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Calculating Mass Balance And Energy Balance In Finish Mill 6 (6zi) Type Opc Using Purified Gypsum

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Abstract

PT Semen Padang is the first cement factory in Indonesia which is located in Indarung, Padang, West Sumatra Province. The raw materials in the cement manufacturing process at PT Semen Padang use four main raw materials, namely, limestone, silica, clay and iron sand and additional raw materials such as gypsum and pozzolan. In general, the process of making cement at PT Semen Padang is divided into 5 stages, namely: the raw material supply and preparation stage, the raw material grinding stage (raw mix formation), the clinker formation stage (raw mix burning) the clinker grinding stage (cement manufacture) and the cement manufacturing stage. cement bagging. The total cement production capacity at PT Semen Padang from Indarung 1 to VI is 10,070,000 tons/year. PT Semen Padang's market share for marketing Portland Cement Type 1, Super Mansory Cement (SMC) and Portland Pozzolan Cement (PCC) products, namely in all provinces on the island of Sumatra, DKI Jakarta, Banten, West Java, Central Java, West Kalimantan and South Kalimantan.

Keywords: *clay, gypsum, irond sand, limestone, silica.*

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INTRODUCTION

In the chemical industry, products are made through a process of chemical (reaction) and/or physical (separation) changes. The process involves several process variables such as mass, flow rate, pressure and temperature. However, not all of these process variables are known, so to know the quantitative values, it is necessary to calculate the mass balance and energy balance. Mass balance and energy balance calculations are carried out to determine the performance of a process and indicators of process irregularities, so that they are immediately corrected so that the production target is achieved.

At this time, with the era towards a free market in Indonesia, goods produced especially in the chemical industry are required to have high competitiveness, both in terms of quality and price. As the largest cement producer in Indonesia, PT. Semen Padang, Tbk. also cannot be separated from this demand, where the demand for cement with high quality at competitive prices is also increasing.

In the production process, energy efficiency needs to be considered. In facing the development of environmentally friendly and efficient industries, energy efficiency has a great influence. The scope itself is quite broad, such as saving fuel and using electricity in a device.

Cement mill is one of the main tools in the cement industry. In this unit, raw materials will undergo a process of drying, grinding, separation and transportation, so as to produce the desired cement product. The cement mill unit uses gypsum raw materials, namely natural gypsum and purified gypsum, with the aim of slowing

cement setting time. The most important physical properties of cement are setting time and compressive strength of cement. Cement with good quality is one that has high compressive strength and a long hardening time according to the specified standards. According to (Diana, 2017) the setting time for purified gypsum is longer, namely 171 minutes for the initial setting and 221 minutes for the final settings. However, the compressive strength of cement with natural gypsum was higher than purified gypsum on days 3 and 7, namely 218 and 291 kg/cm2.

Given the importance of this, it is necessary to calculate the mass balance and energy balance at the cement mill to get cement products that comply with the standards and which type of gypsum is better to use. So, against this background, a special task title was appointed, namely "Calculating Mass Balance and Energy Balance at Finish Mill 6 (6zi) Type Opc Using Purified Gypsum PT. Semen Padang Indarung VI Factory.

METHODS

One way to analyze the effectiveness and efficiency of the cement forming process that occurs is to calculate the mass balance and energy balance of the system. By calculating the mass balance, we can find out the effectiveness of the incoming material and hot gas in terms of the law of conservation of mass. Where later, the amount of oxygen from the air used can be known and analyzed from the mass flow rate entering and leaving the system. The general mass balance is described as follows:

Mass in – Mass out + Production = Accumulation

If the system is assumed to be in a steady state condition, then the accumulation will be 0.

Mass in + Production = Mass Out

In calculating the cement mill mass balance, the data needed include:

1. Incoming mass flow:Material
a. H2O from the cement mill
b. Dust loss from kilns 5
c. Hot gas enters the cement mill
2. Mass flow out
a. Exit Materials
b. Hot gas comes out of the cement mill

Heat balance is a balance of heat entering and leaving the system. The heat balance adheres to the principle of conservation of energy. Some of the terms used in preparing the energy balance are as follows:

1. Sensible Heat

Sensible heat is heat received or released by a system based on its temperature increase, without any phase change and in the cement mill process it uses sensible heat with a hot gas source originating from the kiln. The equation used for the calculation is: $Q = \text{n.} \int_{Tref}^{T} Cp.dT$

2. Latent Heat

Latent heat is the energy released or absorbed, by a body or thermodynamic system during a constant temperature process, usually a first order phase transition.

RESULTS & DISCUSSION

Results

The data obtained is primary data related to the cement mill. Secondary data is in the form of operating conditions from the tool design, materials that enter the tool, and also the presentation of components in each material. Retrieval of data required on the cement mill tool is carried out on the same day and hour as a calculation basis. The data that has been obtained to calculate the mass balance and energy balance at the cement mill is then presented in the following calculation:

a. Mass Balance

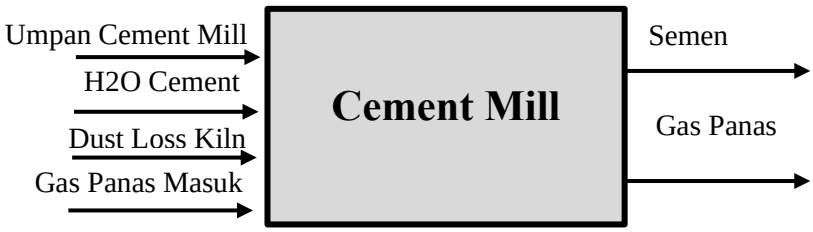

Figure 1. 1 Cement Mill Mass Balance Flowchart

Table 1. 1 Cement Mill Mass Balance Results and Calculations

Cement Mill Mass Balance Results and Calculations		
Component	Mass (Kg/Jam)	
	Input	Output
Materials without H_2O	239510.3001	
H_2O from the cement mill	491.0832	
Dust loss kiln	16983.6	
Hot gas enters	562661.0343	
Material		256496.3433
Hot gas comes out		563149.6743
Total	819646.0176	819646.0176

b. Energy Balance

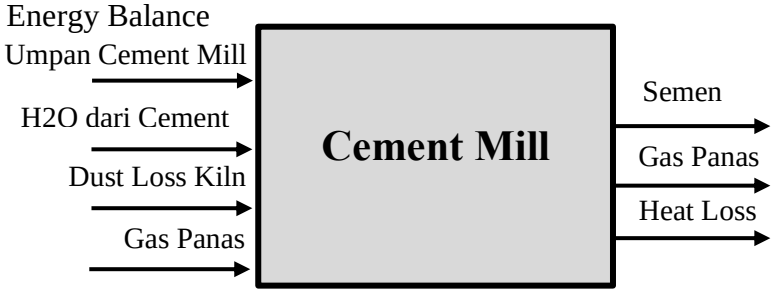

Figure 1. 2 Cement Mill Energy Balance Flowchart

Table 1. 2 Cement Mill Energy Balance Results and Calculation*s*

Results of Cement Mill Energy Balance Calculations		
Component	Energy (Kj)	
	Input	Output
Materials without H_2O	976872.0091	
H_2O from the cement mill	5160.937362	
Dust loss kiln	1444519.924	

Hot gas enters	67194467.45	
Material		13945992.25
Hot gas comes out		39643501.93
Total	69621020.32	53589494.18
Panas Keluar		69621020.32

Discussion

By calculating the mass balance, it can be seen that the amount of mass entering the cement mill is 240,000 kg/hour which can then be used to calculate the heat balance. From the calculation of the mass balance for the cement mill feed feed of 240,000 kg/hour, the cement mill output material is 819,646.0176 kg/hour.

From the calculation of the heat balance in the cement mill system, the heat requirement for the grinding, drying, separation and transportation processes in the cement mill is 69,621,020.32 kJ with a heat loss of 16,031,526.14 kJ or 23.03% and an equipment heat efficiency of 76.97 %.

Heat loss in the system is possible due to the imperfect operation of the cement mill system, heat lost to the air (convection heat), and the presence of leaks so that the heat is not consumed by the material. To reduce the heat difference, it is necessary to periodically control the equipment so that the equipment is in good condition and heat loss can be minimized, for example paying attention to the inlet and outlet of the cement mill system so that air leaks do not occur.

CONCLUSION

Based on the results that have been obtained, it can be concluded that:

1. The results of process flow calculations on the cement mill unit 6Z1 comply with the law of conservation of mass where the incoming mass is equal to the outgoing mass, which is equal to 819,646 tons/h.
2. Calculation of the process flow heat balance in the cement mill unit 6Z1 also fulfills the law of conservation of energy where the incoming heat energy is equal to the outgoing heat energy, which is equal to 69,621,020.32 kJ.
3. In the cemeng mill unit, the amount of heat loss presentation shows that the parts in the vertical roller mill have decreased to a value of 23.03% of the heat of combustion.
4. With a reaction therma efficiency of 76.97%, it can be said that the work of the vertical roller mill in the cement production unit is still quite good because it is still above the minimum efficiency feasible to operate, which is 72% - 75%.
5. The use of purified gypsum with a lower H2O content produces a cement product of 256,496.34 kg/hour with a heat loss of 16,031,526.14 kJ.

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