

# Refractomix™ 1 Refractory

REFRACTOMIX™ #1 is a specially blended refractory mix for use in the “Cast to Size Tooling” field. REFRACTOMIX #1 is designed primarily for the casting of Aluminum, Beryllium Copper, and other copper based alloys.

The REFRACTOMIX™ Process\* is designed to operate at a lower liquid to powder ratio than other similar processes. Molds made by this process do not crack and warp due to excessive shrinkage. Therefore, no special torching or hardening procedures are necessary.

REFRACTOMIX #1 is relatively simple to use. The refractory is blended thoroughly with the proper proportions of liquid binder and gelling agent. After thoroughly mixing, the slurry is carefully poured over the pattern, with the aid of some vibration to help eliminate air entrapment. After the slurry has gelled and become hard, the pattern is removed. The cope and drag sections are assembled and fired at temperatures of 1250°F to 1800°F depending on the alloy being cast. In many cases, for aluminum castings, it is only necessary to burn off the excess solvent from the binder and preheat the refractory mold to the desired casting temperature.

## **MATERIALS REQUIRED**

**Binder:** Prehydrolyzed Ethyl Silicate R&R Binder #18 or R&R Binder #20.

**Gelling Agent:** A 7.5% ammonium carbonate solution is normally used as a gelling agent. This solution is prepared by dissolving 75 grams of ammonium carbonate powder in 500 cc of water and then diluting with water to 1000 cc.

**Mixing equipment:** Various types of mixing equipment can be used with REFRACTOMIX refractory mix depending on the size of the mold to be poured.

1. Hand held mixers such as a Jiffy Mixer\*\* chucked in a ½ inch drill motor.
2. Air driven propeller type mixers.
3. Hobart Mixers\*\*\* (consult dealer for proper size).
4. Cement mixers or mortar mixers can be used for very large mixes.

Since the binders used in this process are inflammable, it is suggested that totally enclosed electric motors be used to prevent fire from electrical sparks.

**Miscellaneous Equipment:** Weighing and measuring equipment should be selected to suit the type and size of molds to be poured.

Bench scale capable of weighing to 0.1 grams.

Bench scale of 25 pounds for small molds.

Scale for 100 pounds and over for large molds.

Two graduated cylinders (plastic) 100 cc 1000 cc.

A vibrating table – vibration assists in filling molds and eliminating air bubbles.

\* U.S. Patent No. 3,690,366

\*\* Product of The Jiffy Mixer, Co., Inc., 515 Market Bldg., San Francisco, CA

\*\*\* Production of Hobart Corp., Troy, OH



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## **PATTERN PREPARATION**

Wooden patterns should be sealed with a good pattern coating material and sprayed with parting agent before pouring of the refractory.

Rubber patterns should be cleaned well with detergent, rinsed with water, and then with alcohol, prior to use. Most rubber pattern materials will separate without a parting agent; however, it is usually best to apply a light coating of parting agent.

The pattern should be fastened securely to the pattern board. A flask or wooden frame is assembled around the pattern and clamped to the pattern board. The pattern board, and wooden frame should be given a coat of paste wax to prevent the refractory from sticking. Before pouring of the refractory, the pattern should be sprayed with parting agent and allowed to dry.

## **MIXING AND POURING REFRACTOMIX™ #1**

The mixing proportions for REFRACTOMIX #1 are 10cc of binder for each 100 grams of powder or approximately 45.5 cc of liquid binder per pound of refractory. To determine the number of pounds of refractory powder necessary for the mold, multiply the volume of the mold to be filled, in cubic inches, times the factor 0.10 lb/cu in. To determine the number of cc of binder required, multiply the pounds of refractory times 45.5 cc/lb.

The amount of gelling agent required will vary depending upon the amount of working time necessary to fill the mold. This will also vary from batch to batch of binder. Therefore, it is best to make small mixes at various concentrations of gelling agent to determine the proper amount of gelling agent that will allow sufficient working time. The number of cc of gelling agent is usually based on the volume of binder. A starting point would be 0.03 cc of gelling agent per cc of binder. Thus, 1000 cc of binder would require  $1000 \times 0.030 = 30$  cc of gelling agent. After determining the quantities of each ingredient necessary, weigh or measure each material carefully.

The REFRACTOMIX™ Process\* was designed to operate at definite liquid to powder ratios. Using more than specified quantity of liquid binder will lead to excessive shrinkage and warping of molds. The use of less than specified quantity of liquid binder may lead to molds of inferior strength.

The correct amount of binder should be placed in the mixing container first. Next, add the gelling agent while stirring with the mixer or by use of a paddle. Agitation is necessary when adding the gelling agent to prevent localized gelling of the binder. Finally, the refractory powder is added and the slurry is mixed until all of the refractory is wetted and mixed thoroughly.

After thorough mixing, the slurry is removed from the mixer and poured carefully into the mold. Some form of vibration should be applied while filling the mold to help make the slurry flow and to avoid air entrapment. In some cases, it may be necessary to use a brush to force the slurry into areas where air entrapment may be a problem.

Once the mold has been filled, it can be vibrated briefly and then allowed to gel. After gelation, the mold should be allowed to age for 20 to 45 minutes before stripping the pattern. The amount of ageing time will be determined by the size and complexity of the pattern. Small, simple patterns can be stripped in 20 to 30 minutes, whereas larger patterns will require more time for the mold to attain higher green strength.

After stripping the mold from the pattern, it is ready for firing. The firing or ignition may take place immediately after stripping or may be delayed up to four hours.

The refractory mold should be placed in the furnace and fired at a temperature of 1200°F-1400°F for at least two hours. Very thick molds should be fired at temperatures for approximately one hour per inch of refractory thickness.

For Beryllium Copper and other copper-base alloys, the above burnout procedure will be necessary.



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In many cases Aluminum castings can be made by simply burning off the excess solvent in the binder and preheating the mold to the desired casting temperature.

**PROPORTIONING CHART**

Pounds of Refractory = Volume of Mold (cu. in.) x .10

<u>LB OF REFRACTORY</u>	<u>CC OF BINDER</u>	<u>FLUID OZ OF BINDER</u>	<u>CC OF GEL. AGENT .0200/cc</u>	<u>CC OF GEL. AGENT 0.030/cc</u>
1	45.5	1.54	0.91	1.37
2	91.0	3.08	1.82	2.73
3	136.5	4.62	2.73	4.10
4	182.0	6.15	3.64	5.46
5	227.5	7.69	4.55	6.83
6	273.0	9.23	5.46	8.19
7	318.5	10.77	6.37	9.56
8	364.0	12.31	7.28	10.92
9	409.5	13.85	8.19	12.29
10	455.0	15.39	9.10	13.65
15	682.5	23.10	13.65	20.48
20	910.0	30.77	18.20	27.30
25	1137.5	38.47	22.75	34.13
30	1365.0	46.16	27.30	40.95
40	1820.0	61.55	36.40	54.60
50	2275.0	76.94	45.50	68.25
60	2730.0	92.32	54.60	81.90
70	3185.0	107.71	63.70	95.55
80	3640.0	123.10	72.80	109.20
90	4095.0	138.48	81.90	122.85
100	4550.0	153.87	91.00	136.50

The above chart can be used to calculate the proportions of binder and gelling agent to be used with various quantities of refractory. The quantities of gelling agent shown are suggested quantities and can be varied to obtain the desired working time. Increasing the gelling agent will cause the refractory to set faster.

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# Refractomix™ 2 Refractory

REFRACTOMIX™ #2 is a specially blended refractory mix for use in the “Cast to Size Tooling” field. REFRACTOMIX #2 is designed primarily for the casting of Aluminum, Beryllium Copper, and other copper based alloys.

The REFRACTOMIX™ Process\* is designed to operate at a lower liquid to powder ratio than other similar processes. Molds made by this process do not crack and warp due to excessive shrinkage. Therefore, no special torching or hardening procedures are necessary.

REFRACTOMIX #2 is relatively simple to use. The refractory is blended thoroughly with the proper proportions of liquid binder and gelling agent. After thorough mixing, the slurry is carefully poured over the pattern, with the aid of some vibration to help eliminate air entrapment. After the slurry has gelled and become hard, the pattern is removed. The cope and drag sections are assembled and fired at temperatures of 1250°F to 1800°F depending on the alloy being cast. In many cases, for aluminum castings, it is only necessary to burn off the excess solvent from the binder and preheat the refractory mold to the desired casting temperature.

## **MATERIALS REQUIRED**

**Binder:** Prehydrolyzed Ethyl Silicate R&R Binder #18 or R&R Binder #20.

**Gelling Agent:** A 7.5% ammonium carbonate solution is normally used as a gelling agent. This solution is prepared by dissolving 75 grams of ammonium carbonate powder in 500 cc of water and then diluting with water to 1000cc.

**Mixing Equipment:** Various types of mixing equipment can be used with REFRACTOMIX refractory mix depending on the size of the mold to be poured.

1. Hand held mixers such as a Jiffy Mixer\*\* chucked in a ½ inch drill motor.
2. Air driven propeller type mixers.
3. Hobart Mixers\*\*\* (consult dealer for proper size).
4. Cement mixers or mortar mixers can be used for very large mixes.

Since the binders used in the process are inflammable, it is suggested that totally enclosed electric motors be used to prevent fire from electrical sparks.

**Miscellaneous Equipment:** Weighing and measuring equipment should be selected to suit the type and size of molds to be poured.

Bench scale capable of weighing to 0.1 grams.

Bench scale of 25 pounds for small molds.

Scale for 100 pounds and over for large molds.

Two graduated cylinders (plastic) 100 cc 1000 cc.

A vibrating table – vibration assists in filling molds and eliminating air bubbles.

\* U.S. Patent No. 3,690,366

\*\* Product of The Jiffy Mixer, Co., Inc., 515 Market Bldg., San Francisco, CA

\*\*\* Production of Hobart Corp., Troy, OH



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## **PATTERN PREPARATION**

Wooden patterns should be sealed with a good pattern coating material and sprayed with parting agent before pouring of the refractory.

Rubber patterns should be cleaned well with detergent, rinsed with water, and then with alcohol, prior to use. Most rubber pattern materials will separate without a parting agent; however, it is usually best to apply a light coating of parting agent.

The pattern should be fastened securely to the pattern board. A flask or wooden frame is assembled around the pattern and clamped to the pattern board. The pattern board, and wooden frame should be given a coat of paste wax to prevent the refractory from sticking. Before pouring of the refractory, the pattern should be sprayed with parting agent and allowed to dry.

## **MIXING AND POURING REFRACTOMIX™ #2**

The mixing proportions for REFRACTOMIX #2 are 18 cc of binder for each 100 grams of powder of approximately 81 cc of liquid binder per pound of refractory. To determine the number of pounds of refractory powder necessary for the mold, multiply the volume of the mold to be filled, in cubic inches, times the factor 0.075 lb/cu in. To determine the number of cc of binder required, multiply the pounds of refractory times 81 cc/lb.

The amount of gelling agent required will vary depending upon the amount of working time necessary to fill the mold. This will also vary from batch to batch of binder. Therefore, it is best to make small mixes at various concentrations of gelling agent to determine the proper amount of gelling agent, which will allow sufficient working time. The number of cc of gelling agent is usually based on the volume of binder. A starting point would be 0.03 cc of gelling agent per cc of binder. Thus, 1000 cc of binder would require  $1000 \times 0.03 = 30$  cc of gelling agent. After determining the quantities of each ingredient necessary, weigh or measure each material carefully.

The REFRACTOMIX™ Process\* was designed to operate at definite liquid to powder ratios. Using more than specified quantity of liquid binder will lead to excessive shrinkage and warping of molds. The use of less than specified quantity of liquid binder may lead to molds of inferior strength.

The correct amount of binder should be placed in the mixing container first. Next, add the gelling agent while stirring with the mixer or by use of a paddle. Agitation is necessary when adding the gelling agent to prevent localized gelling of the binder. Finally, the refractory powder is added and the slurry is mixed until all of the refractory is wetted and mixed thoroughly.

After thorough mixing, the slurry is removed from the mixer and poured carefully into the mold. Some form of vibration should be applied while filling the mold to help make the slurry flow and to avoid air entrapment. In some cases, it may be necessary to use a brush to force the slurry into areas where air entrapment may be a problem.

Once the mold has been filled, it can be vibrated briefly and then allowed to gel. After gelation the mold should be allowed to age for 20 to 45 minutes before stripping the pattern. The amount of ageing time will be determined by the size and complexity of the pattern. Small, simple patterns can be stripped in 20 to 30 minutes, whereas larger patterns will require more time for the mold to attain higher green strength.

After stripping the mold from the pattern, it is ready for firing. The firing or ignition may take place immediately after stripping or may be delayed up to four hours.

The refractory mold should be placed in the furnace and fired at a temperature of 1200°-1400°F for at least two hours. Very thick molds should be fired at temperatures for approximately one hour per inch of refractory thickness.



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For beryllium Copper and other copper-base alloys, the above burnout procedure will be necessary.

In many cases Aluminum casting can be made by simply burning off the excess solvent in the binder and preheating the mold to the desired casting temperature.

**PROPORTIONING CHART**

Pounds of Refractory = Volume of Mold (cu. in.) x .075

LB OF REFRACTORY	CC OF BINDER	FLUID OZ OF BINDER	CC OF GEL. AGENT .0200/cc	CC OF GEL. AGENT 0.300/cc
1	81	2.74	1.62	2.43
2	162	5.48	3.24	4.86
3	243	8.22	4.86	7.29
4	324	10.96	6.48	9.72
5	405	13.70	8.10	12.15
6	486	16.44	9.72	14.58
7	567	19.17	11.34	17.01
8	648	21.91	12.96	19.44
9	729	24.65	14.58	21.87
10	810	27.39	16.20	24.30
15	1215	41.09	24.30	36.45
20	1620	54.79	32.40	48.60
25	2025	68.48	40.50	60.75
30	2430	82.18	48.60	72.90
40	3240	109.57	64.80	97.20
50	4050	136.95	81.00	121.50
60	4860	164.36	97.20	145.80
70	5670	191.75	113.40	170.10
80	6480	219.14	129.60	194.40
90	7290	246.53	145.80	218.70
100	8100	274.00	162.00	243.00

The above chart can be used to calculate the proportions of binder and gelling agent to be used with various quantities of refractory. The quantities of gelling agent shown are suggested quantities and can be varied to obtain the desired working time. Increasing the gelling agent will cause the refractory to set faster.



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# Refractomix™ 3 Refractory

REFRACTOMIX™ #3 is a specially blended refractory mix for use in the “Cast to Size Tooling” field. REFRACTOMIX #3 is designed primarily for the casting of Aluminum, Beryllium Copper, and other copper based alloys.

The REFRACTOMIX™ Process\* is designed to operate at a lower liquid to powder ratio than other similar processes. Molds made by this process do not crack and warp due to excessive shrinkage. Therefore, no special torching or hardening procedures are necessary.

REFRACTOMIX #3 is relatively simple to use. The refractory is blended thoroughly with the proper proportions of liquid binder and gelling agent. After thoroughly mixing, the slurry is carefully poured over the pattern, with the aid of some vibration to help eliminate air entrapment. After the slurry has gelled and become hard, the pattern is removed. The cope and drag sections are assembled and fired at temperatures of 1250°F to 1800°F depending on the alloy being cast. In many cases, for aluminum castings, it is only necessary to burn off the excess solvent from the binder and preheat the refractory mold to the desired casting temperature.

## **MATERIALS REQUIRED**

**Binder:** Prehydrolyzed Ethyl Silicate R&R Binder #18 or R&R Binder #20.

**Gelling Agent:** A 7.5% ammonium carbonate solution is normally used as a gelling agent. This solution is prepared by dissolving 75 grams of ammonium carbonate powder in 500 cc of water and then diluting with water to 1000 cc.

**Mixing equipment:** Various types of mixing equipment can be used with REFRACTOMIX refractory mix depending on the size of the mold to be poured.

1. Hand held mixers such as a Jiffy Mixer\*\* chucked in a ½ inch drill motor.
2. Air driven propeller type mixers.
3. Hobart Mixers\*\*\* (consult dealer for proper size).
4. Cement mixers or mortar mixers can be used for very large mixes.

Since the binders used in this process are inflammable, it is suggested that totally enclosed electric motors be used to prevent fire from electrical sparks.

**Miscellaneous Equipment:** Weighing and measuring equipment should be selected to suit the type and size of molds to be poured.

Bench scale capable of weighing to 0.1 grams.

Bench scale of 25 pounds for small molds.

Scale for 100 pounds and over for large molds.

Two graduated cylinders (plastic) 100 cc 1000 cc.

A vibrating table – vibration assists in filling molds and eliminating air bubbles.

\* U.S. Patent No. 3,690,366

\*\* Product of The Jiffy Mixer, Co., Inc., 515 Market Bldg., San Francisco, CA

\*\*\* Production of Hobart Corp., Troy, OH



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## **PATTERN PREPARATION**

Wooden patterns should be sealed with a good pattern coating material and sprayed with parting agent before pouring of the refractory.

Rubber patterns should be cleaned well with detergent, rinsed with water, and then with alcohol, prior to use. Most rubber pattern materials will separate without a parting agent; however, it is usually best to apply a light coating of parting agent.

The pattern should be fastened securely to the pattern board. A flask or wooden frame is assembled around the pattern and clamped to the pattern board. The pattern board, and wooden frame should be given a coat of paste wax to prevent the refractory from sticking. Before pouring of the refractory, the pattern should be sprayed with parting agent and allowed to dry.

## **MIXING AND POURING REFRACTOMIX™ #3**

The mixing proportions for REFRACTOMIX #3 are 22cc of binder for each 100 grams of powder or approximately 100 cc of liquid binder per pound of refractory. To determine the number of pounds of refractory powder necessary for the mold, multiply the volume of the mold to be filled, in cubic inches, times the factor 0.067 lb/cu in. To determine the number of cc of binder required, multiply the pounds of refractory times 100 cc/lb.

The amount of gelling agent required will vary depending upon the amount of working time necessary to fill the mold. This will also vary from batch to batch of binder. Therefore, it is best to make small mixes at various concentrations of gelling agent to determine the proper amount of gelling agent that will allow sufficient working time. The number of cc of gelling agent is usually based on the volume of binder. A starting point would be 0.03 cc of gelling agent per cc of binder. Thus, 1000 cc of binder would require  $1000 \times 0.03 = 30$  cc of gelling agent. After determining the quantities of each ingredient necessary, weigh or measure each material carefully.

The REFRACTOMIX™ Process\* was designed to operate at definite liquid to powder ratios. Using more than specified quantity of liquid binder will lead to excessive shrinkage and warping of molds. The use of less than specified quantity of liquid binder may lead to molds of inferior strength.

The correct amount of binder should be placed in the mixing container first. Next, add the gelling agent while stirring with the mixer or by use of a paddle. Agitation is necessary when adding the gelling agent to prevent localized gelling of the binder. Finally, the refractory powder is added and the slurry is mixed until all of the refractory is wetted and mixed thoroughly.

After thorough mixing, the slurry is removed from the mixer and poured carefully into the mold. Some form of vibration should be applied while filling the mold to help make the slurry flow and to avoid air entrapment. In some cases, it may be necessary to use a brush to force the slurry into areas where air entrapment may be a problem.

Once the mold has been filled, it can be vibrated briefly and then allowed to gel. After gelation, the mold should be allowed to age for 20 to 45 minutes before stripping the pattern. The amount of ageing time will be determined by the size and complexity of the pattern. Small, simple patterns can be stripped in 20 to 30 minutes, whereas larger patterns will require more time for the mold to attain higher green strength.

After stripping the mold from the pattern, it is ready for firing. The firing or ignition may take place immediately after stripping or may be delayed up to four hours.

The refractory mold should be placed in the furnace and fired at a temperature of 1200°F-1400°F for at least two hours. Very thick molds should be fired at temperatures for approximately one hour per inch of refractory thickness.



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For Beryllium Copper and other copper-base alloys, the above burnout procedure will be necessary.

In many cases Aluminum castings can be made by simply burning off the excess solvent in the binder and preheating the mold to the desired casting temperature.

### **PROPORTIONING CHART**

Pounds of Refractory = Volume of Mold (cu. in.) x .067

LB OF REFRACTORY	CC OF BINDER	FLUID OZ OF BINDER	CC OF GEL. AGENT .0200/cc	CC OF GEL. AGENT 0.300/cc
1	100	3.38	2	3
2	200	6.76	4	6
3	300	10.14	6	9
4	400	13.52	8	12
5	500	16.90	10	15
6	600	20.28	12	18
7	700	23.66	14	21
8	800	27.04	16	24
9	900	30.42	18	27
10	1000	33.80	20	30
15	1500	50.70	30	45
20	2000	67.60	40	60
25	2500	84.50	50	75
30	3000	101.40	60	90
40	4000	135.20	80	120
50	5000	169.00	100	150
60	6000	202.80	120	180
70	7000	236.60	140	210
80	8000	270.40	160	240
90	9000	304.20	180	270
100	10,000	338.00	200	300

The above chart can be used to calculate the proportions of binder and gelling agent to be used with various quantities of refractory. The quantities of gelling agent shown are suggested quantities and can be varied to obtain the desired working time. Increasing the gelling agent will cause the refractory to set faster.



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