GreenChem

AdBlue Solutions

Chris Haynes, Managing Director - GreenChem Solutions Ltd
FAQ – about AdBlue®

- Background of the AdBlue market
- Why do we need AdBlue?
- What is AdBlue?
- What does it do?
- Where do I get it?
- How much do I need?
- Systems, concepts and opportunities, future oil spec E6?
- New markets
AdBlue in the truck & bus market
Emission legislation in the EU

- 94%

- 75%

EURO I 1993
EURO II 1996
EURO III 2001
EURO IV 2006
EURO V 2009
EURO VI 2013
Emission legislation in the EU

- 97%
- 95%

- NOX (g/kWh)
- particles (g/kWh)

EURO I 1993
EURO II 1996
EURO III 2001
EURO IV 2006
EURO V 2009
EURO VI 2013

- 95%
## Environmental policy

### European emission level diesel engine

<table>
<thead>
<tr>
<th></th>
<th>Euro 3</th>
<th>Euro 4</th>
<th>Euro 5</th>
<th>Euro 6</th>
<th>EEV</th>
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<tbody>
<tr>
<td>CO</td>
<td>5.45</td>
<td>4.0</td>
<td>4.0</td>
<td>1.5</td>
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<td>HC</td>
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<td>0.55</td>
<td>0.55</td>
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<td>NOx</td>
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<td>PM</td>
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<td>0.03</td>
<td>0.01</td>
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<tr>
<td>Smoke</td>
<td>0.8</td>
<td>0.5</td>
<td>0.5</td>
<td>-</td>
<td>0.15</td>
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</table>

* gr/kWh, measured according European Transient Cycle
Engine technology

Pre combustion
- Intercooling
- Swirl
- Reduction of oil consumption

Post combustion
- SCR (Selective Catalytic Reduction)
- Particulates filter
- EGR (Exhaust Gas Recirculation)

Combustion
- Injection
- Electronics
- Piston shape
The impact of Euro 6

- Oxidisation catalysts
- Diesel particulate filters
- Ultra high pressure fuel injection
- Variable geometry turbo charging

Exhaust gas recirculation (EGR)

Closed, active soot filter (DPF)

Catalyst with AdBlue (SCR)
23 years of the UK truck market

1988 to 2011

Average market

6.0 tonne+
UK truck market - forecast (6.0 t+)

- Euro 2
- Euro 3
- Euro 4
- Euro 5
- Euro 6

Average
What is AdBlue?

- A very pure watery urea solution
- Especially developed for the SCR catalyst / automotive sector
- AdBlue – according to ISO 22241
- Some characteristics are
  - Freezes / corrosive / cristallisation / Not ADR classified
- The Purity of AdBlue has production and handling implications and limited consequences for the environment
- Production & storage under specific conditions
  - To maintain ISO 22241 quality
AdBlue - The Product

- Urea – base material for making AdBlue through dilution
- Urea is one of the largest worldwide traded commodities with ample supply capacities - Urea fertiliser, resin, pharmaceutical, industrial uses
- Urea made from a direct high temperature, high pressure reaction between ammonia & carbon dioxide

- **32.5% UREA (AdBlue) solution in de-mineralised water**
  - Very high purity, special grade
  - DIN specification to warrant catalyst life/activity
  - Specific quality de-mineralised water
What is AdBlue?

- Colourless clear liquid
- AdBlue is not a hazardous substance
  - There are no known health hazards related to handling of urea solution
  - No restrictions relating to transport on rail, road, ships or storage
- Corrosive: effectively an issue in relation to product quality
  - No use of materials / equipment for oil products
  - Equipment re-developed and available
  - To iron, copper, bronze + some aluminums
- Crystallisation: only an issue for filling equipment
  - Solved & equipment is available
  - Crystallisation when drying can lead to blocking of nozzles and pumps
AdBlue - more facts

- Specific gravity 1.1 kg

- Freezes: this has been solved: trucks and delivery systems
  Starts to Freeze at – 11°C

- Slowly decomposes to ammonia and carbon dioxide, long term + 40°C

- Harmless: the product is NOT dangerous to the environment

- More impact of the environment on product: solved
  - Cannot burn / explode
  - Does you no harm - BUT does not taste good!
  - Easy to store in relation to environmental issues

✓ Safety data sheets available from suppliers provide more information on handling AdBlue.
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Min.</th>
<th>Max.</th>
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<tbody>
<tr>
<td>Urea content</td>
<td>% (m/m)</td>
<td>31,8</td>
<td>33,2</td>
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<tr>
<td>Density at 20°C</td>
<td>kg/m³</td>
<td>1087,0</td>
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<td>Refractive Index at 20°C</td>
<td>-----</td>
<td>1,3814</td>
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<tr>
<td>Alkalinity as NH₃</td>
<td>% (m/m)</td>
<td>--</td>
<td>0,2</td>
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<tr>
<td>Biuret</td>
<td>% (m/m)</td>
<td>--</td>
<td>0,3</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>mg/kg</td>
<td>--</td>
<td>5</td>
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<tr>
<td>Insoluble matter</td>
<td>mg/kg</td>
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<td>20</td>
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<tr>
<td>Phosphate (PO₄)</td>
<td>mg/kg</td>
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<td>0,5</td>
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<tr>
<td>Calcium (Ca)</td>
<td>mg/kg</td>
<td>--</td>
<td>0,5</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>mg/kg</td>
<td>--</td>
<td>0,5</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>mg/kg</td>
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<td>0,2</td>
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<tr>
<td>Zinc (Zn)</td>
<td>mg/kg</td>
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<td>0,2</td>
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<tr>
<td>Chromium (Cr)</td>
<td>mg/kg</td>
<td>--</td>
<td>0,2</td>
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<tr>
<td>Nickel (Ni)</td>
<td>mg/kg</td>
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<td>0,2</td>
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<tr>
<td>Aluminium (Al)</td>
<td>mg/kg</td>
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<td>0,5</td>
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<tr>
<td>Magnesium (Mg)</td>
<td>mg/kg</td>
<td>--</td>
<td>0,5</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>mg/kg</td>
<td>--</td>
<td>0,5</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>mg/kg</td>
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<td>0,5</td>
</tr>
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</table>
Cans

AdBlue
DIN 70 070

AdBlue 4you
FREE PHONE: 0800 8077 788
Drums
IBC & Pumps

GreenStar 1

GreenStar Basic
Bulk systems

- Fully bunded for leak protection
- Housing, to protect against direct sunlight
- Stainless steel piping and connection
- Removable roof for maintenance
- Telemetry
GreenChem

Bulk solutions

AdBlue®4you
Commercial solutions
Equipment

Hardware potentially the biggest risk for contamination

- Problems with hardware!
Hardware potentially the biggest risk for contamination
- Problems with ‘experts’
Equipment

Hardware potentially the biggest risk for contamination
• Problems with lack of awareness
Equipment

Hardware potentially the biggest risk for contamination
• Problems with established suppliers
Where does quality become an issue?

- **Customer handling**
  - Customers ‘touch’ the AdBlue -> many examples

- **Distribution chain**
  - Distributing parties have no understanding of AdBlue characteristics and risks – eg when AdBlue is sold ex-works

- **Filling equipment**
  - Equipment sold as ‘AdBlue equipment’, is not suitable for AdBlue
  - Customers use existing non-AdBlue equipment

*General: lack of understanding; lack of awareness*
Quality awareness campaign

Where does quality become an issue?

- Non Licensed Suppliers
  - VDA approved

Lots of examples

Testing performed by: K. Atkinson
On the: 05-Mar-12

<table>
<thead>
<tr>
<th>Test</th>
<th>Method</th>
<th>Specification</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Urea Content %m/m</td>
<td>ISO22241-2 Pt C</td>
<td>31.8 - 33.2</td>
<td>29.6</td>
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<tr>
<td>Alkalinity as NH₃ %m/m</td>
<td>ISO22241-2 Pt D</td>
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<td>&lt;0.01</td>
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<tr>
<td>Biuret Content %m/m</td>
<td>ISO22241-2 Pt E</td>
<td>0.3 max</td>
<td>0.28</td>
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<td>Insolubles mg/Kg</td>
<td>ISO22241-2 Pt G</td>
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<td>31</td>
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<tr>
<td>Formaldehyde Content mg/Kg</td>
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<td>5 max</td>
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<td>Phosphate mg/kg</td>
<td>ICP OES</td>
<td>0.5 max</td>
<td>0.04</td>
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<tr>
<td>Calcium mg/kg</td>
<td>ICP OES</td>
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<td>Iron mg/kg</td>
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<td>0.04</td>
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<td>Copper mg/kg</td>
<td>ICP OES</td>
<td>0.2 max</td>
<td>0.01</td>
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<tr>
<td>Zinc mg/kg</td>
<td>ICP OES</td>
<td>0.2 max</td>
<td>0.02</td>
</tr>
<tr>
<td>Chromium mg/kg</td>
<td>ICP OES</td>
<td>0.2 max</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Nickel mg/kg</td>
<td>ICP OES</td>
<td>0.2 max</td>
<td>0.03</td>
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<tr>
<td>Magnesium mg/kg</td>
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<td>2.17</td>
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<td>Sodium mg/kg</td>
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<td>Potassium mg/kg</td>
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<td>Aluminium mg/kg</td>
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<td>Refractive Index @ 20°C</td>
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General: lack of understanding; lack of awareness
Synergy with off road market
<table>
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<tr>
<th>Vehicle Type</th>
<th>1950</th>
<th>2010</th>
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<tbody>
<tr>
<td>Cars</td>
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<td>26,878</td>
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<tr>
<td>Vans</td>
<td>457</td>
<td>3,261</td>
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<tr>
<td>Buses</td>
<td>123</td>
<td>109</td>
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<tr>
<td>Motorcycles</td>
<td>725</td>
<td>1,133</td>
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<tr>
<td>Trucks</td>
<td>451</td>
<td>390</td>
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<tr>
<td><strong>Total</strong></td>
<td>3,851</td>
<td>31,824</td>
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### Operational efficiency...

<table>
<thead>
<tr>
<th>Year</th>
<th>Weight</th>
<th>MPG</th>
<th>Payload</th>
<th>MPH</th>
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<tr>
<td>1976</td>
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<td>2010</td>
<td>44 t</td>
<td>8.4</td>
<td>29.4</td>
<td>47</td>
<td>11,607</td>
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</tbody>
</table>

- 385% increase in productivity in 50 years
Summary

- Market growth – AdBlue that is!
- Euro VI
- Additional markets
- Bulk systems ilo IBC
- Solutions for ALL scenarios
- Cowboy suppliers in the market
- Quality awareness campaign
QUESTIONS?

www.adblue4you.com
Thank you