

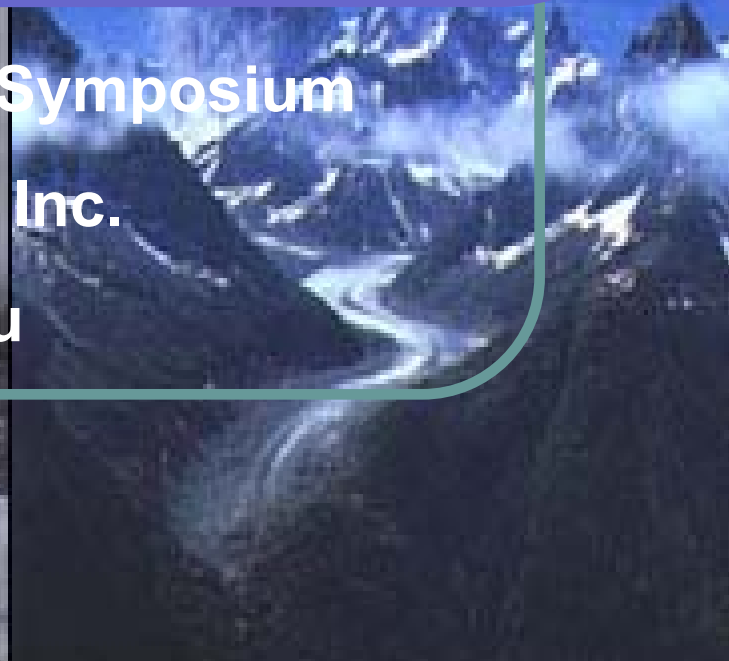
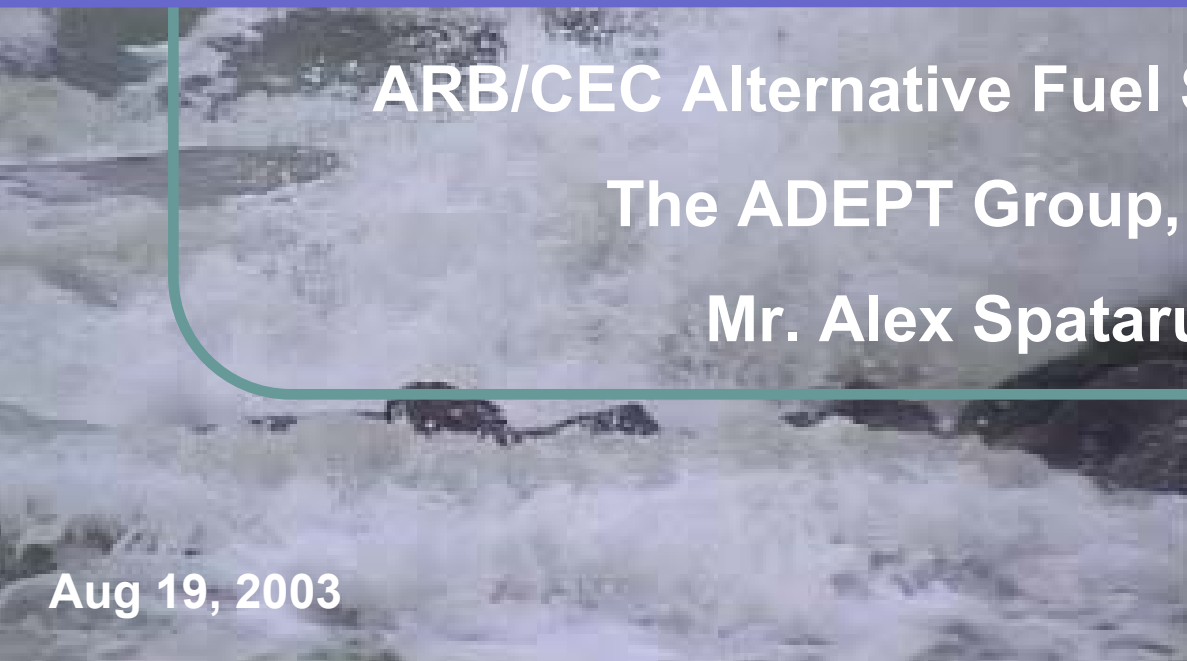


Emulsified Fuels in Western Europe – An Overview

ARB/CEC Alternative Fuel Symposium

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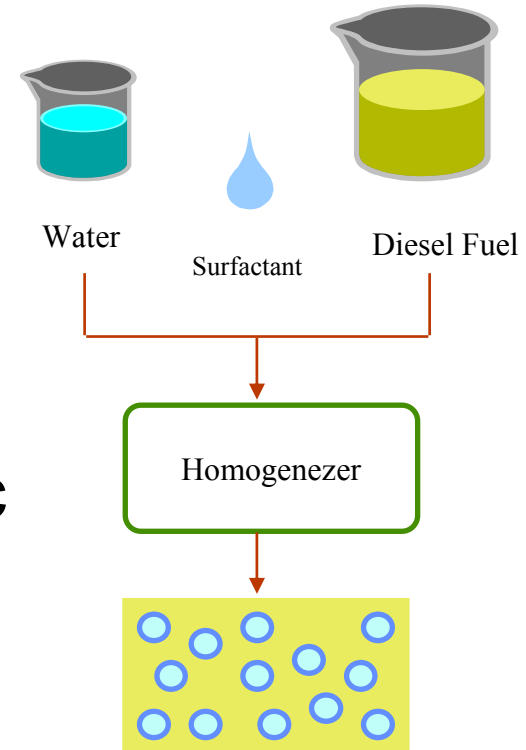


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What are Water - Emulsified Fuels?

- Adding water to diesel dates back to the early 1900's. There are hundreds of patents issued on water-diesel blends.

- Emulsified diesels are defined as emulsions of water in diesel.
- Typically made of 10-20% mass/mass water mixed with specific additives.



How do emulsified diesels work ? And with what results?

- Water in diesel yields the following effects:
 - Water vaporization increases fuel dispersion in the form of smaller droplets.
 - Contact surface between fuel and air is increased.
 - Combustion is more efficient.
- Net results:
 - Reduces combustion temperature peaks (lowers NO_x).
 - Particulate formation is reduced (lowers PM).

What are the benefits?

- Lower emissions:
 - Up to 25% NO_x reduction.
 - Up to 60% PM reduction.
 - Up to 80% smoke reduction.
 - Up to 5% CO₂ reduction.
- Better lubricity.
- Increased thermal efficiency.

Emulsified diesel is only emission-control fuel technology that simultaneously lowers both PM and NO_x.

Qualification of emissions reduction advantages.

- The magnitude of the emissions reductions advantage from emulsified diesels is a function of:
 - Engine type,
 - Operating conditions,
 - Properties of the baseline diesel fuel, and
 - Properties of the diesel fuel that is blended into the emulsion.

European vs. EPA NOx and PM requirements for HD Diesel engines

	European Standards (g/bhp-hr)				EPA Standards (g/bhp-hr)		
	Euro II	Euro III	Euro IV	Euro V			
	1998.1 ¹	2000.1 ²	2005.1 ²	2008.1 ²	1998	2004	2007
NOx	5.22	3.73	2.61	1.49	4	2-2.5 ⁵	0.2
PM	0.11	0.07	0.01	0.01	0.1 ³ 0.07 ⁴	0.1 ³ 0.07 ⁴	0.01

¹ Test Cycle ECE R-49.

² Test Cycle ESC, ELR.

³ For regular engines.

⁴ For urban buses.

⁵ NOx + HC at 2.5 g/bhp-hr; HC contribution can not exceed 0.5 g/bhp-hr.

European emulsified fuel applications

- On-Road

- Public fleets.
- Mass transit fleets.
- Private fleets.
- Garbage collection fleets.

- Off-Road

- Marine engines.
- Locomotives.
- Power generation.
- Construction equipment.

- Other

Large institutional combined heat sites (apartment complexes, hospitals, universities, etc).

- Industrial boilers.

Emulsified diesel providers in Europe

- There are four (4) companies who commercially sell emulsified diesels in Europe.

<u>Company Name</u>	<u>Distribution Mode</u>
1. Cam Technologie*	With own fuel
2. Clean Fuels Technology	Additives Package + System
3. Lubrizol*	Additives Package + System
4. TOTAL*	With own fuel

* Members of the European Emulsified Fuel Manufacturers' Association (EEFMA)

EEFMA* Objectives

- Promote the market image of emulsion fuels in Europe.
- Identify and seek to remove market barriers.
- Define and maintain high standards within the industry.

* European Emulsified Fuel Manufacturers' Association (EEFMA)

EEFMA's Goals

- EEFMA's market barrier removal goals are:
 - Unified European standard for emulsified diesels,
 - Favorable and unique fiscal treatment across the European Community.

Emulsified diesel technology providers

Company	Based in	Countries where sold	In-Field Experience
CAM Technologie	Pero (MI), Italy	France, Italy, Switzerland	5 yrs
Clean Fuels Technology	Reno, NV, USA	Italy	10 yrs
Lubrizon	Wickliffe, OH, USA	Italy, UK	3 yrs
TOTAL	Paris, France	France, Italy	8 yrs

Products overview

Company	Product Name	Distributor/s	OEM Warrantee*	Water Content
CAM Technologie	Gecam™	AGIP, Petrofuel S.p.A, RA.M.OIL S.p.A, ERG, SARAS.	IVECO, Man, Deutz	10-11%
Clean Fuels Technology	Aquadisel	IPLOM S.p.A.		13%
Lubrizol	PuriNOx™, Qwhite, Aspira	BP, Q8, Blanco Petroli, Green Oils, Kuwait Petroleum Italia	Mack, Caterpillar, Man	10-20%
TOTAL	Aquazole™	Own network	Irisbus, Iveco, Scania, Renault VI	14-17%

* On Engine and/or Vehicles; not exhaustive.

Equipment related market barriers*:

- Limited acceptance by engine manufacturers.
- Limited acceptance by equipment manufacturers.
- Limited acceptance due to lack of a European standard.
- Limited fleet acceptance.

* as reported by EEFMA.

Fiscal regimes in seven (7) European countries.

Favorable	Neutral	Unfavorable
France* Italy*	UK Switzerland Netherlands	Germany Spain
Special fiscal classification	No tax on water content	Taxed as diesel fuel

**National Standard established*

The Italian model

- Tax incentive* - 36%
- Bus and Coach market size ~ 34,200
- Running on emulsified diesels ~ 8,100
- Bus and Coach market share ~ 24%

* Italian taxes on diesel fuel are ~ 5.7 x U.S. taxes

Mass Transit use: Emulsified diesels in Europe vs. Natural Gas in U.S.

	Part of Europe: (France, Italy, UK, Switzerland)	U.S.A.
Number of Mass Transit Buses	~9,900 on Emulsified Diesel	~ 7,300 on Natural Gas (~6,200 on CNG; ~ 1,000 on LNG)*
Total Population	~ 180 M	~ 290 M

* Source: American Public Transportation Association

Observations on Mass Transit use: Emulsified diesels in Europe vs. Natural Gas in the U.S.

- There are ~ 36% more buses (9,900 vs. 7,300) on emulsified diesels in four European countries than in the entire U.S. on both CNG and LNG.
- Conversion of mass transit fleets in Europe to emulsified diesels was conducted at lower cost than equivalent U.S. conversion to CNG and LNG.

Remaining emulsified diesel challenges

- Shelf life (stability).
- Power loss.
- Torque loss.
- Compliance with new engine technologies (Common rail, EGR).
- Extension to individual vehicle use (intermittent miscibility with regular diesel).

Europe vs. US comparison

- Diesel use is more prevalent in Europe.
- Fuel costs are higher in Europe (due mainly to much higher taxes).
- Impending EEC-wide tax incentive/s for use of emulsified diesel.
- Near-term expectation of an EEC Standard.
- CO₂ is a European primary air quality concern.
- There is nothing like EEFMA in the U.S.

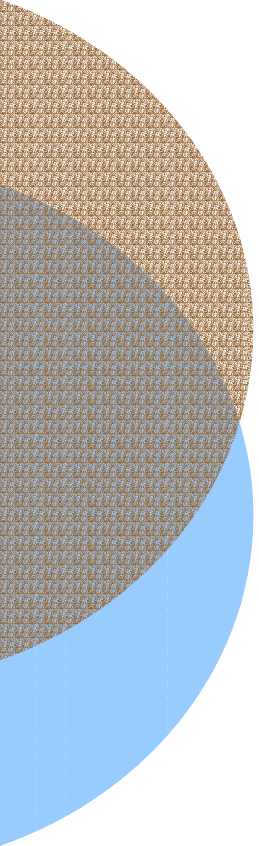
Pertinent trends

- Much \$ will continue to be spent on R&D to:
 - a. Satisfy engine manufacturers requirements for warrantee coverage.
 - b. Address Common Rail and/or EGR challenges.
 - c. Develop intermittent miscibility with diesel capability for use by non-fleet vehicles.
- Sustained growth due to increased competition in Europe and to synergies between European, US and Asian markets*.
- Harmonization of European and North American Standards.

*3 out of 4 entities are active in both Europe and North America.



Q & A



THANK YOU