Technical Information May 2003

Inflating tyres with Nitrogen compared to compressed air.

Nitrogen inflation of tyres has been common for tyres fitted to trucks, aircraft, race cars and vehicles used in mining & other industrial applications for a long time. The nitrogen used to fill these tyres generally came from portable bottles, very similar to those used to store gases for welding equipment. Recently machines have become available that generate & store large volumes of nitrogen suitable for inflating tyres. This equipment has the potential to make the cost of inflating tyres with nitrogen much lower compared to using portable bottles. This technology has been purchased by some tyre retailers, who are now offering nitrogen filling of tyres to customers with passenger cars, four-wheel-drives, vans, utes & light trucks.
There are advantages to inflating tyres with nitrogen rather than compressed air, but not all these advantages will apply in all applications. I will explain these advantages below, together with the specific applications in which they apply:

Advantages of inflating tyres with nitrogen rather than compressed air.

1. Slower rate of pressure loss. The rubber used for tubes & inner liners in tubeless tyres is not 100% impermeable, therefore some pressure loss can be expected over time. This is one reason why regular pressure checks are necessary. Due to its molecular structure, nitrogen bleeds through the inner liner or tube at a slower rate than regular compressed air. This advantage applies to all tyres filled with nitrogen. Regular pressure checks are still recommended, as tyres often lose pressure due to slow leaks caused by punctures or valve leaks. Regular pressure checks may indicate a tyre has a slow leak and needs an internal inspection and repair or valve replacement.

2. Cooler running temperatures. Tyres inflated with nitrogen will run cooler than those inflated with compressed air. There can be significant advantages associated with cooler running temperatures:

a. Improved tread life. Reducing a tyre's running temperature will increase its tread life. The amount of increased tread life will depend on the amount running temperatures are reduced by using nitrogen rather than compressed air for inflation.
The amount by which running temperatures are reduced with nitrogen inflation compared to normal compressed air will depend on the specific application. As a rule of thumb, the closer a tyre is to its maximum heat handling capabilities, the greater the reduction in running temperatures will be experienced with nitrogen inflation when compared to inflation with normal compressed air. The tyre's service description describes a tyre's heat handling capabilities,

Example #1: 205/65R15 95H, 95H being the service description. The load index of 95 indicates this tyre can carry 690kg at a speed of H, which is 210kph, at the tyre's maximum inflation pressure. The tyre size in example #1 is very common tyre size in Australia, and is fitted as original equipment to a large percentage of late model Holden Commodores, Ford Falcons, Mitsubishi Magnas and Toyota Camrys. I will use this tyre size as an example of a typical passenger tyre used on a sedan. For this example the inflation pressure used is appropriate for the load carried, or slightly over-inflated for the load carried. A Holden VT Commodore sedan with 4 passengers, fuel & considerable luggage would be expected to weigh close to 2100kg. The 4 tyres fitted to this vehicle are rated to carry 2760kg. Considering that in most situations the vehicle mentioned above would have only 2 occupants and a small amount of luggage (a total mass closer to 1750kg), the tyres fitted to this vehicle are under-stressed regarding load carrying & speed capabilities. In this application, nitrogen filled tyres would only run marginally cooler than with compressed air. The expected increase in tread life from this marginal decrease in running temperatures would be expected to be very small.

Example #2*:* 185R14C 102/100S. In this example, this tyre is not being used as a dual set, therefore 102 load index will apply. The 100 load index quoted applies when the tyre is used in a dual fitment. The load index of 102 indicates this tyre is rated to carry 850kg at a speed of "S", which is 180kph, at the tyre's maximum inflation pressure. This tyre size is very common on vans and utilities such as the Toyota Hi-ace & Hi-lux. In service, these tyres are often over-loaded or under-inflated compared to the load carried, for a large percentage of their life. Where these tyres are run near, at, or at times over their maximum load carrying capacity, running temperatures will be high. In applications similar to example #2, inflating tyres with nitrogen would significantly reduce running temperatures and should also improve tread life significantly compared to inflation with compressed air.

b. Reduced incidence of tyre damage caused by excess heat. In applications like example #2 where tyres are run at, near, or over their maximum rated capabilities for load (or speed), heat related tyre damage is common. The reduction of running temperatures with nitrogen inflation compared to compressed air should reduce the incidence of such damage. Many of the damage types caused by excessive heat can produce tyre failure in-service. As tyre failure in-service can be extremely dangerous, it obviously should be avoided!

3. Reduced pressure build-up. This is why nitrogen inflation is very common in tyres used for circuit racing. Running a tyre produces heat, this heat will cause an increase in pressure or pressure build-up. The amount of pressure increase will depend upon the amount of heat produced. In example #1, pressure build-up would be expected to be minimal, that is, from 2 - 4psi. In example #2, pressure build-up would be considerable. In circuit racing applications, the high levels of grip provided by race tyres produce considerable heat. The heat produced by this friction, as well as the flexing of the tyre, will produce a large amount of pressure build-up. In race tyres the

pressure build-up can represent up to 50% of the cold inflation pressure. With nitrogen inflation there is less pressure build-up due to heat.
Increasing a tyre's inflation pressure has the affect of reducing the size of its contact patch. Reducing the size of a tyre's contact patch reduces its maximum grip levels. In examples #1 & #2, this is not a problem. In circuit racing applications the pressure build-up experienced when tyres are inflated with compressed air means that grip levels will drop as the tyres heat-up. Reduced grip levels will produce slower lap times. There is some pressure build-up when circuit race tyres are inflated with nitrogen, but the amount is low compared with tyres that are inflated with compressed air.

4. Reduced amount of oxidisation of wheels. Oxidisation (rusting) of wheels is a common problem in many mining and truck applications. Rusting will only occur in the presence of water & oxygen. In theory nitrogen inflation should prevent rusting of rims as there is no water vapour or oxygen present.

Disadvantages of inflating tyres with nitrogen rather than compressed air.

1. Cost. Inflating tyres with nitrogen is considerably more expensive than compressed air. The cost effectiveness of nitrogen inflation will depend on the specific application.

2. Pressure adjustments. To maintain the advantages of nitrogen inflation, nitrogen must be used to adjust inflation pressures when this is necessary. Adding even a small amount of compressed air to a tyre inflated with nitrogen will negate the advantages of nitrogen inflation.

Inflating tyres with dry air compared to nitrogen.

All conditions being the same, the difference in tyre running temperatures when comparing nitrogen with compressed air for tyre inflation is due to the presence of water in compressed air more than any other factor. As a tyre is run, flexing of the sidewalls and tread, as well as the friction between the tread and the road surface produces heat regardless of what gas is used to inflate the tyre. The water molecules in the compressed air behave quite differently compared to nitrogen molecules when exposed to the heat produced by the running of a tyre. Water molecules become much more "excited" by the heat generated by the running of a tyre, creating more heat & pressure build-up compared to a nitrogen inflated tyre. Pressure build-up is explained in advantage 3.
Compressed air, less the water vapour (i.e. "dry air") will provide cooler tyre running temperatures compared to normal compressed air. Compressed air that is completely free of water vapour will provide very similar levels of reduced running temperatures & reduced pressure build-up compared to normal compressed air inflation. Dry air will bleed through inner liners & tubes at the same rate as normal compressed air.

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