Difficult Decisions Need . . .

A 2nd Opinion, Inc.

Clean Fuels and Regulatory Issues **Cal Hodge, President**

Clerk of the Board
Air Resources Board
1001 I Street, 23rd Floor
Sacramento, CA 95814

Also via Email to: mtbepost@listserv.arb.ca.gov
And via FAX to: 1 916 322 3928

Re July 25, 2002 ARB Public Hearing Air Quality Concerns

Subject: Science of Ethanol's Air Quality Benefits Defective

Now that four refiners have committed to using ethanol in California's cleaner burning gasoline I must share some data that raises questions concerning the science of ethanol's air quality benefits. On this issue I am speaking on behalf of my brother and his wife who live in El Cajon, their children and their grandchildren. I am concerned that when California switches from MTBE to ethanol, ozone exceedances will increase. If California's ozone exceedances increase next summer; we must use that data and the data I am going to share with you to stop the increased use of ethanol in gasoline.

When I first drew Figure 1 in 1997 I could not publish it because the type of gasoline used data was subject to a Confidentiality Agreement. Now that USEPA has published the data, I can share this chart with you. Also, at the time I could not explain why ozone exceedances doubled in areas that used ethanol-based RFG. My engineering problem solving training and integrity required that before I attribute the doubling of ozone exceedances to the use of ethanol in RFG, I must have a scientific mechanism to explain how ethanol caused the exceedances to double. Participating in the CARB fuels workshops last summer provided the puzzle pieces. Some dead time this spring allowed me to assemble the puzzle.

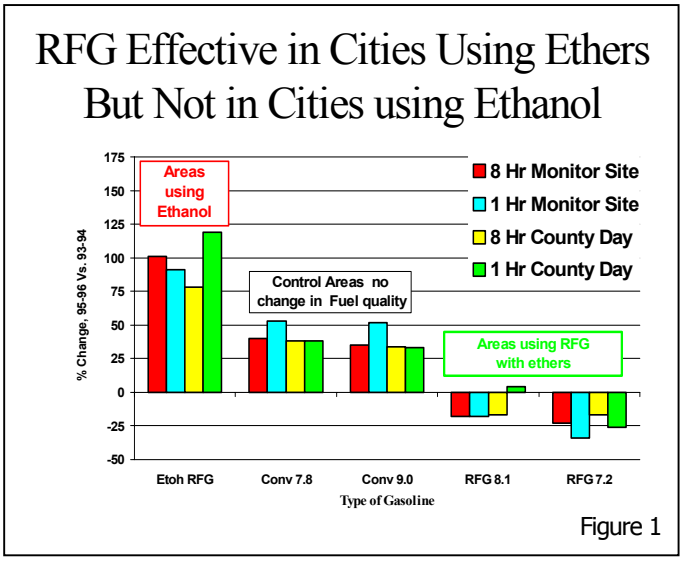


Figure 1

The data in Figure 1 comes from USEPA's database. All I did was have one-hour and estimated eight-hour ozone exceedance data downloaded into an Excel spreadsheet for the period 1993 through 1996. Because ozone monitors tend to be in ozone nonattainment areas the Monitor Site ozone exceedance data was also use to create a county ozone exceedance day data file in which a county ozone exceedance day occurred whenever at least one monitor in the county recorded an exceedance. A column containing the type of gasoline used in each county was then added to the spreadsheet that was then sorted based upon gasoline type. The percent change in ozone exceedances between the two years prior to RFG's introduction and the first 2 years of its use was calculated and then plotted in Figure 1.

4606 FM 1960 West ♦Suite 400 ♦ Houston Texas 77069
Phone: 281.586.2213 ♦ Fax: 281.586.2214 ♦ Email: CalHodge@aol.com

When I used my knowledge concerning the formula for that early Simple Model RFG I concluded that the main difference between the areas in which RFG appears to have reduced ozone and those in which RFG appears to have increased ozone is the choice of oxygenate. I also concluded it did not look good for ethanol. But, at that point I did not have a scientific mechanism to link ethanol's apparent poor performance with the observed doubling of ozone exceedances.

When I participated in the California fuels workshops during the summer of 2001; I saw some data that could explain why ozone exceedances doubled in the ethanol-based RFG areas.

Figure 2 is based upon NOx emissions data presented by the Automakers in a July 12 2001 workshop. It shows that gasoline with ethanol produces more oxides of nitrogen (NOx) than gasoline with MTBE. That reminded me that the Auto/Oil Air Quality Improvement Program test results showed that ethanol increased NOx emissions 5% while MTBE and other ethers did not increase NOx. The USEPA Complex Model is NOx neutral based upon the ether's NOx performance and some solid political science during the model's construction. The observed ethanol NOx increase is consistent with CARB's Predictive Model that shows about a 5% increase when 11 vol% MTBE is replaced with 10-vol% ethanol. There is not much data at 2-wt% oxygen (5.7 vol% ethanol). If the NOx response is proportional to ethanol content rather than oxygen content switching to ethanol could increase NOx emissions 9%. Because ozone is produced when NOx and volatile organic compounds (VOC) react in the air, the increased NOx emissions are an adequate mechanism to explain the doubling of ozone if NOx is the reactant that is in short supply in the area. California has some NOx limited airsheds. California should not use ethanol in those areas.

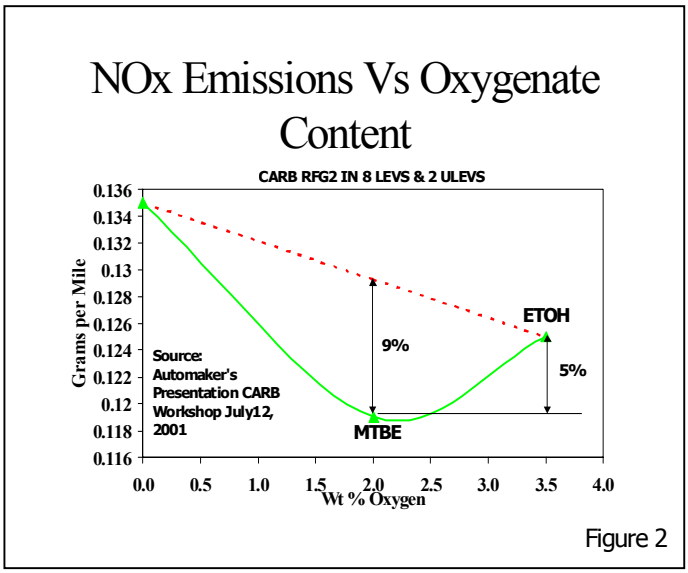
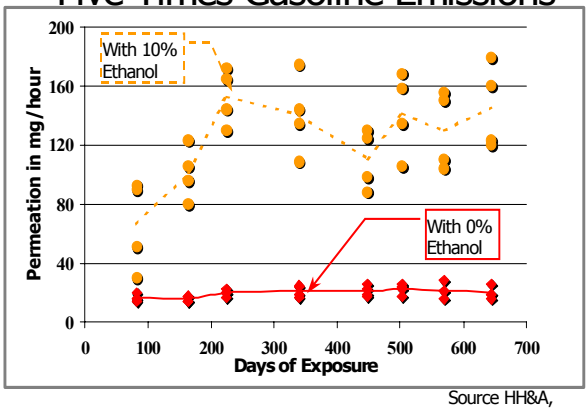


Figure 2

Harold Haskell a contractor for CARB presented the data in Figure 3 at that same workshop. It shows that gasoline containing 10-vol% ethanol has permeation emissions that are 5 times that of gasoline without ethanol. Another thing that is important about these permeation losses is that they do not show up immediately. That means the Auto/Oil studies probably missed them and that they are not reflected in either CARB's or USEPA's models. This is important because if means that ethanol has more VOC emissions than expected. ARB Staff apparently also believes this is significant because they have a permeation study in progress.



Source HH&A, CARB Workshop

Figure 3

The auto industry is very concerned about driveability, or how well a car starts and runs. They lobbied Congress to insert a driveability standard into the Energy Bill. They believe T50 is an important predictor of driveability. Therefore, they oppose any attempts to increase T50 even at the risk of restricting California's gasoline supply. One of the arguments they use is that poor driveability increases exhaust VOC emissions. In the auto industry's World Fuel Charter, they state that a gasoline containing 10-vol% ethanol has a driveability index that is 70 points worse than a gasoline made with all hydrocarbons or MTBE and hydrocarbons. Figure 4 illustrates that using ethanol in gasoline can increase exhaust emissions 11 to 19 percent. This is important because exhaust emissions are 3 times as likely to form ozone. I do not believe CARB and USEPA reflect this driveability debit in the emissions models used.

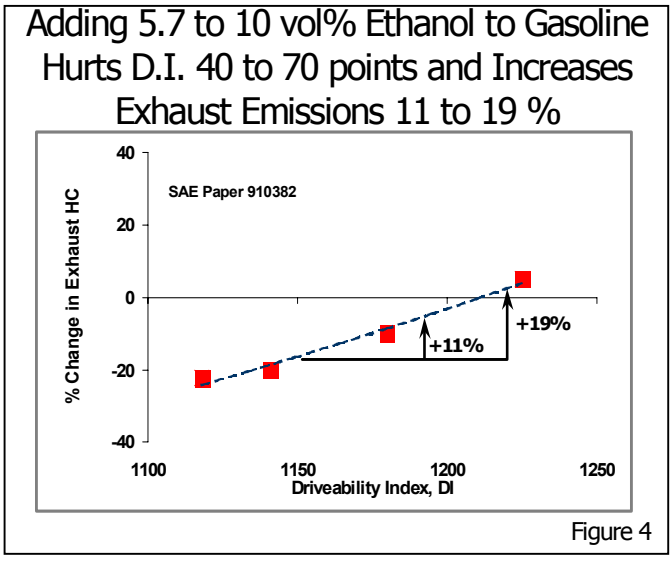


Figure 4

If we amend USEPA's Complex Model to include ethanol's NOx debits, ethanol's permeation debits and ethanol's driveability debits we find that Simple model RFG made with ethanol increased both NOx (4.4%) and VOC (33.6%) emissions relative to baseline conventional gasoline. This means that ethanol caused the doubling of ozone exceedances.

Because these ethanol defects have not been cured, (Ethanol still emits more NOx than MTBE blends. Ethanol still permeates past the seals in automotive fuel systems. Ethanol still has a driveability defect.) California will probably experience more ozone exceedances when ethanol replaces MTBE.

At this point with over half of California's gasoline supply committed to being made with ethanol in 2003 and an MTBE ban less than 18 months away, what can the ARB do? I have some suggestions:

1. Have staff review my analysis and incorporate ethanol's defects into a test Predictive Model.
2. Prepare a contingency plan to be implemented when ozone exceedances increase in 2003.
3. Watch for changes in ozone exceedances and take appropriate action.

For ***A 2nd Opinion, Inc.***