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California Emissions Remission

E85 holds great promise as an integral part of California's transportation fuels strategy to protect air quality, curb greenhouse gas emissions and increase energy security.

by Ron Kotrba

When catalytic converters began to appear on auto exhaust systems as required by The Clean Air Act of 1970, one of the desired conversions was the oxidation of carbon monoxide to carbon dioxide. The converter met those goals efficiently and consistently, as it does today. The catalytic converter was deemed a green solution to transportation's biggest problem—increasing concentrations of air pollution. Hot exhaust flows through the catalyst changing carbon monoxide, NOx and hydrocarbons to carbon dioxide, water and nitrogen. The notion of carbon dioxide from already-treated exhaust streams posing a global threat must have been incredible in 1970. Even 10 years ago, the science behind global warming was up for debate, most of which was political in nature.

Today many of the world's industrialized nations have pledged reductions in carbon emissions in order to curb global warming, except for the United States. California has broken stride with the U.S. federal government's inaction, however. In 2006, a measure to limit greenhouse gas emissions such as carbon dioxide passed legislative muster, and was signed into law by Gov. Arnold Schwarzenegger. This new policy is named California Global Warming Solutions Act of 2006 (AB 32), which would in effect amount to a 25 percent reduction in greenhouse gas emissions by 2020.

California has the fourth-largest economy in the world at a time in history when robust economies and unhealthy excesses are often correlated. A reduction in carbon emissions from such a productive state whose highways are crisscrossed by tens of millions of vehicles daily can contribute significantly to diffusing the global-warming time bomb that's been ticking since industrialization began.

The challenge is to balance carbon-reduction regulations with the previously established and heavily regulated standards for air quality in California. Also, new life has been given to the goal of domesticating energy production in the United States, and California is no exception. In the state's mission to weigh all of these considerations, air quality experts say E85 shows promise on all relative fronts.

Directives From Above

Schwarzenegger issued Executive Order S-06-06 last year to address energy security and air quality. The order set into motion aggressive targets to boost in-state production and use of bioenergy, "including ethanol and biodiesel fuels." An important section of S-06-06 instructs the California Air Resources Board (CARB), which regulates air quality in the state, to "consider as a part of its rulemaking the most flexible possible use of biofuels through its rulemaking to update the predictive model and specification for reformulated gasoline, while preserving the full environmental benefits of California's reformulated gasoline programs."

Well before Schwarzenegger's aggressive bio-mandate, California was already the single-largest ethanol-consuming state in the nation with roughly a billion gallons a year consumed in low-level blends. Outside California, E10 is the most popular low-level ethanol blend, but California gasoline is mostly blended at the 5.7 percent level, which experts refer to as either E5 or E6. In lieu of methyl tertiary butyl ether (MTBE), 5.7 percent ethanol has oxygenated California's gasoline since MTBE was phased out of gasoline supplies a couple years ago.

"California is really poised to become a big—or I should say even bigger—biofuels-using state, which is going to be a function of its low-blend consumption," says Bill Van Amburg, senior vice president of WestStart, a nonprofit consortium focused on clean and secure energy technologies. The organization goes by two different names—CALSTART in California and WestStart elsewhere. "This consortium was brought together to speed up the development, use and commercialization of technologies to clean the air, bring increased energy security and reduce greenhouse gas emissions," he says. More than 130 participants in CALSTART include well-known companies like General Motors Corp., Honda and Volvo, as well as more obscure start-up technology firms. "We want to bridge the gap between users, manufacturers and policy-makers, and we are helping to determine exactly what the needs are and how to meet them," Van Amburg says.

If the only action California took was increasing the ethanol blend volume from 5.7 percent to 10 percent, this would boost ethanol use in the state from nearly 1 billion gallons a year to approximately 1.75 billion gallons. This scenario isn't expected to develop, however, nor are the experts backing such a move.

E10 Emissions Dogleg

Tailpipe-out emissions are produced by the internal combustion of fuel, but permeation and vapor pressure emissions of unburned fuel are big concerns for air-quality regulators, too. "Evaporative emissions are growing as a percent of the total emissions in California," says Paul Wuebben, clean fuels officer with South Coast Air Quality Management District, the smog control agency for all or parts of Los Angeles, and Orange, Riverside and San Bernardino counties. Some good-intentioned efforts are pushing to boost the state's blend level to 10 percent, but state test results show this isn't advisable.

"Evaporative emissions are inherently higher at the E10 blend," Wuebben tells EPM. "But at the higher blends like E40 and up, testing shows evap emissions are lower than gasoline." Van Amburg says E10 is the worst blend-area for evap emissions, calling it

the “dogleg” of testing. The reason is the azeotropic reaction that results from mixing ethanol and gasoline at varying levels. “You can have ethanol and gasoline—each with the same vapor pressure—but when you mix them together, you’ll get an increase in vapor pressure,” Wuebben says. “Evaporative emissions are derived from the volatility characteristics of fuel—and the solubility.”

Evaporative emissions are typically discussed in terms of vapor pressure and permeation emissions. Vapor pressure is driven by molecular weight and density. Unlike petroleum gasoline, ethanol has an oxygen molecule. “That oxygen molecule makes ethanol an inherently lighter fuel,” Wuebben says. “The difference in polarity of the fuels results in an increase in Reid vapor pressure (RVP).” RVP is measured in units of pressure (pounds per square inch) created in a closed-loop system when a fuel is heated to 100 degrees Fahrenheit. Results are used by the fuel industries and regulators to categorize the volatility of a particular fuel. “It’s a physical phenomenon that ethanol blends reach their peak vapor pressure at E10,” Wuebben says.

Permeation emissions, or a fuel’s ability to give-off emissions of unburned hydrocarbons through materials like rubber, are driven by a different characteristic. “Permeation emissions have to do with the solubility of the fuel, and has nothing to do with vapor pressure,” Wuebben says. “Both contribute to evap emissions. E10 has higher permeation emissions and volatile vapor pressure than gasoline.” California petroleum blendstock or California Reformulated Blendstock for Oxygenate Blending (CARBOB) is adjusted for aromatics and olefins prior to blending to accommodate for the physical effects of mixing gas and ethanol at these levels. So, while California air regulators are reluctant to move from a 5.7 percent ethanol blend to 10 percent, they’re in strong support of significantly boosting the availability and use of E85 for the hundreds of thousands of flexible-fuel vehicles (FFVs) already owned by California residents.

E85 Emissions Homestretch

Wuebben says low-level blends of ethanol may produce slightly lower NOx emissions, but at high blends like E85, ethanol’s lower Btu value produces lower flame and combustion temperatures, helping lower the production of NOx during combustion. “It’s important to note that technologies have already advanced to a point that emissions of NOx and hydrocarbons from base tests are already very low,” Wuebben tells EPM. The production of toxic emissions, such as benzene and “1, 3 butadiene,” are also lower from E85, he adds, while acetaldehyde emissions can increase. “However, catalysts on vehicles are so effective these days that acetaldehyde emissions from E85 are virtually the same as with gas,” he says.

While state air regulators seem to agree that E85 poses fewer problems and extends more air benefits compared with E10 overall, the state’s fuel supplies are rampant nevertheless with low-level blends—and only one publicly accessible E85 station. “The air folks feel more comfortable with E85 than low blends, yet we have close to 300,000 FFVs running on E6, the worst-case scenario from an air-quality perspective,” Van Amburg says. Oddly enough, when CARB tests vehicles and fuels for emissions profiling or categorization, FFVs are tested on E10 as opposed to the more common E6. “If FFVs are tested on E10 rather than E6, it gives them a higher base margin,” Wuebben says. Conventional automobiles, ones that aren’t E85 compatible, are tested by the air board using California Phase II gas, a fuel containing MTBE, which is no longer available for purchase in the state. Ironically, there is no emission testing done in California using E6, the fuel that’s used most in the state. The only explanation available for this peculiarity is that CARB is making extensive changes to its modeling. “CARB is looking at its whole predictive model with the acknowledgement that we need to look toward biofuels,” Van Amburg says. “If there are issues there, then we need to look at solutions.” Wuebben confirms the whole process is still being sorted out. CARB officials were unable to respond in time to EPM’s requests for information on these issues.

CALSTART (WestStart), Chevron Technology Ventures, GM and Pacific Ethanol, among other companies, are in the midst of a project to establish 15 new E85 stations in California, which are slated to be positioned where the highest concentrations of FFVs are registered, says Van Amburg. “The first one will be established this spring,” he says. “The remaining 14 should be up within 18 to 24 months. We’ll get the first few established and begin to build our knowledge base from data we collect.”

State agencies support E85 from an air-quality perspective, but the support grows even stronger when the renewable fuel’s carbon-cutting benefits are brought up. “The passing of AB 32 changed how we must view greenhouse gases in California,” Van Amburg says. “When you look at ethanol and greenhouse gases, even with the energy balance issue there are net benefits.” Addressing climate change, Wuebben tells EPM there’s a relevant role for ethanol and E85 in the broader vehicle template, including FFVs and hybrid FFVs. “We are convinced that ethanol has a positive net energy balance and, therefore, a slightly better profile of lower greenhouse gas emissions,” he says. Transportation contributes 41 percent of all greenhouse gas emissions produced in California, according to Wuebben. Increasing E85 availability and use will help state agencies lower well-to-wheel carbon dioxide emissions from vehicles—specifically for the nearly 300,000 FFVs operating on E6. Moreover, when second-generation biofuels technologies become more efficient and cost-effective, E85 derived mostly from cellulosic ethanol will offer substantially greater reductions in carbon dioxide emissions.

The premium positioning ethanol holds in the hot and timely issue of energy security only adds to its proficient functionality in the state’s transportation strategy triad. Domestic production of biofuels like ethanol is mushrooming to reach the goal of increasing our nation’s self-sufficiency in energy production.

“We can no longer develop single-purpose regulations,” Van Amburg says. “Now we have to balance everything—air quality, greenhouse gas emissions and energy security. This means agencies will have to be more creative in developing future regulations.”

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