



TECHNICAL BULLETIN  
ORIGINAL 5 NOVEMBER 1993  
REVIEWED 23 JANUARY 2013

## How Ferox Works on Deposits

Deposits are mostly carbon and aromatic compounds in a highly combustion resistant state. Deposits are the source for many engine and combustion associated problems. Eliminating deposits solves many of the problems that are of a major concern to society. This bulletin generally explains how Ferox combustion surface modifiers and deposit surface modifiers cause the removal of, and inhibit the formation of deposits. How deposits are formed and the basic surface chemistry will be explained first.

Deposit formation begins with spherical molecules called primary particles and branched aromatic chains both of which are produced in the early stages of combustion. The chain branches consist of alkyl, alcohol, carbonyl and carboxyl compounds. The alkyls tend to oxidize to alcohols, which tend to oxidize to carbonyls, which tend to oxidize to carboxyls. The oxidation process stops with the carboxyl compounds, which are acidic and highly combustion resistant with a high energy of activation. The various branch compounds are somewhat attracted to the primary particles, which spin at extremely high rates of speed. When a branch becomes attached to a primary particle the entire chain structure is quickly wrapped around the primary particle forming a secondary particle. When several of these secondary particles agglomerate they form a tertiary particle. This can happen when several primary particles become attached to the same chain on different branches and simultaneously become secondary particles and a tertiary particle as they wrap up the chain. When tertiary particles agglomerate on a surface they become further coated forming what is called a quaternary particle. Coated quaternary particles are what make up deposits. The chain structures coating the surface of deposits leave branches

exposed. These branches are where the Ferox catalyst begins destroying the deposit.

The carboxyl branches being acidic, attract the Ferox catalyst oxide which is basic. When the two combine a process called dehydration occurs and a water molecule is produced. What remains is a compound with a low energy of activation, which readily breaks down at high temperatures releasing a CO<sub>2</sub> molecule and the catalyst oxide. Upon releasing the CO<sub>2</sub> and the catalyst oxide, the end of the chain re-oxidizes to an alkyl, alcohol or carbonyl compound and finally to a carboxyl compound. When the end of the chain reaches this state the catalyst oxide once again combines with the carboxyl and starts the break down cycle again. With time the deposit is removed by being converted to CO<sub>2</sub> and water.

Ferox inhibits the formation of new deposit material in much the same way it destroys existing deposits. The Ferox catalyst interacts with the ends of the aromatic chains and the attachment sites on the primary particles. This interaction keeps the primary particles from wrapping up full chains by blocking or destroying the attachment sites and/or breaking the chains. This interference stops the deposit agglomeration process at the primary or secondary particle agglomeration state thus resulting in lighter, smaller particles that don't stick together. The result of this interference is a lower mass of particulate emissions and the production of CO<sub>2</sub> and water, which are the desirable products of combustion.

By the methods explained above we begin to understand how Ferox inhibits the formation of deposits and destroys existing ones. With the deposits eliminated, the major source of

hydrocarbon emissions is also eliminated. Less soot and smoke is produced and particulate size and mass drop. The Ferox catalyst promotes the production of CO<sub>2</sub> and water during the entire combustion process thus giving rise to cleaner emissions.