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[MHAtech] Plastic refractory materials

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Dear Builders

I am in Ulaanbaatar localising the production of combustion chambers for domestic heating appliances. That involves finding materials that can be processed locally, if possible, and experimenting with different materials – about the most fun I have had in a while.

One of the most promising things I have even come across is known as plastic refractory material. This consists (I think) of a high alumina set of minerals mixed (just before use) with aluminum dihydrogen phosphate (ADP). We will analyse what is in it.

I secured a couple of tons of this material and drums of ADP. After a lot of experimentation we (Altanzul the lady engineer and I) arrived at the following mix:

9.7 kg of ‘plastic’ material

955 g of ADP

150 g of accelerant

After adding the ADP, mix at high speed using a cake mixer for 4 minutes

Use immediately

This yields >10 kg of wet sticky material that is pressed by hand into a rectangular form.

It could be any shape at all, for example a fireplace wall panel or exit tube or inlet pipes set into a plate. We are making half-cylinders with an outside diameter of 320 mm.

The rectangle is lifted on a sheet of plastic and placed into a mould, and covered with another plastic sheet, then vibrated using a shaped tool, in this case a half-cylinder 260mm in diameter.

This gives a 30mm wall thickness. The part is slid onto a similarly shaped form that can hold two parts. We have multiple such forms.

After 12 hours the part can be removed from a form and placed in a warming cabinet: 200 C for a day.

The result is a very hard, strong, heat shock resistant part that does not need firing. After fully drying (the phosphate bonding releases water) it is ready to take temperatures up to 1300.

Held up with one hand, the parts ring like a bell when struck with a hammer. Absolute amazing. It may be very useful for making masonry heaters where the shape you want is very difficult to form using bricks. It can be hand moulded and even hammered into shape with a rubber mallet. We tried all sorts of things. Rolling with a 2” pipe is very effective. So is the hammer.

It will cure in cold weather using the accelerant. 3 kg is provided for each 22 kg of material, but we only use 400g of that. The cost is about 50 cents per kg plus transport and duties. The cost of production (materials) in Ulaanbaatar of one 10 kg part is about $7, the price of 6 refractory bricks.

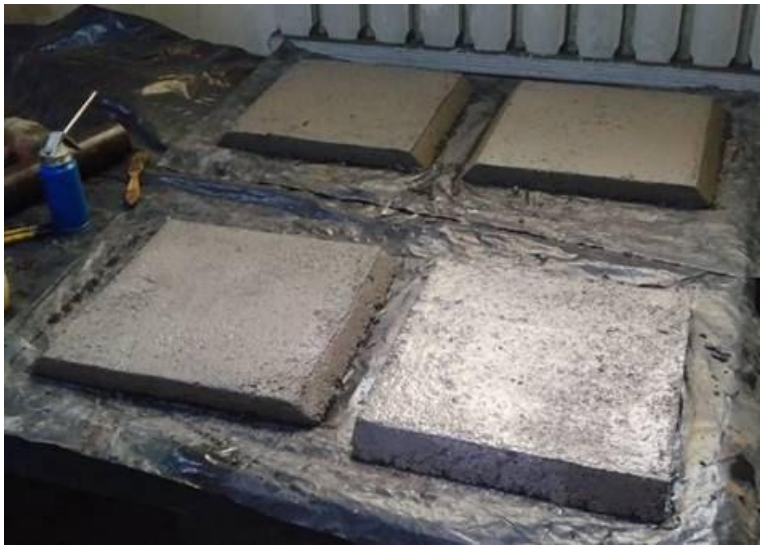
The parts above have slightly different mixes and mixing times. The one in the middle has the most accelerant and 700 g of water added. It sets too quickly for convenient use at normal ambient temperature. The next one to the right is the latest formula (above). Within an hour the mix is too hard to re-form, and after 12 hrs it hard and strong enough to handle easily.

With and without water plus a lot of accelerant: white surface is the water-added one.

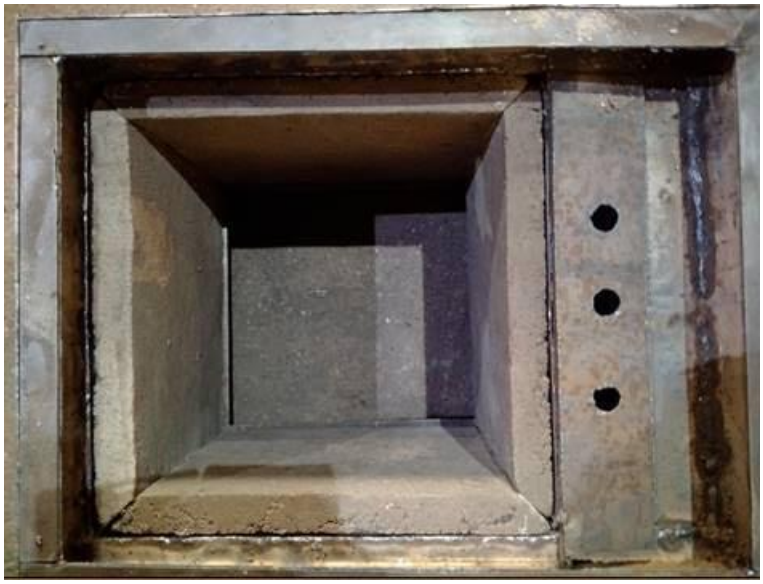
The plastic on the back prevents evaporation of water so it is damp and softer when it is first removed. Within an hour or two it is also dry to the touch.

Left alone, the material should be left for 12 days to evaporate the water from the reaction – so we were told. The usefulness of this material is perhaps best for making transitions from brickwork to chimneys and shaped bases for the fire. It is really easy to make channels by putting strips of wood under the lower plastic sheet. It can also have grooves to have parts hold each other in position.

Here is a simple stove with a square chamber lined with 4 flat places made in a very simple angle iron frame.



Rolled with a pipe and struck off with a steel strip.



These plates were formed by hand pressure only, and dried in the sun for a few days (not 12). They are very hard, strong and difficult to grind using a metal (red label) disk. It is like grinding stone. They can be cut using a green label or diamond cutting disk.

It is likely we will use some form of top-vibration for production of flat components to increase the density which is about 2.4 g/cc. The (metric) heat transfer coefficient is about 1.5.

Regards
Crispin

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