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CALCIUM SULFATE PIGMENT PLANT #293

Detailed Process Description

Wet Grinding Process has been producing ground calcium sulfate pigment for paper coating applications. The process utilizes by-product calcium sulfate from phosphoric acid process as a raw material. Calcium sulfate is ground four times in this continuous process using Netzsch or Drais wet bead mills with 1000 liter volume. Four mills are located parallel in each grinding step of the process, thus the whole four step grinding process contains 16 operating mills in full capacity.

Typical product characteristics for the product (Kemwhite CG80HB) are solids content 67,5%, particle size 68%<2µm, Br100 viscosity <700 mPas (typical <500mPas) and brightness >93% (typically 95%).The process utilizes by-product calcium sulfate from phosphoric acid process as a raw material. Also finer particle sizes (90%<2µm) can be achieved if grinding media is changed accordingly. However, finer grades have not been in commercial production. In the application point of view calcium sulfate is a high brightness white pigment, giving for example exceptionally good delta gloss properties and good surface coverage ability (because of the low density compared to other white pigments, 2,3g/cm3).

Calcium sulfate (or gypsum) is processed through three main steps to obtain the end product, which is stored in storage tanks in slurry form. Product properties are monitored during the storage, and typically product stays from one to several weeks in the tanks before it is transported by trucks to customer mills as a slurry form.
It can be described, that the process consists of four parts:

1) Purification
2) Grinding
3) Screening and post-treatment
4) Storage

Same type of process can be used for other type of by-product calcium sulfates, e.g. by-product gypsum from FGD processes or organic acid processes can be utilized. It is also possible to grind natural gypsum, but crushing and pre-grinding steps would be needed in this case. The following parts describe these three above mentioned process steps in more detailed.

1. Gypsum Purification

Raw gypsum is transported from the gypsum pile to the 300m3 raw gypsum silo by trucks and conveyer belt. Solids content of the gypsym is approximately 80-85%, and d_{50} particle size 45µm in the silo/beginning of the process.

Gypsum is fed to the process by horizontally moving screw feeder under the silo. At first the gypsum is mixed with water to achieve 25% solids content in a 15m3 CC250 mixing tank. pH 3 in this step is around 3. The water/gypsum slurry is pumped via a coarse strainer to two horizontal pre-screens equipped with 500µm screen nets, and onwards to a feed tank of Falcon separators. Centrifugal pumps for the dilute media and mohno pumps for more viscose slurry are used throughout the process.

Falcon separators are high speed rotating machines, which separate heavy and coarse impurities from raw material using centrifugal force. In this case impurities are mainly unreacted apatite mine and different side minerals from the apatite ore. Falcon separators remove some 3-4wt% of residue from the gypsum feed. In Siilinjärvi process it is possible to feed gypsum either to two times Falcon treatment, or one Falcon treatment and one magnetic separation.

Magnetic separation used in the process is continuous wet high current wet magnetic separator (equipment used in Siilinjärvi is not superconducting model). Purpose of the Falcons and magnetic separator is to remove impurities and increase brightness and other optical properties of calcium sulfate. Overflows from prescreening and residue streams from the separators are led to a plate clarifier.

Gypsum streams from the purification are collected to a 25m3 feed tanks of two Larox drum filters. In the drum filters the solids content of the slurry is increased to 78%, and the filtrate water is recycled back to the CC250 mixing tank.

2. Gypsum Dispersing and Grinding

Gypsum filter cake from the drum filters is fed to two dispersing tanks by belt feeders. In these to parallel 9m3 tank dispergators the gypsum filter cake, water and needed grinding chemicals for first grinding step are mixed to the end solids content of 68%. Typically the grinding chemical which is added in this step is CMC (carboxy-methyl cellulose). Also the pH is adjusted with NH3 gas to about value 7.
From the tank dispergators the gypsum slurry is fed to to two parallel Atrex rotor-stator dispergators, which make the slurry more uniform and help the rheology in first mills. Use of these rotor-stator dispergators is not mandatory in this step of the process, but brings some benefits. From the Atrex dispergators the slurry is pumped to 16m3 feed tank of a first grinding step.
The first grinding takes place in 1000l horizontal bead mills, equipped with rotating blades which powerfully mix a bead material inside the mill. Bead material is kaolin, filling degree of the beads in the mill is typically 85% and bead sizes vary from 1-2,5mm depending on the grinding step. Rotating speed used in the mill is typically 340rpm, which gives approximately 14m/s tip speed.

After the first grinding the thick gypsum slurry, or more likely a high viscous paste (due to an increased surface area) is pumped to the next dispersing tank. In the tank dispersing chemicals are added to decrease the viscosity to approximately 500mPas level. Before the second grinding step the slurry is screened with 200µm horizontal sieves. After the second grinding the particle size of the gypsum has diminished to a level 60%<2µm. This material is again dispersed and pumped to mills of the third grinding. Two times ground slurry is also suitable material for some paper pre-coating applications, hence processed gypsum can be separate as a separate product if wanted. The fourth grinding step is equivalent compared to the three first steps, the only thing that varies in the steps is the chemical recipe used and bead size of the grinding media. Screening is only done for the one time ground material during the grinding. A complete time for the whole grinding step takes some 8 hours.

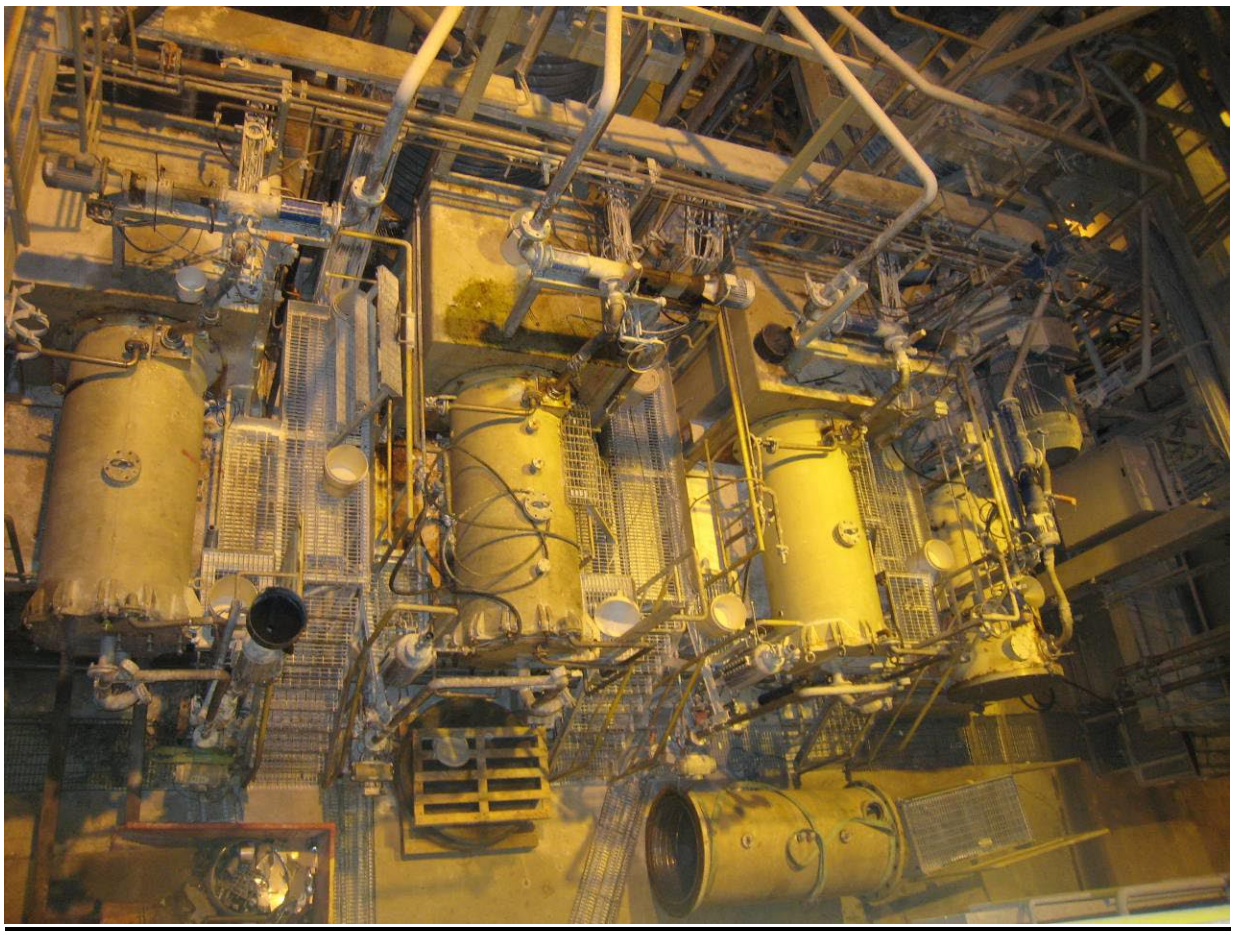
3. Screening and post-treatment

After the fourth grinding step the slurry is pumped as a thick paste to a so called “refining” step. In this step the particle size distribution of the product is changed to a more steep shape via a pH change, which gives better application performance and improves rheology of the slurry. This step is not mandatory but improves product performance and is usually always done.
Another complimentary step - so called “expansion”, follows after the refining. In this unit process the slurry stream is pumped via two parallel under pressurized vessel, during which roughly one wt% of water is evaporated from the slurry, and solids content thus increases. After the expansion the slurry is fed to two parallel Atrex dispergators, and 1500 rpm rotating rotor-stator blades make the slurry uniform and disperse it thoroughly.
Despite this big mechanical energy during the Atrex dispersing, the slurry is one more time chemically treated in CC550 post-dispersing tank. In this tank also per-acetic acid (PAA) to bleach the slurry and to preserve / destroy bacterial activity is added. Also the pH value of the slurry is adjusted to a final ~7,8 level in this tank.
Finally the product is screened in multistep process. The target in screening is to remove all the residual coarse material still existing in the slurry. Screening contains two-step horizontal screening with 42µm screen nets, and one pass pressure sieving with 50µm screen net. Amount of the coarse material is monitored and is one followed quality parameter of the product. After the screening a needed amount of suitable bioside is dosed – also the amount of different type of bacteria in the product is monitored. It is also possible to dose part of the bioside amount to the grinding step if needed.

4. Storage

The product slurry is stored in 3000m3 storage tanks under a gentle, continuous agitation. Needed product quality parameters are followed on daily basis. Usually the product stays unchangeable several week, sometimes small dispersing agent dosages to adjust viscosity or small bioside dosage to kill bacteria are needed.

Photos




C1110


C1051
C1050

Major Equipment

Item Number	Plant Asset No.	Description	Year Built
		GCS Plant	
001	CC254	Used Brant model ATL-120 stainless steel rectangular vibrating screen. Unit measures approximately 1800mm long x 1200mm wide. Includes vibratory motors.	1984
002	CC255	Used Sweco model UMB-AY stainless steel rectangular liquid/solid screen. Unit measures 2500mm long x 1100mm wide. Has 5hp, 3/60hz, 1800rpm vibratory motor.	2003
003	CC659	Used Sepro Mineral Systems model Falcon C1000 continuous gravity concentrator. Approx rated capacity of 5 to 27 ton per hour with maximum slurry capacity of 74cumt/hour. Unit bottom driven by approximately 15kw motor.	2002
004	CC640	Used approximately 14,000 litre stainless steel vertical mixing vessel. Unit has welded dished top and bottom heads. Internal rated atmospheric pressure. Includes top entry 4-tier 2-blade stainless steel agitator with 5.5kw top mounted drive. Unit is mounted on side support ring.	2003
005	CC266	Used Sepro Mineral Systems model Falcon C1000 continuous gravity concentrator. Approx rated capacity of 5 to 27 ton per hour with maximum slurry capacity of 74cumt/hour. Unit bottom driven by approximately 15kw motor.	2005
006	CC269	Used Pacific Electric Motor Co. Model PEM 48"-100KW-20KG magnetic separator. Approximate flow capacity 11ton per hour at 25% solids content.	1994
007	CC280	Used approximately 25,000 litre stainless steel vertical mixing tank. Unit measures approximately 3800mm straight side x 2800mm diameter. Has welded cone top and welded dished bottom heads. Unit rated atmospheric pressure internally. Unit includes top entry stainless steel 2-tier, 2-blade paddle agitator with top mounted drive. Unit is mounted on side support ring.	1994
008	CC250	Used approximately 15,000 litre stainless steel vertical mixing vessel. Unit measures approximately 3,860mm straight side x 2,500mm diameter. Has welded top and bottom heads. Unit rated atmospheric pressure internally. Unit has top entry stainless steel agitator with top mounted drive. Unit mounted on side support ring.	1994

009	CC260	Used approximately 15,000 litre stainless steel vertical mixing vessel. Unit measures approximately 3,860mm straight side x 2,500mm diameter. Has welded top and bottom heads. Unit rated atmospheric pressure internally. Unit has top entry stainless steel agitator with top mounted drive. Unit mounted on side support ring.	1994
010	CC700	Used approximately 29,000 litre stainless steel vertical storage tank. Unit measures approximately 5,500mm straight side x 2,600mm diameter. Has welded cone top and welded flat bottom heads.	1984
011	CC600	Used approximately 29,000 litre stainless steel vertical storage tank. Unit measures approximately 5,500mm straight side x 2,600mm diameter. Has welded cone top and welded flat bottom heads.	1984
012	CC290	Used approximately 25,000 litre stainless steel vertical mixing tank. Unit measures approximately 3800mm straight side x 2800mm diameter. Has welded cone top and welded dished bottom heads. Unit rated atmospheric pressure internally. Unit includes top entry stainless steel 2-tier, 2-blade paddle agitator with top mounted drive. Unit is mounted on side support ring.	1994
013	CC284	Used Larox type VF24/23 TI stainless steel rotary vacuum filter. Drum measures approximately 2,400mm diameter x 3,100mm face length giving approximately 23sqmt filtration surface area. Drum has cloth with wire retainers. Unit driven by 3kw motor. Unit has stainless steel bath with travelling knife discharge. Includes stainless steel slurry tank.	2003
014	CC314	Used Larox type VF24/23 TI stainless steel rotary vacuum filter. Drum measures approximately 2,400mm diameter x 3,100mm face length giving approximately 23sqmt filtration surface area. Drum has cloth with wire retainers. Unit driven by 3kw motor. Unit has stainless steel bath with travelling knife discharge. Includes stainless steel slurry tank.	2003
015	CC340	Used stainless steel mixing vessel	?
016	CC320	Used stainless steel mixing vessel	?
017	CC360	Used approximately 16,000 litre stainless steel vertical mixing vessel. Has welded top and bottom heads. Internal rated atmospheric pressure. Unit has top entry 2-tier 2-blade stainless steel agitator with top mounted drive. Unit is mounted on legs.	1984
018	CC370	Used approximately 14,000 litre stainless steel vertical mixing vessel. Has welded top and bottom heads. Internal rated atmospheric pressure. Unit has top entry 2-tier 2-blade stainless steel agitator with top mounted drive. Unit is mounted on legs.	1984
019	CC343	Used Megatrex model Atrex CD700-90/90 mill. Unit has 90kw drive. Includes stainless steel feed tank.	2005

020	CC342	Used Megatrex model Atrex CD700-90/90 mill. Unit has 90kw drive. Includes stainless steel feed tank.	2005
021	CC802	Used Atlas Copco model GA75VSD air compressor. Rated 14.68cumt/min at 13 bar.	2005
022	CC803	Used Atlas Copco model CD230 air dryer, rated 11 bar pressure.	2005
023	CC804	Used Atlas Copco model GA75+ air compressor. Rated 14.73cumt/hr at 7.5 bar pressure.	2005
024	CC805	Used Atlas Copco model CD280 air dryer, rated 11 bar pressure.	2005
025	CC278	Used approximately 8,600 litre stainless steel vertical storage tank.	1984
026	CC270	Used approximately 7,000 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Internal rated atmospheric pressure. Unit includes top entry stainless steel agitator with top mounted drive.	1994
027	CC660	Used approximately 3,200 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Internal rated atmospheric pressure. Includes top entry stainless steel agitator with top mounted drive. Unit mounted on lungs.	2008
028	CC740	Used approximately 19,000 litre stainless steel vertical storage tank.	1984
029	CC850	Used approximately 4,000 litre stainless steel vertical storage tank.	1984
030	CC293	Used approximately 4,000 litre stainless steel vertical storage tank.	1984
031	CC391	Used Drais model DRA PM1000 TEX H approximately 1,200 litre bead mill. Unit has 355kw main drive. Includes beads.	1984
032	CC392	Used Drais model DRA PM1000 TEX H approximately 1,200 litre bead mill. Unit has 355kw main drive. Includes beads.	1984
033	CC393	Used Drais model DRA PM1000 TEX H approximately 1,200 litre bead mill. Unit has 355kw main drive. Includes beads.	1984
034	CC494	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	2004
035	CC400	Used approximately 8,000 litre stainless steel jacketed mixing vessel. Has welded top and bottom heads. Unit has stainless steel external coil jacket. Unit has top entry stainless steel 3-tier, 3-blade agitator with top mounted Sulzer drive.	?
036	CC526	Used Amkco Process Equipment model A3 Alligaattori stainless steel screen. Unit measures approximately 2,000mm long x 1,000mm wide. Includes (2) vibratory motors.	2005
037	CC524	Used Brant model ATL-120 stainless steel rectangular vibrating screen. Unit measures approximately 1800mm long x 1200mm wide. Includes vibratory motors.	1984
038	CC525	Used Brant model ATL-120 stainless steel rectangular vibrating screen. Unit measures approximately 1800mm long x 1200mm wide. Includes vibratory motors.	1984

039	CC520	Used approximately 6,300 litre stainless steel vertical jacketed mixing vessel. Unit has welded top and bottom heads. Includes stainless steel coil cooling jacket. Unit has top entry stainless steel 2-tier, 3-blade agitator with top mounted drive.	1994
040	CC420	Used approximately 10,000 litre stainless steel vertical jacketed mixing vessel. Unit has welded top and bottom heads. Has stainless steel box section external cooling jacket. Unit has top entry agitator with drive.	?
041	CC460	Used approximately 22,000 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Includes internal cooling coil. Unit has 3-tier 3-blade stainless steel agitator with top mounted drive.	1984
042	CC595	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	1994
043	CC596	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	1994
044	CC597	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	1994
045	CC811	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	2001
046	CC812	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	2001
047	CC813	Used Netzsch model LME1000K mild steel approximately 1,000 litre bead mill. Unit has 355kw main drive. Includes beads.	2001
048	CC814	Used Drais model ST-1200 stainless steel approximately 1,210 litre bead mill. Unit has 3 bar pressure on cylinder. Unit driven by 355kw motor. Includes beads.	2003
049	CC815	Used Drais model ST-1200 stainless steel approximately 1,210 litre bead mill. Unit has 3 bar pressure on cylinder. Unit driven by 355kw motor. Includes beads.	2003
050	CC816	Used Drais model ST-1200 stainless steel approximately 1,210 litre bead mill. Unit has 3 bar pressure on cylinder. Unit driven by 355kw motor. Includes beads.	2003
051	CC819	Used Drais (Buhler) model 1 FSTX SUPERTEX 1200 stainless steel approximately 1,210 litre bead mill. Unit has 3 bar pressure on cylinder at 70 deg.c. Unit driven by 355kw motor. Includes beads.	2005
052	CC818	Used Drais (Buhler) model 1 FSTX SUPERTEX 1200 stainless steel approximately 1,210 litre bead mill. Unit has 3 bar pressure on cylinder at 70 deg.c. Unit driven by 355kw motor. Includes beads.	2005
053	CC817	Used Drais (Buhler) model 1 FSTX SUPERTEX 1200 stainless steel approximately 1,210 litre bead mill. Unit has 3 bar pressure on cylinder at 70 deg.c. Unit driven by 355kw motor. Includes beads.	2005
054	CC560	Used approximately 17,000 litre stainless steel vertical jacketed mixing vessel. Unit has welded top and bottom heads. Unit includes top entry stainless steel agitator with drive.	2005

055	CC033	Used approximately 2,000 litre stainless steel redefined vessel. Unit has top entry stainless steel blade agitator with bottom entry stainless steel rousers type agitator.	1997
056	CC020	Used approximately 2,000 litre stainless steel redefined vessel. Unit has top entry stainless steel blade agitator with bottom entry stainless steel rousers type agitator.	1997
057	CC015	Used approximately 2,000 litre stainless steel redefined vessel. Unit has top entry stainless steel blade agitator with bottom entry stainless steel rousers type agitator.	1997
058	CC010	Used approximately 2,000 litre stainless steel redefined vessel. Unit has top entry stainless steel blade agitator with bottom entry stainless steel rousers type agitator.	1997
059	CC704	Used approximately 1,000 litre stainless steel vertical tank. Unit has bolted dished top and bottom heads.	1997
060	CC702	Used approximately 1,000 litre stainless steel vertical tank. Unit has bolted dished top and bottom heads.	1997
061	CC490	Used approximately 5,700 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Includes top entry stainless steel agitator with top mounted drive.	1984
062	CC545	Used approximately 18,000 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Includes top entry stainless steel agitator with top mounted drive.	2005
063	CC550	Used approximately 8,000 litre stainless steel jacketed mixing vessel. Has welded top and bottom heads. Unit has stainless steel external coil jacket. Unit has top entry stainless steel 3-tier, 3-blade agitator with top mounted Sulzer drive.	2005
064	CC713	Used Megatrex model Atrex CD700-90/90 mill. Unit has 90kw drive. Includes stainless steel feed tank.	2005
065	CC714	Used Megatrex model Atrex CD700-90/90 mill. Unit has 90kw drive. Includes stainless steel feed tank.	2005
066	CC418	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
067	CC419	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
068	CC417	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
069	CC416	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
070	CC452	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
071	CC453	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997

072	CC415	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
073	CC414	Used Ronningen model DCF-1600 stainless steel in-line basket filter.	1997
076	CC708	Used Alfa Laval stainless steel plate heat exchanger.	2002
077	CC910	Used approximately 30,000 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Includes top entry stainless steel agitator with top drive.	?
078	CC363	Used Sweco approximately 47" diameter 5 deck stainless steel screen.	1984
079	CC570	Used approximately 6,000 litre stainless steel vertical jacketed mixing vessel. Unit has welded top and bottom heads. Has top entry stainless steel agitator with top mounted drive. Unit has external stainless steel coil jacket for cooling.	2003
080	CC580	Used approximately 17,000 litre stainless steel vertical jacketed mixing vessel. Unit has welded top and bottom heads. Unit includes top entry stainless steel 4-tier, 2-blade agitator with drive.	1984
081	CC956	Used Safematic model 25AC water filtration system.	?
082	CC480	Used approximately 22,000 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Includes internal cooling coil. Unit has 3-tier 3-blade stainless steel agitator with top mounted drive.	1984
083	CC530	Used approximately 8,700 litre stainless steel vertical mixing vessel. Unit has welded top and bottom heads. Includes stainless steel top entry agitator with drive.	1984
		PSC Plant	
084	C1150	Used approximately 10,000 litre mild steel horizontal storage tank. Unit mounted on saddles.	2005
085	C1115	Used Allgaier model FC10B light diesel hot gas generator.	2005
086	C1110	Used Allagaier stainless steel dispersion dryer. Approx maximum flow rate 3,000kgs/hr. Internal rated -50 to +40mbar pressure at -30 to 450 deg.c. Unit has bottom driven dispersion mixer with 11kw motor. Unit also includes large dust bag filter and various screw conveyors.	2005
087	C1034	Used Elmomet Oy approximately 2,000 litre stainless steel ribbon blade mixer. Trough measures approximately 2600mm long x 900mm wide x 700mm high. Has twin screw mixer type driven by 30kw motor.	2008
088	C1020	Used stainless steel weigh hopper with stainless steel inclined screw conveyor	2008

089	C1030	Used Megatrex Oy model CD750 G110 high speed disperser/mixer. Unit has 30kw main drive,	2008
090	C1035	Used Lodige type Ring type Layer Corimix CM350 stainless steel turbulent mixer. Unit has clamped top.	2008
091	C1036	Used Elmomet Oy approximately 2,000 litre stainless steel pin blade mixer. Trough measures approximately 2600mm long x 900mm wide x 700mm high. Has twin screw mixer type driven by 30kw motor.	2008
092	C1080	Used Sweco type K3CIP stainless steel rectangular screen. Has (2) vibratory motors.	2008
093	C1060	Used Sweco type K3CIP stainless steel rectangular screen. Has (2) vibratory motors.	2008
094	C1050	Used approximately 10,000 litre stainless steel vertical mixing vessel.	2008
095	C1055	Used approximately 10,000 litre stainless steel vertical mixing vessel.	2008
096	C1090	Used approximately 10,000 litre stainless steel vertical mixing vessel.	2008
097	C1070	Used approximately 10,000 litre stainless steel vertical mixing vessel.	2008
098	C1040	Used Megatrex Oy model CD750 G110 high speed disperser/mixer. Unit has 30kw main drive,	2008

CG80 – CaSO4 Coating Pigment (GCS) Product Specification

- Dry Solid, % 67.5 +/- 0.3 %
- Viskosity, Br. 100 rpm < 700 mPas
- pH 8.2 – 8,6
- Brightness, ISO 94 +/- 1 %
- Yellowness < 1,5 %
- Particle size < 2 µm 77.5 +/- 2.5 %
- Particle size < 0.3 µm < 15 %
- Redox > 0 mV

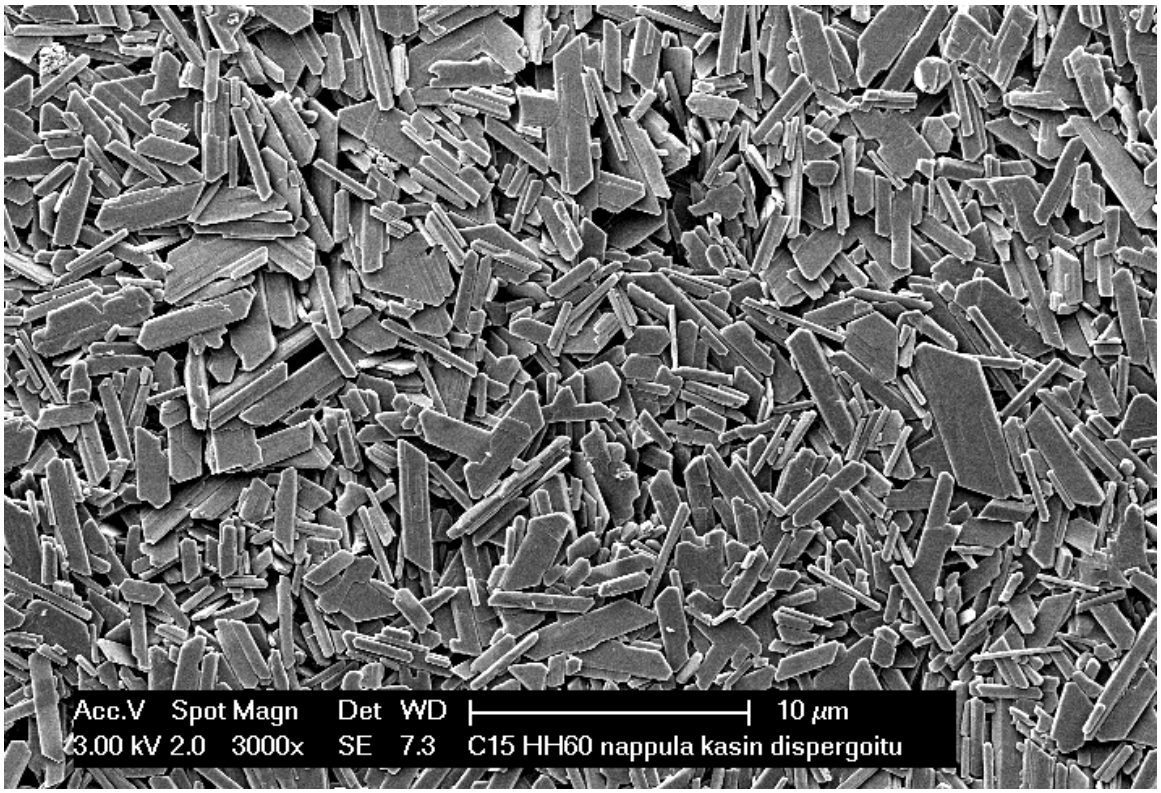
CG60 – CaSO4 Coating Pigment (GCS) Product Specification

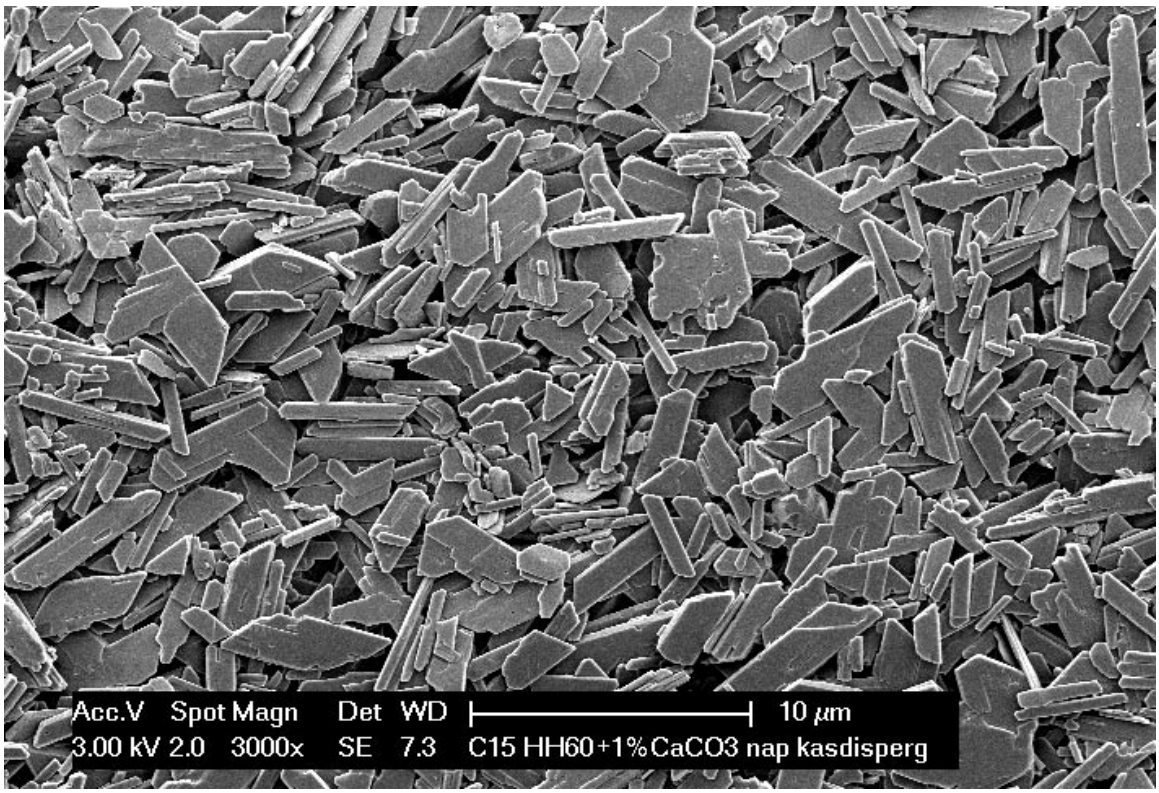
- Dry Solid, % 67 +/- 0.5 %
- Viskosity, Br. 100 rpm < 850 mPas
- pH 8.2 – 8,6
- Brightness, ISO 94 +/- 1 %
- Yellowness < 1,5 %
- Particle size < 2 µm > 55 %
- Particle size < 0.3 µm < 20 %
- Redox > 0 mV

PCS Product Specifications

- d50 particle size 1,0 or 1,2 (can be tailored)
- Steep psd curve
- Platelike or rhombic particle shape
- Viscosity typically <500mPas (Brookfield 100)
- Optical properties as with the GCS products
- pH ~8

SEM (scanning electron microscope) Images of PCS Products

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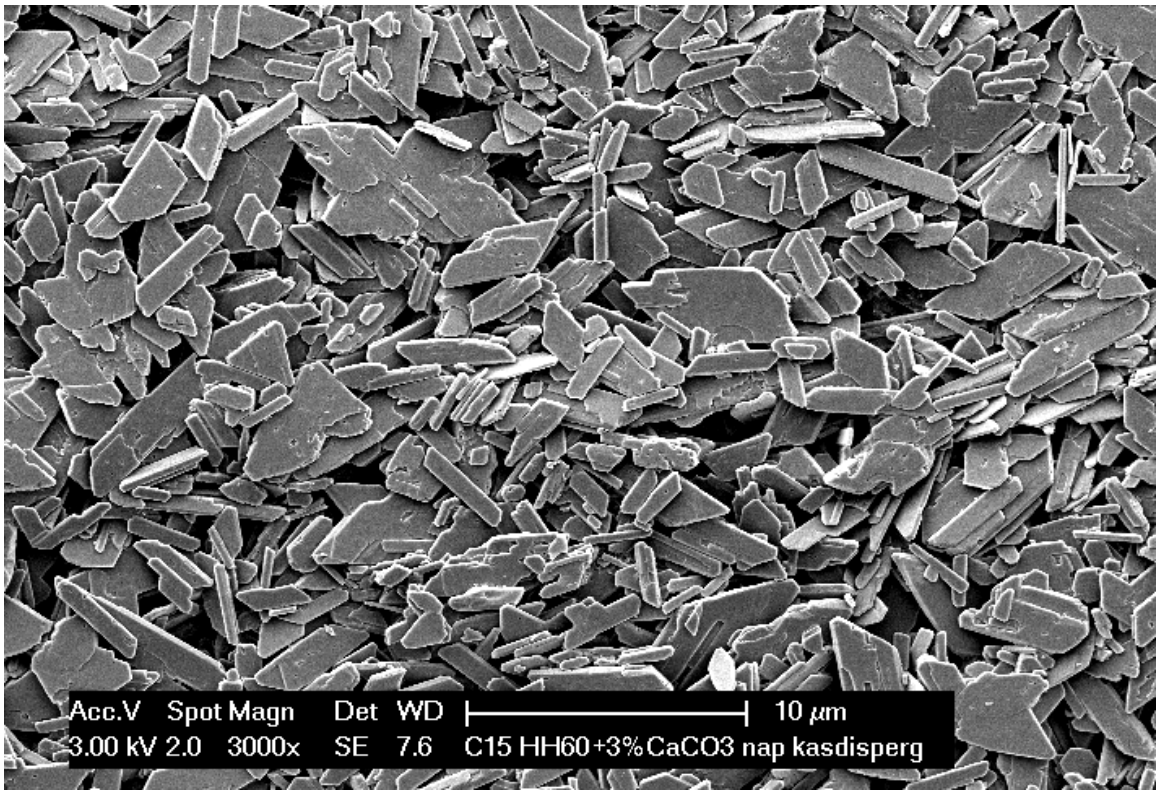
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3.00 kV 2.0 3000x SE 7.6 C15 HH60+3%CaCO3 nap kasdisperg

Plant Infrastructure

The plant is located in the building area of roughly 25m x 50m = 1250 m^2. Equipment is located partly on two floors. Hence the total area used is 2000 m^2. There are actually two different processing units, GCS and PCS. The PCS needs a lot less space than the GCS because its capacity is smaller, and in the GCS there are four grinding steps with big bead mills.

The need for ground foundation (piles) depends on the quality of the ground on which the plant will be built. There are heavy mills in the process which need a solid foundation. The requirement for the ground to sustain seismic incidence is similar to that of other heavy industries.

• Electricity. The biggest variable cost in the grinding process in addition to the dispersing chemicals is electricity. The need of electricity is roughly 280-300 kWh/ton of dry product for GCS and roughly 140-150 kW/h in the PCS process. Hence, total electricity need is in a level of 1700 kWh/h if both GCS and PCS product are in production (300 kWh/t x 4t/h of GCS + 150 kWh x 3.5 t/h of PCS).

• Water (both process and cooling water). Cooling water is needed for cooling of the mills. The quality of the water is not required be very high. Normal lake or river water is suitable. Process water is needed for the make-up of the gypsum slurry before the purification, and in the PCS as a raw material and for dispersing. Process water quality is more important to minimize possible bacteria problems and effect to the product quality (color), and some sort of purification (sand filtration etc.) would be good to have depending on the quality of the available water.

• Steam is not needed.

• Light oil is needed for the calcination in the PCS process (if LPG is available, it might be possible to change the burner to use that. Gas is an alternative option as a calcination fuel.