Nitro-methane.....everybody knows it's there, but few, it seems, really know much about it.

(The following is the third in a series of articles exploring all facets of model engine fuel. The writer is Don Nix, President of GBG Industries, Inc.)

Nitro-methane…everybody knows it's there, but few, it seems, really know much about it. Although most seem to know, at least vaguely, that's its primary purpose is to add power, we still get an occasional call or letter asking, "Why do you use it in model fuel?" At best, there is much misinformation regarding this somewhat exotic ingredient. Let's see what we can do to clear some of it up.

Nitro-methane is just one of a family of chemicals called "nitroparaffins." Others are nitro-ethane and 1-nitro-propane and 2-nitro-propane. Nitro-ethane can be used successfully in small quantities. (Top fuel drag racers, which generally run on straight nitro-methane, sometimes add a little in hot, humid weather to prevent detonation.) At one time, nitro ethane was only about half as expensive as nitro-methane, but its cost now is so nearly the same, using it to lower cost is hardly worth the trouble. Neither of the nitro-propanes will work in model engine fuel. Incidentally, nitro-methane is made of propane, in case you didn't know (and I'll bet you didn't).

Yes, NITRO = POWER! But.there are conditions and contingencies.

First of all, it ***doesn't*** add power because it's such a "hot" chemical. Not at all. This may come as a surprise to most readers, but the methanol (methyl alcohol) in the fuel is by far the most flammable ingredient….nearly *twice* as flammable as nitro-methane. As a matter of fact, if nitro were only 4 degrees less flammable, it wouldn't even have to carry the red diamond "flammable" label! In actuality, nitro-methane must be heated to 96 degrees F. before it will begin to emit enough vapors that they can be ignited by some sort of spark or flame! (I demonstrated this not long ago to a friend by repeatedly putting a flaming match out in a lidful of nitro. I might add that he insisted on standing about 20 feet away during the demonstration.)

So….how does it add power? We all know (I think) that although we think of the liquid part substance we put in fuel tanks (in our automobiles or model airplanes) as the fuel, in truth, there is another "fuel," without which the liquid part would be useless. Remember what it is? Right….just plain old air (in reality, the oxygen in the air). Every internal combustion engine mixes air and another fuel of some sort….in our case, a liquid…glow fuel. The purpose of the carburetor is to meter those two ingredients in just the right proportions, and every individual engine has a requirement for a specific proportion of liquid fuel and air. Try to push in too much liquid without enough air, and the engine won't run at all. That's the purpose of the turbocharger on full-size engines….to cram in a lot more air than a simple carburetor or fuel injection system can handle. Now…..suppose we were to find a way to run more liquid through our model engines without increasing the air supply? That would add power, wouldn't it? Well, guess what....we can! An internal combustion engine can burn more than 2 ½ times as much nitro-methane to a given volume of air than it can methanol. Voila! More Power! That's how it works, and it ain't all that complicated. Nor do we have to spend a lot of time thinking about it in the course of a normal day's sport flying. *However,* there are some factors we do need to consider. As a practical matter, virtually all our everyday sport flying can be done on model fuel containing from 5% to 15% nitro-methane. If you're flying something like a trainer or a Cub or similar model, there's probably no reason why 5% won't work perfectly well. Need a little more power? Move up to 10% or 15%. In most of our sport engines today, I really wouldn't recommend going any higher than that. It probably won't hurt anything, but it won't do you much good, either. We sell more 15% fuel than any other single blend, and for good reason. Most of the popular engines on the market today are built to run on something very near that blend. Typically, European engines will successfully run on lower nitro blends, because they are built to do so. Why? In Europe, nitro can cost between $150 to $200 a gallon! Reason enough?

Nitro does more than just add power. It also helps achieve a lower, more reliable idle. One good rule of thumb for checking to see if a particular engine needs a higher nitro blend is to start the engine, let it warm up for a few seconds, set throttle to full idle and remove the glow driver. If it drops rpm, move up to a 5% higher nitro blend. If there is no discernible drop, you should be fine right where you are. One of the most popular misconceptions is that by adding substantial nitro, the user will immediately achieve a huge power jump. Just ain't so. Most will be surprised to learn that in the 5% - 25% nitro range, you will probably only see an rpm increase of about 100 rpm static (sitting on the ground or on a test stand) for each 5% nitro increase. In the air, it will unload and achieve a greater increase, and it will probably idle better, too. My pet rule is this: If you have a model that's doing well, but just isn't quite "there" powerwise, go up 5% in nitro. If that doesn't do it, you need a bigger engine, not more nitro! Most of our popular sport engines in use today aren't set up to run on much more than 15% or 20% nitro. Increasing the nitro has the effect of increasing the compression ratio, and each specific engine has an optimum compression level. Exceed it and performance will probably suffer, not gain, and the engine will become much less "user friendly."

High performance racing engines, for example, are tuned entirely differently....compression ratio, intake and exhaust timing etc....and are usually intended to run on much higher nitro blends. One exception, of course, are racing engines used in certain international and world competition (FAI). By the rules, these engines are not allowed to use any nitro at all, and they go just as fast as those that run on 60 or 65%! The first question that comes to mind, then, is, "Why aren't *all* engines designed to run on no nitro, so we can all save a lot of money?" Ask any of the world-class competitors. Those engines are a serious bitch to tune and run, and are definitely *not* user-friendly! In fact, they are well beyond the skill levels of most average flyers. There's a price to everything. Another statement we read or hear frequently is that nitro-methane is acidic and causes corrosion in engines. It isn't acidic, and the manufacturers say it doesn't happen.....can't happen. However, at least one noted engine expert and magazine writer insists that it does. Flip a coin. (I once asked Dave Shadel, 3-time World Pylon Champion, and a fellow who works on more high performance engines than anyone I know, how frequently he encounters rust in engines that have been using high nitro blends. His answer? "Never.") Why does nitro cost so much? While I have no clue as to the cost of manufacturing, other than it takes a multi-million dollar investment in a large refinery to produce it, there is *one* pretty good reason: There is only one manufacturer of nitromethane in the Western Hemisphere. Figure it out for yourself. Also (and this will come as a big surprise), our hobby industry only consumes about 5% of all the nitro-methane produced; and full-size auto racing about another 5% or so. This means we have no "clout" whatever, and simply must pay the asking price. Where does the rest of it go? Industry. It's used for a variety of things - a solvent for certain plastics, insecticides, explosives (yes, it *was* an ingredient in the Oklahoma City bombing) and I'm told it's an ingredient in Tagamet, a well-known prescription ulcer medication (no *wonder* that stuff is so expensive!). Please note that while nitro-methane is an *ingredient* in making some explosives, under normal use, it in itself, is not explosive. (Remember....the guy used fertilizer, too.) Hardly a month passes that someone doesn't call to ask, "I hear more nitro will make my engine run cooler. Is that true?" Nope. The higher the nitro content, the higher the operating temperature. Fortunately, in most of our sport engines, the difference in operating temps between 5% and 10% is negligible, and there are lot of other factors (proper lubrication, etc.), that are much more important.

Finally, remember in the beginning of this, we said that nitro adds power because we can burn more of it than we can methanol, for a given volume of air? This also means that the higher the nitro content of the fuel, the less "mileage" (or flying time) we will get. In a typical .40 size engine using 15% nitro, we can usually get a minute to a minute and a half flying time for every ounce of fuel. The Formula 1 guys are lucky to get 2 minutes out of an 8 oz. tank! What's the practical side of this? If you go to a higher nitro blend, be sure to open your needle valve a few clicks and reset before you go flying. Otherwise, you'll be too lean, and could hurt your engine. Conversely, if you drop to a lower nitro blend, you'll have to crank 'er in a little.

This may not be everything you ever wanted to know about nitro but its a great start.

Nitro-methane is one of a group of chemicals known as nitro-alkanes, which consist of an alkane molecule, such as methane, ethane, or propane, in which one of the hydrogen atoms has been replaced by a nitro group (-NO2). Nitromethane is used in a number of products, including fuels, explosives, solvents, preservatives, and pharmaceuticals. Angus's nitromethane production process results in the joint production of four nitro-alkanes, of which nitro-methane has the highest value.

Standard Nitro-methane (CH3NO2) becomes Di-Nitromethane when exposed to UV (Ultra Violet rays as from the sun or "other means") and is more entertaining to run. All commercially available Nitro-methane is never available at 100%. Some agreement with the ICC. It is typically cut (reduced in concentration) by approximately 2% or so with Benzene or "other" agents. Besides, 100% won't light very well without being cut with something. Back in the old days, some few folks were indeed getting hold of REAL 100% (from other than normal suppliers) and cut the load by 2% with spectrophotometric benzene (not your normal get it anywhere Benzene).

Comments about purple nitro: Potassium Permanganate (KMnO4) can be mixed and although a slurry, can be burned with either methanol or nitro-methane, or nitro-propane. Also one can add methyl purple (no gain, just fun coloring), methyl orange, or methyl blue. You can even add oil of wintergreen if you wish.

Like an atomic device, the separate components of a fission-fusion device are relatively benign, but when a special set of artificial conditions is created it will produce a dramatic result. Nitro-methane is the atomic equivalent of uranium 238. Getting it to burn is a major problem, it needs lots of heat. But once the correct temperature is achieved, it will give more energy than most people can use.

A match will not light nitro-methane. Dropped into a pool of nitro spillage floor, the match will sizzle and extinguish just as if it had fallen in a pool of tap water. But take a hammer and hit the pool - it will explode. The small amount of fuel caught between the hammer face and the concrete floor will become unstable and cause a spontaneous fire which occurs quickly enough to be labeled an explosion. The tiny bit of lit fuel is hot enough to set off the rest. And bigger the pool, the bigger the explosion. Enough nitro and the result will be a good-sized crater in the cement floor.

Joe Fette, a former vice president and general manager of Angus Chemical, worked intimately with the nitro-methane departments, and remembers when the discovery was made. "The condition first came about by accident," says Fette. "Luckily, it was an accident where nobody was killed. But nitro-methane used to be shipped in tank cars before this condition was known. Two separate accidents within a year of each other stopped that. The tank cars exploded, leaving holes 800ft wide and 300ft deep. Luckily, these were out in unpopulated areas. What happened is that the fuel was compressed when it slammed into the other car (as the train crashed). There were also rumors of power lines being around, although that was never proven."

Regardless of an external spark, the impact had sufficient force to begin the reaction that would ignite the explosive. The liquid, trapped inside the tanks, had nowhere to go and compressed itself. Under those circumstances it detonated by itself - at least in the corner of the container that suffered the largest degree of compression. With the initial explosion, extreme heat - the second factor that contributes to nitro-methane's instability - was already building up. With nowhere to go the heat spread through the compressed fuel in the tanker, setting the entire railroad car on fire before the structure had been punctured. The result was an explosion that changed the land's geography".

The Chinese nitro is still being made in China at a specially constructed plant. It is imported to the US by Wego Chemical Company in NY. It is made by a different process than the Angus (now Dow Chemical as of 2 or 3 years ago) nitro. A test was done on the three nitro products that were available in 1996 and they found the Chinese nitro to be more pure than the Angus nitro, and much more pure than the product that VP was selling at the time. Those results may not hold up now, but they were accurate at the time the products were tested.

The nitro that Chuck Bryant (C.L. Bryant Inc. in Modesto) sells is the Chinese nitro and is used by a number of the NHRA nitro racers. It is available in both the 90% version and the uncut version which is 99+% pure nitro. Phone number is 800-399-4176.

Steve LeSueur (formerly with World Wide Racing Fuels) is the person selling the Chinese nitro at the NHRA National Events. Steve lives in Virginia and can be reached at 804-842-1838 or by cell phone at 973-454-0663.

Alcohol and Nitromethane

Gasoline is for washing parts, alcohol is for drinking and nitro is for racing. I saw that on the back of a fan’s shirt at New England Dragway. It seems some folks just don’t appreciate gasoline. What is so special about Alcohol and Nitro-methane anyway? Well.....people don’t race funny cars; they race ALKY funnies or NITRO funnies. Gasoline has no real pizzazz in the racing world. Sure it powers Pro stock cars, trucks and bikes, but it just doesn’t have the same powerful intonation as Alcohol or Nitro. So where does this notoriety come from and why would someone want to use either of these fuels? Alcohol is usually used in the form of Methyl alcohol or methanol for short. CH3OH is the chemical formula. Methanol when compared pound for pound to gasoline yields about half of the heat energy potential. Where alcohol offers 9000 BTU/lb. Gasoline offer 18000 BTU/lb. Basically methanol is a far less powerful fuel on a pound per pound basis. Gasoline however burns at a stoichiometric (scientifically correct) ratio of 14.7:1, and makes best power running slightly richer at 12.0 to 12.5:1, while methanol burns at 5.0 to 6.0:1. When the mixture is run in this fashion the result is a 5-11% increase in power. The best part is, the above is not the only benefit. Methanol allows for much higher mechanical compression ratios far in excess of what even the best racing gasolines offer. Just a few years ago Pro stock (gasoline) bikes ran a max of 13:1 to 15:1 compression ratio, but alky bikes of the time could run 16 to 17:1. The extra compression allowed alcohol engines to gain a 15% advantage in power while normally aspirated. Now figure in the fact that methanol has a higher latent heat of evaporation (it absorbs or uses more heat in the evaporation process), and we have a fuel that can cool the intake charge better than gasoline. Can you think of a good use for this? How about supercharging or turbo charging? Compressing air makes it get hot. Superchargers and turbochargers are not 100% efficient for several reasons, not the least of which is through lack of mechanical efficiency and compression of the intake charge itself the intake temp rises. Hot air is not good. 10 psi of hot air contains less oxygen for burning fuel than 10 psi of cold air. Think of it this way. If you blow up a child's balloon and let it sit nothing happens. Put it in the freezer for 5 minutes and what does it look like? It comes out all shriveled up. Put it next to a warm bright light and not only does it return to its original size, it blows up even bigger as the air is heated. Now if we take that same hot compressed intake air and dump a little methanol into it, you guessed it, the temperature drops as the alcohol is evaporated. Alcohol is atomized and the mixture gets denser allowing for a whole lot of mixture to be shoved into the engine, much more so anyway than that of the turbo/gasoline mixture. It is not unusual for supercharged alcohol motors to realize a 20% improvement over their gasoline brethren. Nitro-methane works in a similar way. It is clear and very hard to light with a match. If you are somehow successful at lighting it, you'll see it burn with a lazy blue flame. Smack a puddle of Nitro-methane with a hammer however and the head of the hammer will be come a projectile as the nitro explodes in a violent blast. Like methanol, Nitro-methane does not have a lot going for it in sheer power per pound. ·

Gasoline :	18,400	BTU/lb. ·
Benzol ;	17,500	BTU/lb. ·
TNT (trinitrotulene) :	6,500	BTU/lb. ·
Ethyl Alcohol :	11,500	BTU/lb. ·
Methanol :	9,500	BTU/lb. ·
Nitromethane :	5000	BTU/lb.

Nitro-methane does contain a lot of oxygen, which makes it nearly a mono-propellant. Meaning, it requires almost no additional air (oxygen) for burning. Therefore it burns best when run at a very rich ratio of 2:1 to 1:1! Thus even though pound for pound nitro is less powerful than gasoline, nitro can make almost double the power of a gasoline engine of the same configuration.

<u>Air Fuel ratio vs. Resulting Max BTU released ·</u>

Nitromethane: o 1.3:1 46,000 BTU ·

Methanol: o 5:1	23,000 BTU ·
Gasoline: o 12:1	18,400 BTU