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Drying of Chemical Gypsum

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Abstract-- Gypsum is chemically known as "Calcium Sulfate dehydrate".Gypsum Contains Calcium, Sulphar Bound to Oxygen and Water. Different type of Gypsum are available like as Mineral Gypsum , Synthetic Gypsum and Chemical Gypsum. Mineral Gypsum is a common mineral obtained from surface and underground deposits.Chemical Gypsum is obtained as Chemical waste from Chemical plant. Cement plant Require Gypsum as Additive for Making Cement. Gypsum is useful For Regulate Setting Time. J.K.Lakshmi Cement Limited Use Chemical Gypsum as Additive. Chemical Gypsum has Moisture Contain up to 35%. Due to Moisture Contain Handling of Gypsum is difficult.The purpose of this study was to investigate an economical solution to the Gypsum handling problem at Cement Grinding Unit ,Kalol. The general trend is mechanical dewatering to obtain a Moisture content up to 10%.It was found that, here we can use Mechanical System,Thermal System and Solar System. After Different types analysis Solar drying method was applied the total amount of Moisture of the Chemical gypsum would be reduced by approximately 25%. This would lead to a reduction in the transportation, handling costs and time.

Keywords-- *Gypsum , Moisture ,Cement Industry ,Drying.*

I. INTRODUCTION

Gypsum is important Additive used for Cement Production. It's also known as Regulator. It's contributes for strength acceleration in early stages of hydration. It also give hardness to the Cement. Following table describe Properties of Mineral Gypsum and Chemical Gypsum Which are Generally useful for Cement industry.

Table 1: Properties of Mineral & Chemical Gypsum (A)

Properties	Mineral Gypsum	Chemical Gypsum
Chemical Formula	$CaSO_4$	$CaSO_4.2H_2O$
Molar Mass	136.14 g/mole	145.15 g/mole
Density	2960 kg/m^3	2300 kg/m^3
Solubility in Water	0.21g/100ml at 20°C	0.23 g/100ml at20°C
Acidity	10.4	7.1

On the basic of Availability in Plant near by area , Cement Industry Mostly use Mineral Gypsum but if Mineral Gypsum isn't available then they use Chemical Gypsum from Chemical plant. Gypsum Consumption mainly depends on the Purity of Gypsum.

Two types Cement Production are Main Producation by Cement industry 1) Ordinary Portland Cement 2) Portland Pozzolana Cement . Both OPC and PPC must Contain 2.5-3.0 % of Sulphar Trioxide. So, It's Require to Regulate Gypsum Consumption related to Purity of Gypsum.

Here, In our Plant Chemical Gypsum Comes as Chemical Waste from nearby Chemical Plant. Chemical gypsum made out from Adding Sulphuric Acid with Calcium Carbonate. It Contains Moisture upto 30- 35% in Monsoon and Winter. It Contains Moisture upto 20- 25% in Summer. In this study, different Drying Technology was applied. After Analysis Different Method We select an economical and efficient Solar drying method. This study Show Solar drying for Removing Moisture from Chemical Gypsum in the Cement plant.This plant is Located Where Solar Radiation is high (Kalol).

II. IMPORTANCE OF GYPSUM IN CEMENT INDUSTRY

India is the second largest cement producer in the world and accounts for 6.7 percent of world's cement output. India has nearly 410 million tonnes (MT) of cement production capacity. The top 20 companies account for around 70 percent of the total production. Total of 188 large cement plants together account for 97 per cent of the total installed capacity in the country, while 365 small plants make up the rest. Of the total 188 large cement plants in India, 77 are located in the states of Andhra Pradesh, Rajasthan and Tamil Nadu. India's cement production increased at a compound annual growth rate (CAGR) of 6.7 per cent to 270.32 million tonnes over FY07–15. Cement production is expected to reach 420 million tonnes by FY17.

Gypsum plays a very important role in controlling the rate of hardening of the cement. During the cement manufacturing process, upon the cooling of clinker, a small amount of gypsum is introduced during the final grinding process. Gypsum is added to control the "setting of cement". If not added, the cement will set immediately after mixing of water leaving no time for concrete placing.

III. BRIEF DESCRIPTION OF STUDY

Problem-- Encountering problem associated with drying of chemical gypsum used by J K Lakshmi Cement Ltd. Plant use Chemical Gypsum as additive. Daily consumption of Chemical Gypsum is around 100 tones per day. It is a waste product coming from near by Chemical plants at Very Low Cost. It Containing high amount of moisture. The moisture is causing problem in handling and transportation of Gypsum during the process.

Solution-- Problem can be solved by Removing moisture from Gypsum up to 10% w/w Without Decreasing Purity . Because purity is main parameter for deciding Consumption of Chemical Gypsum.So , We have to Choose a Drying Procedure Which doesn't effect on the Purity of Chemical Gypsum as well as Economical System Because It's Cost is very low.

Present System-- The plant use direct sun drying as a drying technique although It's inefficient process Expect Sunny Days. Moreover, plant needs Chemical Gypsum at least 150 tons/day.

IV. EXPERIMENT & RESERCH (IS4032)

Chemical Gypsum Testing is Carried out in Chemistry Lab Which is NABL accredited Fulfilling all Require Condition. We use IS4032 testing Procedure for We got Following Result.

Table 2: Moisture Percentage Calculation for Sample 1 & 2

Sample No.	Temp.(°C)	Initial Weight(g)	Final Weight(g)	Moisture(%)	Time(hour)
1	100	100	81	19	1
1	75	100	85	15	1

Sample No.	Temp.(°C)	Initial Weight(g)	Final Weight(g)	Moisture(%)	Time(hour)
2	100	100	67	33	1
2	80	100	77	23	1

Table 3: Sulphur Contain and Moisture Percentage Calculation for Sample 1 & 2.

Sample No.	Sulphur Contain	Purity
1(Before Drying)	21.68	46.62
1(After Drying)	31.52	68.25

Sample No.	Sulphur Contain	Purity
2(Before Drying)	21.01	45.08
2(After Drying)	32.54	69.96

Table 4: Comparision of Different Dryer 5. Different Drying System For Drying of Chemical Gypsum

Dryer Type	Capacity	Cost	Effienciey	Payback Period
Rotary Dryer	High	Very High	Very High	High
Spray Dryer	Moderate	Medium	Low	High
Fuid Bed Dryer	High	High	High	High
Microwave Dryer	High	High	Medium	High
Solar Dryer	High	Low	Medium	Low

Among all Dryer we Select Solar Dryer For Chemical Gypsum Drying. Solar Dryer Capital cost is Little High but as Compare to other Dryer it's Capital Cost is Negligible. Operating Cost of this System is also very low.So, it's Effective System for Drying and Important thing is here we use Green Energy for Drying of Chemical Gypsum.

V. METHODOLOGY AND DESIGN

A. Materials

Solar Drying plant was used for the experiments. Chemical Gypsum used was obtained from nearby Chemical plant.The capacity of the plant was 10 Tones / day. Solar drying was applied to the Chemical to obtain a Dry Chemical Gypsum with Not more then 10% Moisture.

B. Experimental design

The experimental study was carried out at the pilot drying plants, located at the region of Moti Bhoyan,Kalol. in Gujarat. Covered Solar drying plants were constructed for Capacity of 10 tones/day with floor dimensions of 10*5 Square metre to conduct the experiments. The Height of the pilot plants was 6.5 m. The covered Solar drying plants were operated according to the conceptual model shown in Following Figure. The sludge was spread out on the floors of the covered Solar drying plants in 25 cm-layers.

C. Design of Covered Solar drying plant

The covered sludge drying plant was constructed as a tunnel type greenhouse with a roof height of 6.5 m. It was completely enclosed by two-wall, 0.2 mm thin transparent Plastic Flm sheet with light transmittance of 85%. The plant was constructed with the main principle of increasing the difference between the Chemical Gypsum relative vapor pressure and indoor relative vapor pressure to obtain effective drying. Its schematic view is shown in Figure.

Table 5: Data of Experimental model.

Capacity (Tones/Day)	10
Gypsum Specific Heat (KJ/Kg*K)	1.09
Water Specific Heat (KJ/Kg*K)	4.184
Water Latent Heat (KJ/Kg)	2257
Density (Kg/m^3)	2300
Thickness of Gypsum layer (m)	0.25
Moisture content (Initial Condition)	35 %
Moisture content (Final Condition)	10 %
Volume (m^3)	11.25
Cross Section Area (m^2)	45
Length (m)	10
Width (m)	4.5
Required Water to be remove (Kg)	2500
Required Latent Heat (KJ)	5642500

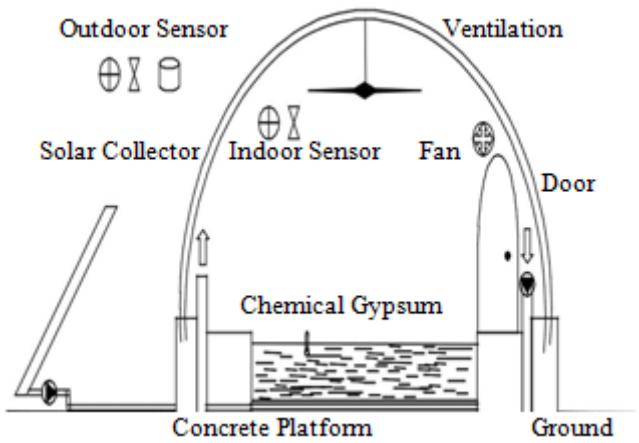

Figure 1: Figure of Experimental model

Aeration of the surface of the Chemical Gypsum : An indoor ventilator was mounted to the roof. The saturated layer developed on the surface of the Chemical Gypsum was removed with the turbulent air provided by the ventilator. The saturated air accumulated in the plant was discharged with two air fans mounted above the doors of the plant, and air renewal was provided.

Sludge Heating-- The greenhouse effect obtained in the plant provided effective usage of the solar energy. The impermeable concrete floor area of 50 m^2 of the plant was heated with the hot Air Pass through flat plate solar collectors.

Surface Renewal-- Chemical Gypsum was mixed manually twice a day for Chemical Gypsum Renewal purpose.

VI. RESULTS AND DISCUSSION

Chemical Gypsum from nearby Chemical plants has 35% moisture content. Mechanical Drying and Thermal drying necessitates high operation costs and energy requirement. Hence utilizing solar energy appears as a more economical, efficient, and less complex choice than the other drying systems.

Solar energy was traditionally used for food and crop drying carried out greenhouse energy conservation experiments in a tunnel-type greenhouse enabled to hold the air temperature difference at 10° C between inside and outside of the greenhouse at night. Several researchers studied solar Solid drying. Solar energy is reported to be used as either the sole source of the required heat or as a supplemental source in Greenhouse. Because natural air drying is incomplete in some periods in the winter months, a covered drying plant was developed by additional solar collectors, thus reducing not only the final moisture content of the Chemical Gypsum. The feasibility of the pilot plants were evaluated according to Removing moisture content.(E)

CONCLUSION

This study recommends the Effective and Economical Solar drying method instead of the Mechanical and Thermal drying for Drying of Chemical Gypsum. The achieved high volume reduction of approximately 30% by solar drying would lead to a reduction of the transportation, handling, and landfilling costs and also Easy for Handling.(B) The covered solar drying system can be applied in cities receiving high solar radiation. The design of the system has some improvement possibilities in the future. Bio-filters can be used to treat the indoor air and outdoor.

If the system is controlled with Programmable Logic Controller (PLC) regarding the control of the indoor temperature and humidity, lower energy costs and higher drying performance can be obtained. For example, if the indoor air is automatically discharged more rapidly at the high-humid periods or if an additional energy supply is automatically used when the temperature decreased, the performance of the system would increase.(C) Natural ventilation of the covered drying plant would increase the performance of the system when the wind speed is continuous. The results of the study showed that the covered Chemical Gypsum. drying plant was more advantageous than the open Chemical Gypsum.Drying plant both in summer and winter periods.(D)The covered drying plant used solar energy effectively to dry the Chemical Gypsum. The covered plant also functioned as an area for temporarily storing the Chemical Gypsum.

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