X-1R Global Ltd

To:	All X-1R distributors	**From:**	Nigel (Mac) McKenzie
Cc:		**Date**	10th January 2012

Subject: How an Octane Booster actually works

Here's how the octane thing works. In normal combustion in an engine with high octane gasoline the flame is initiated at the sparkplug, and the flame-front spreads evenly across the combustion chamber burning up the air-fuel mixture. As the flame-front spreads, the air-fuel mixture ahead of it gets much hotter for two reasons. First it's heated by the radiant heat from the flame-front (like standing in front of a fire), and second, its pressure is rising and that produces heat (like the end of a bicycle pump getting hot when you pump up a tire - or the reverse of the cold feeling when you let the air out of a tire). As a result of the air-fuel mixture getting hotter as the flame progress across the combustion chamber, partial oxidation of the hydrocarbons in that mixture begins to occur, (at this stage the remaining air-fuel mixture is generally referred to as the "end-gas"). The partial oxidation of the end-gas creates some level of a chemical species called "free radicals". As long as there are not too many of these free radicals the combustion continues normally until it is complete - this is generally the case with high octane gasoline.

The difference between high and low octane gasoline lies in their different hydrocarbon makeup. The high octane gasoline contains hydrocarbons that resist the formation of free radicals in the end-gas much more than does low octane gasoline. When the level of free radicals in the end-gas reaches a critical point, random and explosive spontaneous ignition of the end-gas mixture can occur. Some of this occurs purely in the gas phase, but much of it can be initiated by deposit "hot-spots" on the piston crown and cylinder head. This type of random explosive ignition causes pressure rises in the cylinder that are much more rapid than normal, and this in turn creates both vibration and noise - the characteristic "pinging" and "knocking" that is associated with the use of gasoline that has an octane level too low for the engine it's being used in. Left unchecked, the explosive combustion can reach a "run-away" state and blow or burn a hole in the top of the piston!

Octane boosters typically work in one of two ways - they either help prevent the formation of undesirable free radicals in the end gas, or they capture the free radicals one they are formed, thus preventing their further explosive reaction. As a general rule, non-metallic octane boosters help prevent free radical formation, whereas metallic octane boosters tend to capture the free radicals that have been formed. Metallic octane boosters are generally required at much lower levels than the non-metallic type, and are much more cost effective, especially for achieving the first 2-3 RON increase. The problem with the metallic's is that when they burn they produce a residue, typically a metal oxide, which can interfere with the proper operation of today's very sophisticated emission control systems - hence the wariness about their use.

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As far as MMT is concerned, it is a metallic. However, its use level is generally so low compared to the levels at which tetraethyl lead used to be used, that the impact of the residue tends to be minimal. For example, MMT has been allowed for use in Canada at a level of 18 milli-grams of manganese per liter (equivalent to a 2-3 RON increase), in cars fitted with catalytic convertors, since the 1970's. That same treatment is the approved level for China. The EPA approved level in the US is 8.25 milli-grams of manganese per liter. The approved level in the UK for use in Lead Replacement Petrol (LRP) to prevent valve seat recession (VSR) in those vehicles that were built for use with leaded gasoline, is 50 milli-grams of manganese per liter. Our testing shows that 36 milli-grams of manganese per liter is sufficient to prevent VSR, and we have a formula at that level that approved by the Federation of British Historic Vehicle Clubs (FBHVC) for use in unleaded gasoline in order to prevent valve seat recession.

For most markets VSR is no longer an issue as only historic car owners would potentially encounter this issue. All modern cars manufactured since the mid-seventies are designed to use non-leaded fuels.

There are other metallic octane boosters available, Ferrocine is the most common of these. Ferrocene- this is an iron based metallic (MMT is manganese metallic) that is used as either a substitute for MMT (for price) or used in conjunction with MMT. The problem with ferrocene is that there is a limit on how much you can mix into a typical 250 ml – 476 ml bottle. Ferrocene is limited in its ability to solubilize in the diluent (MSO, kerosene, 140 solvent, etc). When you surpass the amount you can solubilize in a treatment, the additional material that does not solubilize, sits in the bottom of the bottle; when the consumer pours the product from the bottle, the last 10 – 15 ml of juice looks like a solid mass of orange rust that will **concern** the typical consumer. Also, the heavy dosage of ferrocene will stain paint, on a light colored car, the dripping from a bottle which is poured a bit sloppy, will stain light colored paints; MMT in large doses can also stain paint but not as severe as ferrocene. Another negative attribute of ferrocene, the maximum amount of ferrocene (without having residue in the bottom of the bottle) will only give a slight increase in octane; most ferrocene octane boosts will give you no more than a single "one" octane number increase. I am not a fan of ferrocene, it's a low-rent form of octane boost, if its formulated without MMT.

There are many none metallic octane boosters available, however these are generally typified by needing a very large amount of product to be effective. In fact a number of these products are simply detergents. Octane 104, one of the leading brands in the USA, contain no MMT and claim to offer "lost horsepower" by cleaning a dirty engine; well, what will it do for a new car with no carbon build-up? NOTHING, a complete waste. Some detergent based octane boosts may have small amounts of ferrocene to keep from being an outright fraud. However, we do advocate including detergency with any "high end" octane boost product. X-1R offered 2 products in 59 ml (2 fl oz) keeping the detergency separate from the octane increase for marketing reasons, so we could have two products rather one; however in a 250 ml – 476 ml bottle, detergency should always be included. The cost of detergency is nominal compared to cost of MMT.

I hope that this clears up some of the questions you all have been havoing. If you want to read more on Octane there is a good Wikipedia entry on this issue at http://en.wikipedia.org/wiki/Octane_rating#Principles

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