

# Catalyst & Technology

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News

## Refined Perspectives

*View on Fuel Technology Today and In the Future*

This article first appeared in Auto Emissions Magazine, a publication of Corning Environmental Technologies, Issue 2002-1, and was based on an interview conducted by Corning Environmental Technologies.

### Our interviewees include:

**Kevin Brown**

Senior Vice President operations,  
Sinclair Oil Corporation

**Terry Higgins**

Director of Refining and Special Projects  
Hart/IRI Information Services

**Art Suchanek**

Vice President  
Hydrocarbon Processing Technology,  
Criterion Catalysts & Technologies

In previous issues, Auto Emissions magazine has focused on the challenges facing auto manufacturers and the businesses with whom their future is inexorably linked. For the first time, we're presenting the perspective of fuel industry experts regarding the current state of the industry, its challenges and technological developments, and possibilities for the future.

It is a common perception that the oil industry is enormously profitable. But it is also reasonable to believe that equally huge reinvestments must be made in its business. What is the real bottom line regarding oil industry profitability?

**Kevin Brown (KB)** The perception that the U.S. refining industry is highly profitable is false. The Energy Information Administration's Financial Reporting System data indicates that the average return on capital from 1981 through 1998 was roughly 5% for the refining and marketing segment of the petroleum industry, and about 7% for the total petroleum industry. During this timeframe, the number of operating refineries decreased from over 300 in the early 1980's to 155 in 1999. During this same period, the industry was faced with enormous

investments in low-sulfur diesel and reformulated gasolines outside California, and even more stringent standards inside California. In addition to these investment requirements, the industry had additional expenses for new safety and environmental regulations. In spite of these significant changes, petroleum products were supplied at relatively constant margins. Our future challenges are likely to be the same as our past challenges. We will continue to work hard to remain profitable in the face of continuing investment requirements to produce ever-cleaner fuels while complying with more complex and demanding environmental and safety regulations.

**Terry Higgins (TH)** While the fuel industry is healthy and has been able to maintain profitability in the face of many fiscal challenges in recent years, returns on investment for petroleum as a whole average below the S&P 500. Furthermore, returns of the refining and marketing segment of the business (i.e., fuels industry) are below that of the other petroleum business segments.

The less-than-average returns can indeed be attributed to the huge investment required to maintain productivity, safety and environmental standards.



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For example, refining and marketing spent about \$50 billion in stationary source environmental facilities over the period 1991-2000.

These investments generate safety and environmental benefits, and sometimes productivity gains, but are difficult to recoup in the market and/or do not lead to market growth. The industry will continue to require similar types of investments, at least through 2005. These ongoing stationary source expenditures, coupled with the need to make significant investments for new product quality changes (i.e., lower sulfur), will result in capital expenditures by the industry exceeding historic maximums. Based on average industry income over the past decade and the anticipated industry costs, the refining industry as a whole will be asked to invest more than two years of income. This burden does not fall equally among all refiners. For some, the impact on income requirements will be much greater.

### What are some of the short-and long-term challenges being dealt with in your industry?

**TH** Increasingly stringent fuel controls are resulting in cost and technical challenges. Costs include the ongoing expenditures and new product quality initiatives. The recent gasoline and on-road diesel sulfur regulations alone are expected to cost the industry somewhere between \$13 and \$16 billion. Regulations for off-road diesel and reduction of the gasoline additive MTBE are expected to be right around the corner. Although the details of these programs have yet to be specified, their cost may be on the order of another \$4 to \$5 billion.

There are also challenges associated with technology itself, operational demands, the fuel distribution system, engineering and construction capability, and permitting. The ultra-low sulfur specifications will require technology only recently or not yet fully commercialized. Development problems are likely and some have already surfaced. Once the facilities are installed, the stringency of the regulations will require near perfect operations for these new technologies and for the entire refining support network. The required reliability, level of performance, and continuity of operation will be well beyond the normal currently required.

In some cases it will also be extremely difficult to deliver the ultra-pure product (i.e., 15ppm sulfur diesel) and maintain the integrity of the sulfur down to the consumer. The on-road diesel shares a distribution system with other products that have higher sulfur contents, posing significant contamination concerns.

There also are concerns about the capability of the engineering and construction industry and specialty equipment manufacturers to accommodate both gasoline and diesel sulfur regulations, along with similar requirements abroad and other U.S. fuel and stationary source control initiatives. The permitting process will also be pressed to the maximum and may not be able to keep pace with the anticipated schedule.

Industry is attempting to address these challenges on a number of fronts. Technology and catalyst vendors have stepped up their development efforts considerably and are working with the refining industry in the evaluation of needs/solutions. Yield loss and operating severity are key focus areas, as is the search for synergistic opportunities between product regulations or product value enhancements. Computer on-line control will have greater significance in daily operations to maintain production with tighter limits. On the engineering side, we understand that firms are undertaking standardization and other measures to enhance the capability to respond to demands. The EPA also is working to streamline the permitting process.

**Art Suchanek (AS)** The biggest challenge for the independent refiner is getting the money to solve problems. For the industry, the challenge is meeting the time requirements to comply with regulations. Globally, one of the biggest problems is the time it's going to take to change out the old engines. Our business is to come up with customized technologies that deliver the right, or better, refining process to achieve whatever end product the refiner wants. I firmly believe that technical people can solve any technical problems - it just takes time and money.



Keeping up with emissions control requirements that become more stringent with every passing year must create unique challenges for the oil industry. Exactly what are some of the challenges being dealt with in the oil industry and how are they being addressed?

**KB** The greatest challenge is in applying the proper technology to meet the new requirements. In some cases, those technologies have not been developed. In my opinion, the greatest challenges currently facing the industry are the low-sulfur gasoline and diesel rules. The low-sulfur gasoline rule will mean investing in technology that will increase operating expenses and reduce the profitability of refineries. The diesel rule presents a greater challenge because of its structure. We believe the implementation schedule is too close to the gasoline sulfur reduction schedule and that the phased approach is flawed.

**AS** There are ways to solve any challenge in making fuels, but having the money to do it and the profitability that needs to go along with the project is another matter. There are also problems with the way we're asked to do things. For example, years ago regulators required that MTBE be added to gasoline. Refiners built plants to produce MTBE and now, they are being told to take it out. That creates a lot of stranded investment.

What are your perspectives on tightening regulations?

**TH** We need to continue progress towards more environmentally friendly and efficient fuel and vehicles. We support environmental improvement through fuel quality changes directly. We recognize that fuels play a major role in enabling vehicle emission control systems. In fact, the refining industry offered proposals for lowering the sulfur content of both gasoline and diesel fuels significantly prior to EPA rulemaking, but not to the ultra-low levels specified by EPA.

**AS** We sell catalysts to the oil industry to be able to make clean fuels, so the regulations help our business. Personally, I think sometimes the regulations go

too far. EPA's regulation-setting process aims to force technologies. They do not seem to hear us say that we have real doubts that a 15ppm diesel standard, for example, is one the oil industry can meet reliably and consistently in the time frame being set. Also, there is not enough cooperation. I firmly believe that if people work together - automobile manufacturers, refiners, regulators, everyone - the technical people will solve the problems.

Do you think it would be beneficial for refiners to accommodate only the toughest fuel standards and market only that quality of product globally?

**KB** Sinclair does not support a single fuel standard for several reasons. First, the tough standards being applied now are "technology enabling" steps. Providing these lower sulfur fuels where not needed has diminished returns relative to the environment at considerable cost to the manufacturer and ultimately, the consuming public. Secondly, these products will be more expensive and it doesn't seem fair to require all areas of the country to pay higher fuel prices to meet a standard for those areas with more polluted air.

**TH** On the surface, standardization of fuel product quality, particularly to the most environmentally beneficially standards, may appear beneficial, and perhaps should not be eliminated from consideration for the very distant future if fleet control technologies are standardized as well. It would offer maximum flexibility in terms of product disposition and maximum environmental benefit to all regions. It may also enhance the ability of less advanced areas to introduce newer technology.

On the other hand, standardizing on the single most stringent specifications has substantial drawbacks, particularly where there continue to be variations in environmental or other circumstances and a non-uniform fuel/vehicle system.

Fuel quality improvements come at increasingly higher costs which cannot be justified for all areas. Some may have available alternate, more cost-effective environmental control strategies while others do not have the environmental need. Fuel quality improvements are also highly dependent on refined

product mixes, refinery configurations, etc., which vary significantly throughout the world (and even within the U.S.) and are not likely to standardize in the foreseeable future. Finally, benefits of fuel standardization cannot be realized without vehicle and proper optimization of the fuel/vehicle system.

**AS** Refiners have been customizing products for years. They are being asked to customize them around total perfection now, which makes it more difficult. In Sweden they have tax incentives to be able to help pay for some of these things. In the UK they literally tax dirty fuel so that people will buy the clean fuel. In the US, I think that somebody needs to do something similar.

### How would you sum up the current state of fuel technologies?

**TH** Fuel technologies have continued to improve, but at the same time, so have quality requirements. The more recent fuel regulations are designed to be technology forcing, requiring that technology be developed or improved to just to keep pace with requirements. These technological improvements focus more on cost considerations and efficiency gains rather than new formulas or reformulations designed at emission control. For example, there have been many recent technology enhancements which allow for lower sulfur product while minimizing loss of product yield, energy content and, for gasoline, octane.

**AS** Everybody is trying to get where they need to be to comply with regulations. I think one of the biggest problems the oil industry, has, especially in the United States, is potential contamination from pipelines. Pipelines have been using high-sulfur fuels for years and it coats part of the pipeline. As you put clean fuel in, it basically cleans it, contaminating the clean fuel. The pipelines are used for many other products and products that still have sulfur in them will cause contamination.

### Are there fuel formulas in development currently that will help to accommodate the need for a cleaner, more efficient burn with fewer emission concerns?

**TH** Development in gas-to-liquids (GTL) technology represents one area of potential for cleaner fuels. While not specifically developed for low emissions, they produce high-quality product consistent with the requirements of upcoming fuel regulations and perhaps in the longer term may offer an option for the fuel cell.

**AS** The timeframe that has been set for this is a problem. The big issue is that no one knows when all of the old engines will be changed out. If you put 15ppm sulfur into an old engine, you still get emissions.

### What do you see as some of the biggest challenges to the evolution of fuel and processing alternatives?

**TH** I do not see much opportunity for solutions until we address the latest round of fuel sulfur regulations and the supply issue. After that, the introduction of new technologies such as fuel cells could ease the pressure on traditional fuels. The biggest challenge is cost. As with other industries, fuel improvements require increasing levels of cost. For an industry already facing huge costs and a history of relatively low returns, incremental focus on emission reduction is difficult to justify. This is particularly so given past consumer response to increases in fuel costs. Another challenge is maintaining adequate supplies. Refiners are operating at near maximum and will need to invest in additional capital to meet future demand. At the same time, the ultra-low sulfur regulations tend to reduce supply capability. Furthermore, the industry may be facing a mandated reduction or elimination of the gasoline additive MTBE. This could remove up to three percent of gasoline volume.

**AS** Cost, time and perceived profitability are the biggest challenges to the evolution of fuel and processing alternatives. There's no way around making additional investments. The question is who can do it for the lowest cost.

**Do you think that diesel-fueled automobiles will gain popularity in the U.S. in the next couple of years?**

**KB** I think this depends on the direction of the auto industry. I think consumers will evolve away from SUVs. The next trend is likely to be toward an all-wheel-drive sedan.

**TH** Vehicle manufacturers indicate their intent to market diesel vehicles in the lighter duty classes. I am not optimistic as some people, but I would think trucks and larger SUVs offer the best potential.

**AS** It depends on the cost of the fuel and the cost of the vehicle.

**What is likely to drive any increased popularity of diesel?**

**KB** Cost of operation and acquisition will be the biggest factors.

**TH** I think a combination of technology and regulatory requirements will be the driver. CAFE requirements will drive vehicle manufacturers to develop the technology necessary to produce an acceptable light-duty diesel from an environmental and consumer satisfaction perspective.

**What is your opinion of hybrid technology?**

**KB** I'm not sure that hybrid systems will gain public acceptance in the short-term or that they will compete with fuel cells in the long-term. Their viability is likely tied to the development time for fuel cells.

**TH** I think that hybrid technology may be viable simply because it is totally compatible with the existing fuel infrastructure. It also has the potential advantage of appeal to the energy conscious or environmentally concerned consumer for its perceived environmental benefit. Despite its excellent gas mileage, I understand that there are challenges with hybrid emissions control systems.

**AS** I like the hybrid engine; it's a neat invention with great potential. If you can cut your fuel consumption by 50% by using a hybrid combination of gasoline and electricity, I think it's a great idea.

**What is your opinion of fuel-cell technology?**

**TH** Fuel cells have made significant progress, but their viability as an auto power system seems uncertain due to the fuel system. The ideal fuel is hydrogen, but on-board storage, safety and logistics are problematic. Methanol and compressed natural gas offer another alternative, but the existing infrastructure does not support them and they require the addition of a reformer on-board. Use of liquid hydrocarbon fuel similar to gasoline eases the logistics problem, but here the ideal fuel would be free of sulfur and other contaminants, and highly paraffinic, unlike today's gasoline. In the end, it will probably come down to the cost to produce the fuel cell and its reformer compared to the cost of an advanced internal combustion engine.

**AS** I think fuel cells may be the next logical step after the hybrid.

**KB** I think the question is when, not if, fuel-cell technology will be implemented and what fuel source will be used.

**What do you see as the fuel of the future for mobile power systems 10-20 years from now?**

**AS** In the future, fuel is going to have to be clean no matter what power system we go to. However, getting a realistic definition of "clean" that everyone can agree on will be challenging.

**KB** We will continue to use carbon and hydrogen to fuel vehicles, whether in liquid or gaseous form. I do see a demand for typical liquid hydrocarbons over the next 20 years, if for no other reason than fleet turnover.



**TH** In 10 years, I anticipate the low sulfur gasoline programs will be in place. In 20 years, I think alternative technology vehicles will represent less than 20 percent of new vehicle sales. The gasoline hybrid, high-efficiency diesel and alcohol vehicles will likely make up about 75 percent of these vehicles, with

gaseous fuels, electric and fuel cells accounting for the remainder. It is unlikely that we will see any significant change in traditional fuels. In fact, the Department of Energy projects that traditional gasoline and diesel use will actually increase by more than 35 percent by 2020.



## Worldwide Offices:

### HOUSTON:

16825 Northchase Dr; Suite 1000  
Houston, Texas 77060-6029  
Telephone: (281) 874-2600  
Facsimile: (281) 874-2641

### CANADA:

Suite 810, Centre 104  
5241 Calgary Trail Southbound  
Edmonton, Alberta T6H 5G8  
Canada  
Telephone: (1) 780-438-4188  
Facsimile: (1) 780-438-3473

### UNITED KINGDOM:

1650 Parkway  
The Solent Business Park,  
Whiteley, Fareham,  
Hampshire, PO15 7AH  
England  
Telephone: (44) 1 489-881881  
Facsimile: (44) 1 489-881882

### SINGAPORE:

298 Tiong Bahru Road  
#07-03 Central Plaza  
Singapore 168730  
Telephone: (65) 6276-3627  
Facsimile: (65) 6276-7455

### LUXEMBOURG:

Route de Longwy, 420  
L-4832 Rodange, Luxembourg  
G.D. of Luxembourg  
Main Tel#: (352) 502-454  
Catalyst Regeneration Services  
Main Fax#: (352) 502-996

Visit us on the web: [www.criterioncatalysts.com](http://www.criterioncatalysts.com)

e-mail address: [publicaffairs@criterioncatalysts.com](mailto:publicaffairs@criterioncatalysts.com)



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