



## *Project Summary*

# Source Test and Evaluation Report: Alcohol Facility for Gasohol Production

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**This study defines the requirements for environmental sampling and analysis of alcohol-producing facilities capable of supporting a Gasohol industry and applies these requirements to the environmental characterization of an alcohol plant. This document includes a conceptual design of a grain alcohol plant using a coal-fired boiler that is projected to be typical of future plants which will support a Gasohol industry. Environmental control options are also discussed based on a comparison of alcohol plant stream compositions with environmental regulations. The results of this study provide preliminary information on the environmental consequences of large-scale fermentation ethanol plants which will provide alcohol for Gasohol.**

***This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).***

### **Introduction**

Ethanol has been used as a fuel mixed with gasoline or alone as early as the 1930s. Before World War II, over 4 million cars ran on alcohol fuels. The market for alcohol fuels, however, diminished as gasoline became inexpensive and plentiful. A systematic investigation of large-scale use of alcohol as a gasoline substitute began only with the advent of the energy crunch in 1973.

Today the term Gasohol has been coined to describe a blend of 90 percent

unleaded gasoline and 10 percent agriculturally derived ethanol, although ethanol can be used in concentrations up to 20 percent in gasoline without carburetor modification. Alcohol is an attractive alternative liquid fuel, since it can be synthesized from renewable biomass sources. As a near-term gasoline substitute, ethanol can help alleviate the oil import problem and reduce the balance of trade deficit while providing a market for farm surpluses or wood and wood residues. Many political and economic factors favor the development of a gasohol industry; however, some uncertainties that exist about the industry should be investigated. One of these is the environmental impact of large-scale alcohol-producing facilities.

Radian Corporation has conducted a program to define requirements for environmental sampling and analysis of alcohol-producing facilities that are developing to support a Gasohol industry and has applied these requirements to the environmental characterization of an alcohol plant. This program was carried out under Work Directive S1003 of EPA Contract No. 68-03-2667. Four interim reports were previously submitted to EPA under this project.

The objectives of this program are to define the requirements for environmental sampling and analysis of alcohol-producing facilities that are developing to support a Gasohol industry and to apply these requirements to a demonstrated sampling and analysis effort at a selected alcohol plant.

## Approach

To address the first objective, the determination of sampling and analytical requirements for facilities capable of providing alcohol for Gasohol, the following tasks were conducted:

- Task 1 - Data collection;
- Task 2 - Process evaluation;
- Task 3 - Review of environmental regulations; and
- Task 4 - Assessment of control technology and requirements.

In the first task, state-of-the-art technology was summarized to identify commercial or pilot plant facilities typical of those that would support a Gasohol industry. Information on ethanol and methanol processes utilizing a variety of biomass materials was collected, and a bibliography containing the sources of information for this task was assembled. It was submitted as the first interim report for this program.

To address the second task, the information gathered on alcohol technology was assessed to identify several existing alcohol beverage plants which employ processing steps similar to those which might be utilized in future alcohol fuel plants. Flow diagrams, processing steps, mass balances, and emissions sources were identified for these plants. These data were presented in a second interim report. A detailed mass and energy balance for an alcohol fuel plant considered to be typical of future alcohol facilities supporting a Gasohol industry, also presented in the interim report, has been updated and included in Section 3 of the full report.

Task 3 consisted of a review of federal and state environmental regulations that might be applicable to fermentation ethanol facilities. This information is presented in Section 4 of the full report.

In Task 4, a comparison of the environmental regulations identified in Task 3 with alcohol stream compositions was conducted to define the environmental control requirements necessary for compliance. A discussion of this analysis and designation of the probable control technologies to be implemented are presented in Section 5 of the full report.

To conduct the sampling and analysis of an alcohol plant, the second objective of this program, a site-specific sampling plan, was formulated based on the sampling and analytical requirements determined in the previous tasks. These sampling requirements and a test plan constituted the fourth interim report of this

program and are presented in Sections 6 and 7 of the full report.

A brief discussion of the sampling trip (which highlights any deviations made in the test plan during sampling and analysis) is included in Section 8 of the full report. The results and conclusions from the sample analyses are presented in Section 2 of the full report.

## Conclusions and Recommendations

The sampling and analytical requirements for the environmental characterization of an ethanol-producing facility include:

- A quantification of the pollutants present in effluent streams such as pesticides, ammonia, benzene, and metals in the solid waste streams and by-products; solids, organics, metals, pH, pesticides and benzene in the liquid effluents; and criteria pollutants, hydrocarbons, and benzene in the air emissions.
- A determination of the effectiveness of environmental control modules such as condensers on distillation columns and vacuum lines; cyclones, scrubbers, or other mechanical collectors on stacks or dryer exhausts; and biological treatment on distillery wastewaters.
- A characterization of selected internal process streams to determine the fate of pesticides or benzene losses in an alcohol plant.

It was determined that:

- Alcohol facilities might cause environmental problems from the discharge of liquid effluents or air emissions if these streams are not properly treated or controlled.
- Untreated distillery wastewaters are acidic and high in biochemical oxygen demand (BOD), chemical oxygen demand (COD), and suspended solids (SS).
- Uncontrolled exhausts from by-product distiller's dried grain (DDG) dryers are high in particulate loading.
- NO<sub>x</sub>, SO<sub>2</sub> and particulate emissions from fuel oil or coal combustion for steam generation can be a major environmental problem at an alcohol plant.
- Solid waste streams, which can be eliminated through recycle and inclusion in the by-products, pose no serious environmental problems, as they are innocuous.

The conclusions listed below are based on the analytical results obtained from

the environmental characterization of an alcohol plant:

## Solid Wastes and By-Products

- The analysis of benzene, pesticides, and ammonia in the DDG, animal feed, and biosludge streams revealed that no major environmental problems would be associated with the discharge or utilization of solid wastes from this alcohol plant due to the presence of these compounds.
- Pesticides identified on feedstock grains were apparently destroyed during feedstock preparation (i.e., cooking) as no traces of pesticides were found in the solid wastes or wastewater effluent streams.

## Wastewaters

- Dissolved solids (DS), the major contributor to total solids (TS), came from the makeup city water and well water, not the fermentation process.
- Barometric condensate, evaporator condensate, and fermenter wash water were the only significant sources of suspended solids (SS) at the alcohol plant.
- Benzene does not appear to be a major wastewater problem for this facility, which employs a benzene dehydration unit, as it was detected at levels less than 60 ppb in the wastewater.
- All wastewater streams from fermentation and distillation were acidic; they could be an environmental problem if not neutralized before discharge.
- Extended aeration and clarification reduced high concentrations of suspended solids (SS), BOD, COD, total organic carbon (TOC), and ammonia in the wastewater from this distiller to acceptable discharge levels.
- The plant records for this alcohol plant show that excursions in the biological treatment system may occur due to occasional spills or mechanical problems. Additional aeration facilities or equalization basins can be employed to avoid the discharge of poorly treated wastewaters due to upsets in the current system.
- Most of the 14 priority pollutants detected at very low levels (less than 40 ppb) in the wastewaters from this facility were found to be contaminants from equipment or

the on-site laboratory and not products or by-products of alcohol production.

- Total solids (TS) concentration in the bottoms from the solvent extractor, rectifier, fusel oil column, stripping column, and dehydration column were very low due to upstream removal in the beer still.

### **Air Emissions**

- Condensers, the only pollution abatement devices for hydrocarbons on the vent lines, provided adequate control for hydrocarbon emissions.
- Sulfur dioxide and nitrogen oxide emission levels were low, as expected for a facility using natural gas. Combustion of fuel oil or coal could present greater environmental problems.
- The analysis for particulate emissions from the cyclones on the dryers showed this facility to be in compliance. However, particulate emissions have a high potential to be an environmental problem for alcohol plants which dry their by-product grains or use coal or No. 6 fuel oil for steam generation.

It must be emphasized that the above conclusions are based on a single environmental characterization. Additional sampling and analysis should be conducted at other plant sites to confirm these initial conclusions.

### **Recommendations**

Recommendations for further research to ensure that alcohol plants supporting the Gasohol industry pose no major environmental problems include:

- (1) Gas chromatography/mass spectroscopy (GC/MS) analysis of pesticide levels in the flash cooler condensate and the feed stream to the fermenter to confirm the fate of pesticides in alcohol synthesis;
- (2) environmental characterization of other distilleries which utilize different feedstocks, processing equipment, fuel sources, and wastewater treatment methods;
- (3) evaluation of other pollution control technologies to control emissions and effluents;
- (4) performance of area monitoring for hydrocarbons to determine worker safety information; and
- (5) analysis for priority pollutant metals for the by-product stream to determine whether these species could concentrate when land-farmed or landspread.

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*The complete report, entitled "Source Test and Evaluation Report: Alcohol Facility for Gasohol Production," (Order No. PB 82-237 041; Cost: \$16.50, subject to change) will be available only from:*

*National Technical Information Service*

*5285 Port Royal Road*

*Springfield, VA 22161*

*Telephone: 703-487-4650*

*The EPA Project Officer can be contacted at:*

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