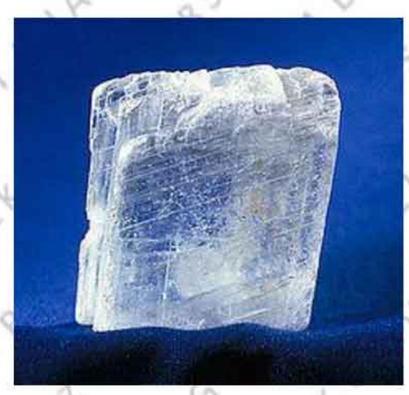
YILDIZ TECHNICAL UNIVERSITY – DEPARTMENT OF ARCHITECTURE
2017 -2018 ACADEMIC YEAR – SPRING SEMESTER
BUILDING MATERIALS LECTURE NOTES / Dr. Polat DARÇIN

BASIC MATERIALS – 2

GYPSUM

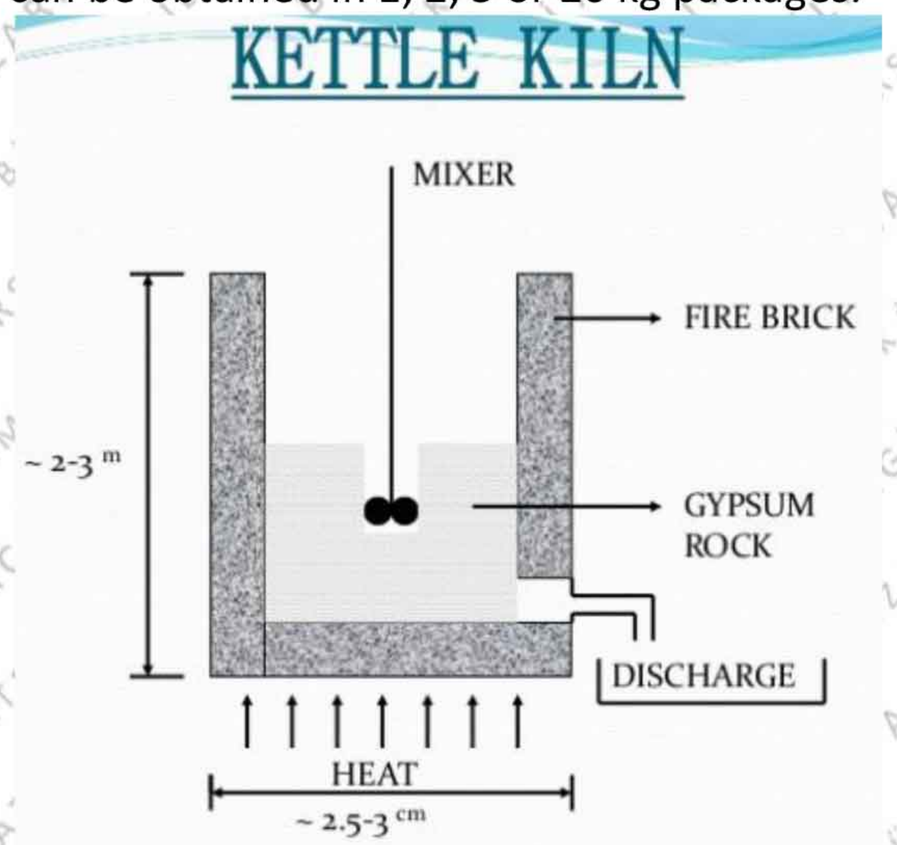


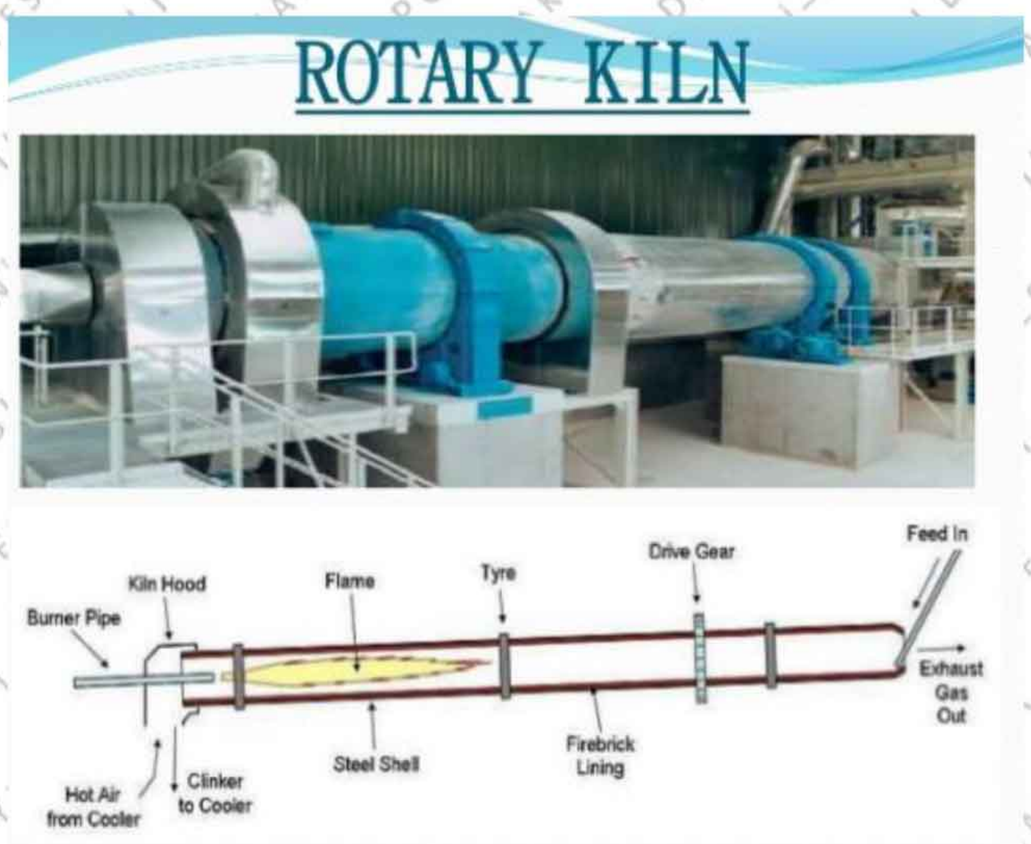
Gypsum is a common soft sulfate mineral composted of calcium sulfate [calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$)] with thick and extensive evaporate beds. Pure gypsum is a white translucent crystalline mineral and is so soft that it can be scratched by a finger nail. Gypsum is moderately water soluble and in contrast to most other salts, it becomes less soluble at higher temperatures.

When gypsum is heated to about 160 °C, it loses a part of its water and converts first to calcium sulfate hemihydrate (plaster of paris / alçı) and if heated further, to anhydrous calcium sulfate (anhydrite). The reaction that occurs during the production of calcium sulfate hemihydrate is called incomplete calcination, whereas complete calcination during production of anhydrite. Because the quarries of the Montmartre district of Paris have long furnished burnt gypsum, this dehydrated gypsum became known as plaster of Paris. The pulverized plaster of Paris is the basic material used to produce many of the gypsum building materials and pieces.

Gypsum binders can be classified as low and high burning varieties.

Low burning varieties: For refined grade of plaster of Paris, the kettle and rotary processes are used. The excavated raw materials are crushed and if the kettle process is used, are grounded before heating. The kettles used for calcination are 2,5 or 3 m in diameter and about 2 m high. The pulverized material is chuted into the kettle and temperature is raised gradually. The calcinated product is then cooled partially and is sent to the screens, fines are stored. In the rotary process, the raw material is crushed and is then fed into a rotating cylinder. Calcination is accomplished with the introduction of hot furnace gases. The product is then ground screened and stored. Plaster of Paris can be obtained in 1, 2, 5 or 20 kg packages.





High burning varieties: Anhydrite is obtained by burning calcium sulfate dihydrate at a temperature of about 700°C and then grinding the product. Due to this calcination process, this product loses its setting ability and because of that, it is grinded with hardening catalyzers (such as lime, granulated basic blast-furnace slag, etc.). A variety of anhydrite is the high-burned gypsum (estrich gypsum). It is manufactured by burning natural gypsum or anhydrite at a temperature between 800 to 1000°C

followed by fine grinding. This results not only in complete dehydration but also in partial decomposition of anhydrite with formation of calcium oxide (CaO).

Hydration:

Because plaster of Paris is a non-hydraulic (air setting) binder, on adding water to the powder, it can easily be shaped and molded and in a short time it hardens again and becomes similar to what it was in its natural state. Hydration process is exothermic. When water is added, the gypsum forms interlocking crystals. The setting and strengthening of gypsum are due to intergrowth of these very fine and poorly soluble crystals. Setting of plaster of Paris starts about 10 minutes after mixing and is complete in about 45 minutes, but not fully set for 72 hours. Plaster of Paris first shrinks and then expands and does not crack due to shrinkage.

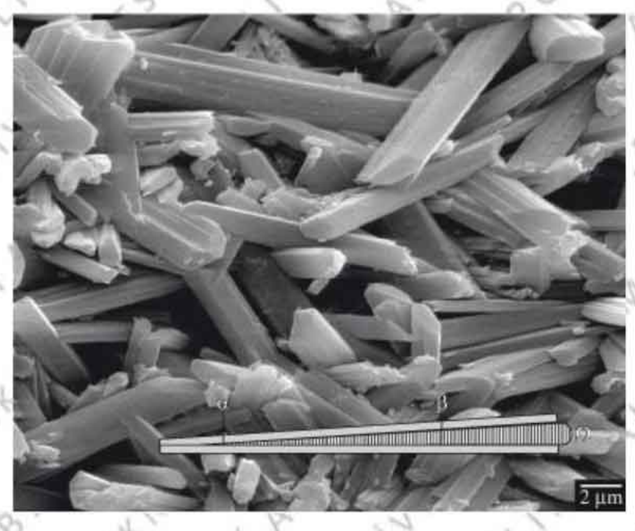
Time of setting can be delayed by adding fraction of retardant like glue, sugar, alcohol and borax, saw dust, sand etc., to accelerate the setting less water and salt and for cohesiveness, cattle hair or wood fiber can be used.

When anhydrite is mixed with water, its setting starts not earlier than in 30 minutes and ends not later than in 24 hours. Calcium oxide in the estrich gypsum acts as a catalyzer which promotes the hardening of the high burned gypsum. High burning gypsums show slow setting but ultimately become very hard.

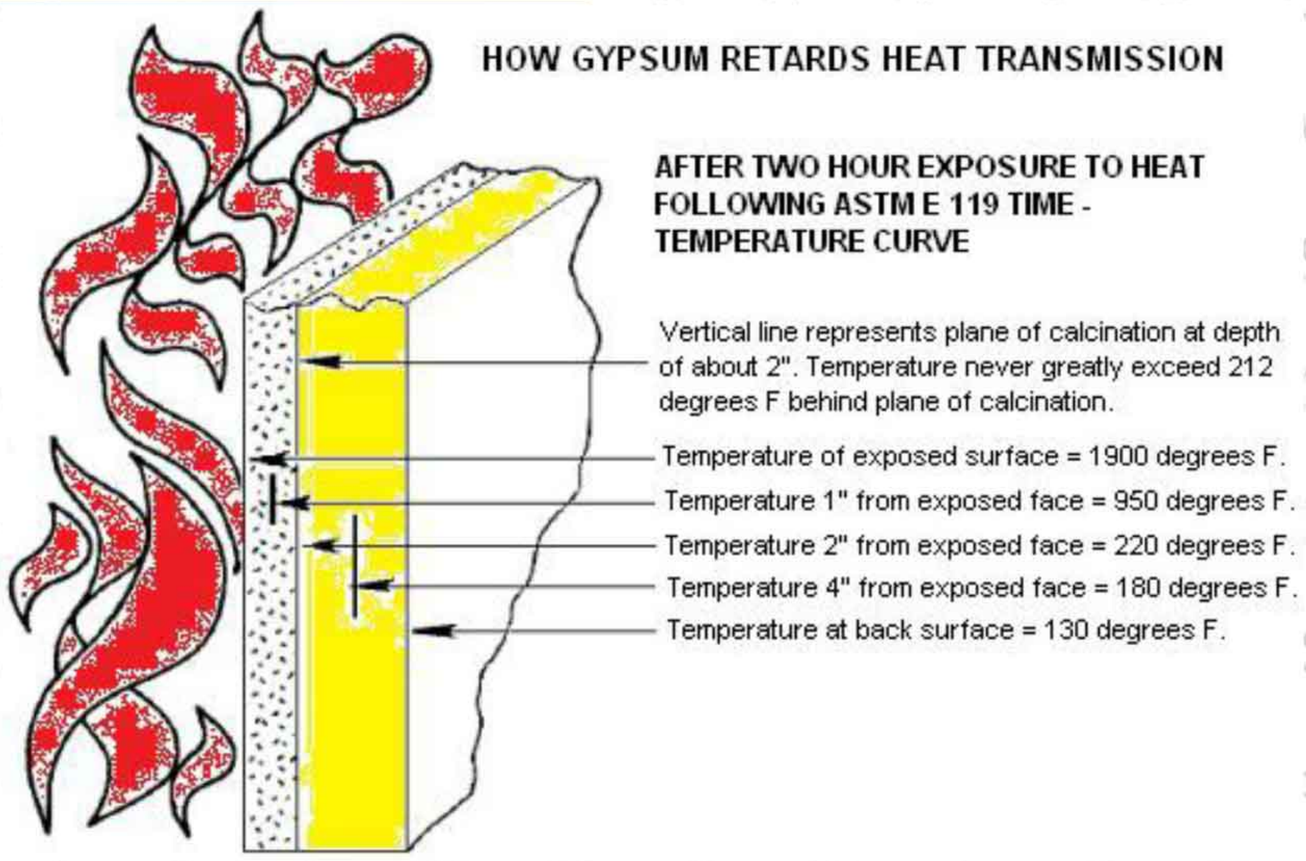
When the hardening starts, the half liquid state of the gypsum paste starts to turn into solid. The shaping process should end before this moment. For the hydration, water, at least 20% of the weight of gypsum powder is required; for better plasticity 60% arkadaşlar merhaba and for viscosity 100% is needed. Setting is highly related with heat of the environment, the presence of additives, heating period and temperature of the plaster of Paris or anhydrite and the amount of hydration water.

Properties of Gypsum Products

Due to open micro pores, gypsum is capable of storing humidity in the air by capillarity and if the air is too dry, the stored humidity in the pores is pushed back to the surface and released to the air around the gypsum product. Gypsum equilibrates humidity. But it is vulnerable to water, not suitable for external or internal applications where dampness occurs. When it is exposed to water for a period, it can get damaged, it may lose its structural integrity and become soft, weak and disintegrate eventually.



The still air in the pores causes a low thermal transmittance in the gypsum products. Gypsum is non-combustible and not flammable. Through the action of fire, the crystal water in the structure of gypsum evaporates and a protective layer of powdered gypsum is formed on the fire exposed surface. Behind this layer, the material under fire attack remains at a constant temperature.



The open pores on the surface of the gypsum products can absorb some portion of the sound waves. If needed, these pores can be magnified by the help of admixtures and foaming the paste.

Calcium sulfate is acidic and if a gypsum product is in contact with iron or zinc, the acidic environment and the humidity held by the pores can cause these metals to be oxidized. In order to prevent rust, two products must be isolated. This oxidation does not happen with copper and aluminum.

The mechanical strength of gypsum products depend on the composition and the properties of the product. The amount of water used for hydration, setting retardants or accelerators, the high and continuous humidity levels around the products causes a decrease in the compression and tensile strength. Anhydrite and estrich gypsum are much more strong then the plaster of Paris in terms of compression.