# Types of Lightweight Camping Stove and Fuels

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This information is prepared for the benefit of people using stoves in conditions found in the UK. In colder or hotter environments some aspects of this information may become irrelevant or incorrect.

This document has been written to offer basic advice on the use of lightweight camping stoves, i.e. those stoves that would be carried by walkers/climbers/paddlers rather than those that would be used by static campers and only carried from the vehicle to the tent.

The stoves are categorised according to their fuel type as this is, arguably, the most important factor to consider.

**Types of Fuel**

Gas: Butane, butane-isobutane, butane-propane, propane, (all stored liquefied);

Gas from a canister (aka cartridge) is piped to a controlled jet and ignited above a burner;

Liquefied gas fuel is generally available, relatively cheaply as butane, butane-propane mix, butane-isobutane mix, butane-propane-isobutane mix and occasionally just propane. They are stored in a variety of canister types, each with a different valve;

Each gas boils at a different temperature so different gas/gas mixtures are used for different temperatures and each has a different heat output (see table below); they require a significant volume of air for complete combustion (x25-32) so ventilation, as with any stove, is essential;

Gas fuels burn readily once ignited, can be explosive when mixed with air, produce low levels of unburned carbon (soot), are toxic, have a significant and recognisable odour, and are significantly heavier than air;

Gas leakage and canister failure is very rare, so associated risks are very low;

Low risk in a tent/confined space;

Butane is used as a recreational drug, resulting in drunken-like stupor with associated aggression with much more serious longer term effects.

Alcohol: Ethanol, methylated sprit (meths), eco-ethanol, IPA (isopropyl alcohol);

Alcohol is poured manually into an open cup-like burner and then manually ignited;

Alcohol fuels, usually meths, increasingly eco-ethanol, are generally available, sold in plastic bottles, throughout the UK, though not nearly as commonly as gas or petroleum fuels;

Alcohol fuels becomes less viable in cold weather ($T_b$ 78.5°C), produce approximately half the relative heat output of the gas fuels and require a relatively low volume of air for complete combustion (x15) and produce significant unburned carbon (soot);

Alcohol fuels are highly volatile liquids; both liquid and vapours ignite readily, burn with a not-very-visible flame and produce significant unburned carbon (soot); they have a significant odour and are toxic;

 

Spillage of volatile liquid fuel is a significant hazard, increased if the liquid is hot and, if burning, spillage is a major hazard.

Low-medium risk in a tent/confined space;

Alcohol is used as a recreational drug but all fuel-grade alcohols are toxic in small quantities.

Liquid petroleum: Petrol, Coleman Fuel, unleaded, white gas, paraffin, diesel.

These fuels are primarily octane (petrol, unleaded, Coleman fuel, white gas) or mixtures of longer hydrocarbon chains (8-16 for paraffin and 8-21 for diesel). They require priming (preheating the fuel so that it turns to gas/vapour before being issued through jets) and pressurising (the user pumps air into the fuel canister to blow the fuel to the burner.

They are, in one form or another, the most readily available fuels (available anywhere there are vehicles) and are also usually the cheapest. There are a few specialist versions (Coleman Fuel) that typically contain fewer additives that have a tendency to block the fuel jets on stoves. They must be stored in appropriate containers to prevent leakage.

Liquid petroleum fuels burn with high temperatures and high heat output and, as long as they can be primed, they will work at very cold temperatures. They require enormous volumes of air for complete combustion (x60+) and can produce copious volumes of unburned carbon (soot) and toxic levels of carbon monoxide.

Note: “impure” liquid petroleum fuel is common in “less developed” locations and can cause effects including flares, fireballs, sheets/towers of flame, irregular burning, high levels of unburned carbon and toxic levels of carbon monoxide. Outdoor use is recommended unless the fuel is known to be high quality;

Properties vary considerably:

Petrol is a volatile liquid and both liquid and vapours ignite readily; petroleum vapour is highly inflammable and explosive under certain conditions;

Diesel and paraffin are less volatile and liquids will not generally ignite easily unless wicked or heated, vapours are highly inflammable;

All petroleum fuels burn with very visible flames; they have a strong and recognisable odour, are toxic and mild irritants;

Spillage of liquid petroleum fuel is a very significant hazard, increased if the liquid is hot and, if burning, spillage is catastrophic; if spilled, cold octane (petrol) will evaporate slowly in most temperate conditions, but paraffin and diesel will not (if spilled onto sleeping bags, the bag is best binned).

Medium-high risk in a tent/confined space;

Wood: wood chips, eco-kitty-litter, wild wood.

Wood is used in several types of stove and is widely available in the wild and can be found sold as kindling, eco-kitty-litter and hardwood chips (from pet stores). Its heat output is low and it produces large volumes of unburned carbon (smoke/soot). Reliance on a source of dry wild wood in the wet UK climate is an unwise choice.

The overall effect is smelly kit and dirty pans. The only viable reason for using wood is that you've lost your stove and fuel.

Used in a tent by Darwin Award winners!

Other fuels:

Gel fuels are available in canisters that will replace a Trangia alcohol burner; the advantage is that the fuel cannot be spilled, and the lid can be screwed back on so the fuel can be stored/carried safely. These are not commonly available, are quite expensive and some produce high quantities of unburned carbon (soot).

**Gas Stoves**

There are two types of gas stove; canister-top stoves which screw directly into the fuel canister and remote-stoves that are fed from the canister via a pipe. The advantages are disadvantages are listed below. If you want to use butane (the cheapest and most widely available gas fuel is a liquid below -0.4°C) at low temperatures you'll need a remote stove with a pre-heater (liquid-feed gas stove) so that the canister can be inverted and liquefied gas can be fed to the stove.

Typically, well-made gas stoves require little or no maintenance, and will last many years (easily 20+). A good canister-top stove can be bought for £20-£30 and a good remote stove will cost £50-£80. If you buy a cheapy off eBay you may or may not get a good stove: Invest and be happy; you know it makes sense!

All gas stoves have built-in pan supports and the remote stoves usually have built in legs (they're sometimes called spider-stoves).

All gas stoves are prone to wind (the wind blows the heat energy away from the pan) so the use of a windshield and a lid is highly recommended, reducing the fuel consumption by up to 60% and the boil-time or cooking time by up to 150%.

For use inside a tent, gas stoves are safer, cleaner and more manageable than all others.

**Canister-Top Stoves**

Advantages

Light, small, easy to use and cheap. Typically durable and long-lasting. Clean burning (no sooty pans) and low carbon monoxide risk. Typically durable and long-lasting.

Disadvantages

Only burn gas so of limited use in low temperatures; below 5°C they will burn the propane and isobutane proportion of gas but not the butane, below -3°C they'll only burn propane); They have a high centre of gravity (canister + stove + pan(s) + lid).

**Remote Gas Stoves**

Advantages

Light, small, easy to use. Typically durable and long-lasting. Often have a pre-heater so they can burn liquefied butane at cold temperatures. Clean burning (no sooty pans) and low carbon monoxide risk. They have a low centre of gravity (burner + pan(s) + lid).

Disadvantages

Not as light or as small as canister-top stoves and cost approximately 2-3 times as much.

**Gas Canisters**

There are three widely available types of lightweight gas canister in the UK; the most common is a screw-on canister with a threaded self-sealing valve usually denoted C500, C300 etc (with a Lindal B188 valve) and these are available in a variety of sizes, each is normally labelled with the type and weight of gas contained but not always with the proportions.

As you might expect the major branded canisters can cost significantly more than lesser known brands but, in the UK, they all meet stringent regulations and you can massively reduce the cost of fuel by shopping around. Buying in bulk also reduces prices. At the time of writing this article, Coleman gas was available online at under £3.50/canister with free delivery for 12x450g (C500) whereas a single canister of the same volume from a stove manufacturer was being retailed at £9 at a well known high street store.

The type of canister also has a massive effect on price; pound shops sell 120g of butane for refilling lighters at £1 and in barbecue season, supermarkets sell 4-packs of the taller CV canisters of butane/isobutane (4x220g) for £2.99. The trouble is that you need an adapter to attach these to your stove and, would you believe it, eBay has them for a few quid!

The most common canisters contain a 70:30 mix of butane and propane; the cheapest contain butane and isobutane, and the most specialised low-temperature fuels contain a mix of around 80% propane and 20% isobutane. Many different combinations are marketed with differing purposes and advantages, some of them genuine. Outside of the “developed countries” there means by which the canisters are filled can result in large proportions of water being included (sometimes driven by profiteers, sometimes by poor technology) – you can’t burn the water.

If your stove has a pre-heater (a liquid-feed stove) it will work with liquefied gas and so will work in the lowest temperatures with 100% butane, but will be a little easier to ignite with a small proportion of propane. If your stove has no pre-heater, you must use a fuel that is a gas at the atmospheric temperature (see table below).

Generally speaking, gas fuel for use at very cold temperatures (below -5°C) contains higher ratios of propane (70% or more) along with isobutane and little or no butane. Gas for use in UK cold temperatures (-5°C to 10°C) contains higher ratios of isobutane (up to 70%) along with some propane, but little butane; gas fuel for warmer temperatures contains an increasingly higher proportion of butane (70% or more) with less isobutane and propane.

**Alcohol Stoves**

Aka spirit stoves, these are usually brass, open-topped burners into which the liquid alcohol is poured, with an outer enclosed tank with jets around the top. The fuel is ignited most easily with a match dipped into the surface of the fuel; as the burner and reservoir of fuel heat up, the alcohol evaporates at a faster rate and hot vapour flows through the jets and ignites.

Most alcohol stoves consist of a burner unit that sits in the surrounding pan support and windshield. The Trangia is probably the most well known alcohol stove and incorporates the burner as the central piece of a well designed modular stove. There are several much simpler stoves used by various armed forces, the most well-known one is used by the Swedish army.

Prices vary from £25 to £75 for good quality units.

A cheap and effective alcohol burner can be made from the bottom of two drinks cans (Coke, beer etc) and will work as well as the best burners (penny stove) however they are not especially durable nor as easily manageable and best not used in a tent.

 

All alcohol burners will produce unburned carbon (soot) so dirty pans are normal. If 8-10% water is added to meths or ethanol, the soot production is much reduced, but the heat output is also reduced so boil/cook times and fuel consumption increases.

For use inside a tent, alcohol stoves are second only gas stoves and, as the air-to-fuel requirement of alcohol fuels is much lower than the gas fuels, they pose low, but not no risk of carbon monoxide poisoning.

Alcohol stoves have two significant risks: the flame is not very visible, especially in bright light and the fuel is highly volatile so spillage (whether burning or not) is a significant fire risk.

Inexperienced stove users should cook outside their tents.

The environmental impact of alcohol stoves is low-medium. Trangias and similar modular stoves support the burner so that it poses little or no damage to underlying vegetation/habitat, but those that rest on the ground will destroy the underlying vegetation/habitat to a significant depth if used for any length of time. Simply resting the burner on a rock will remove this impact. Alcohol fuels evaporate completely and pose no environmental threat in small quantities.

**Cook Systems**

Trangias, Jetboil and similar systems are very popular as the combine elements of the cooking system in one compact unit, often with greater functionality and sometimes lower weight. They all have advantages and limitations that are not necessarily obvious; for example, Jetboil systems are great for boiling/cooking in one pot, but not good for more and they have a high centre of gravity; Trangias are relatively heavy unless stripped down and/or cooking for a large group.

If you are intending to

**Safety Notes**

All fuels pose high risks if carried or used by incompetent, immature or inebriated people.

This document is not a training brief; we highly recommend getting trained or self-training to a level significantly above that which you might normally require so that you are able to deal with pretty much anything that happens whilst using a camping stove, especially as the worst scenarios can occur in remote locations just as easily as they can closer to medical assistance.

There are those who consider that using a stove in a tent is not safe; consider that all adventurers, explorers, mountaineers, expeditioners, etc. use stoves inside their tent, and many will use them at high altitudes, in high winds, at extreme low and extreme high temperatures, and, we can assume that, as they continue to do so without incidents, at all times they do so safely because they have sufficient knowledge, competence and/or quality of training. Camping stoves are adequately safe if used by a competent and knowledgeable person.

Carbon monoxide is generated by all stove fuels, mostly in small quantities. In some situations, and more so with some fuels, high levels of this toxic gas are produced. The simple solution is to ventilate the cooking area so that the carbon monoxide dissipates and not to use the stove as a space heater (turn it off when not cooking/boiling).

Different fuels require different relative volumes of air for complete combustion; butane requires around 33 times the volume of air to burn, isobutane requires around the same and propane requires around 25 times the volume of air (compare with ethanol/meths at 15 times the volume of air and octane (Coleman Fuel?) at 62.5 times the volume of air).

**Data**

| Gas | Boiling point (°C) | Heat output (kJ/kg) | Heat output (kJ/mol) | g/mol | Rel. density |
|---|---|---|---|---|---|
| Butane | -0.4 | 49700 | 2877 | 58 | 132% |
| Propane | -42 | 50329 | 2220 | 44 | 76% |
| Isobutane | -11 | 45590 | 2869 | 58 | 132% |
| Key | Good | Not as good | Worst | | |

Volume of air required for complete combustion

| Fuel | Complete Combustion | $vO_2$ | vAir |
|---|---|---|---|
| Ethanol (meths) | $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ | 3 | 15 |
| Propane | $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ | 5 | 25 |
| Isobutane | $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ | 6.5 | 32.5 |
| Butane | $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ | 6.5 | 32.5 |
| Octane (petrol) | $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ | 12.5 | 62.5 |

Some respected manufacturers:

Alpkit

MSR

Optimus

Trangia

Jetboil

There are many others.

**Cooking/Boiling Times**

The question is: How long does it take to boil 500mls of water?

The answer is: It depends!

There are so many variables: Assuming you have a pan with a lid, temperature, fuel, altitude, stove design, pan design, windshield and heat exchanger design all play a part.

As a general guide; alcohol stoves are slow, liquid-feed gas stoves are fastest down to about -5°C, pressurised petroleum using pure octane take time to prime but are the rockets in colder conditions.

Generally speaking, as you increase the gas flow to speed up boiling, the more noise the stove makes and the less efficient your stove becomes. As with a vehicle, there's a balance between fuel economy and performance that must be found by the user.

A decent time to boil 500ml of water in warm conditions is 3-4 minutes; some stoves can boil 1 litre in that time.

**What's the Best Stove?**

Mine, obviously! ☺

 

**What Does the Author Use?**

My go-to stove, if cooking for 1-3 people, is an MSR Windpro gas-fuelled remote stove with a pre-heater, bought in the late 80s and still going strong with very little need for maintenance and never a single fault; with this model I can use any gas at any temperature that I'm likely to encounter. I usually use butane-propane or butane-isobutane gas mixes, and buy in bulk (12 canisters at a time). I also use a couple of adapters that allow me to use different gas canisters (CV/bayonet).

I also have a small and a large Trangia that I occasionally use, mostly for training others, although I use the large Trangia pans with the MSR Windpro for larger group cooking.

I have a Lixada portable wood-gas stove and a Lixada folding miniature wood stove which I use mostly for education and training, showing off, and especially for showing people how not to damage their environment with fire. I rarely cook on these as I have a gas stove.

I have not yet found a need for a pressurised liquid stove in the UK: I may, one day.

The author: Simon McElroy has been messing with fire for over 45 year and is still not dead.

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