

E85—it's a whole new ballgame

Additive programs must be designed to handle higher ethanol concentrations in renewable fuels

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In the US, the rapid growth in the availability of E85 fuel (85% ethanol and 15% gasoline) to power over seven million flexible fuel vehicles (FFVs) is creating a whole new ballgame for the many industries involved in the E85-supply chain: oil companies, vehicle manufacturers (original equipment manufacturers,) additive companies, etc. But, along with challenges, solutions do exist.

E85 specification. The ASTM D5798 specification covers fuel blends of 75% to 85% ethanol and 25% to 15% hydrocarbons used in automotive spark-ignited engines. The specification was first approved in the 1990s, well before the flood of FFVs hit the road. While E85 availability is still limited to about 1,300 out of more than 170,000 US retail-fuel stations,

its use has grown rapidly in recent years. As demand for this new fuel grows, it is critical that the specification reflects the needs of the producers, marketers and consumers.

The specification was originally based on the knowledge available at that time, which included past experience with experimental methanol-based fuels, specifically M85—85% methanol. With the growth of E85 use and testing, the knowledge level increases. Consequently, an ASTM consensus-driven task group of ethanol, oil company, auto maker and additive company experts is busy debating improvements to the latest version of the D5798. The work is ongoing, and the earliest time that ASTM could vote on task force-recommended changes would be June 2008.

Like gasoline specifications, the E85 specification accommodates changes in temperature by month and geographic location. This allows blending of more volatile fuel for colder times of the year and geographic areas to ensure good vehicle startability.

Unlike gasoline's numerous volatility classes, however, D5798 defines only three volatility classes for E85. Class 3, used for the lowest temperatures, requires a minimum of only 70% ethanol and higher alcohols and allows Reid vapor pres-

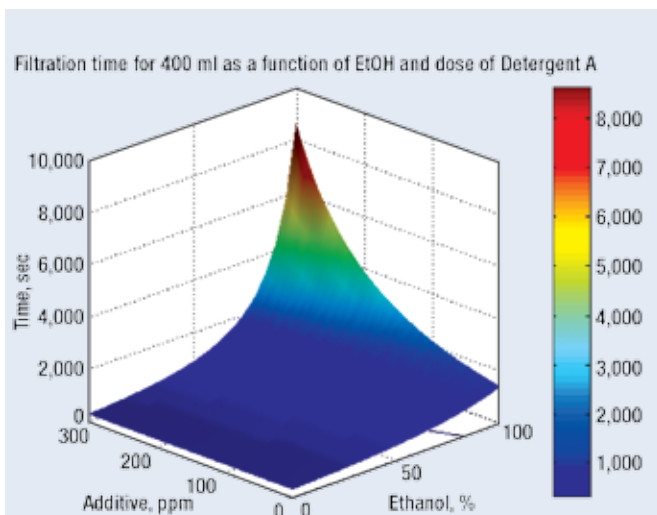


FIG. 1 Filtration times for typical gasoline additives when used in E85.

TABLE 1. E85 specifications from D5798

Ethanol + higher alcohols, vol%, min.	70% (depending on volatility class)
Methanol, vol%, max.	0.5
Higher alcohols (C ₃ –C ₈), vol%, max.	2
Acidity, mass %, max.	0.005
Solvent-washed gum content, mg/100 mL, max.	5
pHe	6.5–9.0
Unwashed gum content, mg/100 mL, max.	20
Inorganic chloride, mg/kg, max.	1
Copper, mg/L, max. 0.07	0.07
Water, mass %, max.	1.0

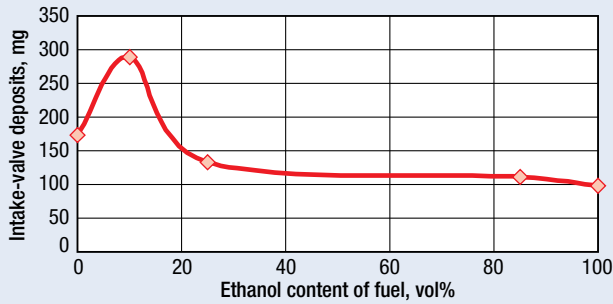


FIG. 2 Ethanol effects on intake-valve deposits.

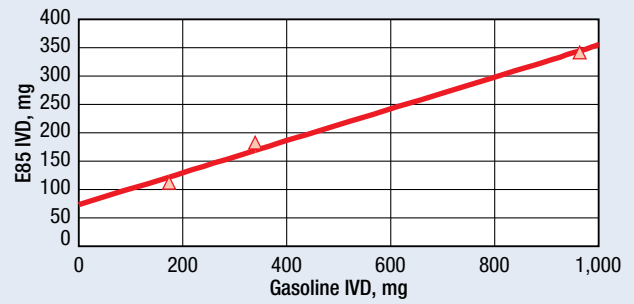


FIG. 3 Gasoline vs. E85 deposit levels.

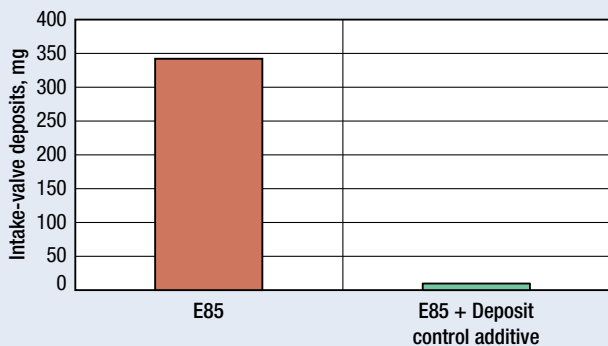


FIG. 4 Intake-valve deposits with E85 deposit-control additive.

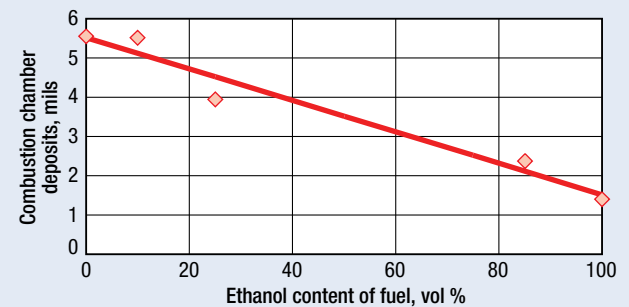


FIG. 5 Combustion chamber deposits with varying ethanol concentrations in the fuel.

sure (Rvp) up to 83 kPa (12 psi). Adding higher hydrocarbons is intended to improve cold-start performance. However, simply blending these proportions of ethanol with any available gasoline may not allow the resulting E85 to meet specification unless blenders use better selection of hydrocarbon components to meet volatility requirements.

Table 1 summarizes some of the primary E85 specifications, including pHe, acidity levels and inorganic chloride levels. These requirements are specifically designed to mitigate potential corrosion concerns that can affect FFVs as well as fuel-handling and dispensing equipment. The industry is debating if these current specifications are sufficient to protect against corrosion, without being redundant, or if other corrosion-related specifications should be included. The D5798 specification relies on many individual test methods. In some cases, the methods were originally intended for use with gasoline or other hydrocarbons and were not designed for use with or verified as being suitable for E85.

How additives come into play. Although certain sections of D5798 do mention deposit-control additives, they currently are not specified. Recent research has shown that FFVs using E85 can produce deposits. The good news is that E85-deposit problems can be addressed with appropriate additives, specifically formulated for E85, which are different from gasoline additives.

Gasoline typically contains additive packages to improve performance and keep engines clean. It is tempting to use these same additives in E85. However, gasoline additives simply are not formulated to meet the specific needs of E85.

E85 challenges. While typical gasoline-deposit-control additives do not address all of the needs for E85 fuel, there is an even greater concern: the potential harmful effects of using gasoline additives in E85. The high ethanol portion in E85 fuel greatly changes the polarity and solubility characteristics of the fuel as compared to gasoline, and even as compared to 10% ethanol-blended gasoline, which is now common in the US. As a result, typical gasoline-deposit-control additives can have difficulty staying in solution with E85.

If a gasoline additive does not stay in solution in E85, it runs the risk of coming out of solution at various points within the fuel system, potentially creating deposits on filters, fuel injectors and the intake tract of the engine. Recently published studies of additive filtration have shown that gasoline additives can result in E85 filter plugging and severe increases in filtration time.¹ At low-ethanol levels, any dosage of typical gasoline additives can be used without leading to excess filtration times. However, at higher ethanol levels (E85),

¹ SAE 2007-01-3995.

using higher doses of typical gasoline additives can result in a rapid increase in filtration time, as shown in Fig. 1. In contrast, an additive specifically formulated for E85 will show normal filtration times, regardless of the additive dosage or the ethanol level.

A possible, unintended consequence of using poorly formulated gasoline additives in gasoline is intake-valve sticking. In this situation, some of the additive can buildup in the annular space between the intake valve stem and valve guide of the cylinder head. At low temperatures, any build up in this area will become more viscous and inhibit valve movement. Under extreme conditions, the valve spring will be unable to close the intake valve, resulting in compression loss. Consequently, the engine will not start.

Modern gasoline additives are formulated to prevent this problem in normal gasoline. However, recent research has shown that ethanol can make intake-valve sticking even more severe and confirms the need to test gasoline additives in the full range of fuels in which they will be used, including low-level ethanol blends that are widely available. More importantly, in the more extreme case of E85, specific additives for E85 that are designed to treat these problems without causing unwanted side effects, such as intake-valve sticking, are needed.

Intake-valve deposits. A series of 5,000-mile tests were conducted on FFVs using varied mixtures of ethanol and gasoline. The results showed that with no additive present, ethanol impacts the amount of intake-valve deposits (IVDs) formed in the engine. At lower ethanol levels, such as E10 (10% ethanol), IVD actually increases to higher levels than in gasoline alone. At higher ethanol levels, the IVD level decreases to the level found in gasoline, or even lower, as shown in Fig. 2. However, as mentioned previously, gasoline and E10 blends are commonly treated to reduce these IVD levels to much lower levels. However, E85 does not normally contain deposit-control additives.

Just as all gasolines vary in their severity and ability to form

IVDs, batches of E85 also show various severity levels. In a series of 5,000-mile tests, three separate batches of gasoline were tested for deposit formation. The results were compared to deposit formation of three separate batches of E85 made from these gasolines. The higher the severity of the gasoline, the higher the severity of the E85 that was used as the hydrocarbon component. The E85-produced IVD was roughly one third to one half of what the gasoline alone produced (see Fig. 3).

While E85 produces fewer intake-valve deposits than gasoline, gasoline deposits can be controlled with deposit-control additives. Solubility issues preclude using these same additives in E85; however, specially formulated E85 additives can be used to control these deposits. Fig. 4 shows the results of using a properly formulated E85 deposit-control additive in the most severe batch of E85 tested.

Combustion chamber deposits. Combustion chamber deposits (CCD) are a secondary concern in gasoline use. Additive packages are formulated to prevent deposits in this area. Test results shown in Fig. 5 indicate that CCD thickness actually decreases as levels of ethanol in the blend increase.

What to do in this new ballgame. As those involved in the E85 supply chain gain more knowledge and experience, we can anticipate that the E85 specification, ASTM D5798, will be updated to reflect the current situation on fuel blending and usage. This updated specification will focus on the primary quality issues of making a product suitable for commercial sale, meeting minimum specifications. Beyond minimum performance, recent developments in E85 additive technology enable the formulation of a fuel that delivers greater performance. **HP**



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