A Gypsum Cement for Every Industrial Use

Drying Plaster Casts

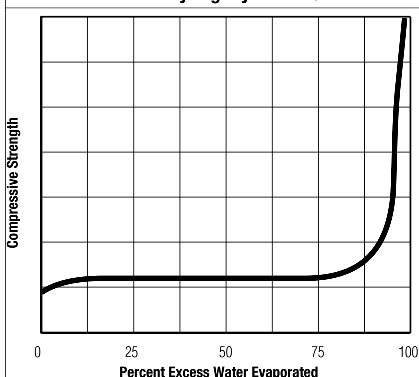
To attain uniform results and optimum physical properties, plaster casts must be properly dried. This involves transferring excess water from the cast to the surrounding air.

Plasters require about 18 parts water per 100 parts plaster by weight for complete hydration in the setting process. However, in order to obtain a mixable slurry, larger amounts of water must be used in mixing. After the plaster has been mixed, poured, and has set, any water above the 18 parts is considered excess or “free” water and must be removed from the cast by drying. (See figure 1.)

Drying equipment can be designed to remove this excess water in a specified time and at a predetermined cost. Advantages of controlled drying include:

1. Proper strength development
2. Uniform absorption
3. Increased production
4. Mildew prevention
5. Better paintability

Fig. 1—Effect of dryness on compressive strength of Gypsum. Note that strength increases only slightly until 93% of the free moisture has been removed



How Does a Plaster Cast Dry?

To evaporate this “free” water from the casts requires an energy source. For each pound of water evaporated, slightly more than 1,000 British thermal units (Btu) are required. As a comparison to show the amount of heat required, the BTU output of a typical home furnace will range from 40,000 Btu per hr. in the South to 100,000 Btu per hr. in colder Northern climates.

Note: A Btu is the amount of energy required to raise the temperature of one pound of water 1 °F. One pound of water is about one pint.

The same drying action takes place whether the plaster cast dries in the workroom, outdoors, or in a dryer. Use of a forced-hot-air dryer speeds and controls the drying procedure. Plaster casts will rarely become 100% dry without the use of a forced air dryer.

As the cast sets or hardens, a chemical reaction causes the piece to heat slightly. Then, because there is more water than required for the chemical reaction, this excess water begins evaporating from the cast. When a new, wet cast is placed in a forced-hot-air dryer, rapid evaporation begins. This initial evaporation keeps the cast cooler than the air temperature in the dryer. Water from the interior of the cast moves to the surface to replace evaporating moisture. As evaporation continues, sufficient water does not move to the surface to keep it cool and the surface temperature will rise although the center of the cast is still moist. As the amount of evaporation is reduced, the cast’s surface temperature approaches the air temperature in the dryer. Once the surface of the cast is up to air temperature, the rest of the free water in the cast evaporates slowly, coming to the surface as vapor where it is swept away. As this occurs, the entire cast warms to approximate ambient air temperature further and further toward its center. When the center of the piece reaches the temperature of the surrounding air, the drying process is complete.

What is Best Dryer Temperature?

The main physical limitation in drying a plaster cast is the maximum temperature at which the dryer can operate and not calcine the cast. Recommended temperatures are 110 to 120 °F for USG® White Art Plaster, No. 1 Casting Plaster, Moulding Plaster, Pottery Plaster, HYDROCAL® Brand White and HYDRO-STONE® Gypsum Cements; from 125 to 130 °F for Industrial Plaster PC. Operating much above these temperatures will result in surface calcination; that is, surfaces of the casts, especially those in front of hot-air ducts, will become soft and powdery.

In the chart on the next page air volumes through the heater were calculated so that hot air entering would be about 30 °F higher than the temperature in the dryer. This gives an adequate safety margin.

Air Circulation Within the Dryer

Drying studies of various materials show that increasing air speed over plaster casts reduces drying time. An air speed of 15 fps (ft. per sec.) is recommended, and speeds up to about 30 fps are desirable. At speeds over 30 fps, cost of moving the air can be greater than the value of time saved.

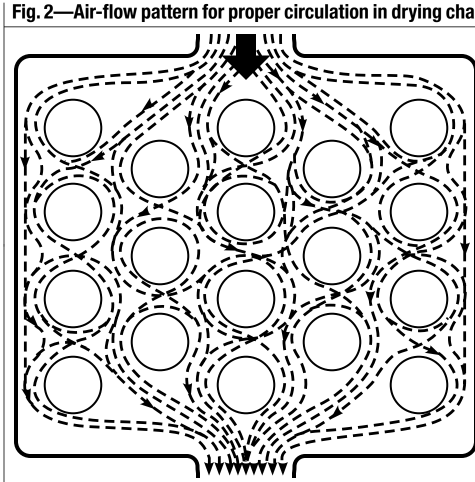
Here is an example of a drying problem in a 3,200-cu. ft. dryer. It was loaded daily with about 4.2 tons of casts containing some 1.2 tons of water to be evaporated. Although the furnace supplied enough heat to evaporate the water, and exhaust air volume was adequate to carry out the water vapor, casts were not drying. The solution was to improve circulation in the drying chamber to 15 fps by adding four 20-in.-dia. supplementary fans. This provided a temperature differential of 2 or 3 °F throughout the dryer, indicating a uniformity of air flow.

Air must flow *around* each cast. (See figure 2.) If the casts are crowded together, they dry very slowly. They should be placed on racks or separated by runners so that water vapor is able to escape.

Following is a summary of important points in designing and using equipment:

1. Is the burner large enough to supply necessary heat energy? (Use chart on next page for size.)
2. Is sufficient humid air being exhausted from the dryer's system?
3. Is the outlet of the exhaust duct well away from the fresh air intake?
4. Is hot air entering the dryer chamber at 150 °F or below? That is the maximum for USG White Art, USG No. 1 Casting, USG Moulding, USG Pottery Plasters, HYDROCAL Brand White or HYDRO-STONE Gypsum cements. Use 160 °F or below for Industrial Plaster PC.
5. Is air circulation within the dryer fast enough? Are fans within the dryer designed to operate at dryer's temperature?
6. Are applicable building and safety codes being met?
7. Can the flame or heating element be seen from inside the drying chamber? They should not be visible.
8. Has production increased since the dryer was designed? If so, larger equipment may be needed.
9. Are spaces between the plaster casts great enough to allow adequate air circulation? (Approx. 1/2 in. on small casts; 2 in. on casts of 100 lbs. or more.) Consider contacting a heating and ventilating engineer to check system for proper air flow and temperature.

Fig. 2—Air-flow pattern for proper circulation in drying chamber.



Designing the Dryer

In using the chart shown here, assume that maximum amount of plaster used per day will be 20 to 100 bags; then design the drying room so that it is adequate for this volume. The chart will indicate how much air must pass through the heater to supply the required heat energy while keeping the temperature of entering air at a safe level.

The column "Minimum Exhausted Air (B)" indicates how much moist air must be expelled to dry casts in one day. More moist air can be exhausted if desired, but less than recommended would increase drying time. The volume of air exhausted must be replaced by fresh air introduced elsewhere in the system. Probably the best point to bleed fresh, cool air into the recirculation system is just prior to the heater. Since total volume of air through the heater (recirculated air plus fresh makeup air) is large, it needs to be heated only a few degrees to supply the necessary energy to dry the plaster casts effectively. Even with this procedure, additional fans within the dryer will be required for adequate air velocity of 15 fps.

Plaster Dryer Design Data (assumes 16-hr. cycle for Art & Moulding Plasters)

Plaster Use tons/day	(A) Burner Capacity[(1)] Btu/hr.	(B) Minimum Exhausted Air & Makeup Air[(2)] Standard cu. ft./min.	(C) Recirculation of Humid Air[(3)] Standard cu. ft./min.	(D) Total Air (Makeup plus recirculated) Through Heater[(3)] Standard cu. ft./min.
5	600,000	1,800	22,000	23,800
4	480,000	1,450	17,600	19,050
3	360,000	1,100	13,200	14,300
2	250,000	800	8,800	9,600
1	125,000	400	4,400	4,800

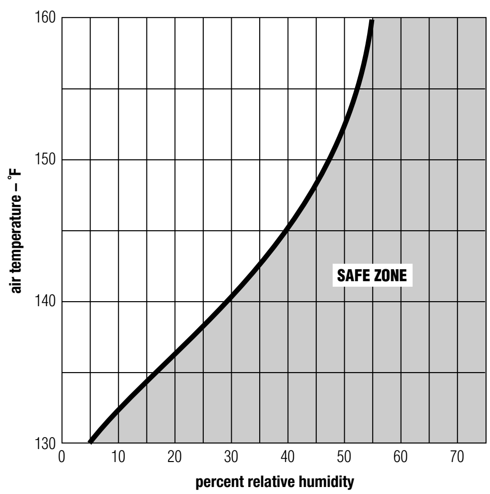
(1) Based on a direct-fired heater. If an indirect-fired furnace is used, the stated figure must be bonnet or plenum capacity (usually 80% of the burner capacity).
(2) Exhaust and dryer interior assumed at 120 °F.
(3) Recirculated and makeup air assumed to enter drying chamber at max. 150 °F.

Faster Drying

By using a humidity control as well as temperature control, drying ratio can be increased. Fig. 3 shows a curve relating relative humidity (R.H.) and air temperature. As long as these two measurements give a point to the right of this curve, drying will proceed without excessive burning of the plaster cast. The closer the control can be maintained to the line, the more rapid the rate of drying.

For example, 140 °F with 40% R.H. will result in faster drying than 140 °F with 50% R.H. If R.H. is 50%, temperature should be increased to 150 °F.

Fig. 3—Minimum relative humidity at temperature to prevent calcination of gypsum casts.



Warning
When mixed with water, this material hardens and then slowly becomes hot. DO NOT attempt to make a cast enclosing any part of the body using this material. Failure to follow these instructions can cause severe burns that may require surgical removal of affected tissue. Avoid dust. Dust may cause irritation to the eyes, skin, nose, throat, or upper respiratory system. Wear eye and respiratory protection to avoid irritation. Product safety information:(800) 507-8899.

Trademarks
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