Tribal Neon

Coloured Flame Dyes

For years Fire Poi Spinners and other Fire Performers have wanted to work with coloured fire. Many have tried various chemicals to change the colour of their fire props. Some have made reasonable colours, but most have been disappointed by low colour intensity and inconsistent results. Chemicals can be hard to buy, and pack sizes are generally too big and too expensive for experimentation.

Now Tribal Neon© makes coloured fire easy!

Each bottle of **Tribal Neon© Flame Dye** contains an optimised blend of metal salts and conditioners that turn 1L of denatured alcohol into 1L of coloured fire fuel.

Colours currently available include Red, Yellow, Green, and Blue.

NB: Tribal Neon© flame dyes work with alcohol based fuels ONLY. They will not work with hydrocarbon fuels such as kerosene.

See the Fuel Guide inside for more information.

Tribal Neon© Flame Dyes are manufactured by:

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How Fire Dyes Work - Fuels and Fire Chemistry

To understand coloured fire you first need to know some fuel chemistry and the process of combustion that gives flames their colour. Fire is a chemical process in which a fuel reacts (burns), usually with oxygen from the air, producing combustion products, releasing the energy trapped in the fuel as heat. The chemicals that make up the fuel are organic materials, mostly hydrocarbons and carbohydrates that contain the elements carbon, hydrogen, and oxygen. These elements are bonded together into molecules, and the energy it takes to join them together is the energy that is released when they are burned.

All combustible organic materials were originally made by plants, making photosynthesis the most fundamental chemical process on Earth. Plants capture energy from sunlight, using it to join carbon dioxide and water into energy-rich organic molecules called sugars. Plants then join these together either to make cellulose, the structural material all plants are made of; or starches, the stuff they use to store energy. Wood and stalky materials such as cane, and plant fibres such as cotton, flax, and hemp, are all made of cellulose. Plant roots and tubers, such as carrots and potatoes, and fruit and seeds such as beans, apples, and nuts, are all rich in starches. Collectively sugars, starches and cellulose are known as carbohydrates. Most animals get their energy from digesting sugars and starches, but apart from bacteria, few can digest cellulose.

When dead plants get buried, away from oxygen, they get compressed and slowly fossilise. Their carbohydrates gradually lose oxygen and turn into hydrocarbons - which we know as our fossil fuels: peat, coal, oil, and gas.

Combustion Chemistry

When organic compounds burn their stored energy is released as heat, and their combustion products are carbon dioxide and water – exactly the same materials they were originally made from.

When an organic fuel burns freely in air the same energy-liberating reactions always take place. Once the fuel gets hot enough it vaporises and its molecules begin to break down and burn, liberating more heat in a chain reaction. If there is enough oxygen all the fuel will burn. If not, the reaction will be incomplete, leaving unburned carbon in the form of smoke, soot, or charcoal. Candle flames illustrate the gas-diffusion process common to all forms of uncontrolled combustion, from candles to forest fires.

The first reaction takes place at the surface of the wick, where melted wax is heated until it vaporises and gets sucked up into the bottom of the flame. Even before the vapour starts to burn it reaches 4-500ºC, and the large hydrocarbon molecules of the wax begin to break apart into smaller fragments. If you look at a candle flame you will see this as a dark region close to the wick surface. When you first blow out a candle you can see these unburned hydrocarbons coming off the wick as white vapour. As air is drawn into the flame, it mixes with this flammable vapour and the oxygen reacts with the smallest hydrocarbon fragments, which begin to burn with a pale blue light. This liberates the stored chemical energy as heat, quickly pushing the temperature up to around 1000ºC. As the hot gases rise further up in the flame the reaction begins to run out of oxygen, leaving the carbon skeletons of the unburned hydrocarbons. The temperature in this region gets as hot as 1400ºC, and these soot particles begin to absorb and re-radiate heat in the form of the typical yellow-white light we associate with candlelight.

This incandescence is called black-body radiation, and is the same thing you see when a piece of steel is heated up. The higher the temperature, the brighter and whiter the light emitted. A dull cherry-red glow for instance corresponds to a temperature of around 500ºC; bright red is about 800ºC, yellow around 1200ºC, and bright white light is around 1400ºC.

All uncontrolled combustion processes have luminous smoky flames. But if the same fuel could be mixed with enough oxygen no soot would be formed and the flame would be pale blue, like the flame from a primus stove or gas burner.

A premixed gas flame is hotter than a candle – up to 1600ºC. But the visual difference between these two kinds of flames doesn't just come from their temperature but from the presence or absence of soot particles, which is the important factor for fire prop work. Petroleum fuels used with fire props may produce flames around 1200-1300ºC, but their typically luminous orange/yellow flame is a result of insufficient oxygen in the flame leading to incomplete combustion and glowing soot.

Coloured Flames – and How to See Them

When certain metals are heated, say in a flame, some of their atoms vaporise and join the flame. The heat energy they absorb "excites" some of their electrons into more energetic states. These excited atoms then re-emit this energy at characteristic wavelengths, some of which are in the visible spectrum, and we see this as coloured light with colours specific to each metal.

Naturally, if there is lots of white light from the incandescent soot it will be difficult to see these colours. To see coloured flames this soot must be removed from the flame. This could be done by using a premixed flame to give complete combustion, but if the idea of twirling blowtorches does not appeal, then the only alternative is to change the chemistry of the flame.

The most practicable way of controlling flame luminosity is by changing the fuel from a hydrocarbon, like kerosene or gasoline, to fuels that already contain a high proportion of oxygen within their molecular structure. The best possible fuel is methanol, a small molecule with only one carbon and one oxygen atom. Ethanol, with two carbons to one oxygen, still burns fairly cleanly. Most other fuels have a too high a carbon to oxygen ratio and burn with a luminous white flame.

Fuel Guide for Tribal Neon© Coloured Fire

- The best possible fuel for coloured fire is **Methanol** (methyl alcohol, wood alcohol), which burns with a hot almost colourless flame. Methanol is poisonous, and causes blindness if ingested. Unfortunately pure Methanol is hard to buy, but if you can get it, it will show superbly clear flame colours with minimal luminosity. NB: Methanol is extremely flammable and its colourless flame may be almost invisible. Take extreme care with this fuel!
- Second best is **Ethanol** (ethyl alcohol, grain alcohol) with a pale blue flame. Pure Ethanol (96% Ethanol / 4% water) distilled from fermented sugars, is very expensive because of excise duty. Industrial "dry" Ethanol is >99% pure but contains a trace of poisonous benzene. NB: Ethanol is extremely flammable and its pale blue flame is hard to see. Take extreme care with this fuel!
- **Denatured Alcohol** or **Methylated Spirits** is a mixture of Ethanol "denatured" with Methanol to make it unfit for beverage use. Pure denatured alcohol containing only Ethanol and Methanol is probably the best fuel you will be able to find easily. A suitable source of good quality denatured alcohol is available from paint shops as **Shellac Varnish Reducer**. NB: Denatured Alcohol is extremely flammable and its pale blue flame is hard to see. Take extreme care with this fuel!
- **Purple household "meths"** is denatured alcohol with a bittering agent and a purple dye to make it unpalatable and recognizable. Some may also contain Acetone or other solvents deliberately added to make the flame visible. Any water present can also contain salt that will colour the flame yellow. Most will work fine but some will be less than ideal. Its worth burning some on its own first. If it is very luminous on its own it won't perform well with flame dyes. . NB: Purple Meths is extremely flammable and its pale blue flame is hard to see. Take extreme care with this fuel!
- Higher alcohols, such as **Iso-Propanol (Isopropyl Rubbing Alcohol USP/BP)**, and solvents like **Acetone, Methyl Ethyl Ketone**, etc, all produce flames that are far too luminous for coloured fire.
- Commercial **lamp and camp-stove fuels** are usually mixtures of Ethanol, Propanol and hydrocarbons, with flame colouring salts deliberately added to make the flame luminous for safer use, and therefore unsuitable for coloured fire.
- Various products containing alcohol mixtures are available. **USP/BP Rubbing Alcohol** and some formulations of **Surgical Spirit** contain Ethanol along with other solvents including Acetone, MEK, and sometimes water, making them luminous and unsuitable for coloured fire.

Tips for Use

- **For best results use with a new, clean, and dry fire prop.** Petroleum based fuels left on a used prop will not mix with alcohol, and your flame will be sooty and will not display good clear colours.
- **Use well made props that are not held together with water-based or alcohol-soluble adhesives.** These may fall apart during use with dangerous results!
- **Use one prop for each colour.** Mixing colours will produce indistinct colours. If you really want to use different coloured fuels with the same prop you can try washing it thoroughly with distilled water then rinse dry with undyed fuel. Some colour may remain even after washing.
- **NB: Tribal Neon© Yellow flame dye matches the flame intensity of the other colours**. While kerosene burns luminous white/orange the hydrocarbon flame is brighter than alcohol flames, and can drown them out. Tribal Neon© Yellow Flame Dye provides a superior alternative pure yellow flame for the best fire performances.
- **NB: Alcohol without any flame dye burns pale blue/white!** Used on its own, denatured alcohol fuel gives a fairly colourless flame. While this provides some contrast with the Red, Green and Yellow dyes, it is nowhere near as good as Tribal Neon© Blue Flame Dye!
- **All salts used are water-soluble and can be washed off skin, fabrics, and props with water.** Salts that build up on a prop over time can be washed out with water. Dry thoroughly before reuse or rinse water out with undyed fuel.
- **NB: It is possible (but unlikely) that the metals used in the flame dyes may react with Textile dyes used on some fabrics and appear as permanent discolouration and/or staining.**

Tribal Neon© Flame Dyes

Most metal salts are completely insoluble in petroleum or straight alcohol fuels. Most are only soluble in water or in weak water-alcohol mixtures. Water cools the flame, and too much will prevent it burning at all. As some commercial Denatured Alcohols already contain a little water, adding more is not desirable. **Tribal Neon©** flame dyes *are formulated for maximum solubility in both pure alcohols and strong alcohol-water mixtures and need no added water.*

What you need to make 1 litre of Tribal Neon© Coloured Fire fuel:

- 1 bottle of **Tribal Neon©** Flame Dye.
- 1 litre of suitable Alcohol as described in the Fuel Guide inside. 1 litre is optimal. Dilution to larger volumes, e.g. to 1 quart, will work but give a proportionally less intense colour.
- Plastic gloves and eye protection are recommended for safe handling of concentrates and prepared fuels.

Instructions For Mixing and Using:

- Take a 1L container of the fuel. Make sure there is room to add 50ml of the flame dye. If you set some fuel aside be very careful: *open containers of alcohol are a serious fire hazard.*
- Slowly add all of the **Tribal Neon©** liquid into the 1L container. Swirl to mix. Note: the mixture may become warm as it mixes.
- Cap the bottle and rinse spills off skin and clothing and from the outside of the bottle with water.
- Pour dyed fuel over your prop in a fuel bath, and tip the excess back into the bottle. Don't leave the bath or the bottle lying open. Watch out for fireballs when lighting it – alcohol vapour is much more flammable than kerosene – and watch out for burning fuel spray when spinning it up!

Always play safe with Fire! You use this product at your own risk!

We offer this product as a service, supplied in good faith that when you decide to play with fire and fire props, including flame dyed fuels, you know what you are doing, and accept full responsibility for all consequences. Please behave responsibly as you use, store, and dispose of coloured flame dyed fuels, because we accept no liability for any harm to yourself or others from your use of this product.

- Store the mixture in a solvent resistant plastic container with a childproof lid and poison warnings. A recycled purple methylated spirits bottle is fine, but label it as coloured fire alcohol fuel. Do not use soda bottles (etc) as they may not be sufficiently resistant to alcohols. Do not store in a metal container. The dyed fuel mixture is corrosive and will cause metal containers to rust and leak.
- **Tribal Neon©** Flame dyes may contain compounds of Ammonia, Boron, Calcium, Carbonates, Chlorides, Citrates, Copper, Ethanolamines, Hydroxides, Lithium, Potassium, Sodium, Strontium, Sulphates, and Tartrates, all of which should be considered potentially harmful. Use eye protection and protective gloves to keep the concentrate and treated fuels off your skin and clothing. Immediately wash dye and fuel spills off skin with water.
- **NOT SUITABLE FOR FIRE BREATHING! NEVER, *EVER*, put treated fuels in your mouth!**
- Burning coloured fire fuel releases exactly the same combustion products as common fireworks, including metal oxides, acid vapours, and smoke particles. To minimise your risk of exposure to these potentially hazardous fumes always use outside in the open air. If you are concerned, special dust masks that block metal and acid fumes are available from safety stores.
- Take care handling alcohol. Alcohols have lower flash points than petroleum fuels, and ignite more readily, and their flames are almost colourless and can be hard to see. Burning alcohol can be extinguished by dilution with water (>50%). Keep a wet towel handy to smother burning spills.
- To avoid vapour fireballs ensure your fire prop is cool before introducing fuel. Do not stand over your prop when lighting. Light at arms length, keeping your face well clear.
- Small quantities of dyed fuels may be diluted with water and disposed of into municipal sewage systems. Do not dispose into drains or waterways.