Ethanol and the Illinois Fire Service (5-23-'08)

Alcohol, which is basically what ethanol is, has been produced for many years. For the past 20 years or so, the fire service has dealt successfully with gasohol, which is a blend of 90% gasoline and 10% alcohol. Due to the low alcohol content, gasohol reacts more like gasoline than alcohol, and our standard foams and methods have usually worked on it. However, due to clean air concerns, in some cases the percentage of alcohol in today's gasohol is being increased to 20%, and AFFF will NOT work on that. Ethanol is very different, since it is a blend of 95-85% alcohol, and 5% or 15% gasoline. Standard foams will not work on ethanol which is a polar solvent, and you cannot dilute it with water. Only alcohol resistant (AR) foams or dry chemical will handle a significant ethanol fire.

A recent reference search found that since 2000 there have been 26 ethanol related major fires in the United States. These include 14 at production facilities, 3 tanker truck fires, and 5 derailed train fires.

Community Planning

In communities considering an ethanol production facility, the fire service, community, and industry leaders together need to plan adequate infrastructure for producing, transporting, and storing this new fuel, and protecting the facilities and community. Furthermore, firefighters need different and proper equipment and training in the event of an ethanol fire or spill or facility related rescue. Most fire departments currently lack the appropriate types and capacities of foam and application devices, plus an adequate volume of water necessary to fight these fires.
Virtually all the current discussion, when the potential for an ethanol plant coming arises, relates to either the economy or the environment. Rarely are public safety and fire department concerns ever thought of.

Discussions should include infrastructure (roadways, railroads, adequate fire water supply, etc.), adequate installed fire protection systems in the facility, stocks of alcohol resistant (AR) foam, proper fire, rescue, and Haz Mat equipment and training.
Another planning consideration is requiring that sufficient open buffer space be provided around the plant to ensure against potential fires or releases causing exposure problems. Buffers of one half mile (ERG recommended) are needed to protect highways, railroads, and possible future neighborhood developments, similar to what happened with subdivisions growing up around airports, and creating problems and complaints 30 years in the future.

Ethanol production facilities, like other industrial sites, have a variety of hazards, in addition to ethanol fires, for which the fire department should be prepared. Some examples include possible grain dust explosions, extrication and vertical rescues of workers from bulk grain storage and equipment, electrical hazards, vehicle wrecks, various hazardous materials incidents, and product spills and releases.

Thoughtful planning, preparation, and training ahead of time, in cooperation with the plant designers and personnel and shippers, will help ensure the safe production and distribution of ethanol throughout Illinois and the nation.

Properties of Ethanol

Ethanol is ethyl alcohol, a colorless liquid with a characteristic alcohol odor.
It is a polar solvent which is soluble (dissolves) in water, so you cannot dilute it.
Ethanol vapors are heavier than air (1.59), so they hang low to the ground.
Ethyl alcohol's flash point is 55 degrees F. (This increases to 58-60 degrees F when gasoline is added.)
It's flammable range is 3.3% to 19%.
Ethanol weighs 6.5 pounds per gallon.
Ethanol fuel E-85 is a mixture of 85% alcohol and 15% gasoline.
Ethanol burns with a virtually invisible flame, like Sterno, once the gasoline burns off.

Production

Illinois is ranked third in the US in ethanol production, with almost 1.5 billion of the 6.4 billion gallons currently being produced nationwide. A national figure of 12.5 billion gallons is predicted for 2009. Illinois will have a growing and increased percentage share of this exponential growth.
Most production facilities are each designed for an output of 100 million gallons per year.
Illinois uses primarily corn to produce ethanol, but other grains and grasses can be used.
Corn is brought into the plant by truck or train, and is stored in bins/elevators on site.
Corn is moved from the bulk storage bins into the distillation process unit. In 2007, dry mill facilities, which first grind the grain, produce 82% of the ethanol, and wet milling, which soaks the grain, produces 18%.
Alcohol is distilled off, and collected (200 proof).
CO2 is also distilled off, and collected for sale.
The grain alcohol is then denatured with 5% gasoline (E-95) before it is moved off site. (This makes it undrinkable, and avoids federal taxes.)
Production facilities typically store 30,000 to 500,000 gallons of ethanol on site.
Some solid waste components, called distiller's dried grains (DDGs, wet or dry) remain after the distillation process, and are sold for animal feed.

Transportation

The vast majority of the proposed or existing Illinois ethanol plants are located in rural areas where the roads are smaller and not equipped to handle the large volume of traffic

that ethanol production brings. Almost all ethanol E-95 is shipped by railroad (75%) and truck (25%). Truck shipments will increase significantly in the future. Today most E-85 is already shipped by truck.

This presents challenges both inside and outside the plants. Outside, the rural roadways need serious upgrading to handle the large increase in traffic which would consist of both grain and tank trucks moving to and from the plant virtually around the clock. A typical 9,000 gallon tanker truck is hauling 58,000 pounds of product. Most rural roads are not designed nor built for this volume of heavy truck traffic. Upgrading to new paved highway costs about $1 million per lane per mile.

A related issue involves railroad track and crossings. Much of Illinois' rural railroad infrastructure may also need upgrading. It is estimated that the increased volume of ethanol will this year be the number one hazardous material shipped by US railroads. Railroad non-pressurized tank cars generally hold 30,000 to 45,000 gallons of ethanol. Most of this product is moved in "unit" or "batch" trains consisting of 70 to 120 or more cars of ethanol. Thus, there could be more than 3 million gallons per train. You may also find ethanol cars included in general rail movement.

Not upgrading roads and rail infrastructure will likely lead to wrecks involving rollovers and derailments, as well as accidents at intersections and crossings.

Only limited barge traffic is handling ethanol. Average sized barges hold 4,000,000 gallons, and large barges hold 8,000,000 gallons of ethanol.

The existing pipeline system will not, at least in the near future, be used to move ethanol, due in part to incompatibility with the pipes and fittings by this polar solvent, and to problems from product mixing with residual contaminants in the pipeline. Sometimes there are short dedicated pipelines from production facilities to nearby barge terminals. Pipelines, however, are not presently expected to become a common way of moving ethanol, as they are for most other fuels, in the near future, though it is possible.

The 2008 Emergency Response Guide (ERG) lists a new number UN 3475 for E-85 and all ethanol and gasoline mixtures having more than 10% ethanol. Straight ethanol is UN 1170. E-95 is currently placarded as UN 1987, but in some cases it may be found marked less accurately as UN 1993. Currently, UN1203 is used for gasohol E-10.

Terminals

Denatured alcohol (E-95, 95% alcohol and 5% gasoline) is delivered to terminals via tanker trucks or railroad, and placed in bulk storage tanks.
At the terminals an additional 10% gasoline is added to create ethanol E-85 (85% alcohol and 15% gasoline) for fuel.
Tanker trucks then deliver the E-85 to local fuel dispensing stations for sale to the public.

Fuel Dispensing Stations

Most current gas station pumps are not useable with E-85 ethanol, due to it's incompatibility with plumbing, fittings, and gaskets.
Work is progressing on developing dispensing stations that can be used with ethanol. Some are now available and in service.
The vast majority of ethanol is mixed at a terminal, but in a few cases the mixing of alcohol and gasoline actually takes place at the fuel dispensing station.
Fuel dispensing stations then store the E-85 in dedicated tanks, and dispense it via pumps as the product is sold.

Fire Department Response / Actions

The 2008 Emergency Response Guidebook, under Guide 127 on pages 200-201, provides general information about the hazards, safety, and response for incidents involving polar/water-miscible flammable liquids including ethanol.

Fires

Grain dryer fires are by far the most common fire incidents occurring in ethanol production facilities. Ethanol processing units are typically inside buildings, not in the open like at petroleum refineries. This can make initial size-up and actions difficult.
A fundamental choice is between fight or flight.
Alcohol burns with a nearly invisible flame, so firefighters must remain aware.
Water will not extinguish an ethanol fire. You cannot dilute nor flood it out.
You may use water streams to cool exposures. For these non-pressurized storage tank fires, do not cool the burning tank's sides, unless you can apply water to all sides of the tank, until you begin flowing foam and are controlling the fire. Otherwise, the metal may cool unevenly, twist and squeeze the tank causing it to overflow or spill burning product.
Some dry chemical agents will extinguish ethanol fires, but there is the danger of vapors reigniting. This is not a practical tactic for most fire departments.
Most common types of foams (AFFF, Class A, CAFS, fluoroprotein, protein, and emulsifying agents) will NOT work on ethanol fires.
AFFF may knock a small fire down long enough to attempt a rescue, but don't count on it, and the fire will burn back rapidly.
Alcohol Resistant (AR) foams are the only ones that may work on ethanol fires. They have an added polymer which forms a blanket that inhibits water absorption by the alcohol, thus not breaking down the foam as rapidly, and having a longer drain time.
AR foams should be applied in 6% or 3% concentration depending on the ethanol fires.
It is recommended that for a formula (NFPA #11) calculated quantity of foam needed to extinguish an ethanol fire, you will likely need 3 times that amount to knock it down and

keep it out. This could require several thousand gallons of foam concentrate itself, plus 97 or 94 times that much water to produce the foam.
Alcohol Resistant Aqueous Film Forming Foam (AR/AFFF) and Alcohol Resistant Film Forming Flouroprotein foam (AR-FFFP) will handle some types of alcohol fires, but not all. Most likely with these foams you will have to periodically recoat the fuel to keep it under control until it can be picked up and reclaimed.
Large volume foam applications may not be practical with the standard 60 and 95 GPM foam eductors and nozzles commonly carried by fire departments. Also, the metering orifices on foam proportioners are designed for the type of foam being used, so what worked with older foams may not work well with AR foams.
Depending on the circumstances the AR foam can be banked off a vertical object so it flows over the fuel surface gently (Type 2 application). This method generally works best. In others you will have to let the foam fall directly on the fuel surface (Type 3 application). This is less desirable. Loading racks protected by foam sprinklers have their own unique characteristics and needs.
As with any foam application, do not start the attack until an adequate supply of foam is on hand to finish the job. Otherwise, you will not be successful, and will just be wasting the limited amount of foam and water, and will have to start all over.
Blind tests at Ansul using various brands and types of foam showed only AR foams will work on ethanol, but none of them will work in all situations and types of applications. This test information is available on the IFSI website.
Massive quantities of foam concentrate and water and large application devices are required to handle a serious ethanol fire. However, do not count on your local airport crash truck saving the day. The FAA currently requires these vehicles to carry straight AFFF for aviation fuel fires, not AR foam, so most airport crash trucks are not equipped for an ethanol fire.

Spills

Since alcohol and ethanol are polar solvents, their spills differ from gasoline and diesel. Common FD Haz Mat booms and diking materials will not work with polar solvents, since the product damages the containment materials.
Most vacuum trucks will not work to recover ethanol, unless they have special filters designed for polar solvents.
Ethanol can be contained by diking with dirt or sand.
Spills should be prevented from entering sewers and waterways.
It may be necessary to cover the spill with alcohol resistant (AR) foam until the fuel can be recovered.
Merely letting the E-85 vapors evaporate does not solve the problem, because the gasoline will still remain.
Open flames should be kept away from the scene.
Clean-up can be very costly.

Technical Rescues

Ethanol production facilities, like other industries, pose the potential for various technical rescue situations.
These could include grain bin rescues, machinery entanglements, as well as vertical and confined space rescues.
Pre-planning should include by whom and how such rescues will be performed, and adequate provisions made for doing so by a Technician level technical rescue team.

Hazardous Materials
Numerous hazardous materials are involved in the ethanol production process, and fire departments should also be prepared to deal with them. They include sulfuric acid, sodium hydroxide, ammonia (hydrous and anhydrous), chlorine based solutions, caustic soda, and water treatment chemicals such as chlorine and bromine. Likewise, a Technician level Haz Mat team would be needed.

Training

IFSI is developing a series of ethanol training classes. Classroom and on-line Awareness courses will be available early in 2008. We will also deliver Operations level training involving both classroom and hands-on foam training. Technician and IC level training will be added to the appropriate Haz Mat, rescue, command, and other courses.

Summary

Every Illinois community, regardless of size and whether it has an ethanol production facility or not, must be prepared to deal with ethanol fires and spills. Ethanol will soon be on every highway and rail line, and in an expanding number of commercial and private vehicles. Ethanol is only one of several possible biofuels which are being developed, but it is here now, and in rapidly increasing quantities. We must prepare now to deal with these new, but controllable, hazards.

Bottom line, we need a true partnership between industry, elected local officials, the fire service, and researchers to ensure public safety keeps up with the evolution and growth of ethanol and other alternative fuels in the U.S.