Ny-Trex Nitrous 101

INTRODUCTION

This page explains some of the features and benefits of running nitrous oxide on your car. Hopefully, these will be useful for those considering a nitrous installation, or just wanting to know what's up.

There are many different philosophies and opinions regarding the proper nitrous system. Please e-mail if you have positive question or suggestion that could improve safety or contribute to quality and performance.

HOW NITROUS WORKS

It is a colorless, odorless gas composed of two (2) nitrogen atoms bonded to one (1) oxygen atom. The scientific abbreviation for nitrogen is N, and O for oxygen. The proper abbreviation for one nitrous oxide molecule is N2O. This where the familiar phrase "N-2-O" comes from.

Nitrous Oxide is an oxidizer that is used as a carrier for oxygen. Mixed with the right ratios of fuel, and fed into the intake, it provides additional combustible material into the cylinders, creating more power. There are many ways to get the nitrous and fuel into the engine, the following describes typical applications that have proven successful.

THE BASICS

The nitrous is compressed to high pressure (900-1100psi) in a tank, in liquid form. From the tank (typically fastened down tightly in your trunk), a hose runs up to the engine bay. From there, an electrically controlled (like, by a button you push) valve called a solenoid is used to release the nitrous into the motor when you request it. At the same time, a fuel line in a "wet system," is controlled by another solenoid, and releases fuel into the motor. This provides the basic mechanism for the nitrous system.

WET VS. DRY

You may have heard the terms "wet kit" and "dry kit." A "wet system" is a nitrous system that mixes both nitrous and fuel, and feeds it (in a "Spray") into the intake. A "dry system" only feeds nitrous into the intake, and tricks the existing fuel system to add the fuel.

As mentioned, there are several ways to feed the nitrous and fuel into your motor. Here are brief descriptions of them.

THROTTLE BODY PLATE

This is a 1/2" thick plate that's mounted between your throttle body and intake manifold. Both nitrous and fuel lines are connected to it (so it's a wet setup) and the plate combines them and sprays into the intake.

FOGGER NOZZLE

A nozzle can support either a single line for nitrous, or a pair of lines for nitrous and fuel, and sprays a fine mist into the intake.

DIRECT PORT

The ultimate setup. Each port is tapped and threaded specifically for a nozzle at each cylinder. nitrous and fuel lines to spray directly into the cylinders. This setup typically provides the most horsepower for extreme race applications.

TRIGGERING SYSTEM

Of course, you don't want the system to be running all the time - a 10lb bottle will last you less than a minute, if it's open. Typically, you want the system triggered on while you're at the track, at WOT (wide open throttle), and at relatively high rpm's (see "Safety" for why). To make that happen, you'll typically want to wire, in sequence, several switches. I won't describe the specific wiring here, but you'll have some or all of the following:

Arming (On/Off) switch.

WOT switch is a micro switch installed on the throttle system, that activates the circuit only when your foot is on the floorboard. 3)pushbutton in the car, probably on the shifter 4)"Window Switch" (see "Safety" for details) that closes the circuit only when the engine RPM is between a certain range (like 3000-6000) that you decide is acceptable 5) Fuel Pressure Safety Switch

NITROUS CONTROLLERS

The system to trigger described above is a basic "single stage" setup. The nitrous is either on or off, and when it's on, the full volume dictated by the jets is sprayed into the engine. There are other applications that are full race or multiple stage nitrous system that require more detailed management at higher rpm, with time-based systems, which delay the nitrous flow for some time after you launch, etc.

These Nitrous controllers are a great addition to any nitrous system and can help to safeguard the engine from Lean-Condition.

SAFETY

Use all the safety mechanisms you have available. They are cheap and very effective. Components such as Fuel Pressure safety Switch, Rev limiters, EGT sensors, Window switches, etc. are relatively inexpensive ways to protect your investment.

WHAT CAN GO WRONG?

Well, a lot can go wrong, but hopefully you'll have adequate safety mechanisms built in to protect your motor when it does. The main thing that can go wrong is adding nitrous into your engine without compensating fuel. This extreme lean condition is disaster for the engine, and you're not likely to get a second chance - at least with the same engine.

Conversely, adding extra fuel without nitrous is not particularly bad for the engine, so you can imagine, it's safer to start with the car running rich (too much fuel), then lean it back from there. Some examples of problems you might encounter include:

Ignition RPM Limiter

The rev limiter is implemented by cutting the signal to the fuel injectors so the cylinders have no combustion. If you're running a dry system, which depends on the fuel injectors to provide compensating fuel for the nitrous, losing fuel this way is the ultimate disaster. An after market ignition will typically implement the rev limit by cutting off spark rather than fuel, which is a much safer implementation of the rev limit. Typically, you'd get your stock PCM programmed to set the rev limit up higher than you'll ever expect to go (like 7000RPM), and use the setting on the after market ignition as your actual rev limit.

WINDOW SWITCH

This electrical device provides an open or closed circuit based on the engine being between two RPM values (hence "window") that you chose, so that you'll only flow nitrous in this range. Why would you do that? Well, for two very different reasons.

At low RPM, think about what's going on: you're spraying nitrous into the intake at a constant flow. That is, the nitrous bottle and solenoids have no idea what RPM you're at, and they're just pushing it into the intake at a constant volume. Inside the engine, though, the nitrous and fuel combination is being sucked into the cylinders during every stroke. The net result is that at low RPM, you're getting far more of the mixture into the cylinders. At 3000 RPM, for example, you're getting twice the amount as at 6000 RPM. So, you can imagine that running nitrous at, say 1000 RPM, is far more stressful on the motor as at

3000 RPM, and typically causes a "nitrous backfire" - meaning that the nitrous/fuel combination can explode in the intake manifold (rather than the cylinders) - a bad thing. So that's why you don't want the system triggered at low RPM.

At high RPM, the situation is easier to explain. Given the discussion of the rev limit above, you may just want the nitrous system to cut off before hitting that rev limit. If you've got a stock ignition, you certainly want a window switch. If your rev limit is implemented by an aftermarket ignition, it's perfectly safe for the motor to run nitrous during the rev limit. It's not particularly easy though, on your transmission or clutch to have all that power during the shift, which may be a reason to keep the window switch set a bit before you shift.

FUEL PRESSURE SAFETY SWITCH (FPSS)

This is a device that's plumbed into the fuel system, and provides an open or closed circuit based on availability of fuel pressure. It can be used in the triggering circuit to make sure the system isn't on when you've got a fuel problem. Typically, you only use it to switch off the nitrous solenoid; turning off the fuel solenoid as well can start a cycle of switching the solenoids on and off while the pressure raises and drops in the fuel system when you're switching the solenoid on and off. Let the pressure build up in the fuel lines when you open that solenoid, and when it's high enough, the nitrous solenoid will open. The switch can be used whether you've got a wet or a dry system. You can adjust the pressure at which it triggers by using an allen wrench on the back of the switch (loosen the screw lowers the pressure threshold).

You want to set the pressure on the FPSS, such that if the pressure drops about 10psi the nitrous system will shut off. On a wet EFI system, this will be around 33psi, and on a dry system I'd leave the switch just above stock, say 45psi.

To set the threshold pressure, you've got a couple options:

Connect enough plumbing so that you can have the FPSS installed at the same time as a fuel pressure gauge. Turn the key on to pressurize the fuel system, then turn it off. As the fuel pressure bleeds down, monitor the continuity across the FPSS contacts (disconnect them from the rest of the nitrous system) and when the pressure reaches the level you're interested in, adjust the screw on the back so it just balances back and forth between the continuity signal.

You could use an air compressor, with the appropriate fitting for the FPSS. Remove the FPSS from the car, and thread it onto the compressor. Set the compressor for the pressure of interest, and measure continuity as above.

If you can't do option #1 above because you don't have two available ports, first thread in the pressure gauge, and cycle the key. Then time how long it takes for the pressure to bleed down to the correct level. Then disconnect the pressure gauge, install the FPSS, and do the process against the clock rather than the pressure.

TIMING RETARD

A nitrous/fuel mixture increases the burn rate in the cylinder, and typically adding a few degrees of timing retard is recommended for safety. A rule of thumb is two degrees per 50hp of nitrous, but this will also reduce the power generated. When I tune my system, I monitor engine knock, and retard the timing only enough to eliminate the knock, which is usually about one degree per 50hp. At the track, under harder conditions (actually pulling the weight of the car, possibly higher outdoor temperatures, etc) I'll add a degree of retard.

HIGH OCTANE FUEL

High octane gas (e.g. 100 or more, unleaded) will also slow the burn rate in the cylinder. This will provide another way, similar to retarding timing, to avoid knock. I only use nitrous on a 50/50 mix of 92 octane pump gas and 100 octane racing gas. Make sure it's unleaded, of course, or you'll destroy your O2 sensors.

By the way, watch out for Octane Boost claims. Typical claims are "8-10 points of octane boost for a tank of gas." You should be aware that these "points" are tenths of a point of octane as you'd purchase at a gas station. So the above example will raise your octane from 92 to 92.8 or 93, not 100-102 as you might think.

Don't assume that if high octane fuel helps on nitrous motors, that it'll help your naturally aspirated motor too. A naturally aspirated motor is tuned for a particular octane of gas; adding more doesn't help one bit. Save your money.

NITROUS FILTER

A simple part, but essential in any nitrous system. This filter is added in-line to your nitrous line, between the tank and the solenoid. Install it as close to the solenoid end as is convenient. It will trap any small particles that may come through the line, much like a fuel filter. A common solenoid failure is due to some particle jamming it open.

FUEL SYSTEMS

Your fuel system is the most important part of the system. As I hope is clear by now, the worst scenario in a nitrous system is a lean air/fuel mixture. The solutions to a good fuel system depend on the type of nitrous system you're using.

On a wet system, you simply need to ensure that your fuel system can supply adequate fuel, at standard (~45psi at WOT) pressure. A stock f-body fuel pump can usually supply enough fuel for around 450 total horsepower to the motor; any more and you want to get a larger pump. Much more than 650hp and you'll want larger fuel lines as well.

On a dry system, not only do you want adequate fuel like the wet system, but on an typical setup the fuel is added by raising the fuel pressure, which forces more gas through the injectors. In this scenario, it's typically recommended that you replace the stock fuel injectors with better quality (not higher rating, just better, like Bosch) injectors. These injectors are able to handle the increased fuel pressures necessary.

SPARK PLUGS

Generally you want to use copper spark plugs or iridium as opposed to the stock platinum ones. You also want to reduce the gap from the stock 0.050" down to 0.035"-0.040". I've received a couple notes on why you use a smaller gap. "The reason you want a smaller gap is because of ionization. If you change from the typical air (78%nitrogen, 21% oxygen)/fuel ratio, a given gap requires more energy to ionize the mixture, resulting in less energy in the spark, if you even get a spark. You could also increase the coil voltage instead of decreasing the gap, but I think using a smaller gap would be preferential since the spark time will be smaller." and also this message: "The reason that you will close the gap on your spark plugs is because when nitrous is added, it raises the cylinder pressure, much like a supercharger. Therefore "blowing" the spark out. When you close the gap it cannot put out the spark as easily."

TESTING SOLENOIDS

I mentioned failed fuel or nitrous solenoids doing damage. Some of the issues here may be hard to cover with only other safety devices. I recommend you wire your solenoids with spade clips, so you can easily disconnect them, and test them on a regular basis. Simply disconnect them from the rest of the wiring, then ground one side, and connect the other side to 12V, and listen for the click-click to make sure they open and close. Some folks will also use two nitrous solenoids, in-line, which will ensure that both would have to fail before the flow would fail to stop. Of course you still need to test this setup, to ensure one isn't stuck open.

TUNING

All of the kit systems will come with a couple tuning setups, labeled "50-shot", "100-shot", etc. These are tuned to provide 35, 50, 75 or other horsepower amounts, usually measured at the crank (i.e., measured on a chassis dyno you'll get a bit less). I consider these a starting point, and certainly good for your first passes (hopefully you'll make these with the lowest power, until you tune the system up). Once you've got the system installed and functional, though, tuning it is paramount, before running any serious power through it. I really recommend you do this tuning right away, even though the temptation will be strong to just go out and enjoy the power. This is the time you're very likely to do some serious damage to the motor, it's important to get it set up right.

GETTING STARTED

I'm not going to go through a bunch of details on tuning here, other than to mention some ideas. You've got a plumbing system to test, as well as an electrical system. You'd like to test each component of both systems, to verify that it's correctly doing it's job. I suggest doing most of this in your garage, with the nitrous and fuel lines removed from the intake, and pointing (or held) into a rag. Keep in mind the nitrous line will give a good kick under pressure, so don't just leave it loose to whip around. You can test your WOT switch easily enough, your window switch (maybe set the window range at a lower rpm for the test, so you don't have to rev up to your red line). To test your fuel pressure switch, you'll need to verify it's got a closed circuit when the engine is running (showing adequate pressure), but you'll also want to verify that it opens the circuit as fuel pressure drops. There are a couple ways to do this. On my car, the fuel pressure bleeds off at about 2psi per hour. So if I switch the engine off, I can use an ohm meter to check continuity across the FPSS connections, and within a couple hours it should switch off. You can also test the FPSS on an air compressor, by generating the pressure you want for the FPSS, and monitoring that it switches at the right point.

For the plumbing, you of course want to verify that there are no fuel or nitrous leaks in the system. You should be able to leave your nitrous bottle open for hours without losing bottle pressure. On the fuel side, of course a fuel leak may be the most disastrous possibility, so check this first by pressurizing the system (turn the key to "acc" but don't start the car) and feel around all the fittings.

I haven't listed all possibilities, but hopefully given you an idea of where to start testing. Once everything seems to check out, put in a set of 50hp jets, and move out on the track.

JETS

All nitrous systems use "jets" inserted in the fuel or nitrous lines to limit the flow. These jets have openings of a specific size, measured in thousandths of an inch. So a "35 jet" is a jet with a hole drilled 0.035" through it. Increasing a nitrous jet size will make the system run more lean, increasing the fuel jet size will make the system run more rich.

There's also a good web site with a jet size calculator on it for a wet setup (where you're metering the fuel and nitrous yourself). It will give you jet sizes based on desired horsepower, fuel and nitrous pressure. I recommend you use these as a target, maybe start a bit richer than shown.

I don't have information here on the use of a jet to apply vacuum pressure to a fuel pressure regulator, as in the NOS 5176 kit. The use of jets for this purpose, and calling them "fuel jets" is NOT related in any way to the normal use of fuel jets in a wet system, and I'm not aware of algorithms that would allow you to select these jets in combination with nitrous jets, to create a certain amount of horsepower. Contact the nitrous kit vendor for recommendations.

SCANNER TUNING

A PCM scanner (Diacom, Autotap, etc) is crucial to successful tuning of your nitrous system. I run most of my nitrous passes while logging with an Autotap, and also use it at the dyno. You'll be monitoring the oxygen sensor voltages, knock, etc, and adjusting the jets to provide the best combination. Note, though, that the stock oxygen sensors are not particularly good, and a wideband O2 sensor (say, at a dyno) is much better to use if you have access to one. Typical O2 values should be around 860-880mv (higher is richer) when running the motor normally aspirated, and I try to tune mine to 900-940 on nitrous. As mentioned above, you'll adjust jet sizes up or down to enrich or lean out the mixture. You'll probably see some knock during a shift, but should see none otherwise. You can add timing retard to reduce knock.

DYNO-TUNING

Doing your scanner tuning at a dyno provides another benefit, since you can see the power the engine is generating, while you tune the system. It also makes the whole tuning process easier than racing up and down the track, swapping jets in the pits, waiting in lines, etc.

HOW MUCH CAN I RUN?

On a stock V8 motor, 150hp appears to be the limit. 125hp is probably a "safe" setup, assuming it's working well. A built, forged motor can take quite a bit more, 200-250hp is probably reasonable, but you'll be going to direct port if you want more power. On a six-cylinder motor, 75-100hp, while stock 4 cylinder can take from 35-75hp. These seem to be the highest "safe" setups. Of course, I use the term "safe" very loosely here, to mean that folks have run this amount of nitrous for quite a while without blowing up their engines.

PURGE

Most nitrous systems are built with a purge feature. The purpose of a purge is to get liquid nitrous oxide up to the front of the car, filling the hoses with nitrous rather than air. To do this, another solenoid is used, but rather than shooting the nitrous into the motor, it's usually shot up over the hood or out of the grill so you can purge until it creates a nice fog. It also looks real cool.. Of course, no fuel is used during a purge.

BOTTLE HEATER

It's virtually mandatory that you install your nitrous system with a bottle heater, which is used to raise up the temperature of the bottle, and therefore increase the pressure at which the nitrous is delivered. If you don't use one, your pressure will quickly drop and won't supply the volume of nitrous your vehicle was tuned for.

REMOTE BOTTLE OPENER

Normally, your nitrous bottle should be kept closed, with no pressure in the nitrous lines. But when you're lined up against that guy that just looks a bit too fast, you'd hate to say "excuse me, do you mind if I hop out and open my bottle in the trunk?". Easy solution, get a remote bottle opener! Most vendors have such a device, which allows you to open the bottle electrically via a switch on your dash.

COLLATERAL DAMAGE

You can break tons of other parts on your car by running nitrous, or any other large power addition. Running slicks at the track will just accelerate the damage. Here are a few things to keep in mind.

CLUTCH

The huge torque spike at low rpm's is particularly hard on clutches. I had to buy a new clutch as soon as I made my first pass with nitrous on slicks. Keep in mind, on a manual transmission car, you're likely to need one too.

REAR END

Not unique to nitrous, but certainly a common failure on high horsepower cars, is the rear end. A 4th generation f-body, with a stock 10-bolt rear end, is not going to last long on nitrous. Plan for an expensive (~$2,000) upgrade at some point.

TIRES

With all the extra power, you'll have trouble hooking up with any traction, especially on street tires. You'll probably have to use drag radials at least, or slicks if you're adding any significant power.