Project Conversion of Electrostatic Precipitator (ESP) Raw Mill To Bag House Filter (BHF) Indarung IV PT. Semen Padang

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ABSTRACT: *The cement is one of the largest constributors to air pollution due to its high level of energy consumption. Emissions from cement factories contain chemicals that are harmful to health and the environment. Electrostatic Precipitator (ESP) is a dust collector commonly used in cement factory. As a result of the lifetime of the equipment being more than 30 years, the reliability of the ESP for collecting dust has decreased. In normal operation, the ESP emits stack emissions of ± 40 mg/Nm^3and can reach more than 60 mg/Nm^3 under abnormal conditions. To reduce the impact of emissions on the environment, reduction efforts are needed so that dust emissions in chimneys comply with emissions standards, both during normal and abnormal operating conditions. To overcome the limitations of ESP performance, conversion to Bag House Filter (BHF) was carried out. After the conversion was carried out, the emission level that came out of the chimney was 9 mg/Nm^3. With BHF's high ability and efficiency in collecting dust, chimney emissions can be reduced by 78%.*

KEYWORDS: *Bag House Filter, Electrostatic Precipitator, Emission.*

I. INTRODUCTION

PT Semen Padang is one of the oldest cement companies in Indonesia and even Southeast Asia. PT Semen Padang has a cement production capacity of 9.000.000 tons/year in 2017. PT Semen Padang has a high commitment to empower, develop and synergize the company's resources with an environmental perspective. This is reflected in the company's vision, where PT Semen Padang's vision is "To become a reliable, superior and environmentally sound cement company in western Indonesia and Southeast Asia".

To become an environmentally sound company, PT Semen Padang is very focused on minimizing air pollution, both due to gas emissions and dust emissions. The semens industry is one of the largest contributors to air pollution due to its high level of energy consumption [1-2]. Emissions from cement plants contain chemicals that are harmful to health and the environment such as CO, NO, SO and other particles [3].

Electrostatic Precipitator (ESP) is one of the dust capture devices in the Raw Mill area of Indarung IV Plant. This ESP has been built since the beginning of the establishment of the Indarung Plant, which is around 1988. As a result of the lifetime or are of the equipment that has been very long, the reliability of ESP to capture dust has decreased. In normal operation the ESP to capture dust has decreased. In normal operation the ESP emits stack emissions of ± 40 mg/Nm3 and can reach mor than 60 mg/Nm3 during abnormal conditions.

To reduce the impact of emissions on the environment, a reduction effort is needed so that dust emissions in the Indarung IV Raw Mill 3 3C chimney can meet the applicable emission standards (can be seen Tbl 1.1) [4], both during normal and abnormal operating conditions. To overcome the limited performance of the ESP, a conversion to a Bag House Filter (BHF) is carried out. BHF is expected to reduce the level of emissions coming out of the chimney below 20 mg/Nm3 with its high ability and efficiency in capturing dust.

II. THEORY

A. *DUST EMISSIONS AND FLUE GAS EMISSIONS OF CEMENT PLANTS*

The cement industry is one of the contributors to air pollution due to its high energy consumtion [5-7] Emissions from cement plants contain chemicals that are harmful to health and the environment such as CO, NO, SO and other particles. There are several potential sources of dust in cement plants including:

1) During the mining process during the dry season
2) At the time of material dumping by the truck
3) At the time of crushing or crushing of raw materials
4) During material transport
5) During the process of grinding the material into flour (Raw Mill)
6) During the raw mix material transport process

7) When the flue gas exits the preheater to wards the GCT and ESP
8) When the flue gas exits the kiln to the ESP Cooler
9) During clinker transport to the silo
10) During raw coal transportation
11) At the time of coal milling
12) When grinding clinker into cement
13) During cement transport
14) At the time of packing cement

Potential sources of gas emissions at cement plants include:

1) Exhaust emissions from the grinding process of raw mix materials
2) Flue gas emissions from the grinding process of coal raw materials
3) Flue gas emissions from kiln firing process
4) Flue gas emissions from the process of grinding clinker into cement

B. EMISSION CONTROL

Emission Control activites are a mandatory commitment from companies or factories to overcome environmental pollution base don national and international standards [8]. It is also carried out by all company personnel to achieve the company's proper rating in Good environmental managemnet. One of the industry's obligations base don aplicable laws and regulations is to report the results of emisión monitoring. Make it easier for companies/industries to report effectively and efficiently.

In environmental management, especially in the cement industry that is more specific, the government in this case has set new regulations through: PERMEN Environment and Forestry of the Republico f Indonesia Number P.19/MENLHK/SETJEN/KUM.1/2/2027. The following emisión quality standards for cement industry activities can be seen in Tbl 1.

Tbl 1. Emission Quality Standards for Cement Industry Activities

No	Activity Source	Parameters	Unit	Quality Standard Value		
				A	B	C
1	Tanu (Kiln)	Particulates	Mg/Nm^3	75	70	60
		SO^2	Mg/Nm^3	650	650	650
		NOx	Mg/Nm^3	800	800	800
		Hg	Mg/Nm^3	0,2	0,2	0,2
2	Slag Cooling	Particulates	Mg/Nm^3	75	70	60
3	Milling and/or grinding units	Particulates	Mg/Nm^3	75	70	60
4	Dust collector unit	Particulates	Mg/Nm^3	60	60	60
5	Bagging	Particulates	Mg/Nm^3	75	70	60

C. DUST CAPTURE EQUIPMENT

The maximum number of heading levels is three levels. Writing headings at each level uses a hanging format size of 0.8 cm and is written aligned left and right [9].

1) Cyclone Dust Coller

Is a type of mechanical dust catcher to separate dust particles with gas centrifugally. Consists of two parts, namely a cylindrical part commonly called a cyclone and a cone part commonly part called a cone, can be seen in fig 1. The syclone converts the inertia of the gas flow to centrifugal force by means of a vortex generated in the cyclone tube [10].

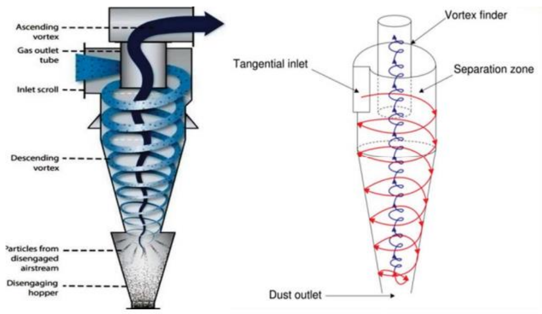

Fig 1. Cyclone Dust Collector

2) Electrostatic Precipitator (ESP)

Is a dust capture device by utilizing positive and negative electric fields [11]. The way it works is that the gas flow mixed with dust is directed by the ID Fan to pass through a high voltage Electric (Electrode) which gives a charge to the particles which are then attracted to the collecting plate. The dust collected on the collecting plate is released or threshed by being hit by a hammer (rapper) periodically which then falls into the hopper where the particles are collected and transported to the exit.

The main components of an ESP can be seen in Fig 2.:

A) Discharge Electrodes (DEs)
Discharging electrodes provide an electrical charge (usually negative) for particulates in the gas stream. The electrode is usually a small diameter pipe or thin plate tipped with a needle and hanging vertically in the ESP or attached to a rigid frame. When the flue gas passes through the electric field, the particulates take on a negative (-) charge and will be thrown on the positively charged (+) collecting plate.

B) Collection Electrodes (Ces)
The collection electrode collects charged particles (-). Negatively charged particles are attracted towards the CE and migrate across the gas stream eventually collecting at the collecting electrode. Gas Velocity is an important factor in the collection process, lower velocities allow more time for charged particles to migrate to the Collecting Electrode better.

C) Electrical System
Electrical system such as Transformer-Rectifier or T-R sets are used to control the electric field strength between the discharge and collecting electrodes.

D) Rapper (Beater)
The Rapper is a mechanism that creates vibrations or shocks on both the collecting and discharging electrodes. This causes particles attached to the electrodes to fall into the hopper or sump.

E) Hopper (Container)
The The hopper is a holding area used to collect and
temporarily store the particles ejected during rapping. Once the particulates have reached the hopper, it is important to ensure that the dust collected in the hopper is emptied.

F) Shell
The shell The shell encloses the electrodes, supports and all other components of the precipitator. It helps maintain proper electrode alignment and configuration. The shell is covered with insulation to conserve heat and prevent corrosion. The outer shell wall is usually made of steel.

G) Fan ID
ID Fan functions to maintain pressure in the ESP and works at low atmospheric pressure because it is used to suck gas and dust from the ESP to be discharged through the stack. To control the pressure, a damper opening or ID Fan speed is used which uses variable speed.

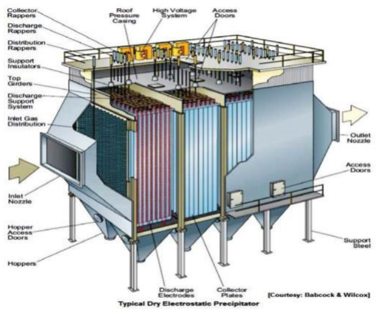

Fig 2. Electrostatic Precipitator (ESP)

Tbl 2. Advantages and Disadvantages of Using an Electrostatic Precipitator

No	Pros	Disadvantages
1	High particle removal efficiency	High capital cost
2	Able to remove small particles	Requires large land area
3	Can be designed for high temperature gas flow	Specialized maintenance personnel required
4	Low operating costs	Emission yields are still high

3) Bag House Filter

Is a dust capture equipment that uses bag filters and pressurized wind. How it works can be seen in Fig 3. Namely the flow of gas mixed with dust directed by the ID Fan to pass through the filter bag. The dust collected on the filter bag is then released or threshed by firing with pressurized wind periodically which then falls into the hopper where the particles are collected and transported to the exit.

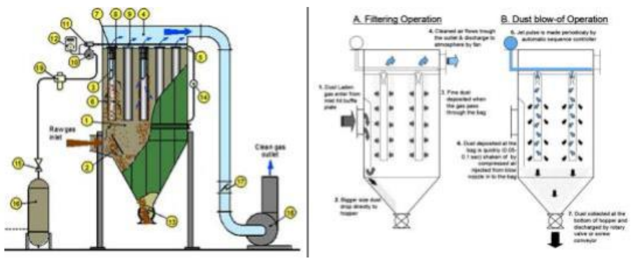

Fig 3. Bag House Filter (BHF)

Types and functions of Bag Filter Dust Collector components:

A) Bag Filter
Serves to filter or capture dust.

B) Supporting Cages
Serves as a support for the inside of the filter bag.

C) Venturis
Serves as a director of purging compressed air to the filter bag.

D) Solenoide
Function pneumatically programmed to open the diaphragm valve.

E) Diaphragm Valve

Serves to open and close the purging compressed air after getting a command from the solenoid valve.

F) Electronic Sequential Programmer
Function to set the purging squence on the bag filter line as desired.

G) Compressor air reservoir
Serves to accommodate air from the compressor used for the purging system.

H) Pressure gauge
Serves to determine the compressor air pressure used for purging.

I) Delta pressure control
Serves to determine the difference in air pressure between the lower filter chamber and the upper clean air chamber.

J) Level sensor
Serves to control the level of material / dust in the hopper under the filter room.

K) Screw Conveyor or Rotary lock
Function to remove the material in the hopper under the filter room.

L) Fan ID
Serves to draw clean air from the dust collector which is then released through the exhaust gas chimney.

The advantages and disadvantages of using Bag House Filters can be seen in Tbl 3.

Tbl 3. Advantages and Disadvantages of Using Bag House Filters

No	Pros	Disadvantages
1	Very high particle removal efficiency	Relatively high maintenance costs
2	Able to remove small particles and can be used again as a product	Not possible in high temperature conditions

III. METHODOLOGY

This project was carried out at Raw Mill 3C of PT Semen Padang's Indarung IV Plant located in Indarung, West Sumatra.

A. *Preparation Stage*

At this stage, the determination or work plan, design and technical calculations, dismantling of the inner part of the Electrostatic Precipitator, and initial fabrication of parts for the Bag House Filter are carried out.

B. *Construction or Installation Stage*

At this stage, the construction work of ESP to BHF conversion is carried out in the following stages: This section contains the methods used in the research.

1) Safety box meeting
2) Pre-assembly part BHF
3) ESP Dismantling
4) New Bag House Filter Installation

C. *Trial Run and Commissioning Stage*

At this stage, trial runs and tests are carried out on newly installed equipment or existing equipment that is still installed.

D. *Data Collection Stage*

At this stage, data collection and retrieval are carried out. Data collection must be done with the right measurement equipment so that the performance data generated from the BHF is accurate and in accordance with the initial design. The data parameters to be collected can be seen in Tbl 4.

Tbl 4. BHF Performance Data Parameters

No	Description	Unit	Design	Actual
1	Gas Flow Fan	mg^3/h	540.000	
2	Dust Emission	mg^3/Nm^3dry	<20	
3	Fower Cons	%	<80	
4	Fan Efficiency	%	<80	
5	Raw Mill 4R2		ON	
6	Feeding Kiln	Tph	Min.300	
7	Pressure After ID Fan	mbar	-1	
8	Static Pressure Inlet Fan	mbar	28,5	
9	Static Pressure Outlet Fan	mbar	-	
10	Total Pressure Fan	mbar	-	
11	Power Fan	kW	503,4	
12	Fan Rotation	rpm	892	

IV. RESULTS AND DISCUSSION

After trial run and commissioning, the BHF performance data is shown in Tbl 5.

Tbl 5. BHF Performance Result Data

No	Description	Unit	Design	Actual
1	Gas Flow Fan	mg^3/h	540.000	647.308
2	Dust Emission	mg^3/Nm^3 dry	<20	9
3	Fower Cons	%	<80	70
4	Fan Efficiency	%	<80	80,1
5	Raw Mill 4R2		ON	ON
6	Feeding Kiln	Tph	Min.300	333

No	Description	Unit	Design	Actual
7	Pressure After ID Fan	mbar	-1	-0,7
8	Static Pressure Inlet Fan	mbar	28,5	21
9	Static Pressure Outlet Fan	mbar	-	2,2
10	Total Pressure Fan	mbar	-	23,2
11	Power Fan	kW	503,4	639
12	Fan Rotation	rpm	892	938,8

Based on the performance measurement results of the BHF, it can be seen that the actual values obtained are in accordance with the desired design specification values. The stack emission has been reduced from 40 mg/Nm3 to 9 mg/Nm3. This value is greatly reduced from the previous equipment using ESP with a percentage reduction of 78%. Under normal or abnormal operating conditions, there will be no more stack emissions that exceed the standard.

V. CONCLUSION

Based on the results of the research and discussion that has been carried out regarding the Electrostatic Precipitator to Bag House Filter conversion project, the following conclusions can be drawn. The conversion of ESP to BHF is done by disassembling the inner part of ESP, the casing is still using the old one, then installing the new inner part of BHF. The efficiency of Bag House Filter in capturing dust is superior to ESP. The BHF chimney emission result is 9 mg/Nm3 with a percentage reduction of 78%.

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