OXYGENATED FUEL STRATEGIES TO COMBAT AIR POLLUTION
A FEDERAL OVERVIEW

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INTRODUCTION:

The use of oxygenate fuel additives in gasoline as a strategy to decrease dangerous ambient air levels of pollutants, especially carbon monoxide (CO), has recently expanded dramatically. Two especially significant programs to combat air pollution were required under the 1990 amendments to the Clean Air Act: the carbon monoxide oxygenated fuels program and the reformulated gasoline program. This paper explores the legislative and statutory history of oxygenate use in gasoline and oxygenate-based pollution abatement programs, program implementation problems and public reaction, health research on oxygenates and the resulting changes in ambient air quality for cities which have instituted programs.

STATUTORY BACKGROUND

Section 211(m) of the Clean Air Act as amended in 1990 (the Act or CAA) requires states with areas experiencing dangerous levels of carbon monoxide pollution to implement winter oxygenated gasoline programs no later than November 1, 1992. This mandate is applicable to 39 areas throughout the country, although just 36 began the program on November 1, 1992.

The oxygenated gasoline program requires gasoline in the specified control areas to contain an average of 2.7% oxygen by weight during that portion of the year in which the areas are prone to high ambient concentrations of CO, typically during the core winter months. The lengths of these control periods have been established by the EPA Administrator. The Act requires that the winter oxygenated gasoline program apply to all gasoline sold or dispensed in the larger of the Consolidated Metropolitan Statistical Area (CMSA) or the Metropolitan Statistical Area (MSA) in which the nonattainment area is located. (See Table 1 below for a complete list of the CMSAs and MSAs affected by this requirement and their control periods.)

Just a few states opted to allow averaging programs, including Pennsylvania and Ohio. Other states, such as Oregon and Washington, have adopted limited averaging scenarios, allowing individual companies to average their oxygen contents over the course of the season, but not allowing companies to sell and trade credits among themselves. The majority of the states adopted programs which did not allow for averaging, thus requiring that <u>each</u> gallon of gasoline contain no less than the minimum 2.7% oxygen by weight.

Table 1: Program Areas

November 1 - February 29

Hartford-New Britain-Middletown, CT CMSA
Seattle-Tacoma, WA CMSA
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD CMSA
Greensboro-Winston-Salem-High Point, NC MSA
Raleigh-Durham, NC MSA
El Paso, TX MSA
Denver-Boulder, CO CMSA
San Diego, CA MSA
Washington, DC-MD-VA MSA
Grant's Pass, OR
Baltimore, MD MSA
Medford, OR MSA
Missoula, MT
Klamath County, OR
Provo-Orem, UT MSA
Albuquerque, NM MSA
Colorado Springs, CO MSA
Fort Collins-Loveland, CO MSA
Portland-Vancouver, OR-WA CMSA

October 1 - April 30 New York-Northern New Jersey-Long Island, NY-NJ-CT CMSA

October 1 - January 31

Minneapolis-St. Paul, MN-WI MSA
Fresno, CA MSA
Reno, NV MSA
San Francisco-Oakland-San Jose, CA CMSA
Chico, CA MSA
Modesto, CA MSA
Sacramento, CA MSA
Stockton, CA MSA

October 1 - February 29

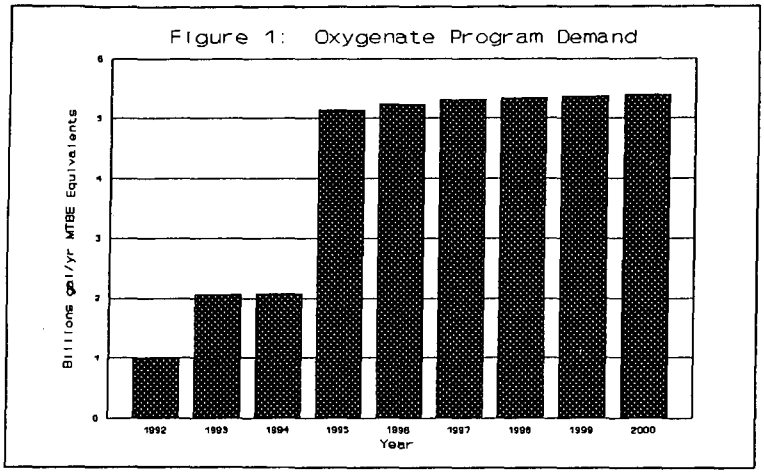
Las Vegas, NV MSA
Los Angeles-Anaheim-Riverside, CA CMSA
Phoenix, AZ MSA

September 1 - February 29 Spokane, WA MSA

Under authority set forth in another part of the Act, the Administrator promulgated labeling regulations for the sale of gasoline at retail gasoline stations in oxygenated gasoline control areas. Under the Agency's regulation, the gasoline pumps at retail stations in each control area must be labeled during the applicable control period with conspicuous labels. The labels must be clearly readable in order to provide the public with information that oxygenated gasoline is being dispensed.

Under section 211(k) of the Act, "reformulated gasoline" is required in certain ozone nonattainment areas beginning in 1995. Among other things reformulated gasoline requires at least 2.0 percent oxygen by weight throughout the year. Reformulated gasoline could represent as much as half of the gasoline utilized in the U.S. depending upon the number of states that decide to adopt the program. (Although some areas are required to adopt the program, other less severe ozone nonattainment areas can "opt into" the program.)

The program-generated demand, on a yearly basis, for oxygenates can be seen in Figure 1.



ENVIRONMENTAL BENEFITS OF OXYGENATED FUELS

Carbon monoxide (CO) is a colorless, odorless gas which can cause central nervous system effects such as a reduction in visual perception and manual dexterity, decreased exercise performance, and among individuals with chronic heart disease, a marked decrease in physical capacity and increase in chest pain. Motor vehicles are significant contributors to carbon monoxide emissions nationwide, adding approximately 75 percent to the CO inventory in major metropolitan areas. Millions of U.S. citizens are exposed to dangerous levels of this pollutant especially during the winter months.

One important strategy which an area may utilize to reduce CO emissions is the implementation of a cleaner-burning oxygenated gasoline program. For any given set of conditions, there is an optimum ratio of fuel to oxygen or air which provides the most efficient combustion. In cold weather when combustion tends to be less efficient, extra oxygen enhances combustion by offsetting fuel-rich operating conditions, especially during vehicle starting. If oxygen is added to the fuel in the form of oxygenates, a second source of oxygen becomes available (in addition to the primary source from the air). A gasoline blend containing 2.7 percent oxygen, by weight, will result in a 15% to 20% reduction in CO emissions, on a mile-for-mile basis, when compared to gasoline not containing oxygenates.

Oxygenates also cause decreases in unburned hydrocarbon exhaust emissions including certain toxic air pollutants such as benzene and 1,3-butadiene. Although oxygenates do increase aldehyde emissions, total toxic emissions decrease through oxygenate use.

WHAT OXYGENATES ARE USED?

Alcohols and ethers have been added to gasoline in various forms for over fifteen years, sometimes to enhance octane, sometimes simply as a fuel extender, and, more recently, to decrease emissions. Typically, although other oxygenates could be utilized (and have been in the past), fuel oxygen is added to gasoline in the form of ethanol, an alcohol, or methyl tertiary butyl ether (MTBE).[1] These oxygenates are used because they are the most economically viable in today's fuel market. Ethanol has been traditionally added to gasoline at 10 percent by volume, which adds approximately 3.5 percent oxygen to the fuel. However, in oxyfuel program areas, ethanol is often added at about 7.7 percent by volume to meet the program requirement of 2.7 percent oxygen. To reach the same oxygen level, MTBE is added at a level of approximately 15 percent by volume.

PROGRAM RESULTS

The previously stated 15 to 20 percent reduction in CO emissions is evidenced by what occurred last year in the cities which implemented an oxygenated fuels program. A preliminary study of exceedances of the National Ambient Air Quality Standard for carbon monoxide in these cities covering the winter months in the 1992-93 season during which an oxygenated fuels program was in place reveals a very telling picture. (See Figure 2.) For 21 areas which had not previously implemented oxygenated fuels programs, CO exceedances dropped by 95 percent when compared to the previous winter (1991-92). In California, where a program was implemented requiring slightly less total oxygen (2.0 percent oxygen instead of 2.7 percent - equivalent to about 11 percent MTBE instead of 15 percent), exceedances dropped by 80 percent. In areas with pre-existing programs, most of which required oxygen levels around 2.0 percent but, under the new program, increased to 2.7 percent, exceedances dropped by about 50 percent. Although normal year-to-year variations in meteorological conditions or patterns of vehicle use might have contributed to the decline in CO exceedances in some nonattainment areas, these aggregate national data suggest strongly that MTBE is having the kind of positive effect overall that was intended.

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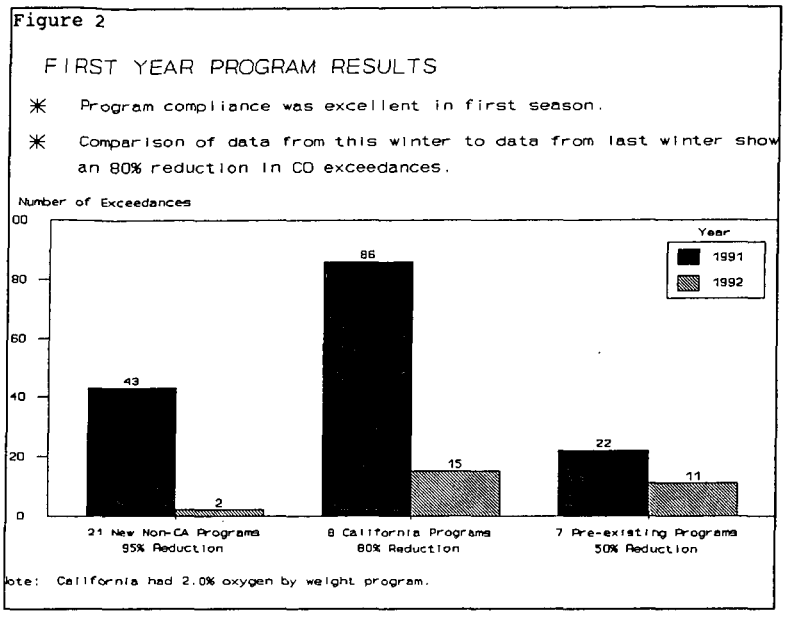
[1] Other oxygenates which can be used include tertiary amyl methyl ether (TAME) and ethyl tertiary butyl ether (ETBE), both of which have been used to a very small extent during the past season in some isolated cases. In the past certain blends of methanol and other alcohols have been used but these blends are not viable in today's market.

Figure 2



HEALTH ISSUES

Citizens in some areas of the country complained of acute health symptoms such as headache and nausea which they associated with use of MTBE in gasoline. There are a number of reasons why this reaction to MTBE-blended gasoline was unexpected. MTBE has been used in the U.S. as an octane enhancer since the late 1970's (at concentrations of 2-11%). Industry had tested many aspects of the fuel additive prior to 1992 and this research indicated no significant health concerns. Seven cities had, in fact, required wintertime use of oxygenated gasoline prior to 1992, most notably Denver which began its program in 1988, and experienced no problems similar to those in Alaska. Under the Clean Air Act oxygenated gasoline program, however, concentrations of MTBE must be generally higher than they were in Denver. (Denver required MTBE concentrations from 10-14.4%, while the Act requires 15%.)

The Environmental Protection Agency (EPA) took these concerns seriously and, in a very short time, organized a comprehensive strategy to investigate Alaska's complaints. In order to address the issue of health symptoms associated with acute exposures to

MTBE-blended gasoline, EPA outlined a six-month test program in January 1993. EPA coordinated almost $2 million worth of studies, working with the Centers for Disease Control and Prevention (CDC), the State of Alaska, industry groups represented by the American Petroleum Institute (API) and the Oxygenated Fuels Association (OFA), as well as other EPA and state offices.

The testing effort included animal studies, human clinical studies, epidemiological studies, exposure studies and automobile emissions studies and air and fuel sampling. In addition, ORD accelerated its review of existing research on chronic effects of MTBE. The results from these studies were presented at a workshop, sponsored by ORD, API and OFA, on July 26-28, 1993. The workshop enabled EPA and others to assess these health concerns before the start of the oxygenated gasoline season in 1993 in Alaska and elsewhere. EPA's assessment of the potential health risks associated with MTBE-oxygenated gasoline has been completed and indicates that MTBE appears to have very little acute health risk to healthy people under relatively temperate conditions. Hence, in terms of short-term acute health effects, these results seem to provide no basis to question continuing the overall MTBE oxyfuels program. This conclusion does not reflect that there may be a particularly sensitive subpopulation which may react to MTBE differently. However, results to date provide no firm evidence that such sensitive individuals exist or, if they do, how they might be identified. Further research on exposure to MTBE and the health effects of MTBE continues.

CONCLUSION:
Available data indicate that oxygenated fuels program implemented for pollution abatement have successfully decreased exceedences of the National Ambient Air Quality Standards for carbon monoxide pollution. Health research appears to indicate little health risk to healthy people under relatively temperate conditions.