



# Blockages in Cement Storage Silos

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www.ximang.vn - www.cement.vn



- More than a 100 years of experience
- Efficient silo conception
- Storage capacity from 1.000m<sup>3</sup> 60.000m<sup>3</sup>
- More than 99% reclaim rate
- Applicable for bulk material such as cement, raw meal, alumina, fly ash, granulated slag etc.

## CLAUDIUS PETERS – 100 years silo technology

A 100 years experience for the benefit of our customers

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- 2. Possible root causes for blockages
- 3. Evaluation/Recommendation



### Introduction

A problem in Cement Storage is the tendency of cement to form lumps:



Problems with Discharge System? Problems with Material Stored? Problems with Silo Design? Problems with Construction?

Cleaning of Silos are very labor intensive and root cause must be analyzed in order to avoid future occurrence.

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### Example – Silo discharge comparison between two silo type





## Positive Effect – with very little dead zone







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## CaSO4 in the cement production

Calcium Sulfate is added in small quantities to the cement during its manufacture to control the setting time.

There are different occurrences of the Calcium Sulfate, these are shown in the following slides Depending on its status the CaSO4 contains between 20-0 % of combined water.

Even though this is only a small amount that is added to the cement this can create unwanted side effects





Picture no. 8

- Gypsum in all forms, are phases of the system  $CaSO_4$  /  $H_2O$ , this is Calcium Sulfate in all hydration phases
- Impurities in Gypsum can have significant influence on the process, machine lifetime and product characteristics
- With additives and fillers it is possible to modify the characteristics of the finished product
- Gypsum typically is
  - transparency transparent, translucent
  - pH-value 7 (neutral)
  - smell none
  - taste none
  - toxic no
  - enflamable no











# Colour of Gypsum



Picture no. 9

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## Terms used for Stucco Production

<u>Free Moisture</u> (FM) is the non cristal bond water of the gypsum and is based on the <u>wet</u> Gypsum

<u>Gypsum Purity</u> (GP) is the content of Dihydrate in the <u>dry</u> Gypsum. Dry means no free water, but containing combined water

<u>Combined Water</u> (CW) is the content of cristal bond water in the <u>dry</u> Gypsum or Stucco sample



Picture no. 10







 $CaSO_4 \cdot 2H_2O$  Gypsum Dihydrate

Contains 20,93% combined water

CaSO<sub>4</sub> • <sup>1</sup>/<sub>2</sub>H<sub>2</sub>O Gypsum Hemihydrate

Contains 6,2% combined water

CaSO<sub>4</sub> (A3) Anhydrite

Contains no combined water

Picture no. 11

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Picture no. 12





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## Possible causes of blockage problems

Lump problems caused by moisture?

The buildups are hardened material, which can not be easily destroyed, therefore there must be some water input:

- Direct water penetration?
- Water intake with air at over/under pressure valve and filter?
- Water intake with aeration air?
- Water intake with material?

Problems assisted by discharge?

 If the material is stored for a long time in the silo (dead zones), then the cement will probably harden in this area



#### **Direct water penetration**





- Silo roof has been tested with direct water test?
- Lump formation is mainly at the walls?
- Determine if coatings are mainly in layers at the wall and not shaped as lumps in the center (what would indicate direct water intake)
- If silo has been filled already some time ago and cleaned afterwards, so moisture from building structure can be excluded.

#### **Conclusion:**

No direct water intake!

#### Recommendation

Nevetheless, check when emptied for direct water from the roof





Absolute humidity is the total amount of water vapor present in a volume of air.

Absolute humidity in the atmosphere ranges from near zero to roughly  $30 \text{ g/m}^3$  when air is saturated at  $+30^{\circ}\text{C}$ 

At an air temperature of  $+30^{\circ}$ C and relative humidity of 80%, the absolute humidity is about 25 g/m<sup>.</sup> Dew point is about  $+26^{\circ}$ C

Taken from: Siegel/ Pneumatische Förderung; Vogel Fachbuchverlag, 1984

## Water intake at upper silo room ?





- If the filter is running there is material feed to the silo
- Air is heated up
- Hot air can take more water
- Condensation can only take place if the air is cooled down below the dewpoint
- This might only be the case in the morning, when hot air might be cooled down at roof

#### **Conclusion:**

No severe water intake!

**Recommendation:** 

- When the feed is stopped no permanent run of the filter necessary. Then the max. moisture that can be released is the moisture in the air of upper silo room
- Negative pressure by the filter in the silo needs just to be sufficient to extract entered air

### **Route of Aeration Air**





Aeration air is travelling not through material to Silo top Only from aeration pads to Dedusting in chamber

So material contact is only given with material, that is immediately discharged

### Water Intake from Aeration





- Aeration is only running, if material is discharged
- Usually the material temperature is far above dew point, so no moisture from the air can be released to the product
- Usually material temperatures at the silo outlet will still be around 85-90°C
- If the water from the aeration would be released to the material, this would be discharged with the material
- This amount of water would be very low
- Max 12 kg of water/h, but appr 200t of material resulting in max moisture increase of 0,006%

#### Conclusion

No severe influence from Aeration air **Recommendation** Only run aeration, if there is discharge



#### Water from material?



- Behind mill the free moisture is measured.
- But the gypsum fraction of the product might still contain inherent moisture.
- The added gypsum to the grinding process, might, due to the short remaining time in the mill only partially calcined when it is leaving the mill. This remaining time in the mill is especially short when the mill has the roller press as pre-grinding in front.
- Only 50% of the combined water are released in the mill!
- The temperature of 105°C behind mill is still enough to keep this process going.
- This first indication of that can be found in already started cloggings in bucket elevator, chutes and feeding aero slides on silo roof. In open aero slides still partially calcined lumps in agglomerated form have been found.
- The rest calcination will take place in the silo were the cement temperature is still above the critical point of 83 °C.
- Then the "steam" is moving to colder areas of the material, where it is condensating and present as free water.









Diagramm 1



#### Thermo gravimetric analysis/ Cement



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### Conclusion

If after confirmation that there is no direct water intake:

- Root cause for the build ups in the silo is most probably the gypsum dehydration in the silo
- With the gypsum dehydration free water is available
- With this free water parts of the cement are hardened at the walls, there are coatings of up to 1m
- When the material level drops, some of these blocks fall down and later lead to blockages at the airslide
- The loose material can still partly be extracted pneumatically



## Recommendation

#### Mill Process:

- The gypsum shown here is quite slow in dehydration, therefore the mill adjustment on gypsum is not easy
- Replace parts of Dihydrate with Anhydrite or Hemihydrate
- In some plants that we know of the ratio of Anhydrite is roughly 50:50, but too much Anhydrite might influence the setting and strength of the concrete

#### Adjust Water Spray

- High temperature in the mill with sufficient remaining time in the mill will lead to a more completed gypsum calcination in the mill
- The dew point behind mill should be monitored as otherwise the cement quality might be affected
- The utilization of a cement cooler might be an option as well
  - Lower outlet temperature below 80° at the outlet will lead to less calcination in the silo
- Further literature is mentioned at:
- Hills, L; Water spray in cement finish mills; Portland Cement Association, R&D Serial No. 2889; Illinois 2006







#### Recommendation

#### <u>Silo</u>

- Silo design has to be fit to its purposes. Some older design allows only funnel flow, but not for mass flow.
- Funnel flow leads to dead stock after some time.
- To achieve mass flow or nearly mass flow, you need to design the right opening size and right inclination.



#### How to reach Mass Flow?



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#### Recomendation





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## Recommendation

#### <u>Silo</u>

- After cleaning and removal of the remaining cement inside the silo a silo inspection by CP is highly recommended
- This should include the condition of filter and dedusting system and the control system
- To reduce the amount of cement coating at the wall a friction reducing coating of the lower part of the silo cylinder up to cone height might be an option.
- By this means the cement can not create large build-ups in the lower area, where the upper cement coatings can rest onto.
- Some old silos have flat bottom, check if modification is an option for the silo but Structural design needs to be considered.



## Coatings at silo wall





- Coatings start building up from the bottom
- New layers build up on top of the old layers
- Appr. 1m -1,5 m thickness



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## CLAUDIUS PETERS silotypes -Inspection chamber technology - IC





#### <u>Features</u>

- Maximum storage capacity
- Small installation height
- Installation of equipment in the chamber
- Discharge capacity up to 1,000 t/h
- Silo diameter from 10 – 30 m
- 2 or more standard discharges
- Relclaim discharge rate > 99%
- Iow energy needs
- Inspection by ICchamber

#### **Advantages**

- Use of ring chamber
- Saving silo corpus
- Small installation height
- Short loading and unloading time
- Optimal utilization of spaces
- High flexibility
- Purity of variety
- Saving operation costs
- During operation

## CLAUDIUS PETERS silotypes -Inspection chamber technology - IC





#### **Ring Channel Inspection**

## **Claudius Peters Gravity separator**





rid prevents throughput of lumps eparation of lumps lead to high ervice reliability and availability ischarge via manual or automatically a pneumatic flaps



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#### Features

- Available for all aeroslides and silo outlets
- Mass flow of cement up to 1000 t/h
- Designed for material temperature up to 180°C
- Motor power: 0,75 KW at 25 min<sup>-1</sup>
- High wear resistant materials for crusher and grid
- Easy maintenance



Lump Breaker, horizontal

Lump Breaker, vertical





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