



# Emulsified Fuels in Western Europe – An Overview

ARB/CEC Alternative Fuel Symposium

The ADEPT Group, Inc.

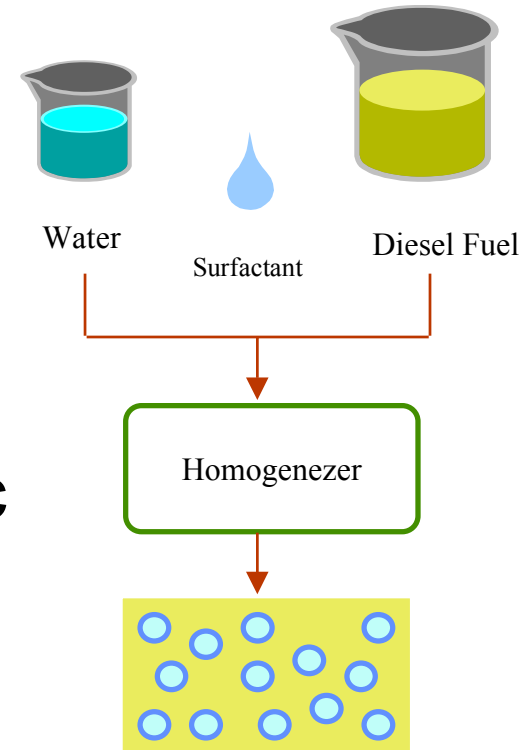
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# What are Water - Emulsified Fuels?

- 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<sub>x</sub>).
  - Particulate formation is reduced (lowers PM).

# What are the benefits?

- Lower emissions:
  - Up to 25% NO<sub>x</sub> reduction.
  - Up to 60% PM reduction.
  - Up to 80% smoke reduction.
  - Up to 5% CO<sub>2</sub> reduction.
- Better lubricity.
- Increased thermal efficiency.

***Emulsified diesel is only emission-control fuel technology that simultaneously lowers both PM and NO<sub>x</sub>.***

# 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 <sup>1</sup>	2000.1 <sup>2</sup>	2005.1 <sup>2</sup>	2008.1 <sup>2</sup>	1998	2004	2007
<b>NOx</b>	5.22	3.73	2.61	1.49	4	2-2.5 <sup>5</sup>	0.2
<b>PM</b>	0.11	0.07	0.01	0.01	0.1 <sup>3</sup> 0.07 <sup>4</sup>	0.1 <sup>3</sup> 0.07 <sup>4</sup>	0.01

<sup>1</sup> Test Cycle ECE R-49.

<sup>2</sup> Test Cycle ESC, ELR.

<sup>3</sup> For regular engines.

<sup>4</sup> For urban buses.

<sup>5</sup> 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
<b>CAM Technologie</b>	Pero (MI), Italy	France, Italy, Switzerland	5 yrs
<b>Clean Fuels Technology</b>	Reno, NV, USA	Italy	10 yrs
<b>Lubrizol</b>	Wickliffe, OH, USA	Italy, UK	3 yrs
<b>TOTAL</b>	Paris, France	France, Italy	8 yrs

# Products overview

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

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

*\*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.

	<b>Part of Europe: (France, Italy, UK, Switzerland)</b>	<b>U.S.A.</b>
<b>Number of Mass Transit Buses</b>	~9,900 on Emulsified Diesel	~ 7,300 on Natural Gas (~6,200 on CNG; ~ 1,000 on LNG)*
<b>Total Population</b>	~ 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.
- CO<sub>2</sub> 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:
  - Satisfy engine manufacturers requirements for warrantee coverage.
  - Address Common Rail and/or EGR challenges.
  - 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**