



## Technical Bulletin – TBN In Diesel Engine Oils

TBN is an important property of engine oils. The abstract definition is as follows;

“Total Base Number (TBN) is the quantity of acid, expressed in terms of the equivalent number of milligrams of potassium hydroxide that is required to neutralize all basic constituents present in 1 gram of sample (ASTM Designation D 974)”. But this tells us little about what TBN in an engine oil does, nor how much we need for effective engine oil performance and engine protection.

The detergent additive in an engine oil has two functions

- To control deposits in the hot parts of the engine such as the pistons and turbocharger bearings.
- To neutralize acidic products of combustion from the fuel that can cause corrosive wear.

Engine oil formulators have always matched the amount of TBN to the amount of sulfur in the fuel. Today Chevron manufactures engine oils with 70 TBN which are used in marine engines operating on 5% sulfur fuel. This is very high sulfur content, 50,000 parts per million. Diesel fuel in the US was approximately 2,500 to 3,000 ppm sulfur (the legal maximum for ASTM 2D fuel was 5000 ppm) until 1993, when EPA regulations required a reduction to a maximum limit of 500 ppm for on road use. Today all diesel fuel is limited to 15 ppm sulfur maximum (Ultra Low Sulfur Diesel, or ULSD).

With 3000 ppm sulfur diesel fuel, oil TBN in the range of 10 to 14 was common, with lower priced oils at approximately 8 TBN. Current engine oils for use with ULSD are around 8 to 9+. Clearly the need for high TBN does not exist with today's ULSD fuels.

**How is TBN measured?** It is important to note there are several test methods for Total Base Number. The one used in product data sheets is generally ASTM D 2896. This method uses perchloric acid to neutralize the alkalinity in the oil and yields a slightly higher number than the test method used by the oil analysis labs. They generally use ASTM D 4739 and the acid used here is hydrochloric acid. This produces a number approximately 2 mg KOH/g LOWER than ASTM D 2896 for the same oil. Due to chemical interferences, this test method does not recognize all of the alkalinity that ASTM D 2796 sees.

**Why are there two test methods?** The oil manufacturers have typically used ASTM D 2896 and their labs are set up to handle perchloric acid, which is toxic and hard to handle. In addition ASTM D 2896 can measure both the “hard base” from metallic detergent as well as the “soft base” from organic, non-metallic ingredients. So it is a more accurate method. BUT, the production oil analysis labs prefer to use a safer and easier to use titration acid, namely hydrochloric acid. The tests can be run faster, more cost effectively and more safely.

**How much TBN do we need to protect the engine?** The old rule was to change the engine oil when 50% of the new oil TBN had been consumed. Because of the virtual absence of fuel sulfur today, much less is needed. Chevron now sets the TBN guidelines for all of its diesel engine oils as follows:

### FOR ALL OILS when using ULSD

- Severity 1: 50%-44% of new oil TBN or 3.5 to 4
- Severity 2: 43%-36% of new oil TBN 3.48 to 2.9
- Severity 3: <35% of new oil TBN < 2.8 to 2
- Severity 4: less than 2 <2

Other parameters of engine oil are now more important to engine durability and extended service protection than TBN. These are parameters such as oxidation stability, wear control, effective soot dispersancy. A balanced oil has multiple performance abilities and TBN is only one of the performance measures that are important in today's high performance engine oil.