A Gypsum Cement for Every Industrial Need

The HYDROPERM® Process

Molds made from conventional metal casting plasters are relatively impermeable. HYDROPERM Gypsum Cement is used to produce permeable plaster molds for casting of many nonferrous metals and alloys. Properly prepared molds made with HYDROPERM Cement have a permeability range which can be varied and controlled to meet particular requirements of the various nonferrous metals and have an extremely smooth surface. Just under the surface is a porous structure of small uniform cells that are interconnected. When the mold is dried, they offer channels through which steam or other mold gases may escape during the metal-casting operation.

Mixing

The structure and surface of the mold made of HYDROPERM are among the most important factors in use of the material. To obtain the proper structure, a mixing procedure must be used which gives uniform density and permeability, as well as a strong, smooth face. A mixer must be used which beats air into the mix and produces cells approx. 0.01 in. dia. Large cells must be eliminated by proper mixing, for they may allow the metal to break through and cause imperfections in the casting. Proper mixing can be accomplished with several different types of mixers, but the higher the energy input per unit of mix, the finer the permeable structure and the smoother the mold surface. For very small mixes a malted milk mixer is satisfactory.

Proportions of HYDROPERM, Water and Air

The amount of HYDROPERM Cement, water and air should be carefully balanced in order to produce a mold of sufficient strength, low expansion and permeability. Based on experience, consistency may vary from 80-100 parts water to 100 parts HYDROPERM by weight with good results; 100 parts HYDROPERM to 100 parts water by weight are recommended. Sufficient air may be incorporated to increase volume from 70 to 100% during mixing.

For consistent results, maintain temperature of both HYDROPERM Cement and mixing water at a constant slurry temperature. Warm water (100°F.) is recommended. This will both maintain a lower expansion than colder water yet not melt wax fillets often used in wood patterns.

A 70-100% increase in volume due to air is recommended. This usually results in a mix having low expansion characteristics and sufficient strength for production of molds from most rigid patterns. Increasing water content results in weaker molds with lower expansion. Increasing amount of air results in weaker molds with higher expansion and more permeability. Generally, an increase in the amount of air should be accompanied by an increase in amount of water to obtain constant fluidity and setting expansion.

Permeability Control

When mixed under controlled conditions, permeability developed in the dry HYDROPERM Cement mold depends primarily on amount of air introduced into slurry during mixing operation. The following table may be used as an example of permeability control:

% Vol. Increase	Wet Weight lb./cu. ft.	A.F.S. dry units perm. (1)
0	90.8	0.5
50	60.6	5.0
61	57.0	8.5
68	53.8	11.5
76	49.4	16.5
100	46.0	30.0

(1) At 150 consistency, permeability of conventional matchplate plaster is 0.75-1.5.

Permeability of proper made HYDROPERM Cement molds may be measured with conventional sand-testing equipment. A dry specimen, 2 in. diam. x 2 in. length, is sealed with mercury in a special adapter. A supply of air at constant pressure is supplied by a bell jar suspended in water. Air passes through the specimen and permeability is read directly on the pressure gauge (by the orifice method) or calculated by amount of air that passes through the specimen in a specified time interval. Permeability testing machines may be obtained from Harry W. Dietert Co., 9340 Roselawn Ave., Detroit, Mich. 48204.

Mixing Procedure

Proper mixing is one of the most important steps in the production of satisfactory molds. This is the point at which air cells are formed and incorporated into the mix. HYDROPERM is added to the water and a high-speed disc is inserted at such a level as to throw air into the slurry. This will result in a noticeable increase in volume. For practical purposes volume may be increased 70 to 100%. The increase may be readily measured with a yardstick held vertically in the bucket, if the bucket has been first calibrated. Time required to obtain any given volume increase will vary with size of the batch and mixing equipment. Generally, mixing times are from 1½ to 3 min.

Several variables will effect efficiency of the mix, speed of set and permeability of the mold. Among these variables are bucket size, disc diameter, mixer speed, and volume of plaster slurry. Disc diameter should be about ⅔ of the diameter of the bucket bottom. Adjust mixer speed to create a vortex of air down to within an inch or two of the bottom of the bucket when mixer shaft is in vertical position.

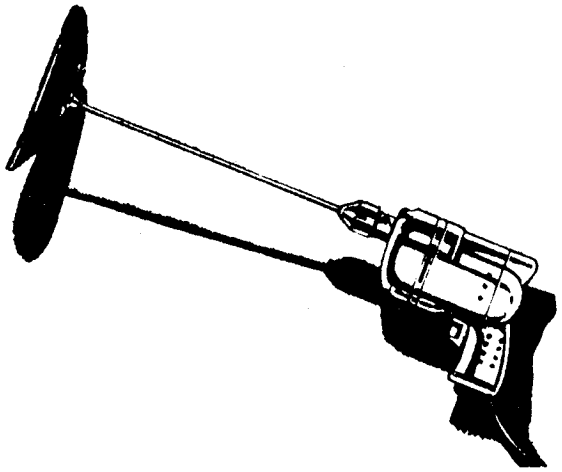

Fig. 1 A 1,750 rpm electric drill with a rubber disc is recommended for mixing HYDROPERM.

Recommended Mixing Procedure

Materials:

HYDROPERM Gypsum Cement—100 parts by weight.

Water—100 parts by weight (100°F.)

Drill Motor—1.750 rpm

Rubber Disc—2-ply reinforced, ⅛ in. thick (can be made from 2-ply rubber belting).

Mixing Bucket.

1. Add HYDROPERM to water in approx. 15 seconds. Let soak for 30 seconds, then place disk near bottom of bucket and mix thoroughly for 15 to 30 seconds.
2. After thoroughly mixing slurry, raise disc to a height sufficient to throw air into slurry. Volume will gradually increase to desired height in the bucket. For a volume increase of 70% this time should be approx. 1 min.
3. When desired volume increase is obtained, lower rotating disc just below surface of mix. There will be many large air bubbles in the slurry that should be reduced to proper size. Continue mixing operation with rotating disc below surface of slurry for approx. 1 min. Large air bubbles may be reduced to correct size by raising and lowering disc during this operation. With practice, sufficient skill will be developed to make a suitable mix that contains air bubbles of proper size (0.01 in. diam.).

For repetitive production work, mixer may be set in a fixed position. By having the disc a definite distance from bottom of bucket, air will be introduced until volume of slurry has risen automatically to close off the vortex. If permeability is too low, raise disc to allow for introduction of more air.

Making the Mold

Pour HYDROPERM slurry into flask as soon as mixing operation is completed. To obtain a smooth bubble-free mold surface on an open-back mold, it may be desirable to vibrate the assembly for a few seconds to make any large bubbles rise to the surface any away from pattern. Alternate methods for obtaining a smooth surface include brushing pattern with a thin coat of mixed slurry or spraying surface of mold with a thin coat of plaster slurry before pouring. After pouring, back of mold may be screeded or struck off when HYDROPERM begins to set, in order to obtain a level back surface.

Usually, the mold may be extracted after 15 to 24 min. From a practical point of view, this is when a clean finger will not longer “pick up” wet material.

Pattern Equipment

Customary allowance for metal shrinkage must be made on the pattern. Because of low drying temperatures permissible with HYDROPERM Cement, drying shrinkage is minimal but should be allowed for (see Fig. 3 in Bulletin IG-538).

Patterns may be made of metal, plastic, properly sealed HYDROCAL Cement or wood. Wooden patterns must be properly waterproofed—preferably with lacquer. Rigid patterns must be designed with sufficient draft to permit release. Patterns should be as smooth as possible since HYDROPERM is capable of reproducing very fine detail. File marks or rough surfaces such as wood grain may prevent extraction due to a locking action of minute "back draft." Flexible patterns are recommended for those intricate castings where release from rigid patterns would be impractical. In large-scale production, include all gates, runners, and risers in the pattern equipment. Because of the insulative properties of HYDROPERM Cement, molds, gates and runners may be made smaller than in sand. On experimental molds or short runs, sprues and gates may be carved in the wet mold. Carved surfaces should be well "slicked down" and cleaned with compressed air to prevent washing loose particles of plaster into the mold.

Chills of cast iron, steel, copper, graphite or carbon may be incorporated in the HYDROPERM Cement mold to provide directional solidification on particular positions of the mold.

Parting Compounds

Apply a parting compound to all types of rigid patterns to permit pattern withdrawal. Commercial parting compounds, commonly found in matchplate shops, are satisfactory *if applied sparingly*. These include stearine and liquid foundry spray. For extremely difficult "draws", a heavy mix of water-ground mica in the liquid parting is recommended.

For separating HYDROPERM Cement from itself, a different technique is employed. The permeable plaster cast is capable of absorbing large quantities of water and when a cope cast is made over a drag cast, it is necessary to first waterproof the drag. Since permeability from cope to drag is seldom a factor, it is recommended that the drag-half of the mold be sealed with a cut shellac or thin lacquer, or waterproofed by spraying a 50% clean-water solution of wax emulsion such as Butcher's "Green Stripe" Floor Wax or Johnson's "Glo-Coat." These prepared waxes are water emulsions. Water in the emulsion is readily absorbed by the HYDROPERM Cement cast leaving a thin layer of water-repellent wax on the surface. Experience is required to produce this thin film of wax so that a satisfactory mold surface results. This is particularly important in matchplate work since portions of the parting surface are used to form the matchplate casting.

Apply parting compounds sparingly with a camel's hair brush or a spray gun. Too liberal use of parting compounds will cause excessive bubble breakage and large air bubbles on the mold surface. These appear as undesirable blemishes on the finished casting.

Pattern Extraction

Pattern extraction may be difficult when compared to the relatively easy withdrawal of patterns from molding sand though a properly prepared and lubricated pattern is generally easily released with air pressure applied at the right point. The important factors in successful pattern extraction may be one or more of the following:

1. Design of pattern—contour, depth of draw, etc.
2. Draft and *smoothness* of pattern.
3. Composition of the pattern—HYDROCAL Cement, metal, wood, etc.
4. Use of proper sealers and parting compounds.
5. Drawing equipment and method.
6. Expansion of HYDROPERM may be minimized by using hot (140-150°F) water for mixing (not on wood patterns)

Some satisfactory methods of pattern extraction are:

1. Blow air between flask joint and plate of cope- and-drag patterns. If necessary, start movement with a wedge-shaped tool.
2. Make a small hole through the plaster to the pattern with a thin wire and gently blow air through hole.
3. Separate patterns and molds with air pressure. At times, a vibrator is helpful. HYDROPERM Cement is rigid and nonresilient compared to rammed sand. Rapping to release pattern may result in a broken pattern or mold. Some patterns are best removed by rapping in a vertical direction only.
4. For flexible patterns such as a cold-formed rubber core box where slurry is poured from the top, blow air between the mold and rubber side walls. The mold will slowly rise in the box where it can be removed easily.

Drying the HYDROPERM Cement Mold

Drying drives off free moisture which is intentionally added during mixing to produce a pourable slurry that will pick up fine pattern details. This excess water must be removed before the metal is poured into the mold. When the metal pouring temperature will be above 1,500°F, all of the water of crystallization also is removed. Oven-drying temperature will vary with type of oven equipment, but generally it will be in a range from 350 to 500°F.

Time required to dry a mold will depend on the following factors:

1. Oven temperature
2. Air circulation and velocity
3. Humidity of circulation air
4. Mold size and thickness
5. Mold permeability

Obviously, with other conditions constant, higher oven temperatures result in more rapid drying. Recirculating-type core ovens will dry molds more rapidly since water evaporation from a mold surface depends on air velocity over the surface.

As in foundry sand-core practice, replace air in dryer with air of lower humidity to speed mold drying. Heavier molds of heavier sections will require more drying time.

There are several methods of determining when the mold is properly dried:

1. Electrical conductivity test for free water
2. Loss in mold weight
3. Temperature of the innermost part of the mold
4. Time and temperature as determined by previous experience

Electrical conductivity test—This test is accurate and is easily performed. HYDROPERM Cement molds containing free water will conduct an electrical current. A testing unit, operated by a two-cell pencil battery, has a direct-reading meter showing moisture percentage, and long, rigid leads. Units may be purchased at a radio supply dealer or from Plaster Supply House, 5346 East Ave., Countryside, Ill. 60525.

Loss in mold weight—When the mold has been stripped from the pattern, record wet weight. Dry in an oven until a loss of 45 to 50% (when using 100 cc mix) of wet weight has occurred.

Temperature of mold—Insert a thermocouple in the thickset portion of mold with leads long enough to reach outside oven. When all free water has been removed, temperature of the interior of the mold will gradually rise to about 212°F. Mold is dry when 220°F is reached.

Time and temperature—Time and temperature in the oven may be controlled based on previous experience, but this method may produce high scrap loss before a satisfactory technique is established.

True judge of mold-drying effectiveness is found in the quality of the castings. If metal "blows" or "wrinkles, the mold is either too wet or too low in permeability. Dry future molds more thoroughly, and/or increase mold permeability as shown in permeability control.

Casting the Metal

HYDROPERM Cement molds or insulating riser sleeves are usually suitable for casting of most nonferrous metals, such as:

1. Low-melting lead-zinc metals
2. Aluminum and its alloys
3. Brasses and bronzes with *low* lead content, particularly aluminized yellow brass

Cast metal in plaster molds at as *low* a temperature as possible. Keep casting temperatures of heavy castings below 2,000°F. Skim metal well and cast without delay. do not disturb the mold until the casting has completely solidified.

Pressure or vacuum casting is not required since permeable metal casting plaster will readily vent any steam formed in the casting operation.

Patience, experience and persistence are needed to master the making of molds. Your first work with HYDROPERM Cement should be done with a casting on which you have previously checked pattern equipment, draft, gating and metal; then concentrate on making the mold with HYDROPERM Cement.

HYDROPERM Gypsum Cement means smoother molds, better castings—plus the reliability of a thoroughly engineered mold-making process.

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HEALTH AND SAFETY INFORMATION

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.