Hotpot

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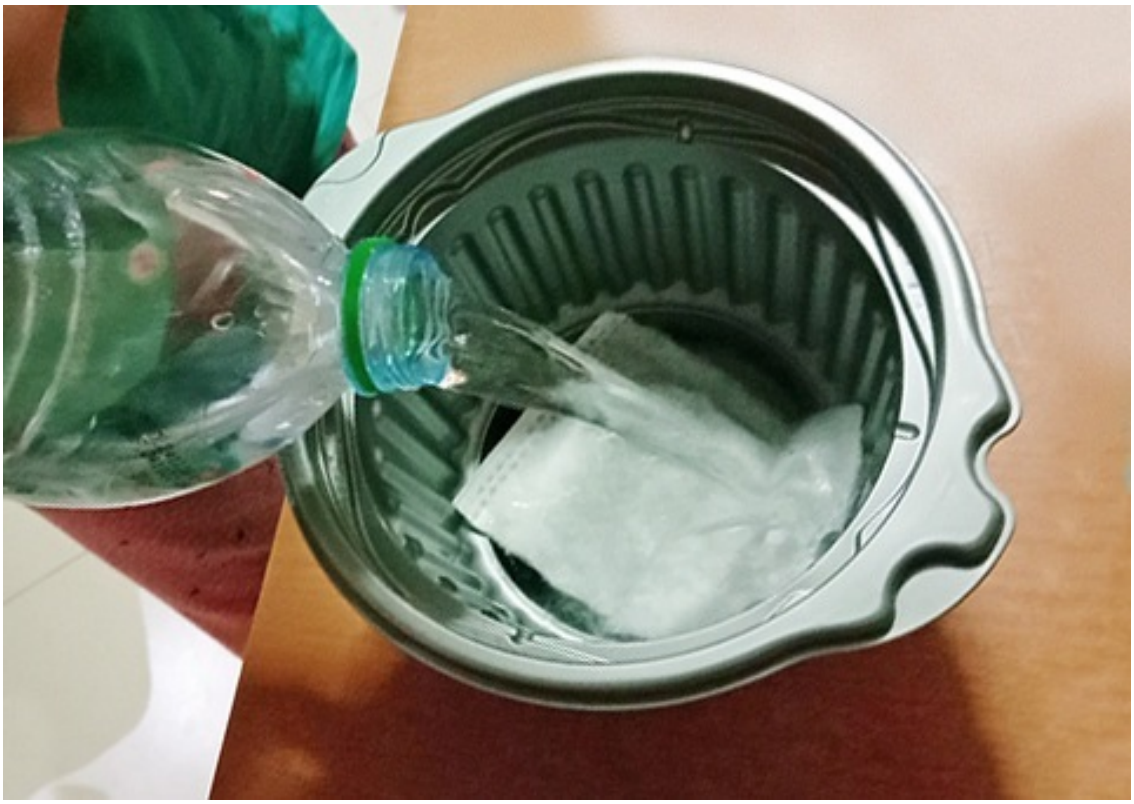
A “Hotpot” is a slow-cooked stew of meat and vegetables. When it’s cold and you’re hungry that’s a very nice way to eat. The supermarket version is a packet of Mama noodles. My little sister demands a packet twice a day. We’ve started rationing and sneaking proper vegetables in there. Doing this in the car is awkward: no heat. We could fix that with a little chemistry, but this time we cheated: we bought noodles with a hot-bag out of China. Next time we’ll make one ourselves.

The soft cloth bag came with plastic pots and instant noodles.

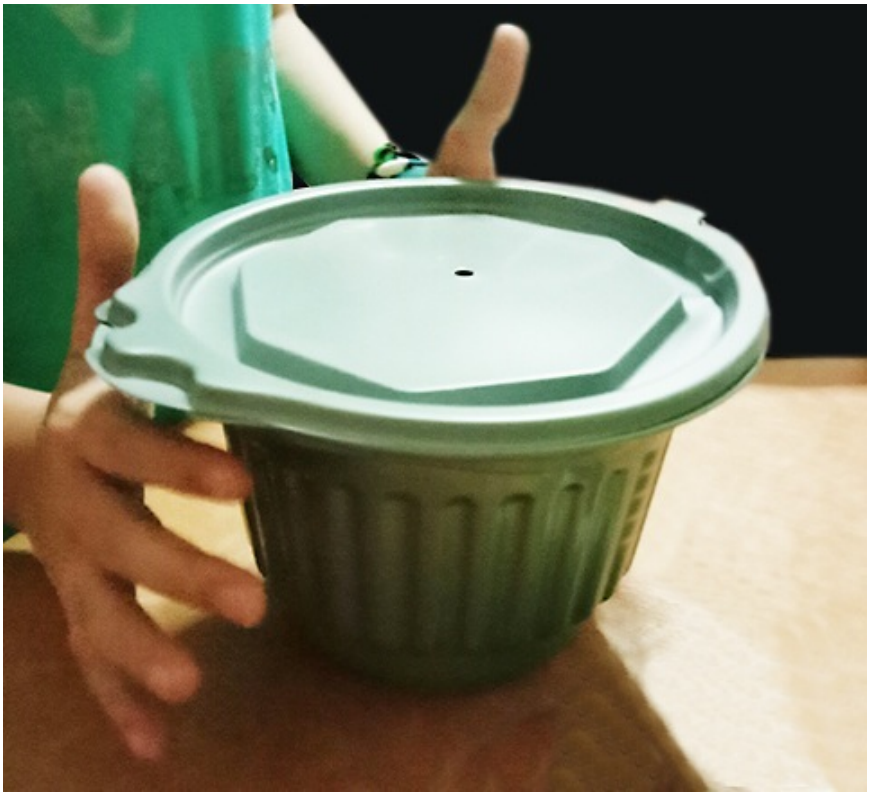


1 Put the noodles, the sauce, dry spice powers, dried shrimp and vegetables in the small bowl. Cover them with water. *Do that first*.

2 Put the bag in the big pot and pour *cold water* up to a mark that clever people in China put there. In science-speak that’s 100 mls.

3 Nothing happens for maybe five seconds. That's enough time to put the noodle bowl in the top of the big pot and put the lid on.

Wait …



… steam will come out that little hole.

4 *Wait five minutes*: the time you have to wait for regular mama with boiling water from a jug. Take the lid off.

There we are. Hot noodles. No mess, no problems. Enjoy the noodles and dump the plastic in a rubbish-bin somewhere. Try not to worry about how much of that plastic will end up as micro-bits in the biosphere.

Wow! *What chemicals were in the bag, what's in there now, how much heat energy was let out and how do we make one ourselves?*

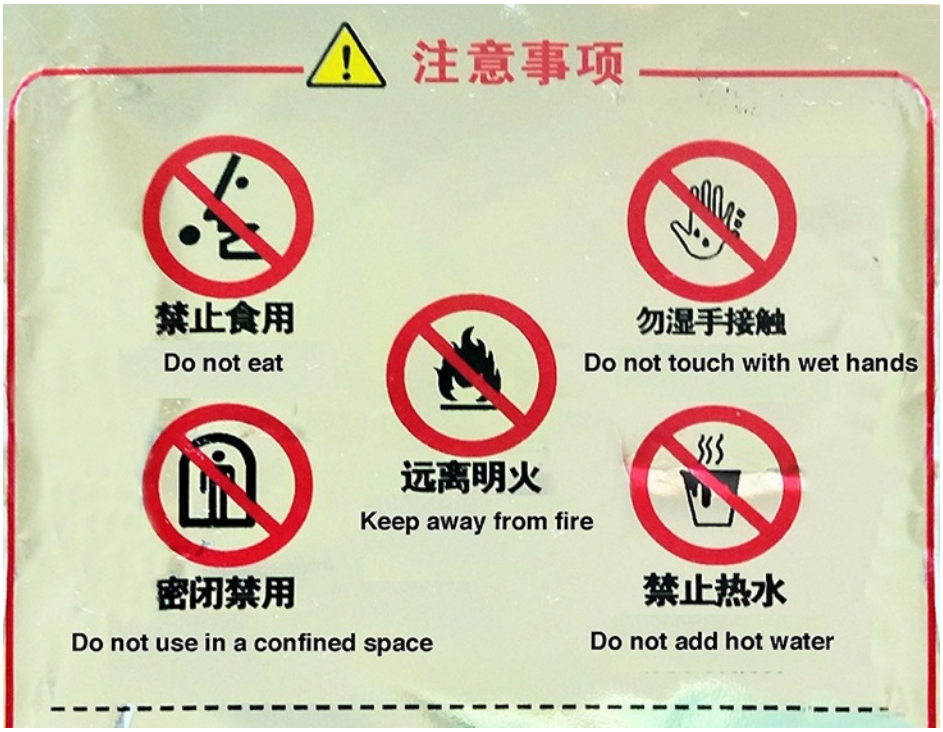
Not so fast. The military have been doing this for years. They call them MRE's (meals ready to eat). One question at a time.

Chemicals

They must be cheap? They are cheap. Calcium oxide powder (CaO), aluminium powder, and for some reason sodium carbonate (Na_2CO_3).
I know about calcium oxide. That releases heat when reacted with water and aluminium does the same in a solution of caustic soda in water. That is how we make hydrogen gas.

How much of the chemicals were in the bag, why sodium carbonate, and why the cautions? One question at a time.

Cautions



Water reacts violently with the contents of the inner cloth bag and it does release some hydrogen gas. Hydrogen burns: not a major hazard, but don't try to light it.

Not adding hot water is interesting. You don't want to have twice the heat energy in the pot by adding boiling water, which would make the reactions faster and just make more steam without getting hotter.

The ingredients (Chemicals)

The ingredients are listed as CaO and Al (powder) with (Na_2CO_3). No quantities are given. The total mass of the bag was around 100 grams.

Reacting CaO with water to give calcium hydroxide $Ca(OH)_2$ with the release of heat, produces 64 kj/mol of CaO. We looked that up - you could do that too. *That is a lot of energy*. More than enough to boil 100 g of water if there was no heat lost to the room.

In hot water, sodium carbonate (washing soda), produces a strongly alkaline solution as it reacts with water.

$$Na_2CO_{3\,(aq)} + H_2O \rightarrow NaHCO_{3\,(aq)} + NaOH_{\,(aq)}$$

Aluminium powder then reacts with water in the alkaline solution, which disrupts the otherwise protective oxide layer on the aluminium.

$$2Al + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2$$

Both reactions are exothermic. They produce more heat.

Reference: https://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/aluminium_water_hydrogen.pdf

> We don't know why aluminium and sodium carbonate were added to the bag when one hundred grams of CaO on its own would be enough, but these reactions might release heat more slowly than the CaO reaction with water and might improve the performance?

Next time we make our own hot-bag …

> *We make about 100 grams of CaO by heating 200 grams of shells in a charcoal fire above 850°C (by blowing air into the fire). We package that in fabric and keep it dry inside a sealed plastic bag.*