

# APT Emulsion Fuels

Environmental Management Presentation

Genova - Autorità Portuale - 14 Dicembre 2011



ALTERNATIVE  
PETROLEUM  
TECHNOLOGIES



*Helping to save the planet - one drop at a time*

Con il Patrocinio dell'Autorità Portuale di Genova

# APT's Emulsification Technology

- Technology
- Regulations of Emulsion fuels
- Commercial and Environmental Benefits
- Commercial Implementation
- Examples of APT's Global technology

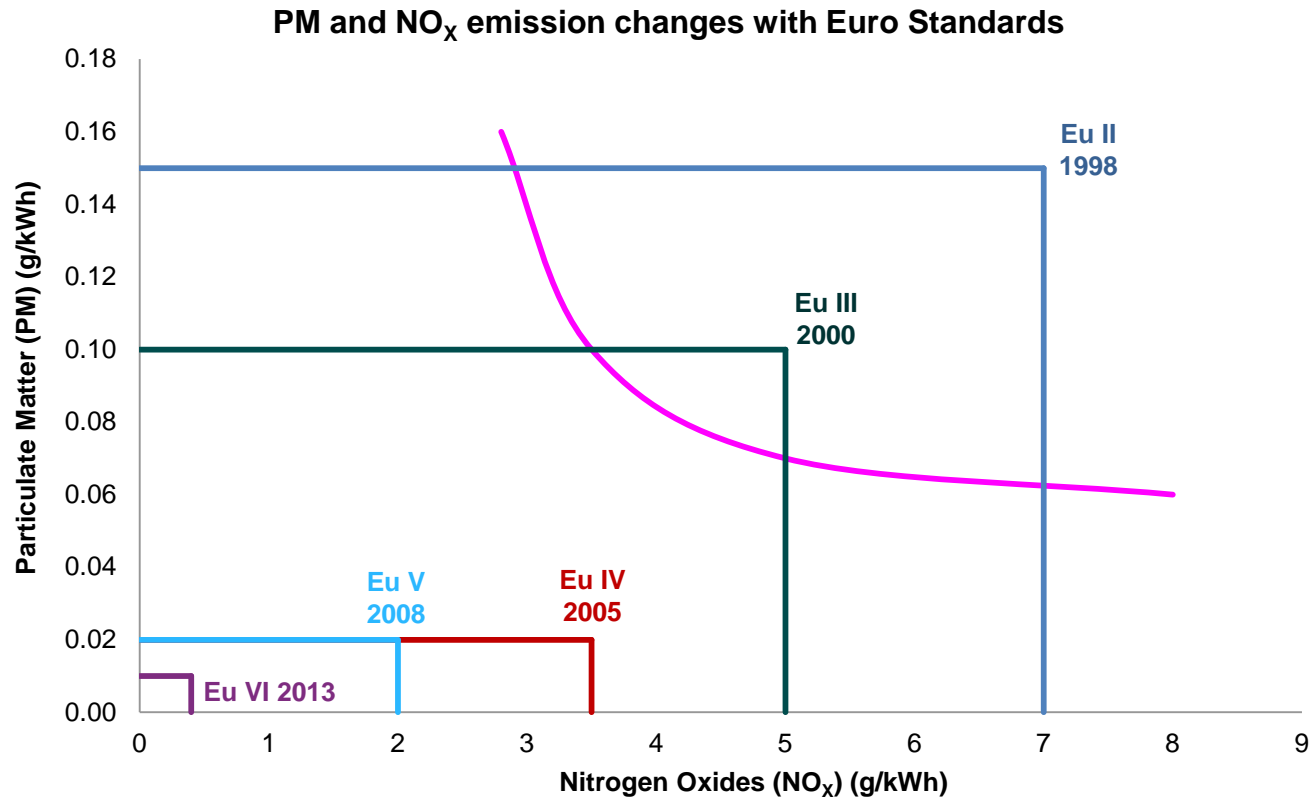
# Drivers for Change in the Transport Sector

- Emissions regulations
- Improved efficiency
- Demographic changes
- Government Fiscal Revenue
- Dependence on finite, imported fossil fuels

## Technological Responses

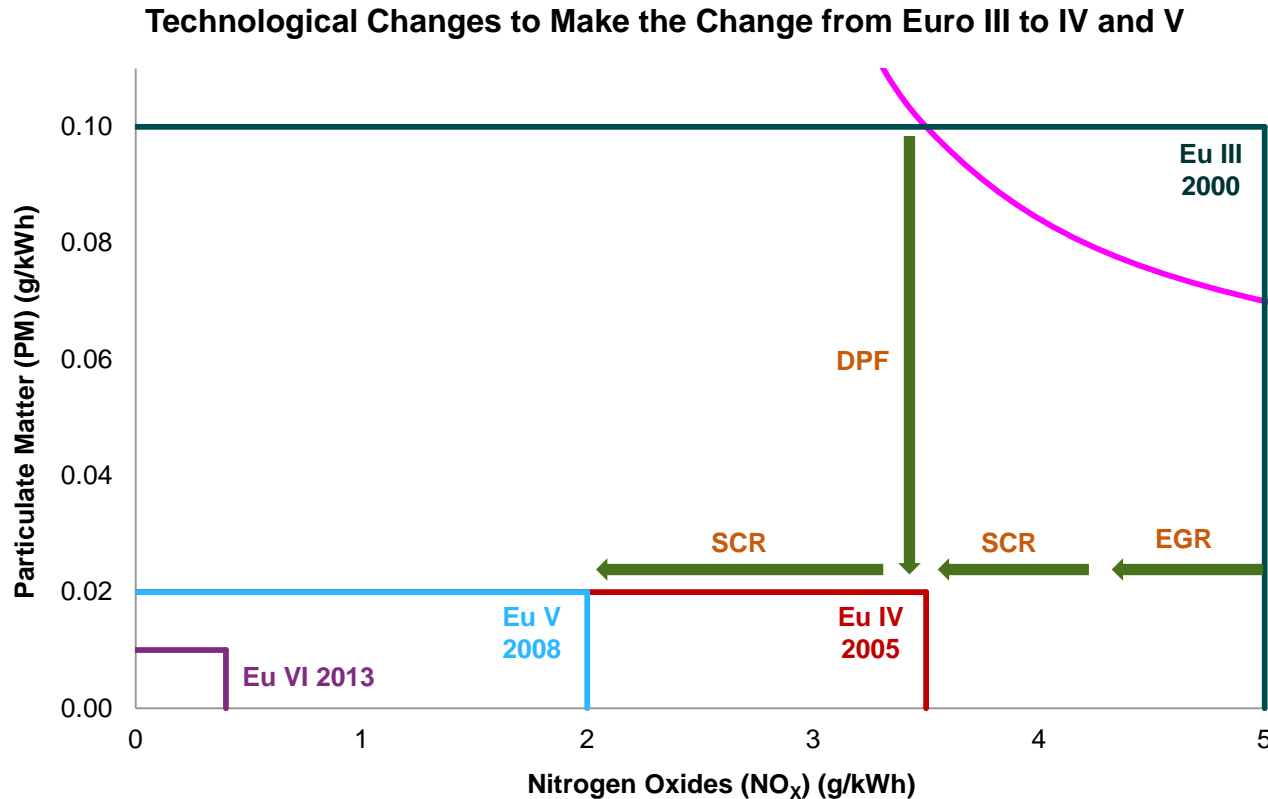
- Oil Industry
  - Fuels
  - Lubricants
- Engine Manufacturers
  - After-treatment
  - Engine modifications
  - LEVs: Hybrids, Electric, Hydrogen, Fuel Cells

# Maximum PM / NO<sub>x</sub> Emissions Permitted by Euro Standards and their Dates of Implementation



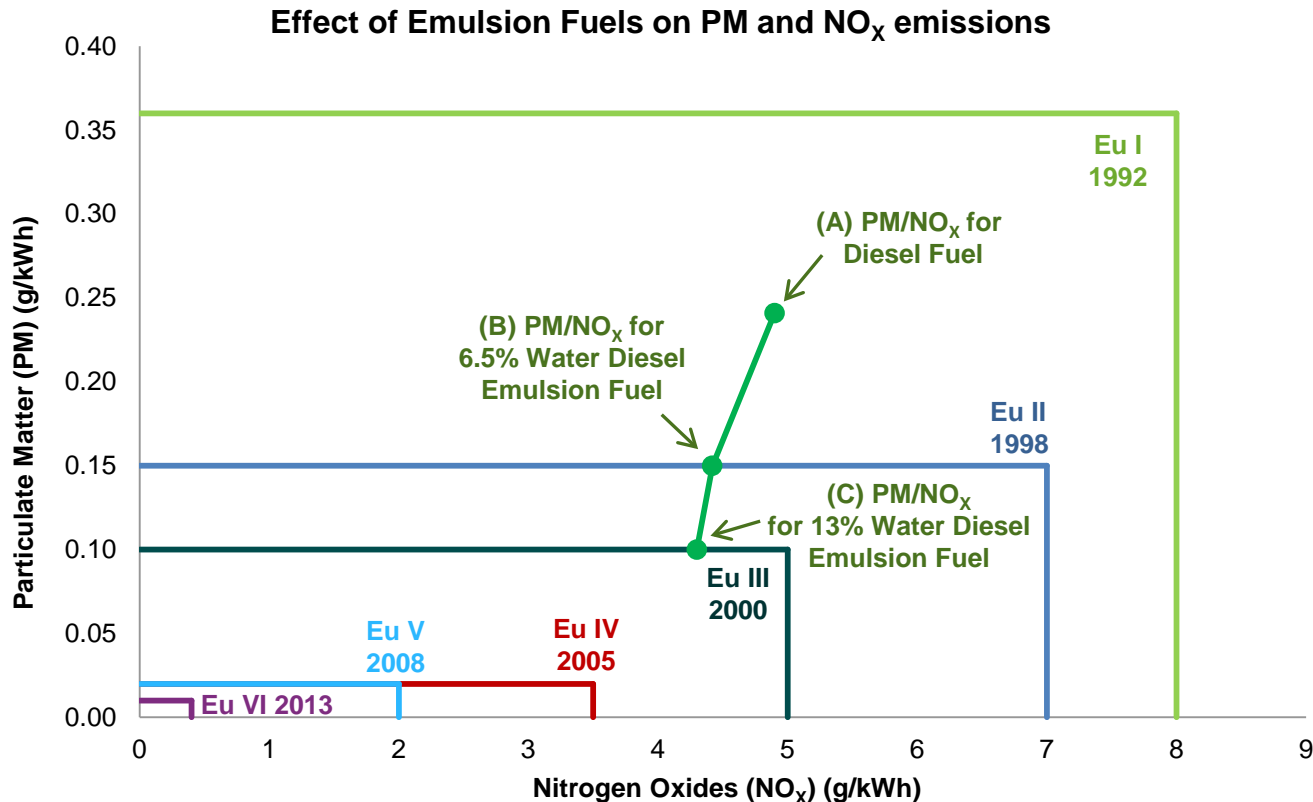
- PM / NO<sub>x</sub> Trade off – a typical graph showing PM and NO<sub>x</sub> can be increased and decreased at the expense of the other in an engine – hence meeting BOTH PM and NO<sub>x</sub> emissions is important.

# Technological Solutions to Meeting New Euro Standards



- EGR – Exhaust gas recirculation ~ reduces excess oxygen (hence NO<sub>x</sub>);
- DPF – Diesel Particulate Filter ~ capture PM and burns off Carbon (soot);
- SCR – Selective Catalytic Reduction ~ Urea injection reduces NO<sub>x</sub> to N<sub>2</sub>.

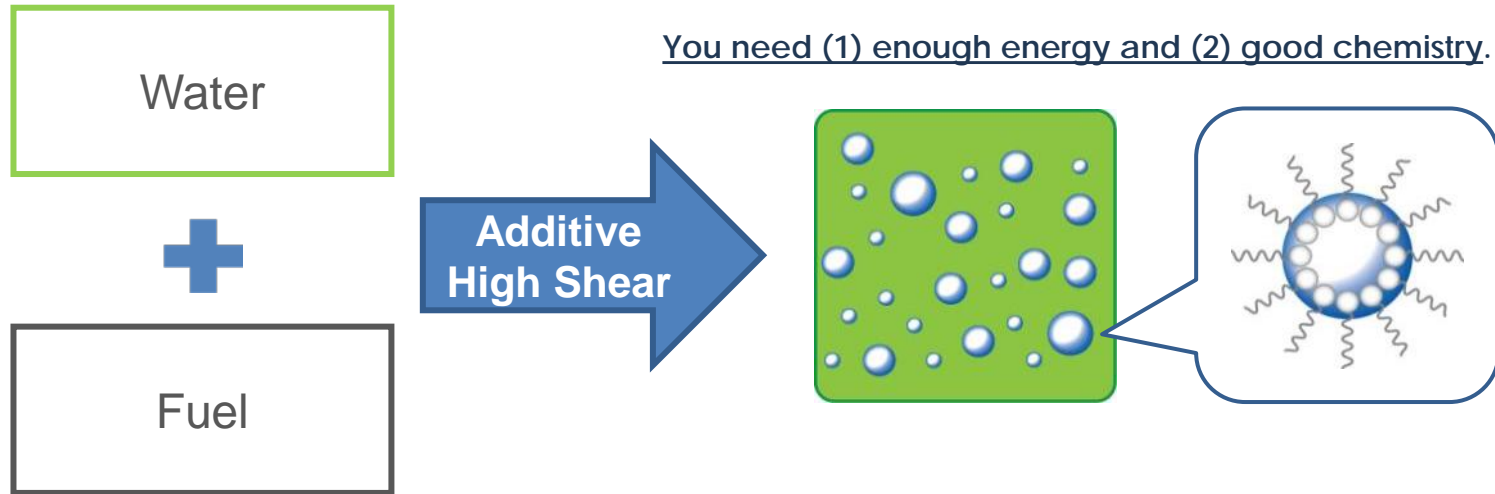
# Emulsion Fuels Can Reduce BOTH PM and NO<sub>x</sub>



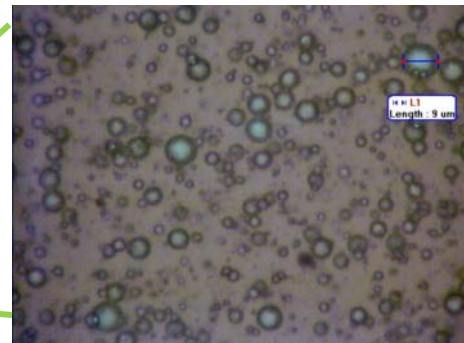
- Emissions data obtained on a 1991 12.7L DD Series 60 Engine;
- The Euro I performance (A) is improved to Euro II (B) and Euro III (C);
- The first 6.5% of water has a greater effect on NO<sub>x</sub> and PM emissions than the second 6.5% water.

# Emulsified Fuels – O/W and W/O

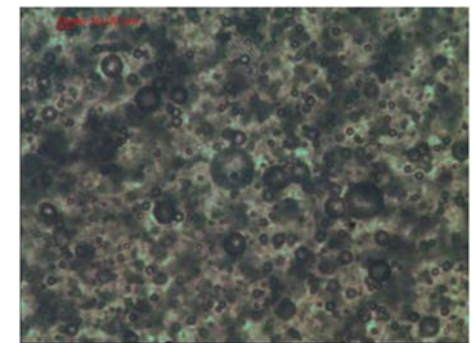
- When two immiscible fluids, oil and water are sheared together in the presence of a surfactant additive, a stable emulsion can be produced.



Water in OIL



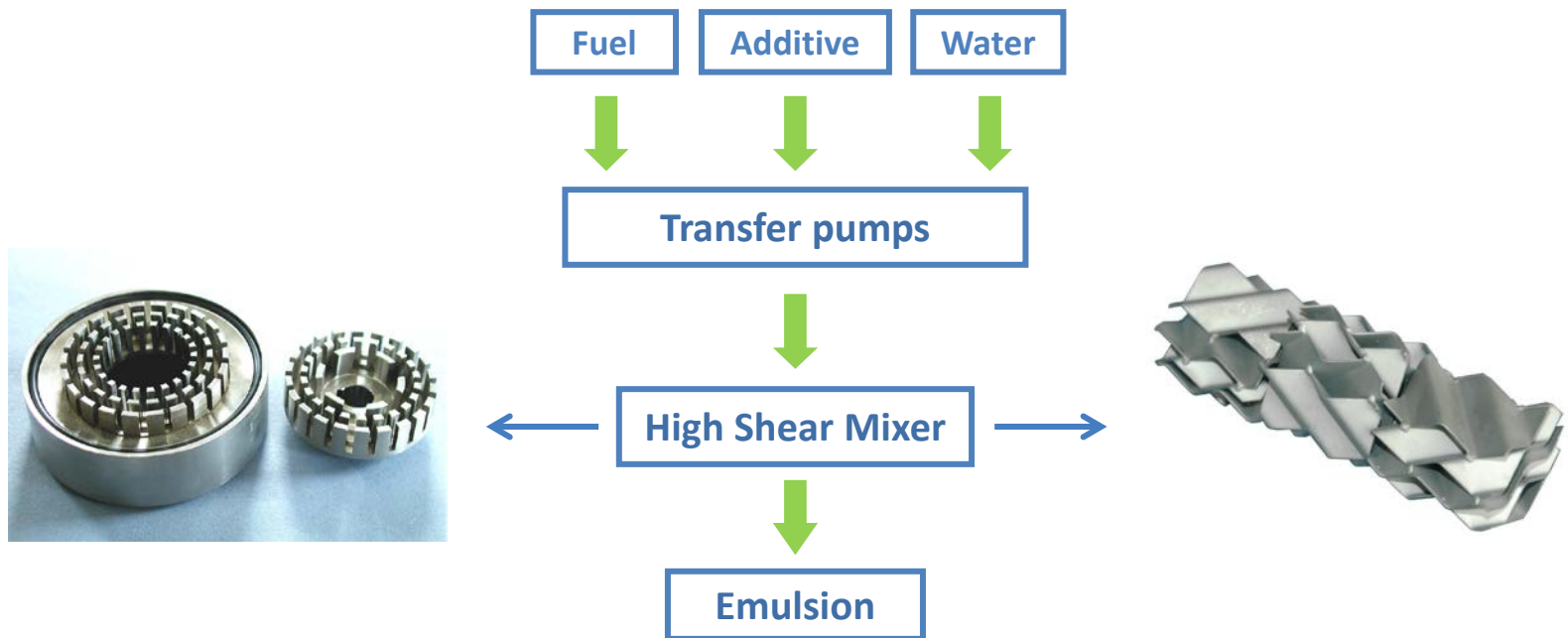
OIL in Water



# The Mixing Energy – Key to Particle Size

- The basic requirements are simple – accurate metering of fluids and good shearing.
- A variety of shearing devices, dynamic and / or static mixers have been demonstrated.
- Units can be compact and designed to fit specific needs.

## Continuous or Batch Blending System





# Aspects of Commercial Manufacture

Surfactant  
Additive Package

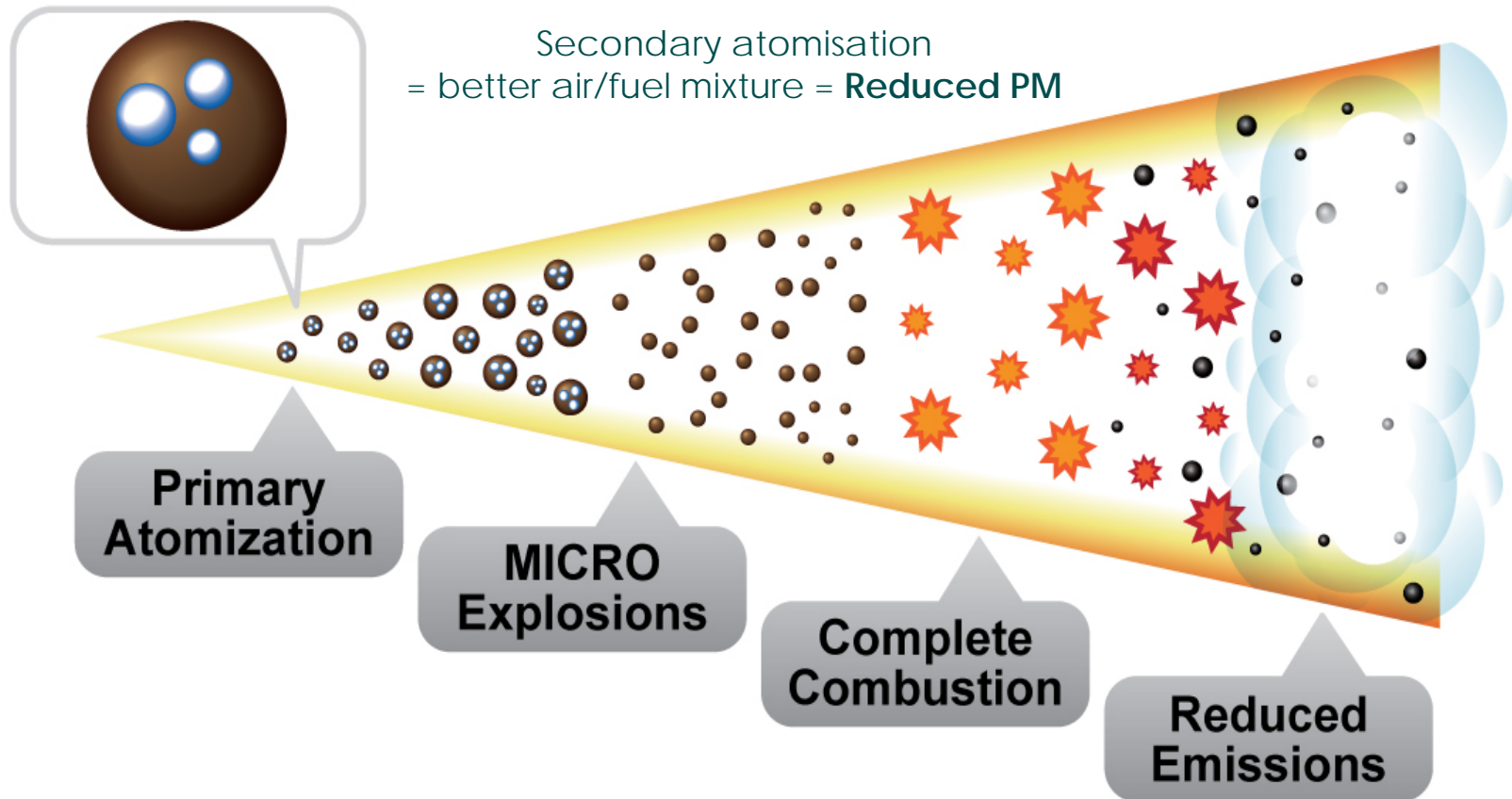
Water

Diesel  
Fuel

Seasonal or Other  
Components



# Influence of emulsions on Combustion



Water vaporisation & higher gaseous specific heat  
= reduced peak combustion T = **Reduced NOx**

# European Emulsion Fuels Manufacturers' Association

Emission	Average emulsion fuel emissions benefits, %
NO <sub>x</sub>	Up to 25%
PM	Up to 60%
Smoke	Up to 80%
CO <sub>2</sub>	Up to 5%



Figures for 13% water emulsion

- **Uses existing storage, distribution, and vehicle fueling facilities**
- **Handles like diesel fuel and remains stable in storage and vehicle tanks for a approx. 4 months**
- **Emulsion Fuels Specifications**
  - French Specification 'Arrete du relatif aux caracteristiques des emulsions d'eau dans le gazole', published in the Journal Officiel de la Republique Francaise. An AFNOR specification can be located on the AFNOR site under NF M15-021 Fevrier 2002 Carburants - Carburants pour moteur diesel (gazole) - Caracteristiques des emulsions d'eau dans le gazole (EEG).
  - Italy 'Caratteristiche Tecniche Delle Emulsioni Stabilizzate' issued on 20 March 2000, appears in Staffetta Quotidiana, 5 April 2000, pg 5. (Pubblicate Sulla Gazzetta Ufficiale N. 78 Del 3 Aprile 2000). The latest CUNA standard (NC 637-01 (Dec 2003) is tabulated below.
  - CEN (Europe) CWA 15145:2004, Automotive Fuels. Water-in-diesel fuel emulsions for use in internal combustion Engines – Requirements and test methods.
  - Israel Standard: SI 5937 [based on CWA 15145:2004]

# Italian Specification

- 'Caratteristiche Tecniche Delle Emulsioni Stabilizzate' issued on 20 March 2000, appears in Staffetta Quotidiana, 5 April 2000, pg 5. (Pubblicate Sulla Gazzetta Ufficiale N. 78 Del 3 Aprile 2000). The latest CUNA standard (NC 637-01 (Dec 2003) is tabulated below.

Characteristic	Unit of Measurement	Limit		Test Method <sup>(5)</sup>
		Min	Max	
Appearance [Aspetto]		mily white		visual
Density [Massa Volumica]	kg/m <sup>3</sup>	835	870	EN ISO 3675 <sup>(4)</sup> EN ISO 12185
Water content [Contenuto di Aqua]	%(m/m)	12	15	NF M 07-104
Centrifuge stability test (4200 rcf after 5 minutes) <sup>(1)</sup>				
Phase separation <sup>(2)</sup> [Separazione di fase]	%(v/v)	-	9	M.U.1548
Free water [Aqua libera]	-	Pass		
Viscosity at 40°C [Viscosita]	mm <sup>2</sup> /s	2.0	7.0	EN ISO 3104
Sulphur content [Contenuto di zolfo]	%(m/m)	-	0.031	EN ISO 14596 <sup>(4)</sup>
Sulphated Ash Content	%(m/m)	-	0.01	ISO 3987
Total Contamination content	mg/kg	-	24	EN 12662
Copper corrosion (3hr at 50°C)	rating	Class 1		EN ISO 2160
Flash point [Infammabilita']	°C	>55	-	ISO 2592 <sup>(3)</sup> EN 22719
Total nitrate expresses as 2-ethylhexylnitrate (EHN)	mg/kg	750	-	UNI EN ISO 13759
Lubricity, mean diameter at 60°C corrected to 14 mbar	micron	-	460	ISO 12156-1
CFPP <sup>(6)</sup>	°C	-	-10 (winter)	EN116
	°C		0 (summer)	EN 116

## Notes:

- The centrifuge test has to be conducted on the sample taken at the time of delivery.
- 'Phase separation' refers to the sedimented emulsion.
- Method ISO 2592 (open cup) is to be used when the flash point is close to the boiling point of water.
- For arbitration the method EN ISO 3675.
- The precise data are reported in Appendix A, with the exception of S content, Total ash, and total nitrate.
- In winter grades it is acceptable to include antifreeze without compromising the water content.

# Heating Oil Emulsions – Italian Standard

Characteristic	Units	Min Value	Max Value	Method
Water content	% m	12	15	ISO 3733
Viscosity at 50°C	mm <sup>2</sup> /s	>91		EN ISO 3104
Flash point	°C	>65		ASTM D93 <sup>1</sup>
Sulphur	% m		0.26 (civil use) <sup>3</sup> ; 0.88 (Industrial uses, BTZ) <sup>4</sup> ; 2.64 (Industrial uses, ATZ) <sup>5</sup> ; 3.52 (Industrial uses, ATZ) <sup>6</sup> .	EN ISO 14596 ENISO 24260 <sup>2</sup>
Sediment	% m		0.5	ISO 3735
Ash	% m		0.20	EN ISO 6245

Appendix 3: Heavy Fuel Oil emulsions with water intended for Combustion

## Notes:

The heavy fuel oil used in the preparation of the emulsions must comply with the specification UNI 6579.

1. In the event of flash points close to the boiling point of water the ASTM D92 method must be used.
2. For arbitration the method EN ISO 14596 must be used.
3. Also for new industrial plants with a potential of less than 3MW – DPCM 2/10/95.
4. Industrial plants with a potential of less than 50 MW – DPCM 2/20/95.
5. Industrial plants with a potential of greater than 50 MW – DPCM 2/20/95.
6. Industrial plants in which at least 60% of the combustion products of the above sulphur is absorbed – DPCM 2/10/95.

Straffetta Quotidiana, 5 Aprile 2000: Caratteristiche Tecniche delle emulsioni stabilizzate

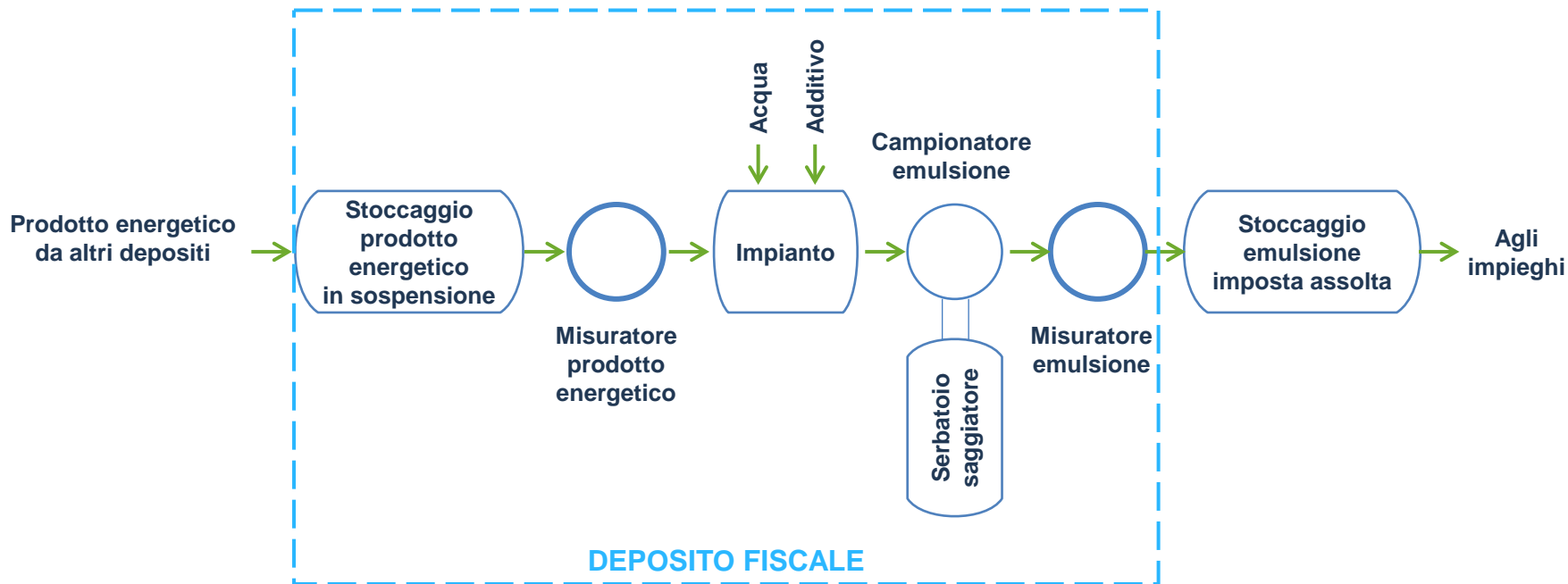
# Fuel Duty – Euro / Litre

- Italy has provided a tax incentive for the use of emulsion fuels (as defined by national standards).

	Prodotti	Carburazione	Riscaldamento	Industriali
	Olio Gasolio	0.4811	0.4032	
	Emulsioni	0.2805	0.24516	
<b>Olio Combustibile (OC)</b>	ATZ		0.12827	0.06375
	BTZ		0.06424	0.03139
<b>Emulsioni di OC</b>	ATZ	-	0.09932	0.04169
	BTZ	-	0.02952	0.2084

November 2011

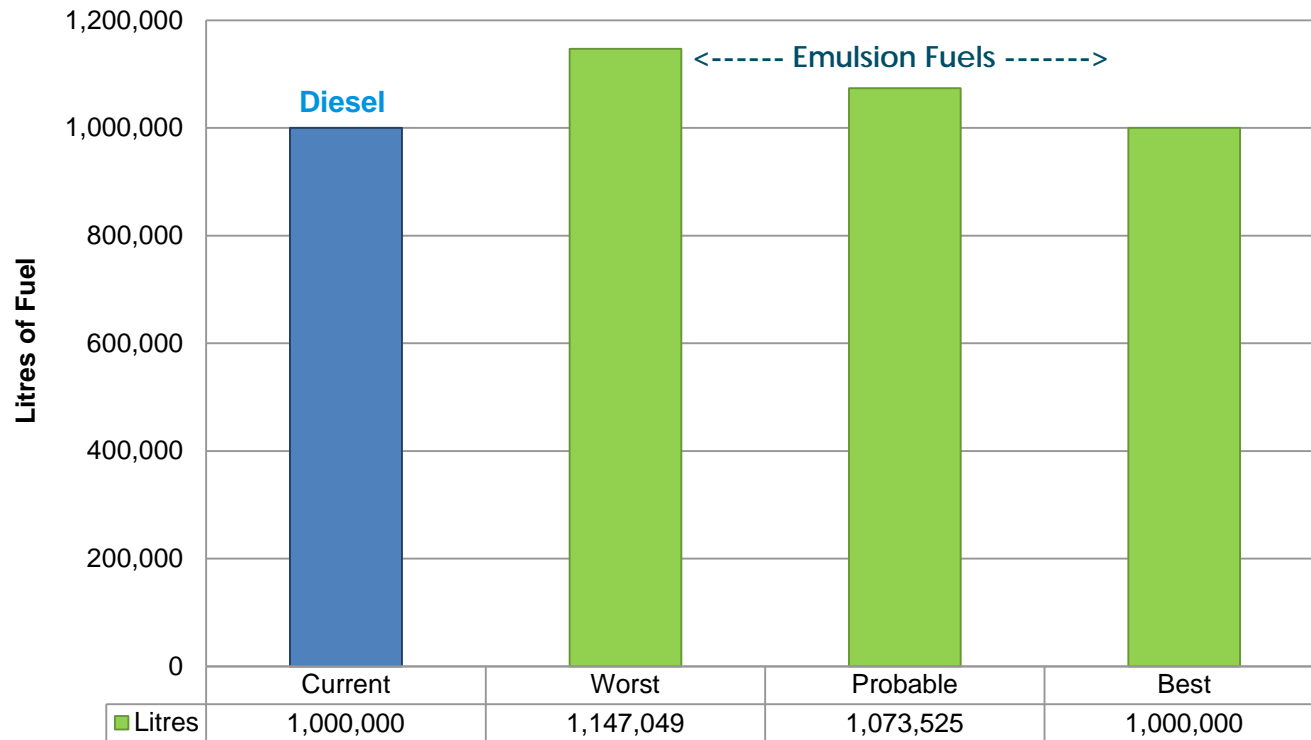
# Circolare N.28/D, Roma, 6 settembre 2011



Auto-produzione e consumo di combustibile.  
piu' di 100,000 litre per anno.

# Implications of Changing from Diesel to Emulsion Fuels: A. Volume of Fuel

Volume of Diesel and volume of Emulsion Fuel

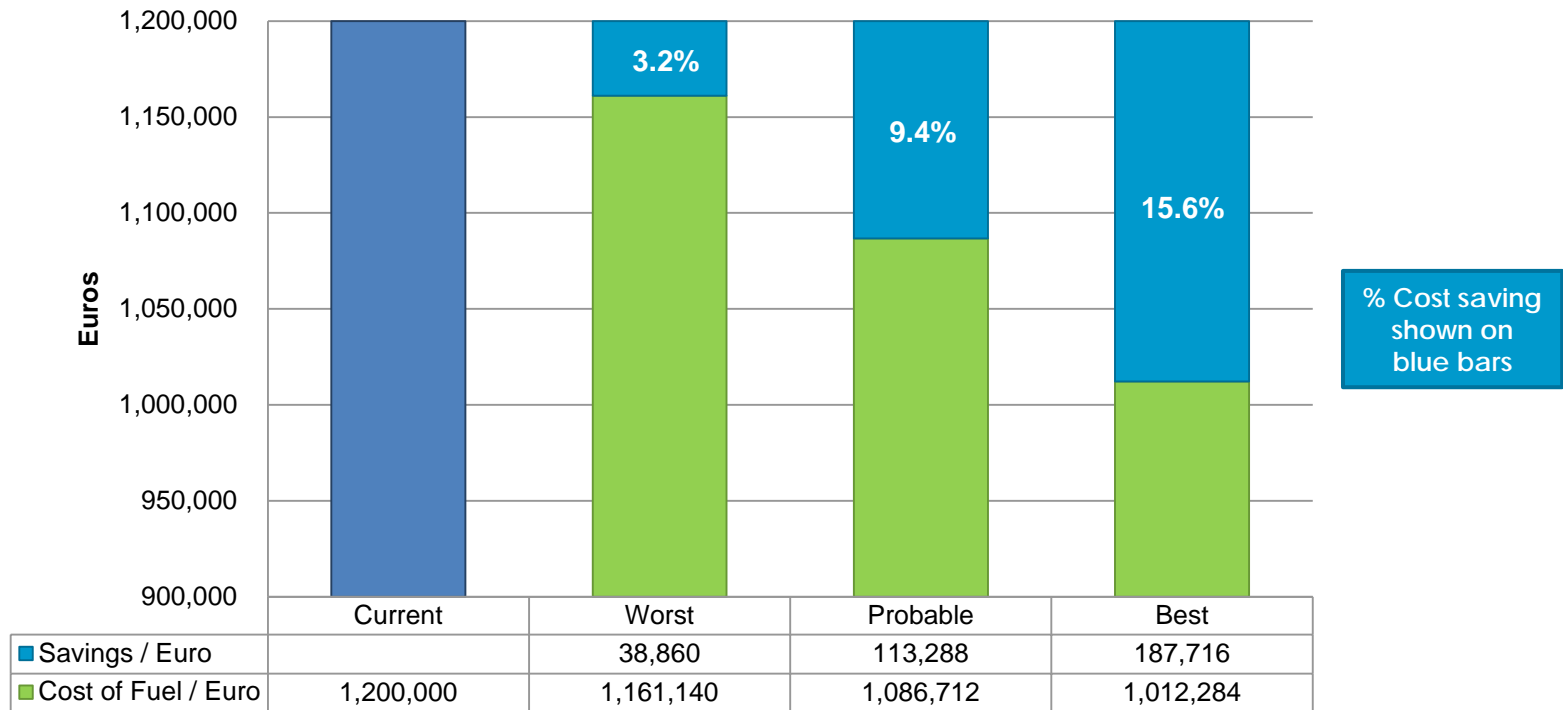


- Current: One million litres of diesel fuel by Fleet operator;
- Worst case: The fleet operator still buys 1 million litres of diesel fuel which is converted to 1.147 million litres of Emulsion Fuel;
- Best Case: The Fleet operator consumes one million litres of fuel after conversion to Emulsion fuels (this requires 871800 litres of diesel);
- Probable Case: Intermediate between the Best and Worst case – 1.073 million litres of Emulsion fuel (this requires 936000 litres of diesel).



# Implications of Changing from Diesel to Emulsion Fuels: B. Cost of Fuel

Savings: 1 million Litres of Diesel (1.2 Million Euro) converted to Emulsion Fuel

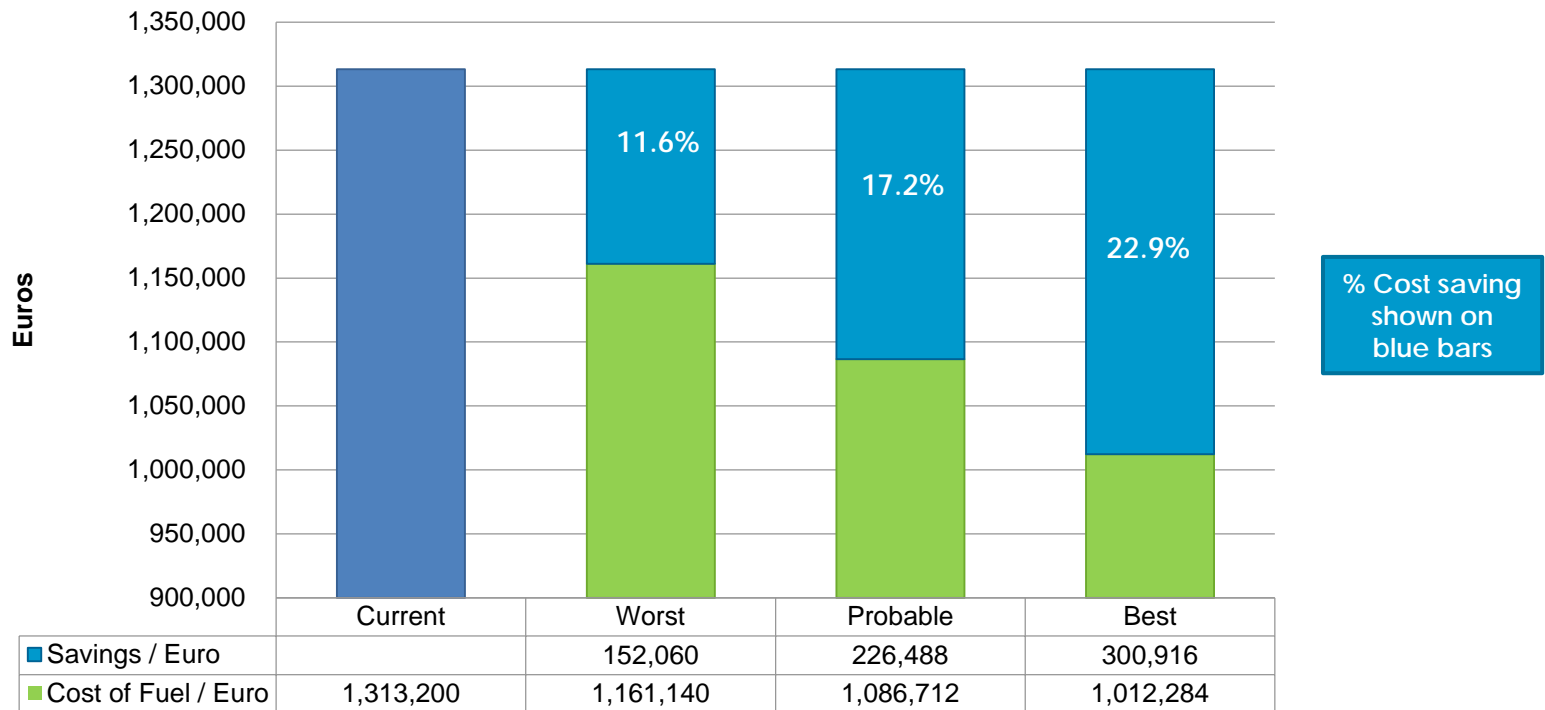


## ● Assumptions:

- Diesel Commercial Price 0.7200 Euro / Litre
- Fuel Duty (Diesel) **0.4811** Euro / Litre
- Emulsion Fuel Duty 0.2805 Euro / Litre

# Implications of Changing from Diesel to Emulsion Fuels: B. Cost of Fuel

**Savings: 1 million Litres of Diesel (1.3 Million Euro) converted to Emulsion Fuel**



## ● Assumptions:

- Diesel Commercial Price 0.7200 Euro / Litre
- Fuel Duty (Diesel) **0.5932** Euro / Litre
- Emulsion Fuel Duty 0.2805 Euro / Litre

# Towards Commercial Implementation

- Three Stage Model
  - Qualification
  - Exploration
  - Implementation

# Commercial Model – APT Technology

- **Qualification Stage**

- Fuel consumption more than 100,000 litres per annum of fuel (typically more than 0.5 million litres).
- Use of fuel is for either transportation or / and heating own fleet and / or premises (internal consumption ONLY).
- Diesel purchased from a Supplier who can provide the fuel 'duty unpaid'.
- Storage tank for diesel used exclusively for own consumption.

# Commercial Model – APT Technology

- Exploration Stage

- Details of Fleet of Vehicles (age, model type etc.)
- Emulsification plant and Fiscal Depot – adapt designs to specific location.
- Agree Project costs and Time scale:
  - Commercial Proposal (prepared by APT)
  - Exchange Letter of Intent (defines scope of Project)
  - Contract

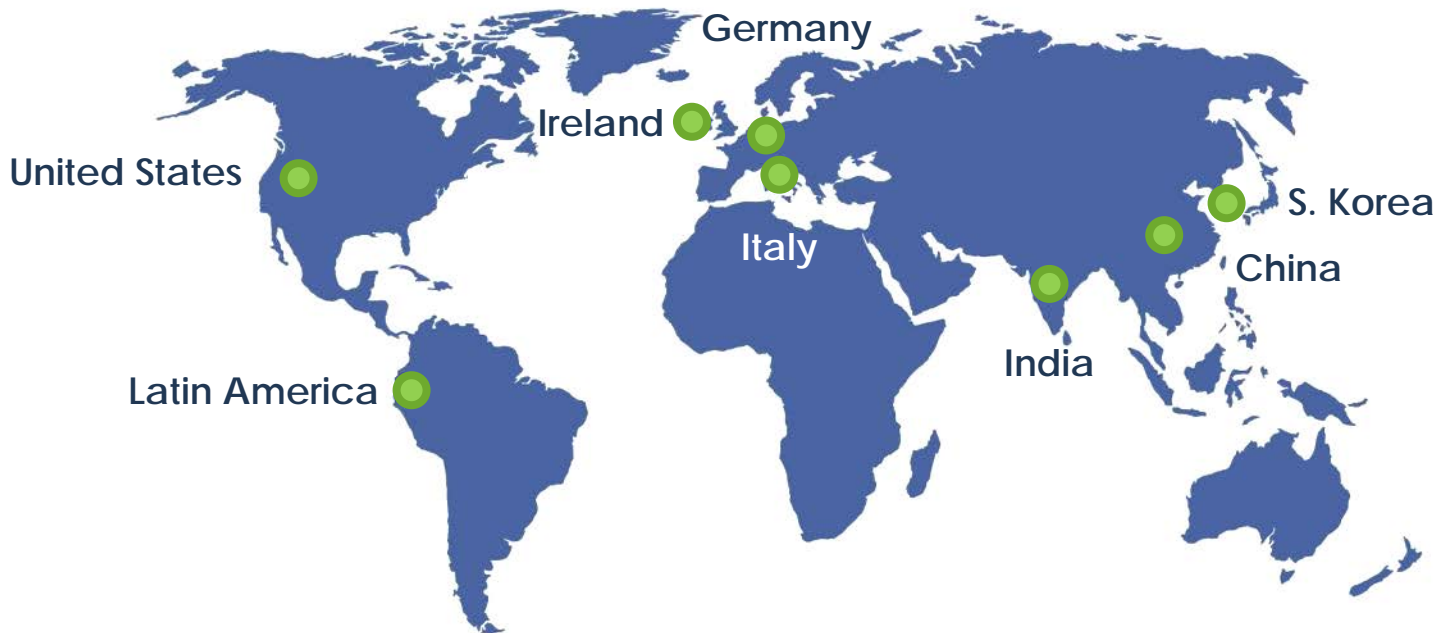
# Commercial Model – APT Technology

- **Implementation Stage**

- Modify vehicles (filter, transducer to ensure correct fuel is used).
- Build the 'Deposito Fiscale'.
- Carry out Production Trial of Emulsification Unit
- Establish Management Systems
  - Accounting for fuel bought and used, duty payable.
  - Establish Quality System, sampling, tests and reporting.
  - Monitor Performance.

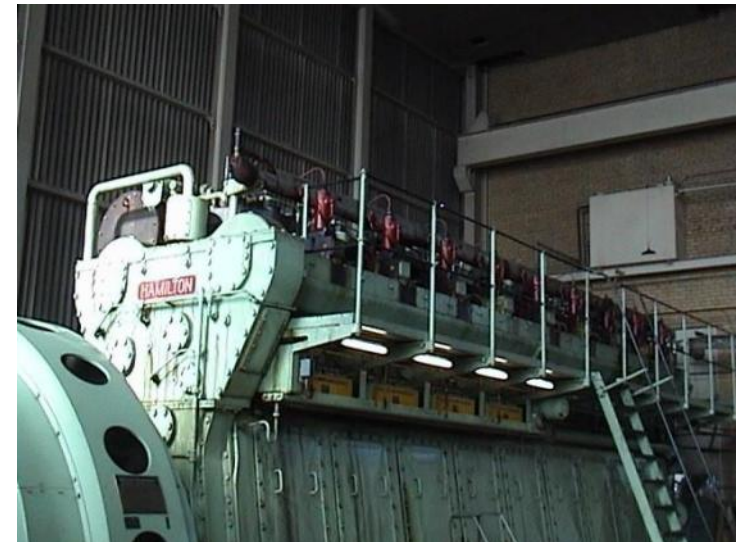
# APT Around the World

- Commercial activities underway in



# Emulsion Fuel: Global Applications

- Fleets and Port Terminals
- Marine Auxiliary Engine
- Boilers and Furnaces



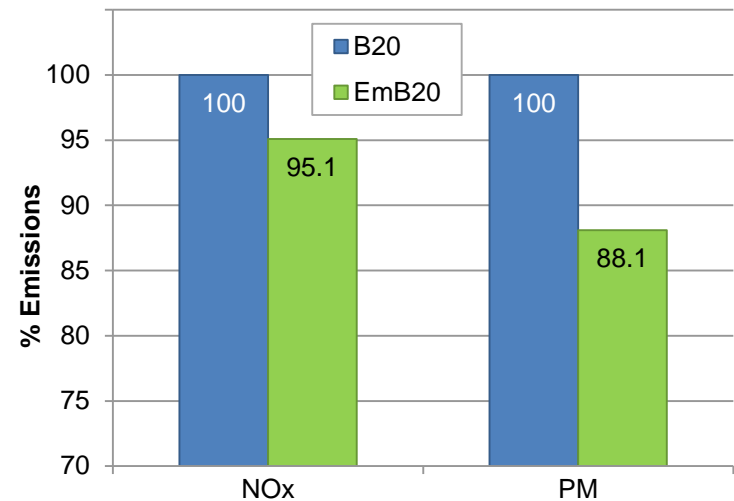


# Port of Los Angeles

- Port Terminal Operations

- A 3 month trial where three vehicles (one shown in the picture below) were running on 6% water in 20% biodiesel fuel blend (so called B20 fuel).

*Port of Los Angeles  
West Basin Container Terminal*



Emissions Reductions:	
PM	-12%
NO <sub>x</sub>	-5%

Fuel: Biodiesel (B20) – B20 emulsion with **6%** water

# Operations in Port Terminal, Italy

- A Port Terminal where all the vehicles have been running on stabilized Emulsion Fuel with 13% water for 4 years in Genoa using APT technology:
  - Four years uninterrupted operation;
  - Dozens of vehicles operation round the clock;
  - 1.2 million litres of Emulsion Fuels consumed every year;
  - Maintenance benefits include:
    - Longer oil drain,
    - Reduced fuel filter changes,
    - No visible 'black' smoke;
    - Operators able to work in confined spaces;
    - Benefits spill over to the City



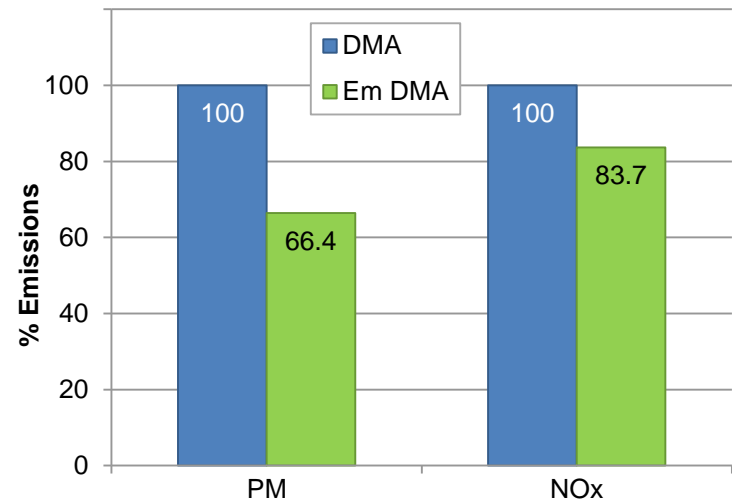
# How Do Emulsions Perform in Marine Engines?

- **Application: Marine power generation**

- In a recent trial conducted on board a roll-on, roll-off container vessel, while docked in port we measured fuel consumption and emissions when using Emulsion Fuel – the results obtained with 13% water are shown here. The Auxiliary engine, shown below, runs on marine diesel (DMA) fuel.



*Pervomaisk Dieselmash, 4 stroke, 8 cylinder, Model 8CHN25/34-3, constructed in 1986 500kW engine*



Emissions Reduction	
PM	-34%
NO <sub>x</sub>	-16%
Fuel Eff.	5.5%

Independent measurement of emissions by Ismar Chimica S.p.A, Genova.  
Analytical standards: UNI 10169, UNI EN 13284-, EPA 201, UNI EN 12619, EPA CTM030

# APT Industrial Fuels

- Significant projects are underway in various global locations where heavy fuel oil emulsion fuel has been shown able to replace HFO and to deliver significant emissions reductions and fuel cost savings.
- APT industrial fuels were recently aligned with Thermax, India's largest industrial boiler manufacturer
  - In addition to having US\$1 billion in annual turnover, Thermax was recently selected by Babcock & Wilcox to be India's licensed manufacturer of power boilers
- Thermax entered into an exclusive arrangement with APT, after more than 1 year of due diligence which focused on a 3% net savings and 1.5 year return on investment (ROI)
- India's largest oil company, the Indian Oil Company (IOC), awarded APT a contract for one of its refineries through an international tender process with 5% savings target
  - The emulsion is used in the refinery's Thermal Power Production (about 50 MW) and Distilled Crude Heating Units (about 5 MW).



# Heavy Fuel Oil Emulsions in Refinery Boilers

- Another boiler example is the power generation at one of IOC's (Indian Oil Corporation) refinery.
- *Application: IOC Refinery*  
Emulsion-Heavy Fuel Oil Emulsion Blending Unit
- **IOC: Indian Oil Corporation**
  - Purpose built plant;
  - ~50MW power plant output
  - 200 tons per day of Emulsified Fuel (HFO) with 7% water stabilised with APT5500 additive is yielding fuel savings of ~5%.
- The unit, shown in the pictures above, was designed and built by us. The unit is more than capable of supplying the 200 tons of fuel (i.e. 7% water in HFO) per day. Over several months of operation a fuel saving of 5% has been demonstrated.



Entrance to Emulsification Plant



500+ Liters/minute Fuel Inlet

# Power Generation, Kowepco, Pyong Taek



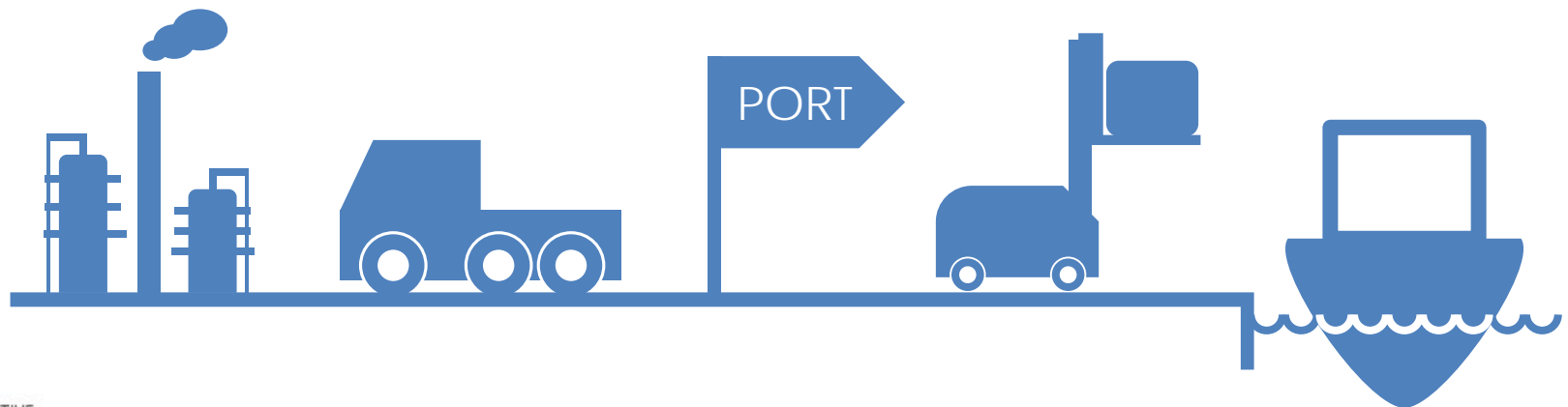
HFO emulsion using 5% water  
and 0.025% Additive APT5510K

Six month trial to start in January 2012  
> Emulsification of 200 tons / hour of fuel.



# Emulsion Fuels: Summary & Benefits

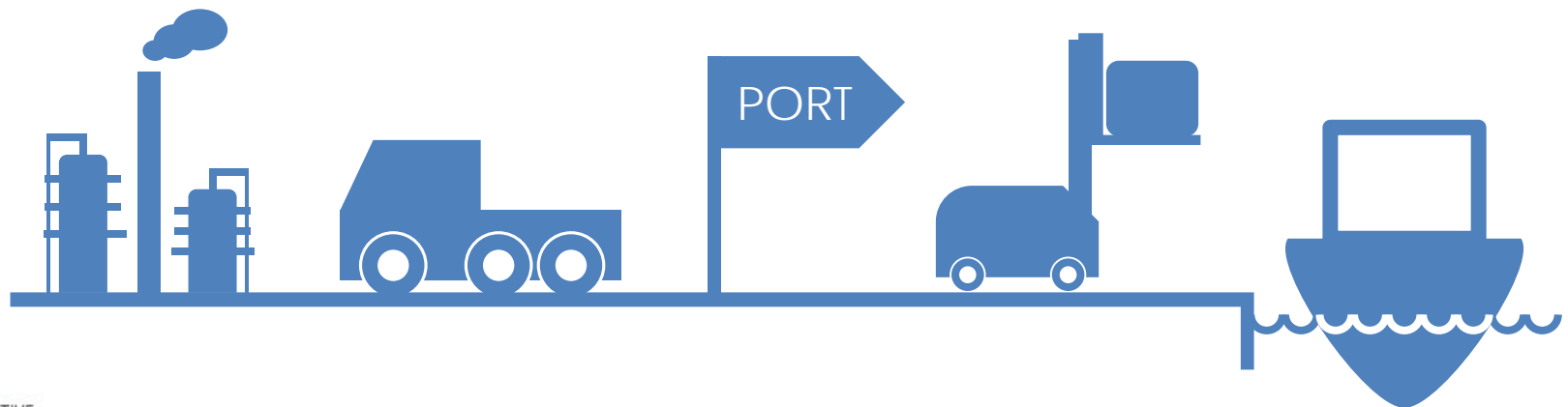
- The Benefits of using stabilized Emulsion Fuels in Italy compared to diesel fuel are:
  - Fuel economy (= CO<sub>2</sub> reduction);
  - Emissions Reductions: PM10, Smoke and NO<sub>x</sub>;
  - Reduced Engine / Boiler maintenance;
  - Reduced Fuel Duty: [0.2805 €/L versus 0.4811 €/L for diesel].
- These benefits have been illustrated with:
  - Marine power generation; Port Terminals and Industrial Boilers;
  - Emulsions made with Diesel, Biodiesel, Vegetable oils, Fuel oils.



# Emulsion Fuels: Summary & Benefits

- **Benefits of APT's Technology (Fleets):**

- Diesel can be purchased from regular supplier;
- Diesel can be purchased duty-free;
- Fiscal advantage (difference between duty payable on Emulsion and on Diesel fuel) goes to the consumer;
- Fuel duty is paid after Emulsion fuel is produced;
- The Emulsion fuel is made and consumed on demand with no need for storage;
- Diesel is the only fuel stored;
- Only one Fuel dispenser is required – a dual system able to deliver both diesel and emulsion fuel.
- An automated transponder system can be installed on vehicles to ensure that the correct fuel is supplied.





# Con il Patrocinio dell'Autorità Portuale di Genova

Alberto Cremonini - [acremonini@altpetrol.com](mailto:acremonini@altpetrol.com)

Marco Balzi - [mbalzi@altpetrol.com](mailto:mbalzi@altpetrol.com)

Alex Psaila - [apsaila@altpetrol.com](mailto:apsaila@altpetrol.com)

**Thank You  
Grazie**

## Alternative Petroleum Technologies (Europe) Limited

77 Sir John Rogerson's Quay, Suite 1168, Dublin 2, Ireland

Phone Number: +353 1 6499061

Fax Number: +353 1 6401899

Website: <http://www.altpetrol.com>

