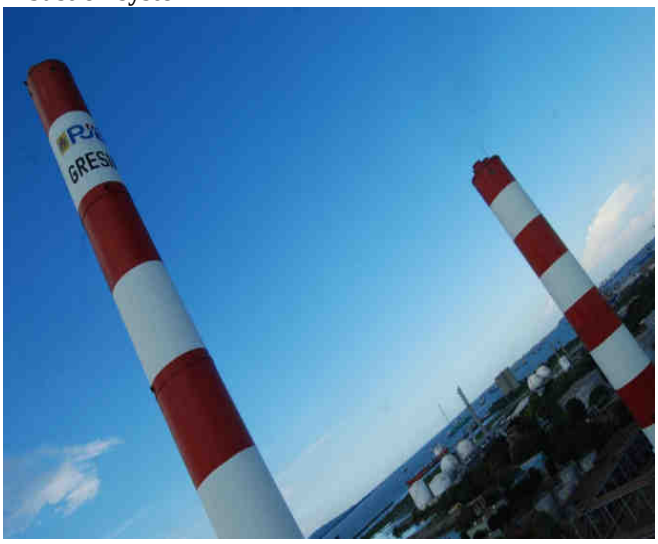

Fig. 2. Clean flue gas at stack outlet using gas

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Fig. 1. Tube inside boiler before and after using gas

CO_2 emision measuremeent using online instrument andr laboratory testing were performed to obtain qualitative data. The data were compare with the same powerplant in the world. Some power plant polutant contont in flue gas data consisted in the benchmarking NRDC 2013 [7] and PT.PJB UP GRESIK 2013 were comparared and there are tabulated in Table 1.

In term of CO_2 emission, PT. PJB UP Gressik lay at the best ten compared to oters power plant performance in America. It is shown PT. PJB UP Gresik have been performing best green practice especially in reducing CO_2 emmision in the steam power plant by utilize fuel gas.

Tabel 1. Benchmarking NRDC 2013 and PT.PJB - GRESIK 2013

NO	Power Plant	Total Production (MWh)	CO_2 Emission (Tone)	CO_2 Emission Intensity (Tone/GWh)	CO_2 Emission Intensity Average (Tone/GWh)
		1	2	(2/1)*1000	
1	Sacramento Municipal Util Dist	6765215	2334956	345141	451283
2	Sempra	13258115	4965089	374494	449081
3	Calpine	103040845	41996312	407570	449081
4	Exxon Mobil	11388564	4740664	416265	449081
5	Dow Chemical	13372349	5746793	429752	449081
6	Rockland Capital	13565458	5911134	435749	449081
7	Energy Investors Funds	10343553	4680042	452460	449081
8	Tenaska	16161599	7349385	454744	449081
9	Occidental	14093903	6491309	460576	449081
10	PJB UP Gresik	11422633	5391258	471980	449081
11	J-Power	8439903	4017573	476021	449081
12	Brazos Electric Power Coorp	7212209	3615188	501259	449081
13	Entegra Power	10386954	5533581	532743	449081
14	NV Energy	22084046	12349673	559212	449081

V. CONCLUSION

The uutilization of fuel gas by retrofitting oil fuel combustion steam power plant was performed succesfully. The evidents were compare with the same powerplant in the world. In term of CO_2 emission, PT. PJB UP Gressik lay at the best ten compared to others power plant performance in America. It is shown PT. PJB UP Gresik have been performing best green practice especially in reducing CO_2 emmision in the steam power plant by utilize fuel gas.

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