

## SOLUBLE MAGNESIUM (MOLECULES) VERSUS CORROSION IN ENGINES

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Technical document RB-28

**In relation to the heavy fuel oil combustion, the following facts are generally accepted worldwide:**

Heavy fuel oil contains several metallic impurities, mainly Vanadium and Sodium, that promote the formation of **compounds which are corrosive if they are hot** during the combustion because all of them are in liquid state at temperatures below 650°C:

- Vanadium pentoxide (melts at 600-650°C)
- Sodium vanadate (melts at 340-650°C depending on molar ratio V/Na)

If these kind of compounds are not neutralized, during the combustion a lot of corrosion will appear on the engines' valves and turbo compressors (besides solid encrustations).

**Regarding the use of heavy fuel oil ADDITIVES CONTAINING MAGNESSIUM as a solution for the Vanadium and Sodium corrosion problems during the heavy fuel oil or crude oil combustion, it is necessary to clearly understand the following concepts and proved facts:**

Additives with Magnesium oxide or hydroxide with non-soluble micrometric particles in suspension, **CAN NOT BE USED IN ENGINES THAT BURN HEAVY FUEL OIL OR CRUDE OIL** since the Magnesium in-suspension solid micro particles can produce damages at the fuel injection system<sup>1</sup>.

In order to avoid the Vanadium and Sodium corrosion in ENGINES when using additives containing Magnesium and **not making any damage by solid Magnesium particles scratching or hitting the metallic parts** in the fuel injection nozzles and pumps, nozzles ring, turbo's blades and rotors, it is only possible when Magnesium is in form Organic salts of Fatty acids (molecules - trade secret) **SOLUBLE in HYDROCARBONS**, like the "**rb bertomeu**" additives.

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<sup>1</sup> The Magnesium Oxide and the Magnesium Hydroxide particles, which are solid minerals, can damage the fuel injection system. The injection pumps in engines fed with fuel oil have the piston adjusted approximately to 1 micron and work under a pressure of 400-500 bars.

The Magnesium Oxide and the Magnesium Hydroxide solid particles would cause the breakdown of the injection system.

**The chemical synthesis process by "rb bertomeu" produces the before-mentioned Magnesium Organic salts of Fatty acids completely soluble in hydrocarbons where the Magnesium particles are  $Mg^{2+}$  ions, with a radius of 72 picometers (1 picometer is 1,000 times smaller than a nanometer).**

**The surface reactivity of these Magnesium ions over conventional materials (oxides and hydroxides of Magnesium) is about 10 times higher if the particles are nanometric and 100 times higher if the particles are micrometric.**

**The "rb bertomeu" additives with soluble Magnesium are the most reactive agents known to neutralize the corrosion by Vanadium pentoxide and Sodium vanadates and cannot make any damage by hitting because the Magnesium particles are molecules. Being the additive in molecular form, provides an active area (~ 1,800  $m^2/g$  Mg) between 10 and 100 times higher than the one in nanometer-sized and micrometer-sized particles, and thereby increasing by a proportional factor the chemical reactivity.**

During the combustion, the SOLUBLE Magnesium of the additives produced by "rb bertomeu" react with the Vanadium oxide and forms Magnesium Vanadates of high melting point (more than 1, 200°C), which are solid and non-corrosive at the internal temperature of the engine exhaust.

The action of fixing heavy metals (Vanadium), is also translated into a decrease in the oxidation of  $SO_2$  to  $SO_3$  (formed from the fuel oil's Sulphur) by minimizing its catalytic action on the reaction; as a consequence, the formation of Sodium sulfate is reduced ( $Na_2SO_2$ ) that melts at 888 °C and also diminishes the appearance of Sulphuric acid condensation when the combustion gases cool down and, along with it, cold corrosion.

The Magnesium (Mg) molecule, becomes integrated in the Vanadate molecule, which leaves the engine together with the rest of solid residues formed in the combustion (for example,  $MgV_2O_6$  o  $Mg_3V_2O_8$ ). The rest of the organic components of the "["rb bertomeu" beco F1/ASF](#)" additive, including the organic anion which has supported the atom of Magnesium in soluble form, are burned during the combustion in the engine, generating residual gases as  $CO_2$  y  $H_2O$ , like the fuel oil itself, and not generating solid residues.

More information in [RB-12 "Magnesium as a solution for the corrosion problems derived from the combustion of heavy fuel oil"](#) and [RB-7 "Fuel oil and its corrosive effects in the industrial combustion"](#).