**SOME OBSERVATIONS ON BURNING NITRO-METHANE**

*Neville Higgins*  
*MPH 655  Page 29*

When I say nitro is even slower burning than alkyl, Mac has to "argue about that" but then admits he doesn't know! He also says it is an oxygen catalyst (whatever that is? - but incorrect anyway) and a little less explosive than nitroglycerine (also incorrect). He has also missed quoting from T for S page 42 which says "... it requires careful handling, as it is chemically unstable... For that reason it is not supplied neat but diluted with an equal proportion of methanol." Mac, like most ordinary racers who have never seen or used it, has succumbed to the many wild myths and stories about the dangers of nitro. Even T for S was way out of date by the sixties, and 100% nitro could be bought for about £8 a gallon - a fortune to me in those days. Eamon Hurley, a Coventry friend, who built and ran the very fast 350 cc Manx Dragster, bought some and spent a whole evening hammering and banging small puddles on his garage floor - but nothing happened - even when he put a match to it, it would not burn! I had an e-mail from Dr. Doug Ahern of Sydney, Australia, which said "By the way, you are absolutely correct in saying that nitromethane is slower burning than methanol. By simply lighting the stuff in a sealed trough about a metre long at atmospheric pressure the difference can be seen. Nitro needs to be at least around 96F (35.5C) before a match will even light the stuff." The thing that hits you on your first contact with nitro is how HEAVY the stuff is! If, like me you are used to lifting gallon cans of petrol and meth around, the first time I went to lift a can of nitro - it just stayed on the floor! With methanol at a specific gravity around 0.73, nitro at 1.125 is almost half as heavy again.

I got one of the Yanks to bring a gallon over for me to try at the last Drag Fest meet. I ran 25%, but by this time both my motor and my blower were destroying their insides, so any extra power developed didn't give me any extra speed, it just accelerated the destruction process. The Yanks flew large quantities of nitro over together with their dragsters; if it was really as dangerous as Mac and the myths suggest this would not be permitted! The rest of my gallon sat safely in its can for several years, until I sold it on to someone else.

I'll bet that Mac cannot tell us why Don Garlits only used 85% nitro in his dragster; if 85% goes so fast, wouldn't 100% go faster still!? The answer is NO because 100% nitro will not fire at all in an engine - it has to have at least 15% alkyl to fire it off. [The local 'Top Fuel' Harley boys are now running sub-six second quarter miles on 98% nitro - right from the man who twists the throttle, Dave O'Hara. - Ed.] In 1964 Alfie Hagon and I went together to talk to Don while he serviced his engine between runs. Alf was planning to run nitro in his JAP dragster and was after all the gen he could get - and he wasn't shy about asking questions! Don was a real nice, down-to-earth guy, who not only drove, but built and serviced his dragster himself, unlike most of the others who had teams of mechanics to serve them. In answer to Alf's direct question he told us "nitro needs loads of advance - I'm running 45 deg right now". There is a mysterious discrepancy between this and Mac's e-mail 34 deg which will probably never be solved - but I know what I heard, and I know what I believe!

As a little addendum, I can tell you that alkyl also just will not fire in a cold engine when the weather is at about 13 C or below. I learned this also the hard way, by pushing Jindivik until I dropped on 27 March 1964 at Great Yarmouth sprint. I could find no fault, so then a kind soul towed me up and down the paddock at high speed with his van - but still not a pop from my motor! (This was before the days of rollers.) I then had a brainwave and tipped an egg cupful of petrol down the carb - one push and we were away! Once having been warmed up the engine would then fire up without the petrol snaps for the rest of the day. Somewhere I once read that the temperature of a meth. mixture in a cylinder which has failed to fire goes down to -200°C during the subsequent expansion when the piston drops -yes -minus 200°C

I am also highly skeptical of the myths and hearsay which surround most of the "dope" fuels which are, or were available, and were claimed to give increased power outputs. The majority which have just a few percent of petrol or acetone etc added to meth are, I believe, made to get around the cold start problem. It is not logical that exchanging 5% of meth which contains extra oxygen, for 5% of petrol which does not, can produce more power. Methanol has been pushed quite hard in recent years as an environmentally friendly alternative fuel, but this too has to contain 10% petrol for cold starting. If 100% meth is used the engine has to be adapted to start on petrol and then switched to meth. (Max Lambky runs the Streamliner on 100% methanol and when all the mechanical bits are working properly it starts right up. - Ed.) Other dope fuels containing large percentages of petrol and benzole were, I believe, more used for their reduced fuel consumption in long road races, rather than in the hope of getting more power than straight meth. Anyway, dope fuels are of much less interest these days, when road racers are restricted to petrol only, and drag racers go the whole hog regardless of cost, with nitro and/or nitrous oxide.

Next month, if you wish, and for those of you who really like punishment, we can take a look at the chemical formulae for methanol and nitromethane, and the equations to show how they burn. I can also show you the calculations I did back in '64 to check how much to increase the main jet size to run Jindivik on 25% nitro. Sleep well up there in the mountains Mac, maybe it's the rarefied atmosphere or the lack of oxygen that does it!

**FUN WITH FUELS**
Valve Timing and a Dragster C.R. (and a prize for the winner)

El Prof felt free to taunt me with an 'a' word... 'on fire'. Generations of schoolkids associate those words with "liar, liar", so I'll feel free to play with it and no apologies. Dear Professor.... go char-yer-arz.

CONJECTURE
1. "Mac's not used methanol" sez El Prof. Young Neville helped me at Shelsley Walsh hill climb in 1958, being even newer to the game than I . He'd bought his first Vix... and 'wanted' my Scintilla mag! I was Club MAO and Neville was the supreme non-stop vacuum cleaner of knowledge, just as I was (and still am). Fuel at Shelsley? Methanol, and at Long Marston. So much for El Prof's dogma. Photos of a young Prof anyone? One sale (at 10 pounds?) could mean I turn a 5 pound profit here.

2. There's professorial, but unprofessional, conjecture, inuendo perhaps? What Neville or I achieved (he paraded this irrelevant issue) is not going to prove 2+2=5. I laid down and built 2 short strokers and one long, with several innovations, for SE Asian GPs (not Formula Ford!) which were 100/150 milers. The engines (not !) won the lot in 1975. That takes care of that one year. A few more years are on your search engine at 'Macau John Macdonald' and ditto with 'motor cycles' adds for SE Asian GPs (not Formula Ford!) which were 100/150 milers. The engines (not I!) won the lot in 1975. That takes care of that irrelevant issue) is not going to prove 2+2=5. I laid down and built 2 short strokers and one long, with several innovations, for SE Asian GPs (not Formula Ford!) which were 100/150 milers. The engines (not I!) won the lot in 1975. That takes care of that one year. A few more years are on your search engine at 'Macau John Macdonald' and ditto with 'motor cycles' adds.

3. "Granted" is a word I used. Neville actually quoted it, then went bananas. 'Granted' meant 'agreed' or 'accepted'. e.g. (Airways) Racing Team did just that for several very winning years. Enough.

Missiles
3. "Granted" is a word I used. Neville actually quoted it, then went bananas. 'Granted' meant 'agreed' or 'accepted'. e.g. "Methanol burns slower than petrol, granted" which is a precis of what I wrote. It sent Neville skywards ...er...why? Pricked a nerve? I'm sorry for that but let's stick to facts. He didn't read or understand a word 'granted' then threw a tizz, and missiles.

4. Missiles? Tuning for Speed takes a missile hit with derogatory comment; "compiled in 1948" ... "against my (prof) practical experience over 40 years". Phil Irving re-edited it in 1987 which seems to cover 40ish years. I "only used the bits that suited". Rubbish, It does not contradict itself. I quoted exact page(s) of Tuning for Speed to avoid silly barracking and easy ID of typos or confusion. Neville found confusion on engine at 'Macau John Macdonald' and ditto with 'motor cycles' adds.

Full Lift Checking Comes Home To Roost
5. Neville with whiz accurate tools loses sight of the objective. "Remember however," says he, "we still don't know whether it is meant to represent the lift measured directly on the cam (which operates a pivoted follower!!) or at the valve" which is something he could have established when reading off Terry Prince's numbers. 'Lift' is lift (of valve gear, what else?), not numply lift.

a) To throw in argument on flat(tish) nosed cams is more irrelevant pooh. Such cams, Einstein, also found on Columbo SOHO Ferraris, produce the same old selection of lift curves by using convex small radiused followers, or rollers in the case of Fezzaz. Lift is lift. Maybe... er...he's ...muddling up my concave followers in 1958 to get some ultra cheap valve acceleration/duration with what I'd got... and that wasn't cash... and maybe not that much sense.

b) SS (Neville's Shabby Shadow motor) has a problem. He says this motor's inlet cam (valve gear?) should be fully open at 98 deg ATDC. So why is Neville so happy to read off full lift at "76 deg ATDC followed by 79, 77, 79" to prove my "intelligent guesses" are so wrong? His numbers on this motor are ludicrous (nothing to do with me!) and show how easy it is to screw up the plot by relying on whizzo accurate tools. Best check that motor's valve timing again, Mr Prof, afore ye try to start it. I rest this case.

The Dragster
6. Mac is "Talking more nonsense without knowing the facts about the blown dragster". says MPH 654 page 21. Far be it from me to have tacked about that beautiful blown dragster, other than in awe. I wouldn't dare. That was yesterday. Today Neville tempts providence.

a) "Mac will probably want to argue the c.r. as well". Naturellement, Neville, but I'll let you finish the job off. You might even earn a fiver. There's a large error which proves my point absolutely that running methanol at the appropriate c.r. for methanol demands a retarded ignition timing. There's elementary tech reasons for this which can be read anywhere. The solution to the dragster conundrum's excess advance just needed that "Macdonald terrier" (professorial words) nose.

b) I suggested that detonation was a limit of allowable advance/nitro/fuel/boost/cr for serious competitors at 441 yards for a 1/4 mile sprint (drag). Neville now says he ran the same settings for a 1 Km sprint. Therefore, for the 1/4 mile, those settings were not close to my suggested absolute limit. If they had been, the motor, in the 1 Km sprint, could have come apart at the seams shortly after 1/4 mile! Neville is proud that it didn't. Good but maybe he could've gone quicker!

c) El Prof calculated his dragster c.r. at 14.2 (he writes that twice). That erroneous calculation came out at 14.23 but that's OK. And I guess he started out at wanting 14.23 c.r. or he adjusted the base c.r. of 9:1 to suit the blower limitations. Either way a half ratio error would be a heck of a lot and he gets this error according to some, but not quite, according to me.
d) Any-one else want to use MPH, p.21 top paragraph to do the calculations using Neville's figures for Neville's bike? Best build your ICBM shelter first. You could even try using page 203 of that old "1948" book again.
e) If the dragster blower can manage it, then 10% extra blower pressure could get him to where he wanted to be without shuffling measured c.r and not forgetting to knock ignition timing back! 10% of pressure is a pretty fair whack at this level and should help those ETs.

A fiver in the mail to the first person to come up with the absolute correct answer of the El Prof c.r. and how you got there. Email diohnmacdo@hotmail.com, and convince me!
I rest this case too.

A BIT OF SIMPLE CHEMISTRY ON METHYL ALCOHOL AND NITROMETHANE

Neville Higgins

Don't let the title put you off - it's not really so difficult. The first thing you need to appreciate when talking about fuels and combustion in engines is that it is the amount of air that you can burn which limits the power output. It is relatively easy to add more fuel (bigger jets) but unless you can induce more air into the cylinder you cannot burn it, and it therefore does no good. Good porting, big carbs, and high RPM are all aimed at getting more air to flow through the engine, thus allowing more fuel to be burnt to get more power. Air consists approximately of 21% oxygen \( O_2 \), and 79% nitrogen \( N_2 \), and since the nitrogen is relatively inert it is only the one fifth consisting of oxygen which is burnt. The nitrogen is pumped through the engine and out of the exhaust pipe. Many dragsters use compressors to force a greater weight of air into the same cylinder volume by compressing it first.

Each chemical element has its own letter in the Periodic Table and its own unique atomic weight, and it is these atomic weights which determine the exact proportions of each element which combine together to produce a compound. This is what happens during combustion, and it is the heat produced during this chemical change of state which we utilize to drive our Vincents. By assuming a realistic volumetric efficiency - say 90% for a free breathing race motor, it is possible to calculate the weight of air which will pass through the motor at a given RPM at full throttle, and then, using the chemical equation for burning methanol, to calculate an approximate jet size. If we already have a jet size for alcohol (which is usually the case) then it becomes quite a simple little exercise to calculate the increase required for a given percentage of nitromethane.

### Chemical Formulae

<table>
<thead>
<tr>
<th>Material</th>
<th>Chemical Symbol</th>
<th>Atomic weight</th>
<th>Normal state</th>
<th>Molecular weight</th>
<th>Specific gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>1</td>
<td>H2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td>C</td>
<td>12</td>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N</td>
<td>14</td>
<td>N2</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>0</td>
<td>16</td>
<td>02</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td>CH3H</td>
<td>32</td>
<td>CH3H</td>
<td>0.820</td>
<td></td>
</tr>
<tr>
<td>Nitromethane</td>
<td>CH3NO2</td>
<td>61</td>
<td>CH3NO2</td>
<td>1.125</td>
<td></td>
</tr>
</tbody>
</table>

First we note that my last month's guess (!) at the specific gravity of alky was wrong at 0.73 and should have been 0.82 - but my comments still apply OK. Second you see oxygen and nitrogen are unstable as single atoms and therefore combine with themselves to form the stable gases which we know. The oxygen breaks down at combustion temperatures and the single atoms become active again to combine with the fuel, but the nitrogen is so stable that it passes right through the combustion process without reacting. Next we look at the chemical equation for the combustion of methyl alcohol - remembering that only the oxygen in the air burns, and the nitrogen just passes through the engine.

\[
\begin{align*}
2\text{CH}_3\text{O}H + 3\text{O}_2 &= 2\text{CO}_2 + 4\text{H}_2\text{O} & \text{Equation 1} \\
2(12+3+16+1) + 3\times32 &= 2(12+32) + 4(2+16) & \text{Atomic wts.} \\
\text{ie 64 alky + 96 oxygen gives 88 carbon dioxide + 72 water}
\end{align*}
\]

The number of atoms on each side of equation 1 has to balance, and only whole numbers of atoms can exist, so as we cannot have 1.5 oxygen molecules we have to double up both sides of the equation to get whole numbers. We can equally well write pounds instead of molecular weights, so we see that 64 lbs of alky require 961 lbs of oxygen to burn completely - or 1 lb of alky requires 1.5 lb of oxygen. Converting this to air instead of oxygen only we find that 1 lb of alky requires (1.5 lb oxygen + 1.5 x 79 lb nitrogen) which equals 7.14 lb air to burn. Thus a 1:5 mixture, which is commonly recommended for alcohol is very rich, and well on the safe side. A weak mixture on alcohol is more dangerous than on petrol as it causes devastating detonation which will burn a hole through a piston in seconds - usually without the rider hearing it!

Looking back at eqn 1 again we can understand how alky can give increased power. Petrol is a very complicated blend of complex hydrocarbons - but these do not contain any oxygen atom, so ALL the oxygen for combustion has to be supplied in
the intake air. Alcohol, however, contains one oxygen atom, so this does not have to be supplied in the intake air; since we fill the cylinder with the same amount of air whatever the fuel (neglecting density changes) this means we can add a bit of extra alky and still burn it all properly. This is where the extra power comes from. In fact burning 1 lb of alky produces a lot less heat than burning 1 lb of petrol - but this is partly compensated for by the fact that alky will tolerate a much higher compression ratio than petrol, and the rest comes from the ability to burn nearly 2.5 times as much alky using the same weight of air.

The Combustion of Nitromethane

\[4\text{CH}_3\text{NO}_2 + 7\text{O}_2 = 4\text{CO}_2 + 4\text{NO}_2 + 6\text{H}_2\text{O}\]  

Equation 2

In this case we have to multiply both sides by 4 to obtain whole molecules - but there are still the same number of atoms of each sort on both sides. Using atomic weights we get: \(4(12+3+14+32)+7x32\) gives \(4(12+32)+4(14+32)+6(2+16)\) i.e. 244 lb nitro + 224 lb oxygen give 176 lb carbon dioxide + 184 lb nitrogen dioxide + 108 lb water

That is: 1 lb nitro requires 0.918 lb oxygen to burn completely. Converting to air again we get:

\[1\text{ lb nitro requires } (0.918 + 0.918 \times 79) = 0.918 + 3.45 = 4.37 \text{ lb air to burn completely.}\]

Compare this with the 7.14 lb air required to burn 1 lb of methanol and we see why the same cylinder full of air is able to burn a lot more nitro than alky, and give a big power increase. Once again this comes from the 2 oxygen atoms hiding in the nitromethane formula. In this case the nitrogen atom in the nitro becomes a single N atom during the process and burns to nitrogen dioxide giving extra heat. It is only nitrogen gas N2 which is almost inert and does not burn.

Calculating Jet Size Increase for a 25% Nitro Mix

This can be done by simple proportion, - and then add a safety margin for first tests!

Mixture by volume: 75% alky 25% nitro Per 100 parts

By weight 75 \(\times\) 0.820 = 61.5 25 \(\times\) 1.125 = 28.2 Per 89.7 parts

By weight 68.5% alky 31.5% nitro Per 100 parts

Air required to burn 1 lb of mixture = 0.685 \(\times\) 7.14 + 0.315 \(\times\) 4.37 = 4.89 + 1.38 = 6.27 lb air.

To burn the 7.14 lb air for pure alky with which we are comparing, we therefore need to supply a proportionally greater amount of fuel = \(\frac{7.14}{1.141}\) lb nitro mixture.

6.27

This indicates that we should jet up by 14% , but since this calculation is very approximate, and does not take into account the variations between weight and volume proportions, specific gravity, viscosity etc. we jet up by 20 to 25% for safety, and than work on spark plug readings afterwards to see if the jet size can be reduced a bit in practice.

At this time I was experimenting with a 2" Wal Phillips fuel injector, and was running a 5/32" dia jet for alky With a dia of 0.156" the area was 0.0191 sq in.

Increase area by 25% gives 0.0239 sq in.

New diameter = \((\text{Square root of}) (0.0239 \times 4)\) = 0.174" (3.142)

Select drill 11/64" dia = 0.172 or No. 17 drill = 0.173" Eureka! And off to the drag strip for testing!

Before we rush away we must take a quick look at Woolly Robert's interjections in my August Piece. When I claimed that nitro needs 15% alky to fire it off in the combustion chamber he said the Harley boys now run 98% nitro (and get to the end of the strip before they've even started!) Now this has to be an example of that super-modern phenomenon called Technical Progress which sadly, seems to have passed me by a bit during the last few years. It is still true that nitro will not ignite in the combustion chamber itself, but it would seem that they are utilising a much more effective combustion initiator (to coin a phrase) which works with only 2% present. This is confirmation of what I said at the beginning of the article ie. the greater the percentage of nitro you can burn with the same air throughput, the more the power you can get out. Now Mr. ED, what we want you to do is to go back to Dave O'Hara and find out for us what this vital 2% actually is!

Near the end of the article he tells us the Streamliner starts right up on 100% alky. This I don't doubt in the least - both The Heap and Jindivik would do exactly the same in the hot temperatures at Bonneville and do on any normal summer day - BUT if Max brings the Streamliner to Great Yarmouth sprint on an icy cold Easter day with a temperature of 8° C I can guarantee it won't fire up the first time from dead cold, which was what I told you last month!

Neville Higgins

MPH 676  Page 15

More On Nitromethane: With apologies to Glenn Schriver of course. At the beginning of February Jan Ostnas had his Shadow on show at one of the Club stands in the Swedish Motorcycle Show, which was in Gothenburg this year, so a few of us went along for support. Wandering around the many stands we stopped at the dragster stand for a chat. There were two Harley Parkinsons, and a monster top fueller on show. The latter had a 2400 cc blown Vee twin engine which was entirely
home made, and ran 7 sec quarters. It used a fuel injection system with twin air inlets which were nearly 3 inches in diameter, and a frightening looking electronic ignition system which appeared capable of blowing the heads off a Vincent - even without using any fuel! - or alternatively firing up a dragster from stone cold on 100% paraffin fuel! The man on the stand was not the owner, but appeared to be a crew member and he told us the engine was currently suffering a cracked cylinder block, so the owner had tired of it and it was up for sale.

Talking fuels, he told me they ran 94 to 95% nitro which confirms what Robert the Watson told us about his Harley friend when I last wrote about nitro: Robert still hasn't told us what the remainder of his man's fuel is, but our man used methanol. I tried to get him to tell me that this was required to fire off the nitro, but he wouldn't really go along with this, claiming rather vaguely that 100% nitro gave no more power than 95%. Is the methanol then just an economy measure I wondered to myself? In reply to a question about ignition settings he told me they ran 45 to 50 degrees of advance, which seems to confirm what Don Garlits told me back in 1964. It seems that one must buy and operate one of these fearsome machines to really find out the answers to these secrets!

Neville Higgins

Nitromethane: In his last paragraph Hans tells us that nitro is not a fuel, (but an oxygenator). Mr Ed remonstrates very gently with him, but I will jump straight in and tell him he is talking rubbish. The Oxford dictionary definition of fuel is “material for burning as fire or source of heat or power”, and nitro is most certainly this. If Hans bothers to read my Sept 2003 Piece he will see the chemical equation for the combustion of nitro, and this shows that it does indeed burn as a fuel, and also contains a lot of oxygen, which makes it possible to burn more fuel than could be burned using petrol for instance. This chemical change produces a lot of heat, which can be used to drive dragsters as well as model aircraft.

Most people tend to think of petrol (or diesel fuel) as the working medium for the ordinary internal combustion engine, but this is not so -it is air which is the working medium and the fuel is only introduced as a convenient method of heating the air in the cylinder - and once again convenience determines that the easiest way to do this is to burn the 20% of oxygen in the air. It is the amount of oxygen available which determines the maximum power output, as it is easy to put in more liquid fuel. This is the reason for trying to improve engine breathing to get increased power outputs. Most ordinary fuels (petrol, paraffin, etc) do not contain any oxygen, so the amount of fuel which can be burned is directly limited by the amount of air in the cylinder. By using fuels like methanol or nitromethane, which contain oxygen, more fuel can be burned by this limited amount of air - to produce more power.

Perhaps seeming strange, but nonetheless true, is that pound for pound, methanol is a less effective fuel than petrol - that is it produces considerably less heat. How then can it produce more power than petrol for the racers? There are two major reasons; the first is because you can burn about two and a half times as much methanol on the same cylinder full of air (this is mostly the result of the oxygen contained in the fuel), and the second is that methanol is very knock resistant, and so can be run at extremely high compression ratios (up to 14:1) to further increase power output. A third reason is that meth. has a very high latent heat of evaporation, thus cooling the incoming charge of air to increase its density and get a greater weight of air into the same cylinder volume. Unfortunately I have never seen any figures for the heat content of nitro in comparison with methanol or petrol, but once again the major advantage of nitro over other fuels is its high oxygen content. We have an Australian member, Dr Doug Ahearn, who wrote to me with very useful information when I last wrote about nitro, who could probably enlighten us on this subject. As far as I know nitro will tolerate the same high compression ratios as methanol, but it is much less volatile, and very slow burning, so not only does it require major jet size increases, but also much more ignition advance.