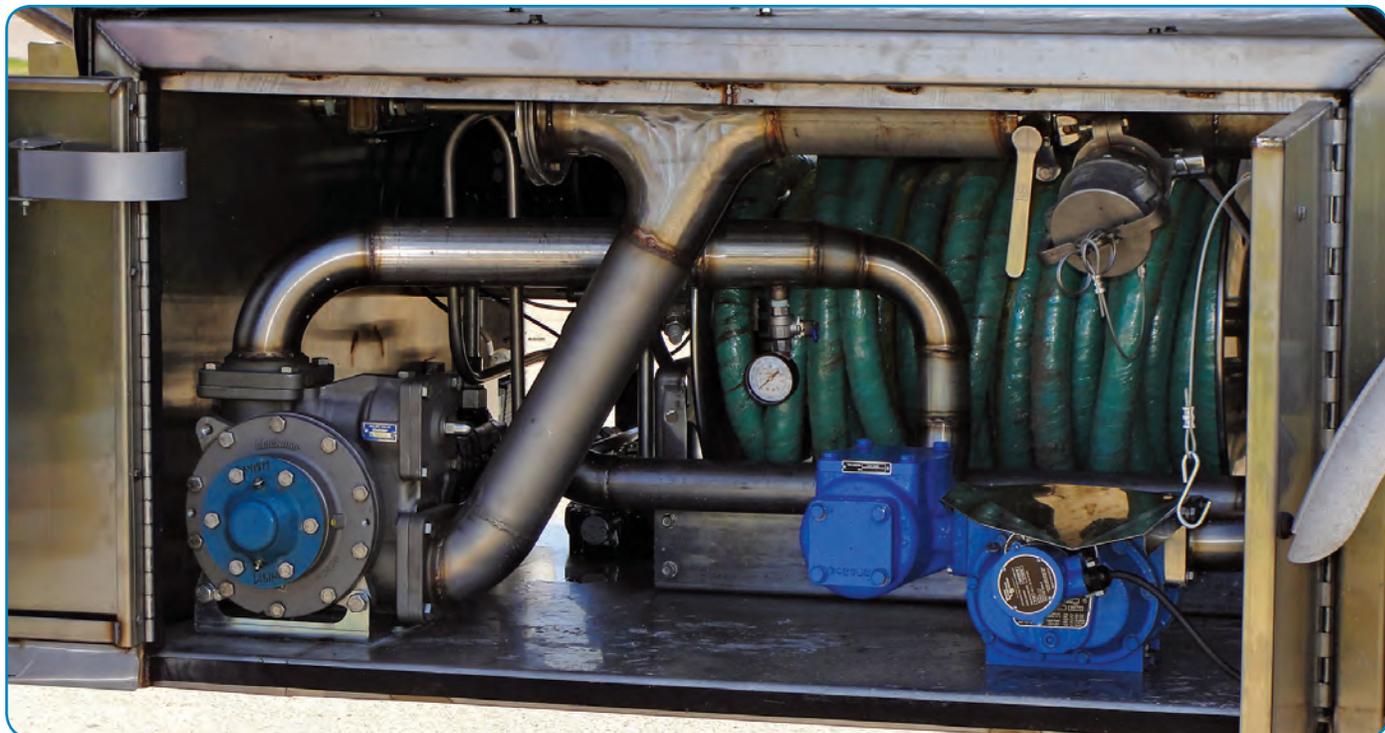


# DEF-ty Cultivating a New Market

## ENHANCED EPA REGULATION OF DIESEL EMISSIONS MAKES DIESEL EXHAUST FLUID A HOT COMMODITY

By Tom Stone



Transport companies are able to tap into the emerging Diesel Exhaust Fluid (DEF) market and delivery bulk quantities of DEF with the help of the new Blackmer line of STX3-DEF sliding vane pumps.

### Introduction

Founded 40 years ago in December of 1970, the stated mission of the United States Environmental Protection Agency (EPA) "is to protect human health and to safeguard the natural environment – air, land and water – upon which life depends," in the process creating a cleaner, healthier environment for the American people. The EPA works to meet this lofty goal by identifying potential environmental hazards and developing rules, regulations and, sometimes, mandates whose implementation will curb any possible dangers.

Since its founding, the EPA has been concerned with the amount and makeup of vehicle tailpipe emissions. The passage of the Clean Air Act in 1970 established the first tailpipe emissions standards, with those standards subsequently tightened three times between 1977 and 1988. The Tier I standards that went into effect in the 1990s reduced the allowable rate of emissions by 40 percent and dictated that these standards would be reassessed for vehicles produced in the years 2004, and beyond.

In all cases, the target of the EPA's standards were a reduction in the amount of carbon monoxide (CO), volatile organic compounds (VOCs) and nitrous oxide (NOx) being emitted into the atmosphere through a vehicle's exhaust system. Over the years, the standard of NOx emissions, for example, from light-duty trucks went from 3.1 grams per mile in 1975 to as low as 0.6 grams per mile in 1994.

The regulation of NOx emissions reached another threshold on Jan. 1, 2010, when a new EPA requirement went into effect. This requirement necessitates that all new cars and trucks with diesel engines that are sold in the U.S. must include enhanced methods that are used to treat the exhaust emitted by these vehicles with a goal of further lowering the amount of NOx that is released into the atmosphere. For example, one of these methods is known as Exhaust Gas Recirculation (EGR), which recirculates a portion of the engine's exhaust gas back to the engine cylinders. In a diesel engine, the exhaust gas replaces some of the excess oxygen in the pre-combustion mixture, thereby reducing the amount of NOx the combustion generates.

This white paper, however, will take a look at another increasingly popular method that has been developed to meet the EPA's NOx-reduction requirement, as well as the fluid and pumping equipment that have been developed to meet the production and supply needs of this emerging technology market.

## Selective Catalytic Reduction

While the EPA can mandate that certain actions be taken, the agency has no interest in dictating the specific ways that the mandates can or must be met. So when word spreads of an upcoming new EPA regulation, the automotive industry's entrepreneurs put on their thinking caps and begin working on the best way to meet the tenets of the EPA's ruling. As it turns out, while the EPA was turning its attention to the amount of NOx produced by diesel engines, so were the regulatory agencies in Europe. This led to a flurry of developmental activity that ultimately resulted in various solutions to the NOx-reduction quandary.

In addition to the previously mentioned EGR, one of the leading solutions is called Selective Catalytic Reduction, or SCR. SCR was originally developed by Daimler AG, the German automotive company well known for its line of Mercedes-Benz cars, as a way to reduce emissions in power plants and utilities. SCR has now been modified into an advanced emission-control technology that can help light-, medium- and heavy-duty diesel vehicles meet the EPA's new standards on NOx emissions.

In an SCR system, a liquid reducing agent composed of urea and purified water is combined with engine exhaust in the presence of a catalyst to convert NOx into harmless

nitrogen and water vapor that is introduced into the atmosphere. Urea is a non-toxic colorless and odorless nitrogen-containing substance that is highly soluble in water and turns into ammonia when heated.

The SCR process begins when hot diesel exhaust from the engine flows through a diesel particulate filter toward the SCR system. At this point, the urea/water solution is injected into the exhaust stream, which enters into the SCR chamber. In the presence of the SCR catalyst, the exhaust and urea/water solution react to convert the NOx into nitrogen and water vapor. This process has been shown to reduce NOx emissions by up to 90%, while lowering particulate emissions by more than 95%.

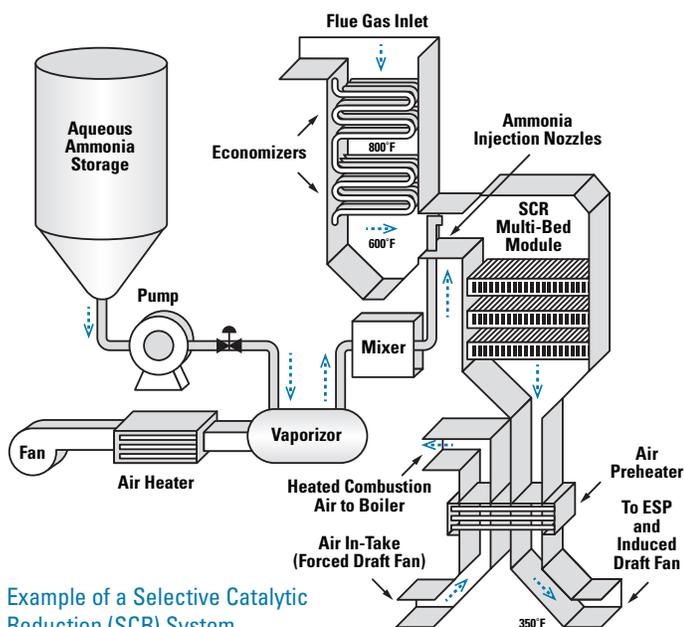
## Diesel Exhaust Fluid

In the United States, the urea/water solution that plays such a prominent role in the SCR process goes by a proper name: Diesel Exhaust Fluid (DEF), which is a solution consisting of 67.5% water and 32.5% automotive-grade urea. To get the DEF into the exhaust stream, diesel vehicles are now being designed and equipped with separate tanks in which the DEF is stored and from which it is introduced into the SCR process.

This use of DEF as a way to reduce NOx emissions has created a new market. Experience with DEF-type fluids in Europe indicates that DEF consumption is between 2% to 5% percent of diesel-fuel consumption, meaning that a truck averaging 6 mpg can travel approximately 300 miles on one gallon of DEF. New diesel vehicles are now being equipped with a warning light that alerts the driver when the DEF level is low. To refill those DEF tanks, the fluid is being packaged in a variety of formats: 1- and 2.5-gallon jugs, 55-gallon drums, 275- or 330-gallon totes or intermediate bulk containers (IBCs) and 800-gallon mini-bulk dispensers.

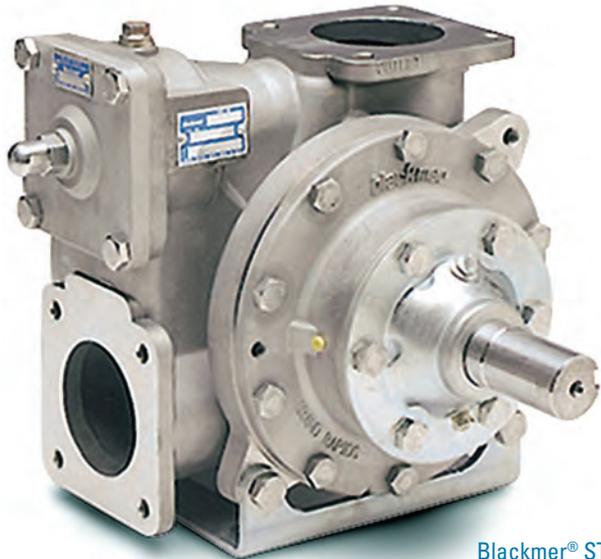
A concern with DEF use and storage is that it can begin to crystallize and freeze at 12°F (-11°C). During vehicle operation, the SCR system provides heating for the tank and supply lines. If the DEF does freeze in the vehicle's storage tank, at startup the SCR will quickly return the DEF to liquid form without any product degradation or adverse effects on vehicle operation. While the vehicle's SCR system has been designed to protect DEF from freezups, precautions must be taken when storing DEF in extremely cold environments.

Knowing that diesel vehicles now require the use of technology such as SCR and, by extension, DEF in order to be in compliance with the EPA's NOx emissions



Example of a Selective Catalytic Reduction (SCR) System

standards is one thing. Obtaining the DEF is quite the other. According to the Website [www.FactsAboutSCR.com](http://www.FactsAboutSCR.com), as of June 2010, DEF was available across North America at more than 5,000 locations where drivers could top off their DEF tanks with pre-packaged 2.5-gallon jugs or refill their DEF tanks via truck-stop fuel-island pumps. To help the drivers of diesel vehicles, several DEF locators have been developed for online use, including [www.discoverDEF.com](http://www.discoverDEF.com), [www.findDEF.com](http://www.findDEF.com) and the U.S. Department of Energy's Clean Cities Program and National Renewable Energy Laboratory's cooperative Website at [www.afdc.energy.gov/afdc/locator/def/](http://www.afdc.energy.gov/afdc/locator/def/).



**Blackmer® STX3-DEF  
Sliding Vane Pump**

Additionally, a study titled "Diesel Exhaust Fluid Supply: Current State" that was presented by the Quixote Group at OPIS's 16th Annual Fleet Fueling Conference in September noted that 45 percent of the companies they surveyed were selling or dispensing DEF. These companies were broken down into fluid suppliers (55% selling), retailers (53% selling) and fleet fuelers (33% dispensing).

Of the fluid suppliers who responded positively to selling DEF, 100 percent had it available in jugs, 94 percent were selling drums, 81 percent were offering totes or IBCs and 26 percent were selling mini-bulk dispensers. Of the retailers who are selling DEF, 100 percent were carrying jugs, while 22 percent had on-island or bulk dispensers at their facilities. Sixty-five percent of the fleets dispensing DEF have operations of 150 or more trucks. Forty-nine percent meet the DEF needs of their fleets through the purchase of totes/IBC's, while 42 percent purchase drums and 33 percent purchase jugs of DEF for their vehicles.

## DEF Case Study: Brenner Oil Holland, MI

The initial reaction of many in the motor-fuel production, storage, delivery and retailing industries to even the slightest hint of new federal regulation is often an exasperated, "What now?" In reality, the simple truth is that changes in fuel standards, whether in regards to production or regulation of emissions, usually create opportunities for savvy operators to create a new niche market for their businesses. That is definitely the case with Diesel Exhaust Fluid (DEF).

Brenner Oil, Holland, MI, was founded in 1930 by Leonard Brenner and has grown into the largest independent oil company in western Michigan, one that hauls more than 1.3 million gallons of product a day. With that much experience and market success, when the new EPA diesel-exhaust emissions levels were announced, Brenner instantly knew that a new business opportunity had presented itself.

"We saw that these new standards would present an opportunity to haul some DEF so we decided to look into what it would take to get the job done," said J.C. Sikora, Maintenance Coordinator for Brenner Oil.

To do that, Brenner turned to Liquid Haulers Maintenance (LHM), Moline, MI, a builder of tank trucks and transport trailers for a wide variety of liquid-handling operations, primarily refined fuels and motor oils. LHM has built a number of tank trucks and trailers for Brenner Oil over the years. This time, Brenner required a stainless-steel 5,500-gallon trailer that could meet all of the unique hauling and delivery characteristics of DEF, which can be highly corrosive.

"It was a unique application and the first time we had built one of these trailers, so there were a lot of challenges," explained Tom Bouwma, LHM's Director of Manufacturing. "No one had really dealt with DEF, so we did a lot of homework on this one. For example, if DEF gets below 12°F it tends to turn to a solid or slush. Also, if the urea sits in one area too long it crystallizes. We made areas where the system could be flushed out, if need be, or cleaned out with deionized water."

The result is a DEF-specific transport that features a Blackmer 3-inch STX3-DEF Series Sliding Vane Pump and a Blackmer Hydrive 2-2010 Hydraulic Cooler. LHM chose Blackmer products for this project because of its long and successful history of incorporating Blackmer equipment into the construction of other transports.

"This DEF trailer is the only one in the state of Michigan that we know of, and we're preparing to build another one," said Sikora. "Liquid Haulers took all of the challenges we presented them and they delivered on those challenges. Now, we have a finished product that's ready to work. With the help of Blackmer, they put a trailer together that fit our needs and did a wonderful job."



Jerry (left) and Doug Brenner, owners of Brenner Oil, Holland, MI, USA, stand next to the company's new diesel exhaust fluid (DEF) transport. The Brenners are taking advantage of an emerging market with this first-of-its-kind DEF trailer.

## Proper Transfer of DEF

So, an SCR system can take potentially harmful diesel exhaust and, through the use of DEF, turn it into harmless nitrogen and water vapor, while diesel-vehicle manufacturers have modified their manufacturing processes to include on their trucks the storage tanks, lines, filters and other equipment that allow an SCR system to operate effectively. And suppliers, retailers and fleet operators have identified the potential of DEF and are now offering it to their customers.

But there's one more link in this chain that needs to be considered – how does the DEF get from where it is manufactured to the business end of the supply chain? Enter the need for transports that are designed specifically for hauling DEF. These could not be just any transports, however. DEF is highly corrosive to materials such as copper and brass. That means that any transport used to haul DEF, as well as all of its wetted components, need to be made of stainless steel or approved plastics such as high-density polyethylene.

By extension, the pumps that may need to be used during the DEF production process, or are required to load the DEF onto the transport and off again into a storage vessel, must also be compatible with DEF's corrosive nature.

Recognizing the opportunity in the growing DEF market, Blackmer® has made a commitment to developing pumping and other ancillary equipment that meets the needs of DEF production and transport. The first piece of Blackmer equipment to be developed specifically for use with DEF is the STX3-DEF Series Sliding Vane Pump. The pump features 316 stainless-steel construction with external ball bearings, chemical-duty mechanical seals, non-metallic vanes, self-priming and dry-run capabilities, and minimal shear and agitation, making it ideal for the challenges presented in handling DEF. STX3-DEF pumps offer flow rates up to 250 gallons per minute (946 liters per minute) with differential pressures up to 125 psi (8.6 bar) and maximum speeds of 800 rpm, meaning that a 5,500-gallon transport trailer can be unloaded in less than 25 minutes. Designed around the ISO 22241-3 standard, which describes best practice recommendations and requirements for the handling, transporting and storage of Diesel Exhaust Fluid, the STX3-DEF pump was extensively tested to assure material compatibility with DEF.

## Conclusion

While some greet the announcement of a new federal regulation with trepidation, others look at it as an opportunity to take advantage of a new market. The EPA requirement further regulating the amount of NOx that can be emitted by diesel engines will be a boon for those companies that manufacture SCR systems and the DEF that is a major component in them. Also benefitting will be the pump manufacturers who can create the equipment needed to handle the unique characteristics of DEF. Blackmer has already made inroads in this new market with its STX3-DEF pumps and is hard at work developing the additional equipment needed for a complete DEF family of products that will make the production, shipping and handling of DEF even more efficient and cost-effective in the future.

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