An introduction of scada-based based back pressure vessel (BPV) at palm oil factory with biomass energy

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Abstract. Empty bunches, shells and fibers are waste biomass for renewable energy in steam power plants. The automatic control system provides many advantages for industrial use. Apart from speeding up time, work productivity is also able to reduce human error. The SCADA system includes a number of RTUs (Remote Terminal Units), Main Station / RCC (Area Control Center) and a data telecommunication network between the RTU and the Main Station. Application of scada, BPV can be controlled easily. This study introduces the application of scada to the BPV regulation in the biomass power plant at the Gunung Melayu palm oil mill

Keywords: BPV, renewable, scada, palm oil mill, biomass

1. Introduction

Palm oil is currently the world’s largest source of vegetable oil. P.OM in Indonesia produces about 23 MT of crude oil CPO or 46% of total world palm oil production in 2011 [1]. Increasing population growth, the food and chemical industry will be followed by an increase in world demand for palm oil

Abundant palm oil waste production in Plantation areas, FFB production, and palm oil mills are spread across 22 provinces in Indonesia. The waste is still economical because it can be used as an alternative fuel source, biomaterials, chemical compounds, and fertilizers.[2-6].

The contribution of palm oil to the state budget reached 9.11 billion rupiah. In 2010 Indonesia exported 23 million tonnes of CPO. Apart from Indonesia, other countries are the largest palm oil producers in the world among others are Malaysia, Thailand, Nigeria and Colombia. Tight competition makes Indonesia should pay more attention to product quality and the effectiveness and efficiency of internal processing palm oil production process[7]

From time to time the need for the quantity of electrical energy and the quality of the power transmission system is increasing. Failure in the power transmission system can result in fatal damage to electrical components or operational losses in an industry. To accommodate these problems, build a system capable of monitoring and controlling disturbances in the form of Supervisory Control and Data Acquisition (SCADA) on a Programmable Logic Controller (PLC) based redundant electrical system.[8]. By involving aspects of automation in the form of Supervisory Control and Data
Acquisition (SCADA) systems it is expected to increase the safety and convenience aspects of the controlled installation.

2. Research Methods
This research was conducted in three main stages, namely selection of the POM for case studies, collection of articles, international journals and e-books, data collection and surveys. Furthermore, the selected articles and field data will be recorded as data and information to be presented and discussed.

The survey was carried out in POM Gunung Melayu area of Gonting Mahala Village, Bandar Pulau District, Asahan Regency, North Sumatra in July 2020 which is the most concentrated area of oil palm plantations (Figure 1). The state lies between 2° 44’ 58” N latitudes and 99° 28’ 11” E longitudes. CPO Tonnage Estimated (2014) 44,832 Tons. Estimated tonnage of palm kernel / kernel (2014) 9,678 tonnes and estimated tonnage of plantation fresh fruit bunches (FFB) alone was 139,799 tonnes. Biomass-based cogeneration is carried out to generate electricity and steam which is used in the milling process, while the biogas produced from POME is used as fuel for gas engine power plants.

Figure 1. Author have conducted observations in palm oil factories

3. Results and discussion

3.1 Electrical energy from Oil Palm Biomass in Palm Oil Mills
For decades, Indonesia has been using bio waste from palm oil mills (PKS) as a source of renewable energy (RE) to generate steam and electricity in POM (palm oil mill). Oil palm (Elaeis Guineensis) is an oil-producing crop that is mostly produced and consumed worldwide. This plant was first introduced in Indonesia in 1911 and since 1970 has grown rapidly as one of the most important commodities. [2][3] said that biomass including palm fronds and stems produced during replanting activities in oil palm plantations. According to [5-8] when harvesting, the palm bunches and midribs are cut during the conversion process of fresh fruit bunches (FFB) into crude palm oil (CPO), various types of waste including empty fruit bunches (EFB), mesocarp fibers (MF), palm kernel shells (PKS), palm kernel cake (PKM), and palm oil mill effluent (POME) are produced (Figure 2). Abundant waste production can be found in 65% of the provinces in Indonesia as oil palm plantations. Oil palm trunk biomass is produced from moderate regeneration of plants (25-30 years) classified as old / damaged and unproductive plants. By using a rejuvenation rate of 4% of the total Plantation area, estimated in 2015 the area for replanting is 452,015 hectares. Assuming there are 143 plant populations per hectare of oil palm plantation area, the potential for palm oil waste is estimated to reach 34.13 million tons of stems in 2015.
According [9-10] that utilization EFB (Empty Fruit Bunch) as an energy source produces about 530 kW / tonne of excess Fresh Fruit Bunch (FFB) energy or a twofold increase from the use of non-existent FFB. A research results shows that a mill with 30 tonnes of FFB / hour produces at least 20 MW (20 MW to 35 MW). The total capacity of the factory in East Kotawaringin Regency is 2,115 tons of FFB / hour, so the liquid waste that can be utilized is 1,269 tons of search waste / hour and is capable of producing 1,269,000 biogas m[11]

Figure 2. Oil Palm Biomass in Palm Oil Mills

Figure 3. Palm waste for fuel

3.2 Potential Losses Based on Losses In the Processing of Crude Palm Oil (CPO)

The processing of FFB into Palm Oil (MKS) and Palm Kernel (IKS) is divided into two, namely the main station and the support station. The main station serves as reception fruit (fruit reception), stew (sterilizer), stripper, chopping (digester), pressing (presser), purification (clarifier), and separation of seeds and kernels. Meanwhile, the support station is functioning as a power plant (power), laboratory (laboratory), water treatment (water treatment), product hoarding (bulking), and a workshop. In the process of processing, the company has always been trying to optimize the yield of CPO and Palm Kernel Oil (PKO) [13].

The average percentage of oil loss in the processing of FFB into CPO at PT. PP London Sumatra Indonesia, Tbk. Gunung Melayu POM for 30 days is on a press cake of 3.7210%, the DCO was 35.4985%, the condensate was 1.5933%, the sludge centrifuge was 0.8384, the empty bunch before press was 3.5233%, the empty bunch press was 1.3557% and the empty bunch liquor at 5.8122%. Loss of oil in processing FFB becomes CPO at PT PT. PP. London Sumatra Indonesia, Tbk. Gunung Melayu POM already meets the standard when seen from the average losses for each sample, there are only a few samples on a certain day the losses exceed the norm limit set by the company.[14]

3.3 Company Efficiency Crude Palm Oil (CPO)

The efficiency value is calculated based on comparison between the output value and the input value for each CPO mills. Efficiency calculations with using data envelopment analysis (DEA), basically comparing the efficiency value with one another. Of the 547 PKS factories, only 17 factories efficient factories or only 3.11% with The overall average efficiency is 0.253. Of the 17 efficient PKS, the largest proportion is owned by the national private sector, namely 12 PKS, PKS 4 are owned by foreign private companies and one is owned by the government. When viewed from the perspective of PKS ownership, the highest efficiency value is found in national private factories, namely 0.260 (Table 1). this could be because the PKS factory is owned by a national private company relatively newer especially in comparison to property government. There are also many national private-owned factories which is integrated with CPO derivative industries such as cooking oil is more efficient.[15-16].
**Table 1.** Value of efficiency based on ownership, location and marketing orientation

| Ownership  | Average efficiency |
|------------|--------------------|
| Government | 0.218              |
| National private sector | 0.260 |
| Foreign    | 0.246              |

| Location  | Average efficiency |
|-----------|--------------------|
| Sumatra   | 0.246              |
| Borneo    | 0.283              |
| Others    | 0.262              |

| Market orientation | Average efficiency |
|--------------------|--------------------|
| Export             | 0.228              |
| domestic           | 0.266              |

### 3.4 Use Of Scada Based Back Pressure Vessel (Bpv) In Palm Oil Factories

Based on the description of potential losses in the crude palm oil processing process and the efficiency of Palm Oil (CPO) companies, a tool or system is needed to make improvements. Various improvements need to be made to increase efficiency, by reducing the use of inputs (the number of workers and the value of raw materials) with a fixed output. This reduction in input can be done by efficient use of labor and also improvement of CPO mill technology so as to reduce the use of raw material values.

Machine tools in the factory are grouped at work stations, namely loading ramp stations, sterilizers, threshers, screw press, clarifiers, seed mills, steam boilers and engine rooms. Machines that require steam during the CPO processing process are steam turbines in the engine room, sterilization vessels at the sterilizer station, digester at the screw press station and continuous settling tanks at the clarification station. Process stages processing that requires a certain level of temperature and pressure at work is the temperature and pressure when boiling fruit, temperature during fruit mashing, pressure during pressing, temperature during separation (clarification), temperature when drying the oil and drying the seeds and seed cores[17].

To control these various machines, a system that can monitor and control disturbances is built in the form of Supervisory Control and Data Acquisition (SCADA) on a programmable logic controller (PLC) based redundant electrical system.[10]

![Common SCADA system architecture](image)

**Figure 4.** Common SCADA system architecture

SCADA (surveillance control and data acquisition) is an automation control system used in industries such as electricity, energy, oil and gas, water, and so on. This system has a centralized system that monitors and controls all locations, from industrial plants to factory complexes across the country. The SCADA system works by operating with signals communicating through channels to
give the user remote control of any equipment in a particular system. There are 5 main constituents of the SCADA system including (Figure 4): (i) Human Machine Interface (HMI), (ii) surveillance system, (iii) Remote Terminal Unit (RTU), (iv) Programmable Logic Controller (PLC) and (v) communication infrastructure.[16].

The HMI processes the data from each tag and sends it to a human operator, where humans can monitor or control the system. The surveillance system collects the data sent from each tag and then sends commands or operations to the process. The RTU connects the sensors and converts the signal into digital data and sends it to the surveillance system, where it can be stored as a distributed database. PLCs are used as field devices because they are much more versatile and economical than process-specific RTUs.[8][19].

**Back Pressure Vessel (BPV)** is a unit for receiving and temporarily storing steam from the exhaust steam driving the turbine temperature which is used to be distributed to all processing stations that require steam. The maximum pressure on the BPV is 3.2 barg. In addition, BPV is also equipped with Make-up steam, which is a by-pass steam from the boiler station which functions to increase the pressure on the BPV if there is a shortage of steam supply from the turbine.

![Figure 5. Back Pressure Vessel (BPV).](image)

Auto back pressure control system to add (make up) steam to BPV when experiencing low pressure and discharge / discharge steam. By controlling a PLC based on a PID controller, it is able to handle changing process conditions immediately so that the predetermined pressure can be maintained. BPV control system to regulate proper steam management and avoid unnecessary steam waste. The control system for make-up valves consists of: 3 controllers, 2 control valves (usually with a pneumatic drive) and 3 pressure differential transmitters.

The way it works is as follows:

- PT-1 detects the pressure on the main steam line where the output is connected to the PIC-1 which functions to protect pressure so that PIC-2 can only work at steam line pressures above 17 barg, this is to prioritize the pressure from the boiler when the pressure is below 17 barg only used to drive the Steam Turbine.
- PT-2 detects pressure on the BPV and the output is injected into the PIC-2 and processes it in such a way as to modulate Control Valve 1 opening at pressures below 3 barg.
- The PT-3 also detects the pressure at the BPV and the output is injected into the PIC-3 and processes it in such a way that it can move Control Valve 2 to open only at pressures above 3.2 barg by modulate.

With this system, it is expected that the use of steam will be optimized both for the process and for moving the steam turbine and can keep the BPV pressure at the expected limit of 2.5 - 3.0 barg.
4. Conclusion
The SCADA application that is made has a functions monitoring (supervising conditions plant), take action (control the process on plant) and displays the database. The communication infrastructure provides connectivity to the surveillance system and then to the RTU and PLC for user commands. A communication infrastructure is required to convey data from remote RTUs / PLCs, which run along the power grid, water supply and pipelines. Communication is the absolute most important link in order for the SCADA system to operate properly; However, how well the system manages communication from HMI to RTU and PLC basically determines how successful the SCADA system is.

References
[1] Oil World. Statistics for 17 oils and fats, database 2011. Germany: Oil World; 2012.
[2] Hambali, E., and M Rivai. 2017. The Potential Of Palm Oil Waste Biomass In Indonesia In 2020 And 2030.2017.International Conference On Biomass: Technology, Application, And Sustainable Development. IOP Conf. Series: Earth and Environmental Science 65 (2017) 012050. DOI: 10.1088/1755-1315/65/1/012050
[3] Pattanapongchai, A., and B. Limmeechokchhai. 2014. The Co- Benefits Of Biogas From The Palm Oil Industry In Long- Term Energy Planning: A Least- Cost Biogas Upgrade In Thailand. Energy Source, Part B: 360 – 373.
[4] Rajagukguk J, Situmorang R, Djamil M, Rajaramakrishna R, Kaewkhao J, Minh PH. Structural, spectroscopic and optical gain of Nd3+ doped fluorophosphate glasses for solid state laser application. Journal of Luminescence. 2019 Dec 1;216:116738.
[5] Teuku Meurah Indra Mahlia, Norasyiqin Ismail, Nazia Hossain, Arridina Susan Silitonga&Abd Halim Shamsuddin. 2019. Palm Oil And Its Wastes As Bioenergy Sources: A Comprehensive. Review Environmental Science And Pollution Research. Volume 26, Pages 14849 – 14866(2019)
[6] Rajagukguk J, Hidayat R, Djamil M, Ruangtaweep Y, Horprathum M, Kaewkhao J. Structural and optical properties of Nd3+ doped Na2O-PbO-ZnO-Li2O-B2O3 glasses system. InKey Engineering Materials 2016 (Vol. 675, pp. 424–429). Trans Tech Publications Ltd.
[7] Abnisa F, Daud WMA, Wan WMAW, Husin WNW, Sahu JN (2011) Utilization Possibilities Of Palm Shell As A Source Of Biomass Energy In Malaysia By Producing Bio-Oil In Pyrolysis Process. Biomass Bioenergy 35:1863–1872.
[8] Chiew YL, Shimada S (2013) Current State And Environmental Impact Assessment For Utilizing Oil Palm Empty Fruit Bunches For Fuel, Fiber And Fertilizer—A Case Study Of Malaysia. Biomass Bioenergy 51:109–124
[9] Ermaawati, Tuti & Yeni Saptia. 2013. Kinerja Ekspor Minyak Kelapa Sawit Indonesia. Jakarta Pusat :Pusat Penelitian Ekonomi LIPI
[10] Almuhtarom, Priyo Sasmoko. 2014. Perancangan Supervisory Control And Data Acquisition (Scada) Menggunakan Software Cx-Supervisor 3.1 Pada Simulasi Sistem Listrik Redundant Berbasis Programmable Logic Controller (Plc) Omron Cplc Na-20-Dra. Gema Teknologi Vol. 18 No. 2 Periode Oktober 2014 - April 2015
[11] Ansori. MN .2014. Analysis Of Palm Biomass As Electricity From Palm Oil Mills In North Sumatera . Conference And Exhibition Indonesia Renewable Energy & Energy Conservation. Energy Procedia 47 (2014 ) 166 – 172
[12] Yulian Mara Alkusma.,Hermawan, Hadiyanto.2016. Pengembangan Potensi Energi Alternatif Dengan PemanfaatanLimbah Cair Kelapa Sawit Sebagai Sumber Energi BaruTerbarukan Di Kabupaten Kotawaringin Timur.Jurnal Ilmu Lingkungan. Vol. 14 Issu No 2 . Hal 96-102
[13] Devani, Vera &Marwiji. 2014. Analisis Kehilangan Minyak Pada Crude Palm Oil (CPO) Dengan Menggunakan Metode Statistical Process Control. Jurnal Ilmiah Teknik Industri, Vol.13, No. 1, Juni 2014

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