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BUILDING RESEARCH NOTE 46

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

IMPROVED CALCINATION OF GYPSUM THROUGH MECHANISED PAN SYSTEM

Gypsum is a versatile material known for its application in production of cement, plaster of paris, fertilizers and soil reclamation. Over 1200 million tonnes of natural gypsum deposits have been found in the states of Rajasthan, Gujarat, Jammu & Kashmir, Andhra Pradesh and Uttar Pradesh. About 92 per cent of it comes from Rajasthan alone. Besides natural gypsum, about 2.5 million tonnes of phospho gypsum is available as a by-product from the phosphoric acid fertilizer plants in the country.

Since this mineral finds industrial importance usually in the form of plaster of paris or calcined product, its dehydration becomes an essential operation. Manufacture of gypsum plaster of various grades like building, ceramic, surgical or dental requires that the mineral should be calcined to hemihydrate or plaster of paris. Chemically, gypsum plaster is $CaSo_4 . \frac{1}{2} H_2O$. It is produced by heating ground gypsum at 130–190°C in a suitable calcining plant when it loses one and a half molecule of water of crystallization in the form of steam. As a result gypsum plaster with half molecule of water is produced. This is also called first settle plaster.

Gypsum plaster sets to a hard mass when water is added to it. This property is utilized in the production of pottery, terracota, ceramic and building grade plaster and plaster products. As gypsum plaster is the starting material for market use, calcination of gypsum to hemihydrate is of utmost importance.

Calcination

There are several methods of calcination viz. kiln process, open pan process, continuous rotary kiln process and kettle process. A brief account of each is given below :

Kiln Process :

This is the most primitive process in which the calcination is accomplished in any form of kiln or oven, constructed on the lines of baker's oven. The temperature is maintained at 140°C for 30 to 36 hours. The process is particularly suitable for manufacture of porcelain grade plaster.

Open Pan Process :

This is the simplest process and is adopted throughout the world. In India, this process is widely used for the production of building grade plaster. Gypsum ground to about 60 mesh is placed in open metallic pans, heated from below by burning firewood or coal. Manual agitation of the charge is carried out with pokers. The calcination is considered complete when emerging of steam stops and the material starts settling.

Rotary Kiln Process :

Small rotary kiln similar to the one used for cement manufacture is employed in this process. Gypsum of lump size 30 mm is normally fed into the kiln which is heated with hot gases produced in a separate combustion chamber. The product after grinding is

suitable for wall plasters and building boards. This product is considered inferior to that produced in the kettle process.

Kettle Process :

A kettle is a cylindrical metallic vessel heated externally from the bottom. Kettles of various designs and sizes varying from 10 to 30 tonnes are used. The process is a batch operation, but continuous operation kettles with submerged burners in which extra heat is added directly to the charge, are also available.

Amongst the above four processes, open pan process is mostly used in India due to simplicity in operation and low initial cost of installation. But the process is heat wasteful. The product is also not of uniform quality. It is under calcined and over calcined in different portions of a batch. The temperature cannot be controlled which is a must for uniform quality product. Moreover, dust losses during calcination are upto 20 percent. The properties of final product are influenced not only by the quality of raw material used, but also by control over the temperature of calcination, extent and method of churning and the duration of calcination. Necessity was, therefore, felt for developing an equipment with efficient simultaneous agitation and calcination of raw material to get uniform quality product. The system should be such which can be easily adopted on the existing open pan set-ups. Accordingly, a new system named as 'Improved Mechanised Pan Calcination System' has been developed at this institute and the prototype has been successfully tried.

Improved Mechanised Pan System

The system (Fig 1) comprises of power operated stirring mechanism to ensure uniform and continuous churning of the charge during calcination, collapsible metallic lid to cover the pan to reduce dust losses and a system for automatic discharge of hot gypsum. Two steel pans each of 500 kg capacity are used to take a charge of one tonne of ground gypsum. The equipment is powered by a 5 HP motor which is capable of churning simultaneously the charge contained in two pans, thereby producing 840 kg of calcined gypsum per charge. When required, churning can be carried out in any one of the two pans while keeping the mechanism idle in the other pan. Provision has also been made for manual churning but this should be used only in situations when electric power suddenly fails and the charge under calcination is required to be protected against burning or over calcination. The design of pan system is amenable to much better controls.

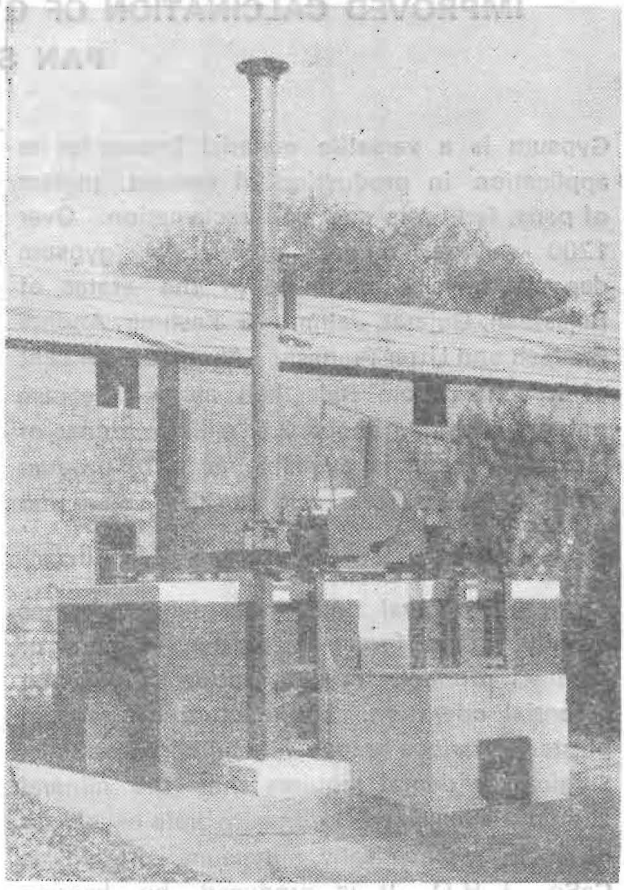

Fig. 1

Salient Features

Salient features and advantages of the system are :—

1. Its capacity is one tonne per charge.
2. The time taken by the first charge is 4½ hours while subsequent charges get calcined within ~~two~~ three and a half hours.
3. Coal consumption in the system is about 35 kg per tonne of gypsum against 150 to 200 kg in open pans. Thermal efficiency of this system is about 55% as against 12% for open pans.

TABLE — 1 CHEMICAL REQUIREMENTS*

Property Studied	Gypsum Plaster Samples			IS : 2547–1976 limits for Retarded Hemi-hydrate Plaster.
	Sample–1 (Rishikesh)*	Sample–2 (Rajasthan)*	Sample–3 (Rishikesh)*	
1. SO_3, % by mass, Min.	44.5	47.0	49.5	35.0
2. CaO, % by mass, Min.	33.20	35.80	36.20	2/3 of SO_3 content
3. Soluble magnesium salts expressed as, % of MgO Max.	0.28	0.30	0.20	0.3
4. Soluble sodium salts expressed as, % of Na_2O, Max.	0.16	0.10	0.10	0.3
5. Loss on ignition, % by mass.	7.06	6.84	6.44	Not greater than 9 and not less than 4.
6. Free lime, Min %.	0.54	0.52	0.52	3

*Determined as per IS : 1288–1973. Specification of test for mineral gypsum and gypsum products.

The names mentioned in the parenthesis are the sources of gypsum.

TABLE — 2 PHYSICAL REQUIREMENTS*

Property Studied	Gypsum Plaster Samples			IS : 2547-1976 Part-1) limits for Retarded Hemihydrate Plaster
	Sample-1 (Rishikesh)*	Sample-2 (Rajasthan)*	Sample-3 (Rishikesh)*	
1. Setting time, minute				
(a) Plaster-sand (1 : 2) mixture (Retarded)	140	152	156	120-900
(b) Neat plaster (Retarded)	80	84	85	60-180
2. Transverse strength, Kg/cm², Min.	20	24	29.5	14.0
3. Soundness	Passes	Passes	Passes	Set plaster pats should not show any sign of distintegration, popping and pitting.
4. Mechanical resistance of set plaster, Min.	4.0	3.8	3.7	Diameter of indentation shall not ba less than 3 mm & not more than 4.5 mm.
5. Residue on 1.18 mm I.S. Sieve %, Max.	1.00	0.8	0.8	1.0
6. Expansion on setting %, Max.	0.02	0.02	0.018	0.2 at 24 hours

*Tested as per IS : 2542 (Part-1)—1978. Specification for methods of test for gypsum plaster, concrete and products, Part-1, Plaster and Concrete.

TABLE—3

PROPERTIES OF GYPSUM PLASTER FOR USE IN FIBROUS PLASTER BOARD

	Particulars	Gypsum Plaster Samples			IS : 8272 – 1976* Limits
		Sample-1 (Rishikksh)	Sample-2 (Rajasthan)	Sample-3 (Rishikesh)	
1.	Chemical composition SO_3 %, by weight, Min.	44.5	47.00	49.5	42.0
2.	Fineness, % weight retained on IS : 600 micron IS Sieve.	0.5	0.8	0.5	1.0
3.	Setting time, minutes,				
	a) Unretarded.	6.0	6.0	7.0	25±5
	b) Retarded	24.0	26.0	26.0	
4.	Compressive Strength, Kg/cm^2, Min.				
	a) Unretarded.	110.0	118.0	128.0	76.0
	b) Retarded.	95.0	105.0	110.0	

*Specification for gypsum plaster for use in the manufacture of fibrous plaster board.