

## Kao-Tuff<sup>®</sup> Monolithics

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### Product Description

Kao-Tuff C and Kao-Tuff CV are abrasion resistant monolithics. Kao-Tuff C is installed by using standard vibratory casting techniques while Kao-Tuff CV has easy flow capability under vibration. The high strength materials consistently produce abrasion losses in range of 6-15 cc's.

Kao-Tuff G is an abrasion resistant monolithics installed by using standard gunning techniques. This high strength material consistently produces abrasion losses within the range of 7 - 15 cc's.

Kao-Tuff 110C and Kao-Tuff 110FF are medium-weight erosion-resistant monolithics with excellent insulating properties installed by standard vibratory casting techniques. Abrasion losses 7 - 15 cc's and a thermal conductivity of 5.5 at 1500°F (816°C) make them effective for numerous applications in FCCU and other industrial uses. Kao-Tuff 110 FF is the free flow version where extra flow capability is needed.

Kao-Tuff 110G is a medium-weight erosion-resistant monolithic with excellent insulating properties installed by standard gunning techniques. Abrasion losses of 7 - 14 cc's and a thermal conductivity of 5.2 at 1500°F (816°C) make it effective for numerous applications in FCCU and other industrial uses.

Kao-Tuff FS and Kao-Tuff FS Gun are medium-weight, fused silica based monolithics with excellent thermal shock resistance. They are installed by standard vibratory casting techniques (FS) and dry gunite methods (FS Gun).

### Features

- Feature specially enhanced properties that allow them to out-perform conventional refractories
- Low abrasion losses
- Gunning, hand packing and cast vibration placement techniques
- Excellent thermal conductivity
- Excellent thermal shock resistance (Kao-Tuff FS)

### Applications

- FCCU linings
- Molten aluminum contact (Kao-Tuff FS)
- Kiln car

### Instructions for Using

#### Casting

Highest strength is obtained with a monolithic refractory by using the least amount of clean mixing water which will allow thorough working of material into place by vibrating or rodding. A mechanical mixer is required for proper placement (paddle-type mortar mixer best suited). After adding the recommended amount of water to achieve a ball-in-hand consistency, wet mix for 4 to 6 minutes. Place material within 10 - 20 minutes after mixing.

#### Gunning

Use suitable gunite equipment. Material should be pre-dampened uniformly with approximately 3-4% of clean water. This should be mixed in a mechanical mixer and allowed to slake if necessary for up to 20 minutes (the cooler the mix temperature, longer the slaking time) before placing into gun. At 50° F a slaking time of 10 -15 minutes is normal. This will greatly reduce rebound and dusting. Add the required amount of water at nozzle using a recommended minimum 18" nozzle extension past the water ring for better intermixing. A water needle valve is also needed to control flow of the water more precisely. A desired air pressures at the nozzle is 25 to 35 psi for these monolithics. Due to the pressure drop between the nozzle and the gun, the gun operator should use as a guide add 5 psi for every 50 feet of hole length more than the standard two lengths, and 5 psi for every 50 feet of elevation above the gunning machine.

For improved properties and lower rebound it is recommended that a water booster pump be used to increase the plant water pressure. For best results a 16 hole water ring along with water pressure at the nozzle of 125 to 200 psi will help drive the water into the material at the water ring for the best mixing of the water and monolithic.

#### Other

Kao-Tuff G, Kao-Tuff 110G and Kao-Tuff FS Gun can be hand rammed by adding a sufficient amount of water for proper consistency. Follow recommended mixing instructions described above.

#### Precautions

Use watertight forms; when placing against porous surfaces, waterproof the surface. For maximum strength, cure 24 hours under damp conditions before initial heat-up. Keep freshly placed monolithic warm during cold weather, ideally between 50°F and 80°F (10°C - 27°C). In hot conditions, keep mix temperatures below 80°F or working time will be greatly reduced.

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Monolithic Product Name	<u>Kao-Tuff C</u>	<u>Kao-Tuff CV</u>	<u>Kao-Tuff G</u>	<u>Kao-Tuff 110C</u>	<u>Kao-Tuff 110FF</u>	<u>Kao-Tuff 110G</u>	<u>Kao-Tuff FS</u>	<u>Kao-Tuff FS Gun</u>
Material method of installation	vibratory cast	cast	gun/ram	vibratory cast	free flow /vibratory cast	gun/ram	vibratory cast	gun/ram
<b>Physical Properties</b>								
Temperature use limit, °F	2800	2800	2800	2400	2400	2400	2400	2400
Temperature use limit, °C	1538	1538	1538	1316	1316	1316	1316	1316
Placement, average lb to place 1 ft <sup>3</sup>	136	138	135	110	112	111	126	124
Placement, average kg to place 1 m <sup>3</sup>	62	63	61	50	51	50	58	57
Pounds per bag, lb	55	55	55	55	55	55	55	55
Pounds per bag, kg	25	25	25	25	25	25	25	25
Shelf life, months	12	12	12	12	12	12	9	9
<b>Water, %, recommended</b>								
casting by vibrating	8.0-9.5	7.5 - 9.0	9 - 10.5 (testing purposes)	13.5 - 15.5	14 - 15.5 / 13 - 15	13.5 - 15.5 (testing purposes)	5.5 - 6.5	-
<b>Density, ASTM C 134, pcf</b>								
dried 24 hrs @ 220°F	138-149	139-150	138-149	113-124	113-124	112-123	124-134	121-130
fired @ 1500°F	131-141	132-143	132-142	106-116	107-117	106-116	121-131	118-129
<b>Density, ASTM C 134, kg/m<sup>3</sup></b>								
dried 24 hrs @ 104°C	2211-2388	2228-2404	2211-2387	1810-1986	1810-1986	1794-1970	1986-2162	1906-2082
fired @ 816°C	2100-2259	2114-2291	2114-2275	1698-1858	1714-1874	1698-1858	1938-2098	1891-2067
<b>Abrasion loss, ASTM C 704, cc</b>								
fired @ 1500°F (816°C)	8-15	6-13	8-15	7-13	9-15	7-14	12-22	13-23
<b>Modulus of Rupture, MOR, ASTM C 133, psi</b>								
dried 24 hrs @ 220°F	1100-2000	1200-2200	1100-2000	1000-1800	750-1200	800-1300	700-1200	600-1100
fired 5 hrs @ 1500°F	900-1400	950-1500	950-1500	800-1400	650-1000	700-1100	600-1000	500-900
fired 5 hrs @ temperature use limit, °F	1200-2000	1500-3000	1200-2000	850-1400	650-1000	750-1200	-	-
<b>Modulus of Rupture, MOR, ASTM C 133, MPa</b>								
dried 24 hrs @ 104°C	7.6-13.8	8.3-15.2	7.58-13.80	6.90-12.41	5.17-8.27	5.51-8.96	4.83-8.27	4.13-9.76
fired 5 hrs @ 816°C	6.2-9.7	6.6-10.3	6.6-10.3	5.15-9.65	4.48-6.89	5.17-7.58	4.14-6.89	3.45-6.21
fired 5 hrs @ temperature use limit, °C	8.3-13.8	10.3-20.7	8.3-13.8	5.52-9.65	4.48-6.89	5.17-8.27	-	-
<b>Cold crushing strength, CCS, ASTM C 133, psi</b>								
dried 24 hrs @ 220°F	6000-10000	7000-11000	7000-11000	6000-9500	-	6500-10000	6000-9500	5000-8500
fired 5 hrs @ 1500°F	6000-11000	7000-11000	6500-12000	7000-12500	6000-11000	6500-11000	5000-9000	4500-8000
fired 5 hrs @ temperature use limit, °F	8000-12000	8500-14000	7000-12000	6000-10000	6000-10000	7000-11000	6000-10000	-
<b>Cold crushing strength, CCS, ASTM C 133, MPa</b>								
dried 24 hrs @ 104°C	41.4-68.9	48.3-75.9	48.3-75.9	41.4-65.5	-	44.8-68.9	41.4-65.5	34.5-58.6
fired 5 hrs @ 816°C	41.4-75.8	48.3-75.9	44.8-82.7	48.3-86.2	41.4-75.9	44.8-75.9	34.5-62.0	31.0-55.2
fired 5 hrs @ temperature use limit, °C	55.2-82.7	58.6-96.6	48.3-82.7	41.4-68.9	41.4-68.9	48.3-75.9	44.8-68.9	-
<b>Permanent Linear Shrinkage, ASTM C 113, %</b>								
dried 24 hrs @ 220°F (104°C)	0 to -0.2	0 to -0.2	0 to -0.2	0 to -0.2	0 to -0.2	0 to -0.2	0 to -0.2	0 to -0.2
fired 5 hrs @ 1500°F (816°C)	-0.1 to -0.3	-0.1 to -0.3	-0.1 to -0.3	-0.1 to -0.3	-0.1 to -0.3	-0.1 to -0.3	-0.1 to -0.3	-0.1 to -0.3
fired 5 hrs @ temperature use limit, °F (°C)	-1.0 to -2.0	-1.0 to -2.0	-1.0 to -1.8	-0.6 to +0.4	-0.6 to +0.4	-0.6 to +0.4	0.2 to -0.5	0.2 to -0.5

Compliance data sheets for specific applications or job requirements are available upon request. The values given herein are typical average values obtained in accordance with accepted test methods and are subject to normal manufacturing variations. They are supplied as a technical service and are subject to change without notice. The data contained herein should not be used for specification purposes. Check with your Morgan Advanced Materials office to obtain current information.

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### Chemical Analysis, % weight basis after firing

Alumina, Al <sub>2</sub> O <sub>3</sub>	59	60	57	47	49	49	21	22
Silica, SiO <sub>2</sub>	33	32	34	35	33	33	75	74
Ferric Oxide, Fe <sub>2</sub> O <sub>3</sub>	0.8	0.8	0.6	1.6	1.7	1.5	0.2	0.4
Titanium Oxide, TiO <sub>2</sub>	1.3	1.3	1.4	0.8	0.7	0.8	0.4	0.4
Calcium Oxide, CaO	5.5	5.4	6.5	14	14	14	2.3	2.5
Magnesium Oxide, MgO	0.2	0.2	0.2	0.4	0.4	0.4	0.1	0.1
Alkalies as Na <sub>2</sub> O	1.2	1.2	1.2	1.3	1.2	1.3	0.1	0.1

### Thermal Conductivity, BTU•in/hr•ft<sup>2</sup>, per ASTM C201

Mean temperature @500°F	8.9	9	7.3	5.1	5.1	5.2	8.4	-
1000°F	9	9.2	7.4	5.2	5.2	5.3	9.3	-
1500°F	8.9	9	7.5	5.3	5.3	5.4	9.8	-
2000°F	8.7	8.8	7.7	5.4	5.4	5.5	9.9	-

### Thermal Conductivity, W/m•K, per ASTM C201

Mean temperature @260°C	1.28	1.3	1.05	0.74	0.74	0.75	1.27	-
538°C	1.3	1.33	1.07	0.75	0.75	0.76	1.40	-
815°C	1.28	1.3	1.08	0.76	0.76	0.78	1.48	-
1093°C	1.25	1.27	1.11	0.78	0.78	0.79	1.49	-

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