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Technologies For Making Clean Diesel Fuels

Over the last three decades, refiners have been forced to make difficult investment decisions to produce the more environmentally acceptable fuels required by increasingly stringent regulations. As long as the public continues to demand cleaner air and safer products, we expect fuel specifications to become even more stringent. In this enclosure, we discuss the catalysts and technologies we offer to make cleaner burning diesel fuels and our thoughts on possible further changes to such fuel specifications.

Today, *there are two approaches for reducing emissions from diesel engines:*

(1). Improve the diesel quality so that the fuel burns cleaner. Fuel qualities that contribute towards a cleaner burn are higher cetane number and lower density, polynuclear aromatics, endpoint, and sulphur content.

(2). Install a post-treat device on the tailpipe to complete combustion of the fuel and remove nitrous oxides. For effective operation, these devices require that the diesel fuel contain very little sulphur.

Worldwide, regulators differ on the best way to effect emissions reductions. For example, in the US, regulators currently emphasize post-treating to reduce emissions while Europe and Japan have chosen to improve diesel quality.

This latest round of regulation will not be the last. A likely end-state can be found in the *World Fuels Charter*, endorsed by vehicle and engine manufacturers. It specifies the following qualities for future diesel fuel:

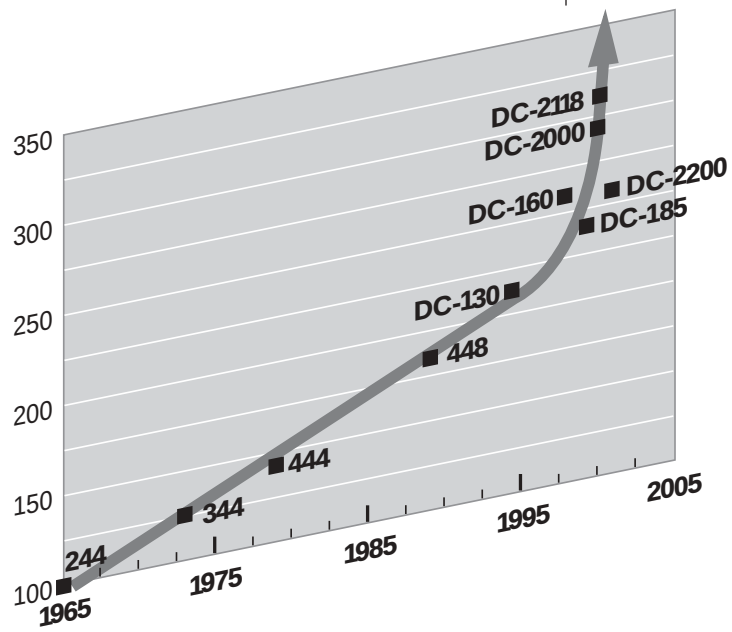
Sulphur	nmt	5ppm
Cetane	nlt	55 number
Gravity		37-41° API
Density		0.82-0.84 g/cc
T90	nmt	610°F (320°C)
PNA	nmt	2 wt%
Aromatics	nmt	15wt%

Why does the WFC call for both lower sulphur and improved diesel quality? This combination will enable diesel engines to provide the best combination of fuel efficiency, emissions reduction, and driveability. Driveability is most important for automotive diesel engines, which are inherently more efficient than gasoline-powered engines.

CENTINEL Technology for Ultra Deep Desulphurisation

The graph below shows how the desulphurisation activity of Criterion's CoMo catalysts has improved over the past thirty-five years. The activity has doubled over the past ten years. Our latest development is CENTINEL technology, based on a breakthrough in the understanding of hydroprocessing catalysis. CENTINEL catalysts have significantly higher activity for diesel desulphurisation compared previous generations of catalysts. CENTINEL technology also provides enhanced nitrogen removal and aromatics saturation for FCC and hydrocracker pretreating catalysts. Since the technology is relatively new, we have just begun to exploit its benefits in our products. Over the next few years, we expect to offer a series of activity enhancements in our catalysts based on CENTINEL and other innovative technologies.

SYNShift for Density and Cetane Improvement



SYNShift catalysts improve diesel quality by selectively opening naphthene rings. This reaction is very efficient for reducing the density and improving the cetane number of diesel fuels. That is, the improvement per unit of hydrogen consumption tends to be higher than obtained by aromatics saturation, as the chart below illustrates. This chemistry gives additional benefits in promoting the removal of sulphur, nitrogen, and polynuclear aromatics, as well as lowering the 90% point in the distillation of diesel fuel.

In many applications, SYNShift catalyst can be used in place of a conventional HDS catalyst with no additional reactor volume required. Our first commercial SYNShift application started up five years ago and confimed our theories on this important technology. We are gratified to see that many of our competitors and others in the industry are starting to talk about the benefits of ring-opening on diesel quality. Meanwhile, we continue to improve our commercially proven SYNShift catalysts.

	Feed	HDS Only	SYNShift	SYNSAT
API Gravity	25.3	30.4	32.6	33.2
Specific Gravity (60/60)	0.902	0.874	0.862	0.859
Sulphur, ppm	13800	18	<10	3
Nitrogen, ppm	1010	17	<10	2
FIA Aromatics, lv%	58.2	54.5	45.8	34.9
Cetane Index	34.3	39.2	41.4	41.7
Chemical H2, SCFB		600	900	1100
Liquid Yield, lv% feed		102.7	104.7	105.1

SYNSat for Aromatics Reduction

With SYNSat technology, a refiner can modify an existing HDS to make a diesel fuel containing reduced aromatics. A noble metal catalyst is used in a second stage, which enables aromatics reduction at half the pressure needed for base metal catalysts. Lummus' patented counter-current reactor provides an environment where the activity of the noble metal catalyst is extremely stable. There are eight operating units based on SYNSat technology.

In newer diesel hydrotreaters, we can sometimes achieve the required reduction in polynuclear and total aromatics using base metal catalysts. This is the result of the higher design pressures favored for ultra deep desulphurisation and improvements we have made in catalyst activity.

Don't Risk Stranding Your Investment;

Call Us!

Around the globe, Criterion is working with refiners to develop non-regrets solutions for their clean fuel needs. Using a non-regrets approach, we anticipate future changes in fuel qualities so that investments can be made in a step-wise manner. This maximises cash flow to the refiner by deploying capital only when necessary.

For more information, call your local Criterion office.

We look forward to serving all of your hydroprocessing needs.

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