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Committed to evolution

ADDITIVE COMPOSITION FOR ETHANOL FUELS

1st Brazilian BioEnergy Science and Technology Conference

Campos do Jordão – August 2011

Agenda

- Oxiteno
- Sustainable Biofuels Alternatives
- Ignition Improver Evolution
- Lubricity
- Ultrafluid ECO®
- Application Results
- Conclusions

Oxiteno

- Brazilian company part of ULTRA

  largest producer of surfactants in Latin America

- Integration in key raw materials (Ethylene Oxide and Natural Fatty Alcohols)
- **10 industrial sites** located in Brazil, Mexico and Venezuela
- Commercial offices: São Paulo, Buenos Aires, Caracas, Mexico City, Chicago and Brussels
- **Permanent innovation** (R&D centers in Brazil and Mexico) – 10% of total employees

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greenformance®

ACHIEVING SUSTAINABILITY AND PERFOMANCE WITH OXITENO'S PRODUCTS

Renewable resources
Raw materials from vegetable origin replacing synthetic and petrochemical components.

Environmental care
Concentrated and biodegradable products that help reduce energy use, water consumption and packaging.

Health and wellness
High performance formulations, minimal by-products, non irritant, mild and safe.

20% of raw materials from renewable sources

30% of products with renewable ingredients

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Sustainable Biofuels Alternatives

- Economical and environmental factors dictate the development of non-polluting fuels obtained from renewable sources in order to replace fossil-based fuels.
- Gasoline- and diesel-powered vehicles are the largest source of VOCs in most urban areas (1)

Viable Biofuel should provide

- Environmental benefits
- Low emissions (CO_2, THC, NOx, PM)
- Cost effectiveness
- Availability in large quantities
- Non competition with food supplies

(1) Pereira, P.A.P; De Andrade, J. B.; Miguel, A.H.J. Environ. Monit. 2002, 4, 558-561

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Main Biofuels Alternatives

Ethanol

- Most of World's biofuel
- Local and global fuel
- Many feedstocks & forms
- CO_2 reduction

Biodiesel

- Many feedstocks
- Similar to diesel
- Fuel quality issues
- High and low blends
- CO_2 reduction

Biogas

- Local waste to fuel
- Good for local fleets
- Can be combined with CNG
- Expensive infrastructure
- CO_2 reduction

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Ethanol

- Well-known alternative fuel for otto cycle engines (spark ignition)
- Technology development over decades

Ethanol in diesel engines (**Compression Ignition)**

- Calorific value of ethanol is about two thirds of diesel oil
- Ethanol has poor ignitability (high heat of evaporation of the fuel)
- The direct use of ethanol in Diesel engines is limited by its inherent low lubricity and low cetane number

Ethanol as main fuel for diesel engines requires some form of ignition improvement

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Ignition Improver

Cetane Number is an indicator of the time delay between injection and spontaneous ignition of fuel in a standard diesel engine running under specified conditions; the shorter the ignition delay; the higher the cetane number

Diesel N° 2

Typical Cetane Numbers are 40–50 (minimum 40)

Ethanol

Estimated cetane number is between 5 and 15 (low cetane rating).

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Ignition Improver Landscape

Ignition improver based on nitrates

- Shorter ignition delay
- Hydrolysis – corrosion, effectiveness and shelf life issues
- Instability at handling temperature – explosion risks
- Toxicological issues
- Poor lubricating properties

TREND

Ignition improver based on polymeric oxygenated compounds

- Free of nitrates
- Stable at room temperature
- Safe handling
- Inherent lubricant properties
- Low residual ash
- Low soot formation

Trials with ignition improvers give a cetane number of ~40 for ethanol

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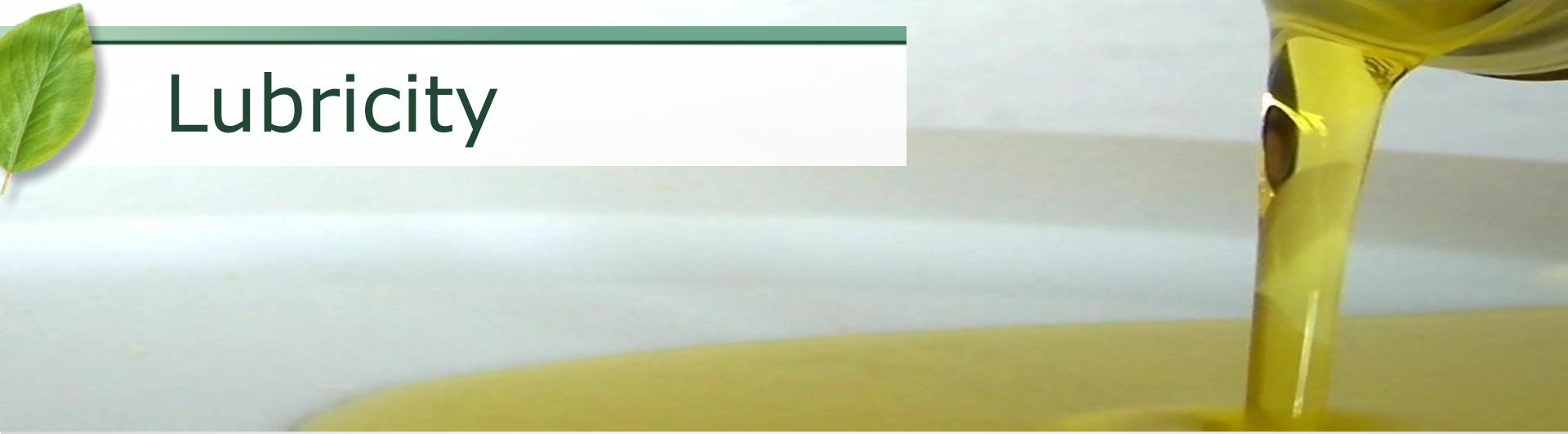
Lubricity



Fuel viscosity and lubricity play significant roles in the lubrication of fuel injection systems

Mineral Oil			Synthetic lubricants	
Improving Volatility & Low Temperature Performance →				
Group I	**Group II**	**Group III**	**Group VI**	**Group V**
80 < VI < 120 Sat < 90% S > 0.03%	80 < VI < 120 Sat > 90% S < 0.03%	VI > 120 Sat > 90% S < 0.03%	PAOs	OTHERS (e.g. Synthetic Esters)
			Synthetic Hydrocarbons (Polyalphaolefins PAO and polybutenes)	(Esters and PAG´s) Raw materials include Oleochemicals
Hydrocarbons from Refineries				

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Lubricant Agent

- Good thermal and oxidative stability that allows the lubricant to operate over a broad temperature range
- Biodegradability features that allow formulation of products with environmental benefits.

Factors such as saturation, chain length might influence the performance of these additives

Unsaturation
Chain length → **Better lubricity**

High Performance Lubricants

Synthetic lubricants

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Ethanol additive for diesel engines

Ultrafluid® ECO

Ethanol additive characteristics

- Nitrate free
- Based on oleochemical feedstocks
- Composition:
  - Polymeric Oxygenated Compounds (cetane improver)
  - High Performance Group V (Lubricant agent)
  - Corrosion inhibitor
  - Coupling agent

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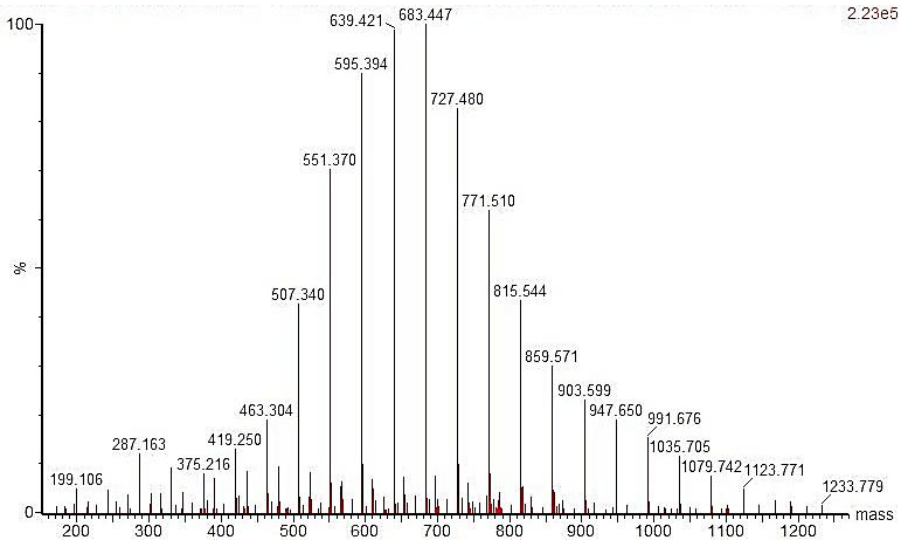
Ethanol additive for diesel engines

Igniton Improver Development

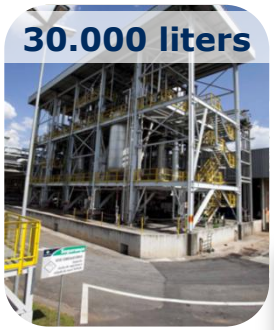
- Multi sequential addition reaction
- Product configuration design
  - Process parameters
  - Capability (R&R)
  - Side reactions inhibition
- Purification process development
  - Low ash/soot

Chemical Characterization



Homologues Distribution

Scale up evaluation



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Ultrafluid® ECO development

Lubricant Agent

- Group V lubricant– higher unsaturation levels
- HFRR test - a lower wear scar indicates better lubricity

Performance Tests - Lubricity

Sample	ASTM 6079 WSD [mm]	ISO 12156 WS1,4 [µm]
Diesel Reference	**Max 0,52**	**Max 460**
Ethanol with Ultrafluid ® ECO	**0,41 ± 0,01**	**423,5 ± 6,4**

ASTM D 6079-99 (*Standard Test Method for Evaluating Lubricity of Diesel Fuel by High Frequency Reciprocating Rig)*
ISO 12156 (*Diesel Fuel – Assessment of lubricity using the high frequency reciprocating rig (HFRR))*

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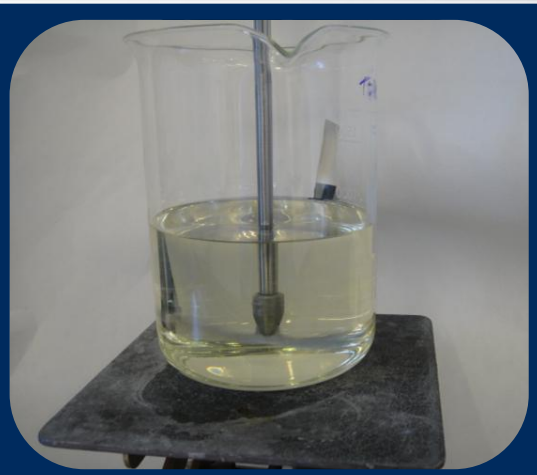
Ethanol additive for diesel engines

Additive Compatibility

- Lubricant agent and ignition improver are immiscible – non-stable solution
- Coupling agent - sugar derivative – was added to produce a stable solution
- Additive stability was evaluated during one year.

Ignition Improver + Lubricant agent two-phase formation

Ignition Improver + Lubricant agent Non-stable solution



Ignition Improver + Lubricant agent + coupling agent Stable solution

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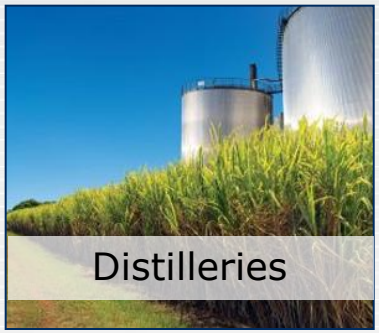
Ultrafluid® ECO Value chain



Ethanol

Ethanol

OXITENO **Ultrafluid ECO®**

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Ultrafluid® ECO

Conclusions

The additive Ultrafluid® ECO developed with a new generation of ignition improver has demonstrated excellent application results, as demonstrated in the following highlights:

- **Safe handling product**
- **High efficiency in ignition improvement**
- **High lubricity properties to ethanol**
- **Use of additives from renewable sources**
- **95% Renewable Source Fuel**

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Thank you!

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