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Evaluation of Several Solid Camping Fuels and Storage

Several common solid camping fuels were tried in various environments and evaluated from both this and a preparedness perspective based on heat output, availability and storability. Of the choices below, the fuel that produces the most heat from a smaller portion and widely available to civilians is selected over one that does not have these characteristics. In any case, the fuel must be available on the civilian market over the foreseeable future and must be safely storable over some period of time without much degradation of it's utility.

None of these fuels should be used in an enclosed space: house, apartment, tent, camper, etc. because of fire hazard and irritating/toxic fume production and accumulation.

Hexamine (hexamethylenetetramine): HOC: 13,300 BTU/lb (31,000 kj/g)

Hexamine was popular with the U.S. Military in West Germany and the Bundeswehr of the 1980's and early 1990's in my experience. Folding Esbit stoves were carried and used as ration heaters since Esbit was a popular and widely available brand in local stores ('on the economy') and were available at the Post Exchange (PX). Hexamine may produce ammonia vapor when combusted and is unsuitable for areas without ventilation.

Trioxane (1,3,5-trioxane): HOC: 7200 BTU/lb (7596 kJ/g). and Hexamine are two formaldehyde compounds. Trioxane was a U.S. military's ration heater before the flameless ration heater and DEG gel (below) were available. Hexamine was also a military ration heater but was seemingly not as popular or available as Trioxane in the U.S. Army of the late 1980's, 1990's. Trioxane was available in some quantity. S-4 in late 1980's Germany had Trioxane rarely, but never Hexamine. Trioxane produces formaldehyde vapor when combusted and is unsuitable for areas without ventilation.

Diethylene Glycol (DEG): HOC: 212 BTU/lb (223.7 kJ/g) is one of the current military ration heaters. Based on heat output alone, it is inferior to hexamine but does not produce the irritating and carcinogenic fumes of formaldehyde that Trioxane and hexamine do. It is a gel (or thick liquid) and will dry out like gelled alcohol if it's exposed to air. There is sometimes discussion that DEG is poisonous and accounts for some cases of poisoning historically, however, these poisoning cases were from oral ingestion and all of the camping fuels discussed here are poisonous if ingested orally. Solid camping fuels are not for ingestion.

There is no shelf life associated with the Fuel, Gel Diethylene Glycol NSN 9110-01-518-9201 and a five year interval between manufacturing date and the inspection/test date. Box of three packs.

Gelled alcohol (ethanol) ('Sterno'): HOC: 1.2 BTU (2 kJ/mL). A popular and commonly available solid fuel consisting of gelled alcohol. It is readily and widely available and has the lowest heat energy output of the solid camping fuels here. The gel will dry out as the alcohol evaporates if the container is left open and exposed to air. Not recommended for long term storage since it lacks ROI in terms of size and heat. If the container is punctured or the lid is not well sealed, then loss of product through evaporation will result.

Hexamine is commonly available 'off the shelf' in a variety of brands and locally, being a product for civilian outdoor markets, Trioxane is confined to military surplus stores and Internet purchase of military surplus. Stocks of Trioxane fuel tablets are from U.S. military surplus and Trioxane does not appear to be made for the civilian outdoor market like hexamine. Since the military no longer uses Trioxane, existing supplies are not being replenished. I've noticed over the years a decrease in publicly available Trioxane. Trioxane offers nothing that hexamine cannot deliver, is more difficult to procure, produces less heat energy than hexamine and produces formaldehyde vapor when burned. Trioxane fuel is seemingly available only from military surplus stocks.

The author speculates that there is a national direction to remove hexamine from retail sales, much like mercury thermometers were replaced for public safety in the early 2000's. Hexamine is a precursor to RDX, a relatively easy to make secondary explosive. Hexamine can also be used as a precursor to methylamine, a precursor to methampehtamine. See 'Uncle Fester's Home Workshop Explosives' for RDX synthesis using hexamine. Hexamine can be easily synthesized using ammonia and formaldehyde, if one needs quantities of hexamine in a future of scarcity.

There is no tactical, survival or practical value of Trioxane over hexamine. Because the military used Trioxane does not, necessarily, mean that it is superior to non-military alternatives. Trioxane fuel bars were manufactured and distributed by several companies out of business since the 1995, at the latest. There does not appear to be any current production of Trioxane fuel tablets.

Hexamine is a common solid fuel for camping and is a choice solid fuel for long-term storage and caching. It has a characteristic 'dead-fish' odor that can contaminate foodstuffs and permeate fabrics that may be objectionable or cause health issues.

Below are some attempts to control hexamine odor in order to store hexamine in a plastic cache bucket with a Gamma-Seal lid at room temperature to concentrate odor. Several techniques were tried.

Best overall container for storing hexamine, or other solid fuel, is the metal paint can with lid. This is a one gallon metal can with press on lid, available for $10.00 from hardware stores and much cheaper online. A pound of hexamine placed in this container did release faint odor after a full day at 70F. There are many of ways of storing hexamine, many do not fully contain the odor. Hexamine will corrode zinc ('galvanized') and aluminum.

Metal paint cans may also provide protection against accidental ignition. Sealing the lid using a RTV sealant does provide an effective, long-term seal for deep storage. Paint cans are available in one and five gallon capacities. We estimate that a 5 gallon paint can with crimp seal lid and gasket seal will work as well.

Other storage attempts and their results:

- Hexamine bars in Mason jar. Did little to contain hexamine odor. Odor control achieved when jar threads and lid gasket was sealed with petroleum jelly ('Vaseline'). Consider using white lithium grease to maintain lid gasket.
- Hexamine bars in Mason jar with Mason lid and ring. Used inexpensive black electrical tape around jar threads (like Teflon tape) and also to seal metal screw rings to jar. Much improvement in hexamine odor containment, but still noticeable.
- Hexamine bars in Mason jar with Mason lid and ring. Used clear silicone RTV sealant/adhesive with so far good effects, however now there noticeable acetone/silicone smell from sealant.
- Sealed hexamine in plastic (Ovaltine) jar (above) using inexpensive, unscented candle wax. Dripped wax from lit candle to union of jar and lid.

Successful in preventing hexamine odor from escaping jar confines. No hexamine odor after 14 hours in sealed bucket. No hexamine odor after three years.

- Hexamine bars may deform in storage into a single mass of hexamine. Consider wax paper.

The advantage of wax seals is that it can be removed and reformed by body heat and replaced on the jar by melting with a locally available heat source. Wax provides a firestarter or field expedient candle as well.

Note: HOC is Heat of Combustion

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