



 Fluid technologies for a better world™



## Diesel Emulsion Fuel Reduces Diesel Particular Matter in the Mines

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## Participating Companies

- Cargill Salt – Lansing, New York
  - Location of Underground Salt Mine
  - Desire to Reduce DPM Emissions
- The Lubrizol Corporation – Wickliffe, Ohio
  - Technology provider of PuriNOx™ Low Emission Diesel Fuel
- Clayton Group Services Inc. – Akron, Ohio
  - Provides Industrial Hygiene and DPM Emission Assessments



## Introduction

- Clayton Group Services Inc. Conducted DPM Measurements Pre and Post the Introduction of PuriNOx™ Low Emission Diesel Fuel
- A Four Week Period Was Allowed Between Measurements to Provide Adequate Atmospheric Dilution
- 25 Personal and 12 Area Long-Term Samples Were Collected
- Results Are Compared to Establish Reductions in DPM



## Facility and Process Descriptions

- This Cargill Site Manufactures Rock Salt at a Depth of ~2300 Feet Underground
- Air Sampling was Conducted in Sections U42 and U44
- Employees Work 8-Hour Shifts, Five Days Per Week



## Sampling Strategies and Methods

- MSHA 5040 Method performed by Clayton Group Services
- Personal and Area Monitors
- Phase 1 = Mine on diesel fuel
- Phase 2 = Mine on PuriNOx™ fuel
- Care was Taken to Ensure Constancy Between Diesel and PuriNOx™ Duty Cycles and Conditions



## Pre PuriNOx™ Preparation

- Ensure Circulation of Main Fuel Storage Tank is in Place
- Ensure No Water Absorption Media is Being Used with Fuel Filters or Water Separators
- Inspect Fuel Tanks for Cleanliness



## Analytical Methods

- DPM Samples were Analyzed According to NIOSH 5040 Method using a Thermal Optical Analyzer Which Provide Concentrations of:
  - Organic Carbon
  - Elemental Carbon
  - Total Carbon (sum of elemental and organic carbon)
- All Samples and Blanks were Analyzed by Clayton's Detroit Regional Laboratory



## Results

Sampling Locations	DPM Reductions (%)
Personal	34
Area	39
Intake	27
Exhaust	52
Both Personal and Area Combined	35

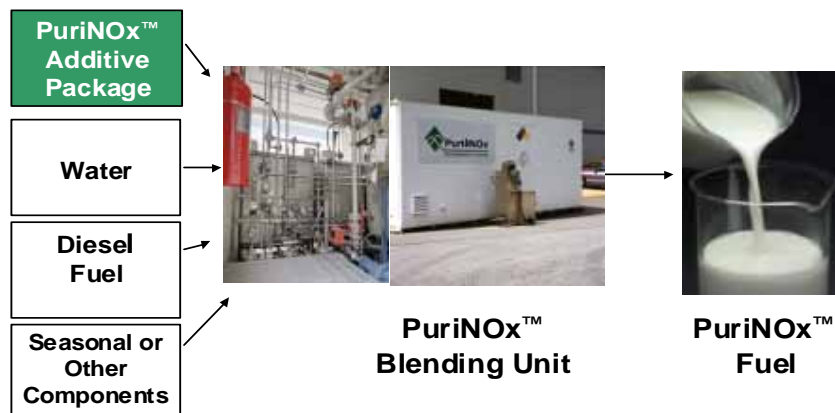


## What is PuriNOx™?

- A Diesel Fuel Emulsion
- A pollution mitigation technology
- A cost effective means of reducing NOx and PM



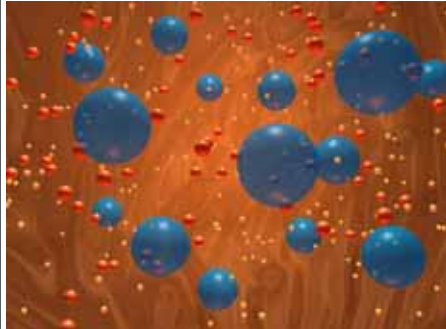
## PuriNOx™ Performance Systems



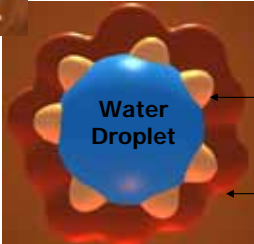
## PuriNOx™ Fuel

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**Water-in-Diesel Fuel**




- **Low Viscosity**
- **Fuel in Contact with Tank and Engine**
- **Efficient Water Dispersion**
- **Mixes with Diesel Fuel**



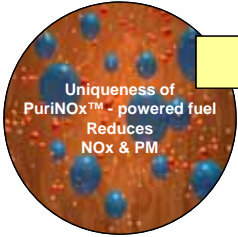
Water Soluble "Head" of Additive

Fuel Soluble "Tail" of Additive

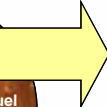
Water Droplet



## PuriNOx™ - powered fuel



Uniqueness of PuriNOx™ - powered fuel  
Reduces NOx & PM



- Reduces NOx typically by 20% and PM typically by 50%
- Tested and Confirmed Energy Savings of 1-3%
- Used immediately with minor maintenance ( Fuel Filter Change) by Dispensing Fuel Directly into Vehicle Tanks
- Uses Existing Storage, Distribution and Fueling Facilities with Minor Modifications
- Handles Like Diesel Fuel But with defined stability parameters

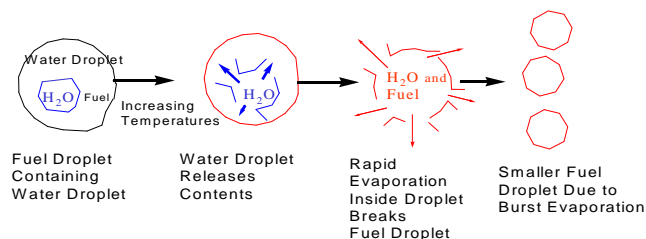
## What Water Does in The Fuel

- Water Reduces Combustion Temperature Which Reduces NO<sub>x</sub>
- Water Changes the Combustion Process to Burn the Fuel More Efficiently
  - Which Reduces Particulate Matter and Smoke



## Combustion Mechanism


Burst Evaporation Leads to Enhanced Vaporization of the Fuel and Turbulent Mixing Results in Improved Combustion



The Loss of Energy in the Vaporization Process Decreases Combustion Temperature Which Slows the Reaction Between Oxygen and Nitrogen to Form NO<sub>x</sub>

**LUBRIZOL**

## EPA Update

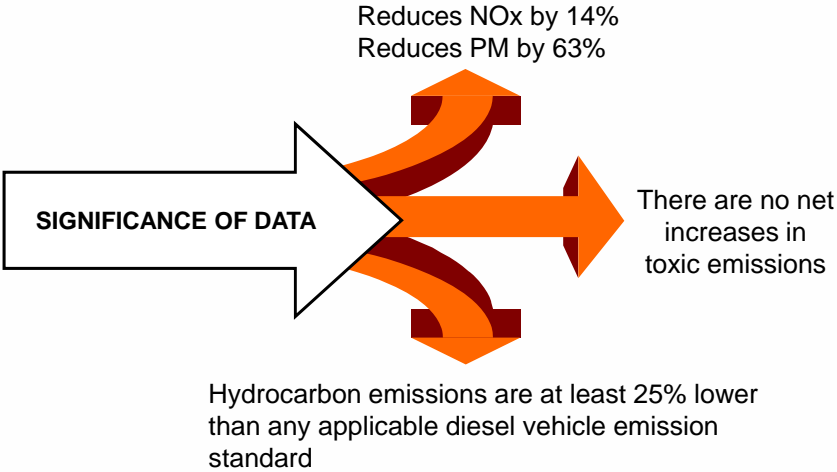


- US EPA On-Road Registration
  - Tier 1 Testing **Complete**
  - Tier 2 Testing **Complete**
  - Tier 2 Data **Complete**
    - Summer Fuel Registered
    - Winter Fuel Registration Expected 3/2003
- Emission Technology Verification
  - Data collection is an ongoing process
    - Verification Expected 3/2003

**LUBRIZOL**

## CARB Verification of Emission Reductions

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Reduces NOx by 14%  
Reduces PM by 63%

**SIGNIFICANCE OF DATA**

There are no net increases in toxic emissions

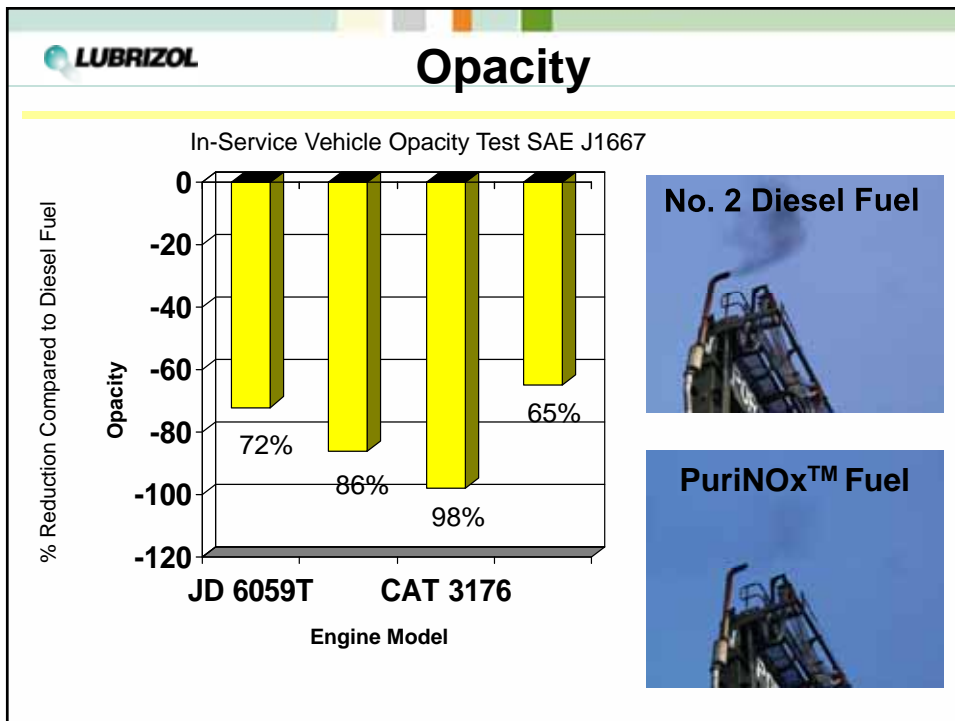
Hydrocarbon emissions are at least 25% lower than any applicable diesel vehicle emission standard

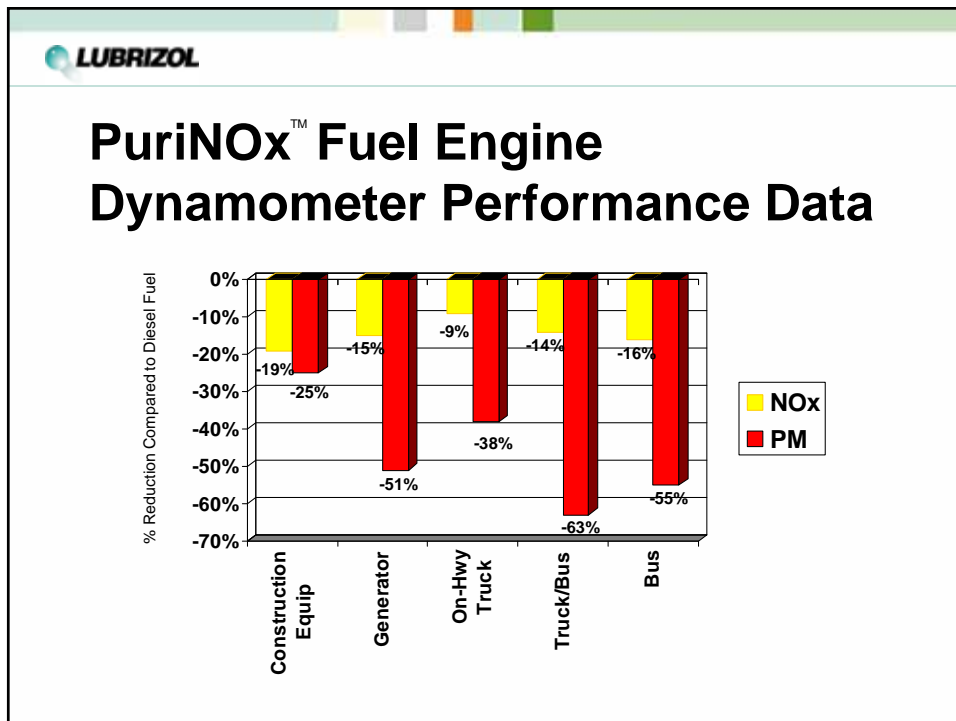
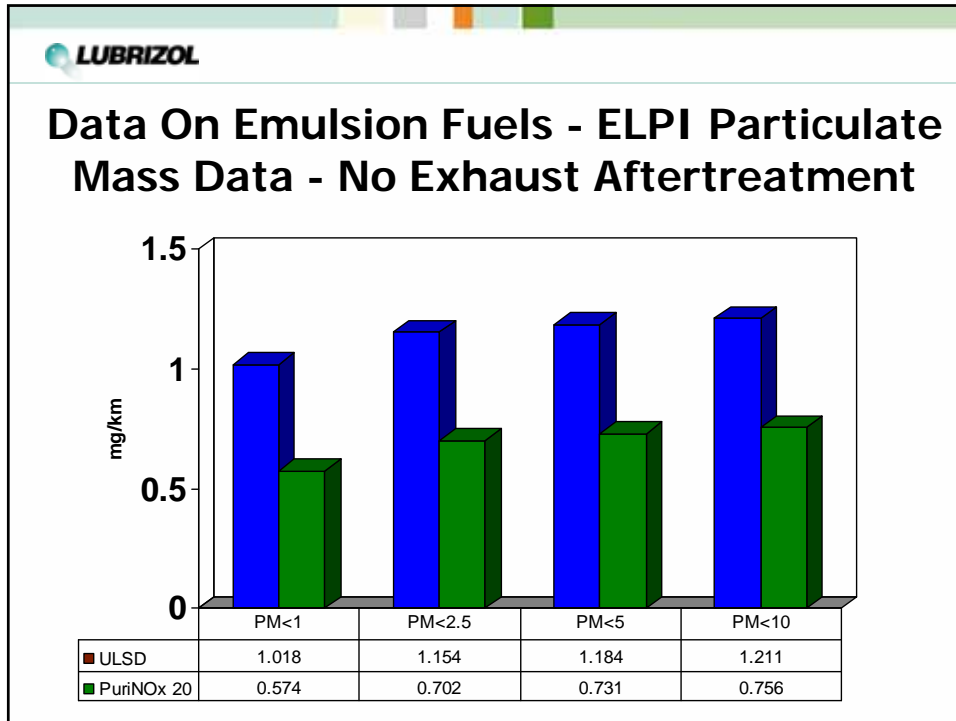


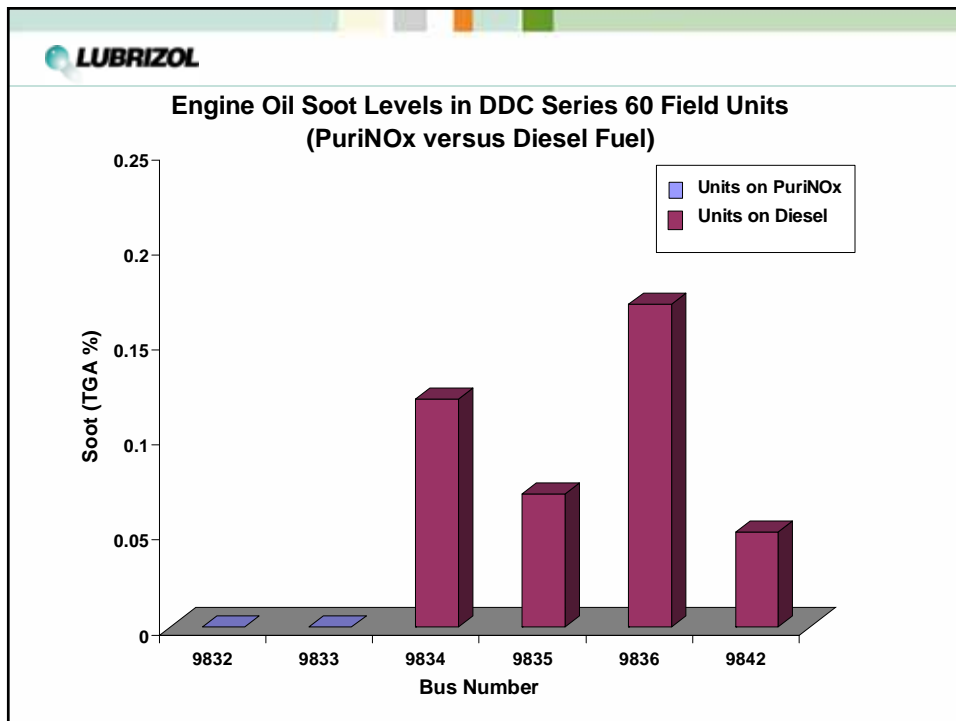
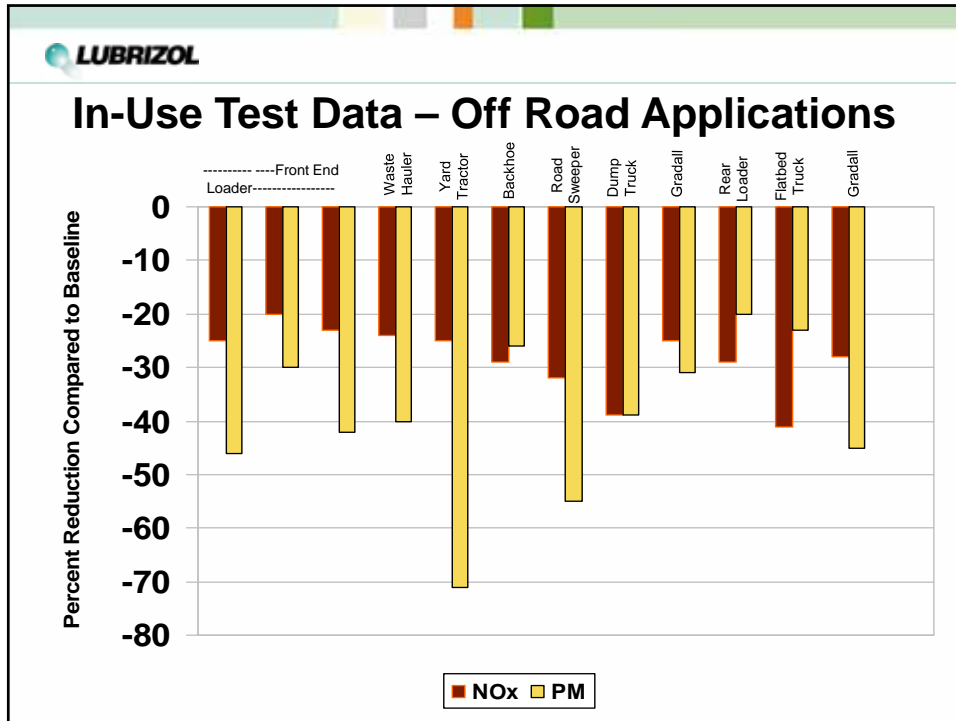
**LUBRIZOL**

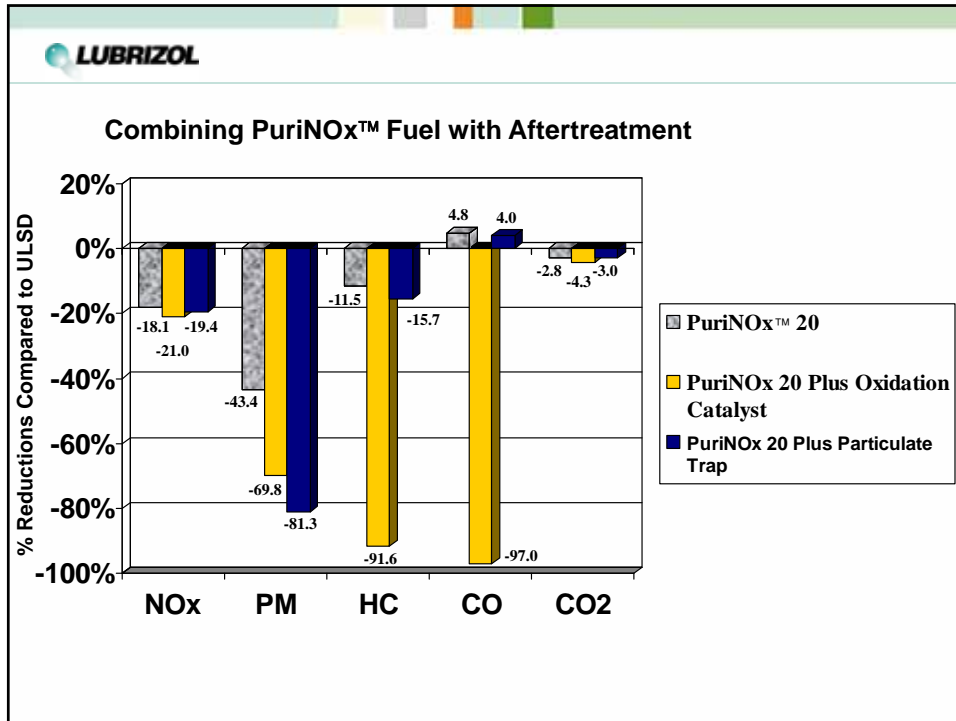
## Cost of Using PuriNOx™ Fuel

- Slight Loss in Power
  - Typically 10-15%
  - Often Transparent to Operators
- Slight Increase in Fuel Consumption
  - Typically 10-15%
- Typically a Slight Increase in Price by Volume Compared to Diesel Fuel









**LUBRIZOL** *In Summary*

- An Overall DPM Reduction of 35% was Realized by using PuriNOx Low Emission Diesel Fuel
- Existing Infrastructure is Used with No Significant Capital Costs
- Reductions are Achieved Across the Entire Fleet
- Air is Considerably Cleaner Across the Entire Mine



# Thank You

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<http://www.lubrizol.com/PuriNOx/default.htm>

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