

Ultra-Low NOx Solution for Mining Operations

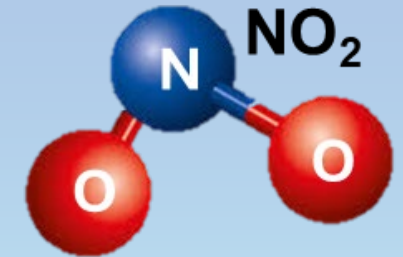
Emissol LLC



NOx Toxicity in Mining Environments

- **On Respiratory System**

- Short term: Coughing, wheezing, shortness of breath
- Long term: Chronic bronchitis, asthma, lung function ↓



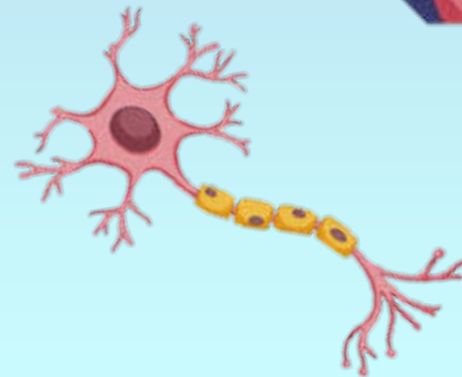
- **On Cardiovascular System**

- Blood pressure ↑, arterial inflammation
- Long-term exposure: ↑ risk of heart disease
- Pulmonary edema (likely delayed)



- **On Neurological Symptoms**

- Headaches, dizziness, fatigue
- ↓ alertness and ↑ accident risks



- **Others Long-term exposure**

- Spasms, swelled tissues, fatal in severe cases

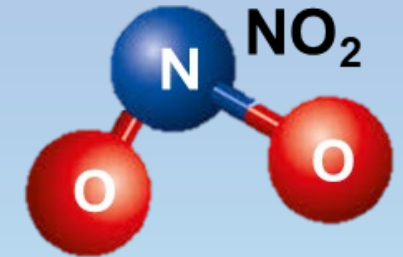
- **Higher Risk Mining Conditions**

- Confined/ underground spaces
- Poor ventilation systems
- Using older diesel-powered machinery

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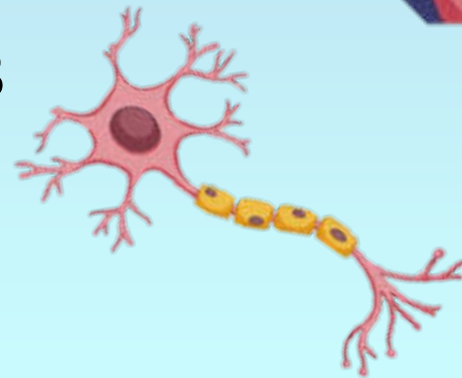
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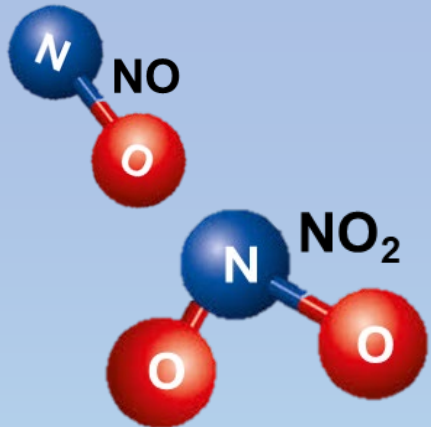
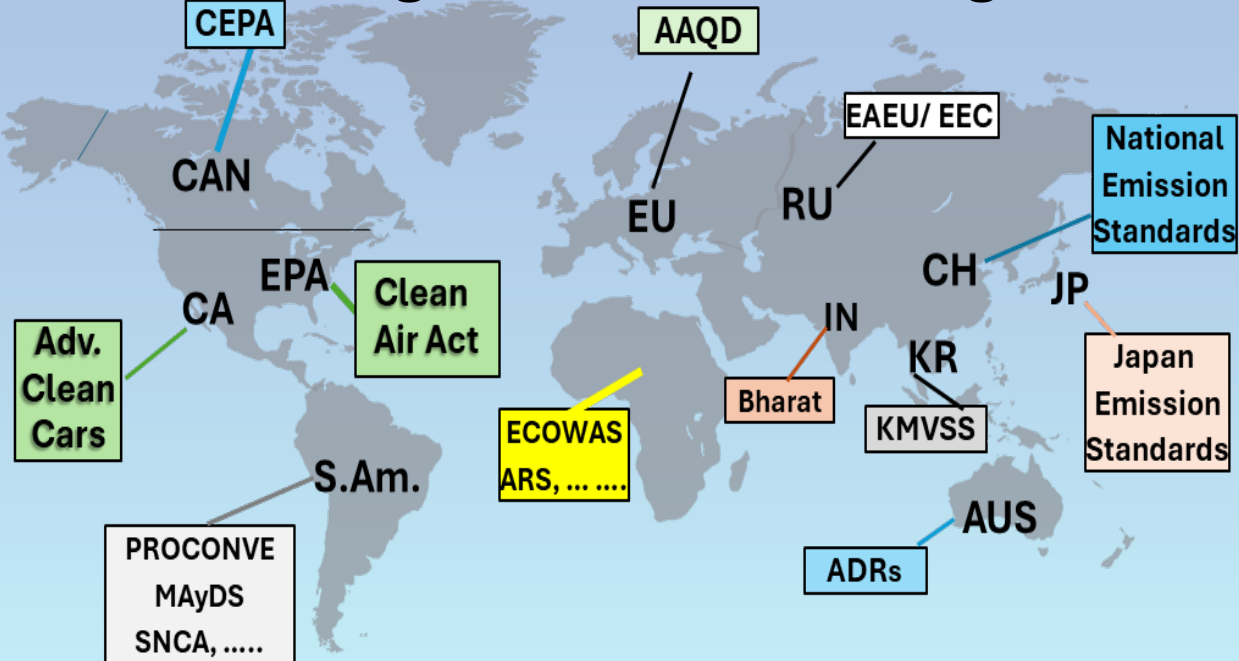
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Global NOx Rules.... Regulatory Fines

- Worldwide Regulations for Mining Machineries, Non-road, On-road, others



Examples of Regulatory Fines

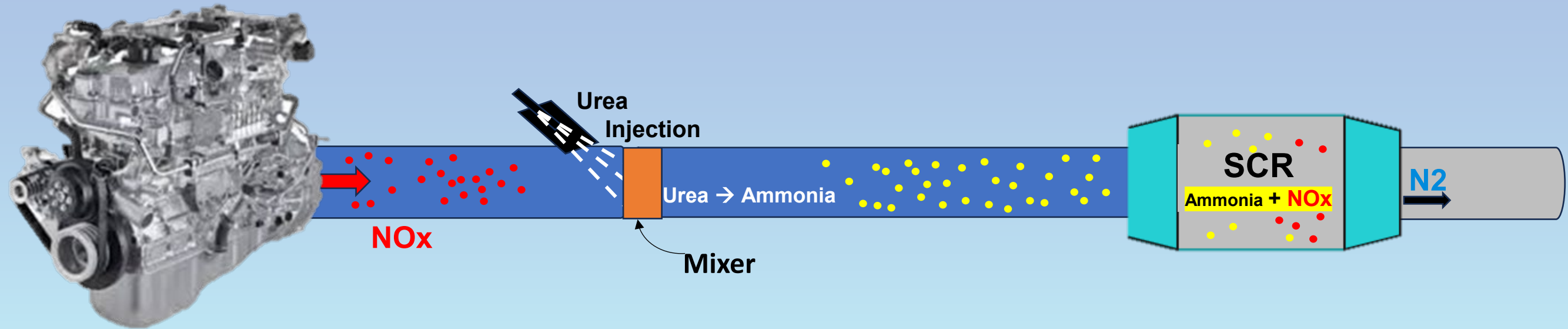
Suppliers to Mining Industry

- Manitowoc: \$42.6 M (2024)
- Fayat Group: \$11 M (2025)
- Hyundai Heavy Ind. \$47 M (2011)
-

On-road:

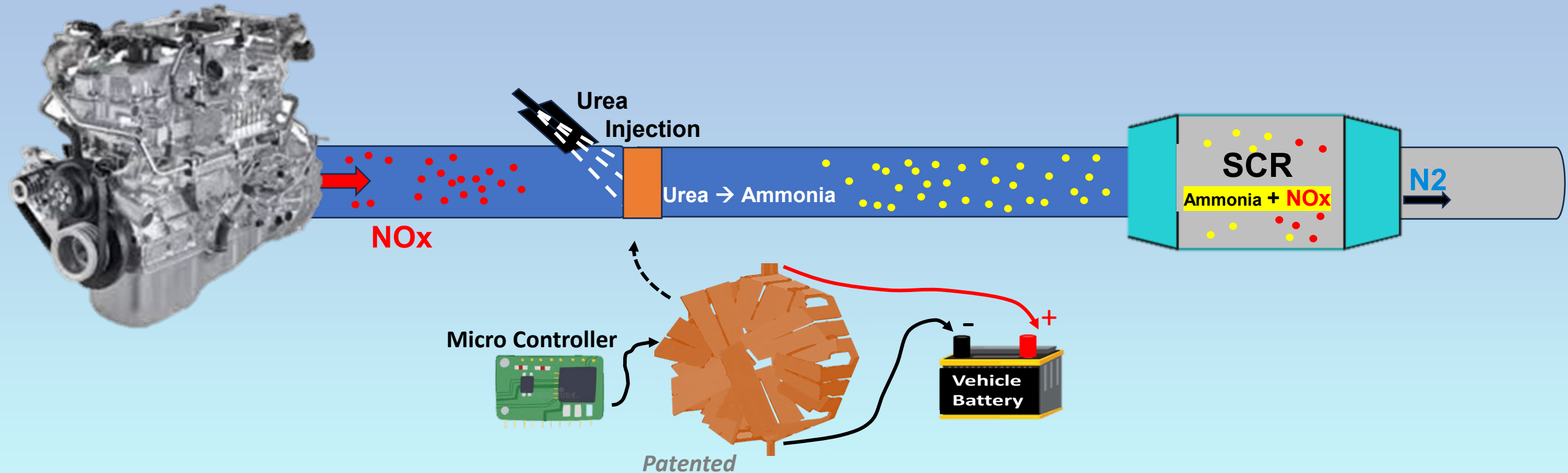
- Chrysler: \$305 M (2019)
- Cummins: \$1.6 B (2025)
- Hino: \$1.6 B (2025)
- Volkswagen: \$18 B (2016)
- BMW, Daimler \$1 B (2021)

NOx Treatment Challenges



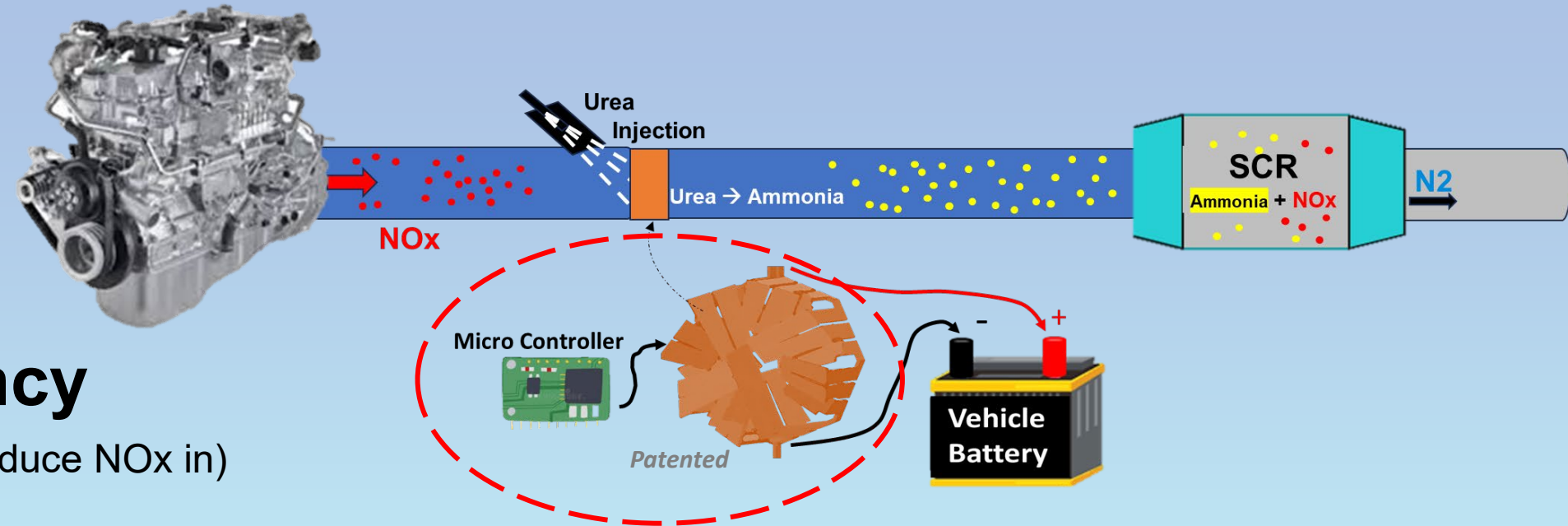
- **Poor NOx Reduction** *in Low-Load Cycles: Idling, Stop-n-Go, Local Driving, ...*
- **In-Use Compliance** *(regulatory fines, public image, ...)*
- **Downtime** *(due to urea deposit, ...)*
- **Warranty Costs**

Achieving Ultra-Low NOx with Relative Simplicity



- **Very small unit**
- **Low cost**
- **Low pressure drop**
- **Low Power** compared to other solutions
- **Durable** (withstands thermal shocks, DPF regen, ...)
- **Easy fit** (replacement for static mixer)

Achieving Virtual Zero NOx Emission



- Yields Peak SCR Efficiency

- In Low-Load Cycles (hard to reduce NOx in)
- In Cold Environments

- Enables

- *Maximum* ammonia/ HNCO (reductants)
- Very High Uniformity

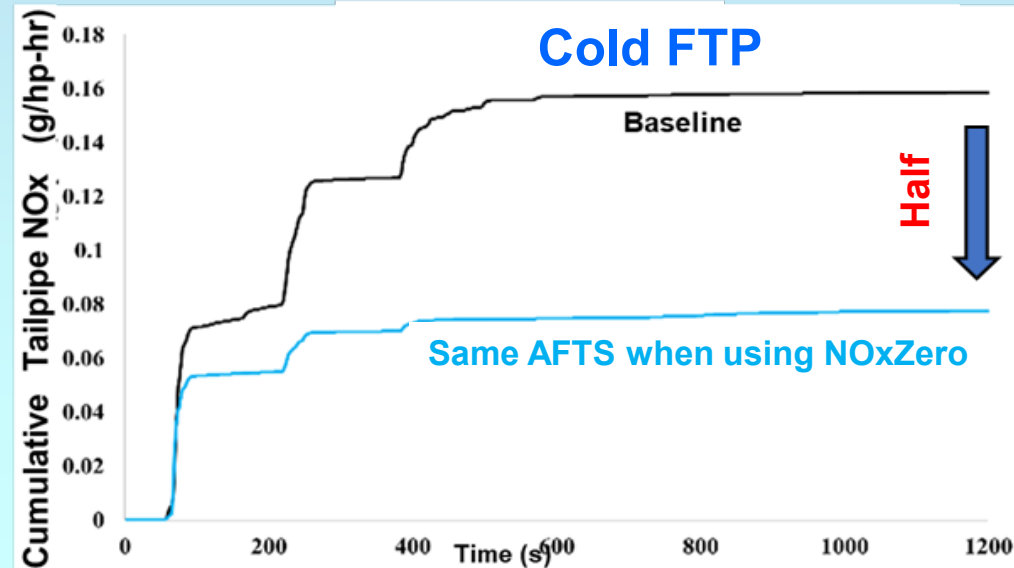
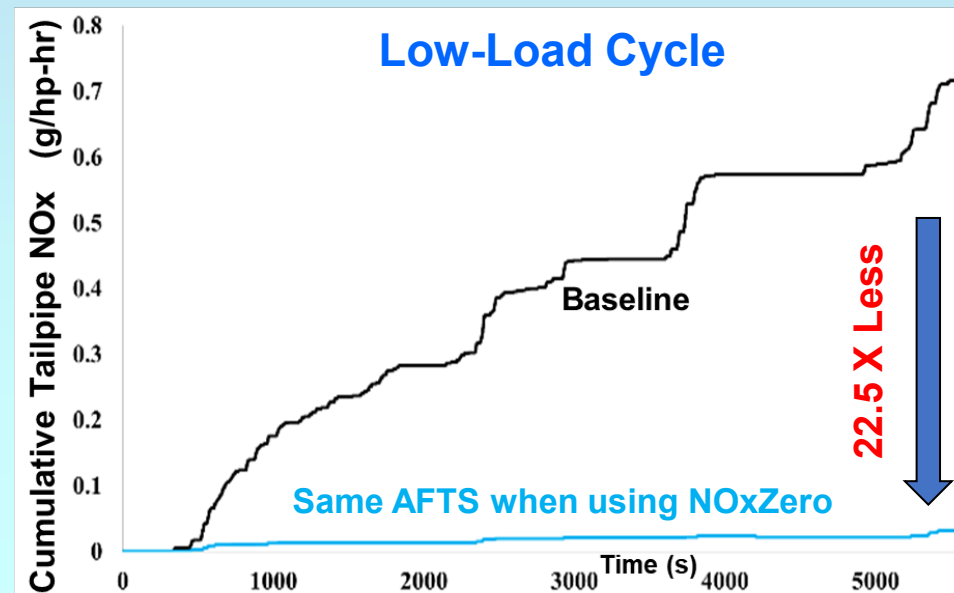
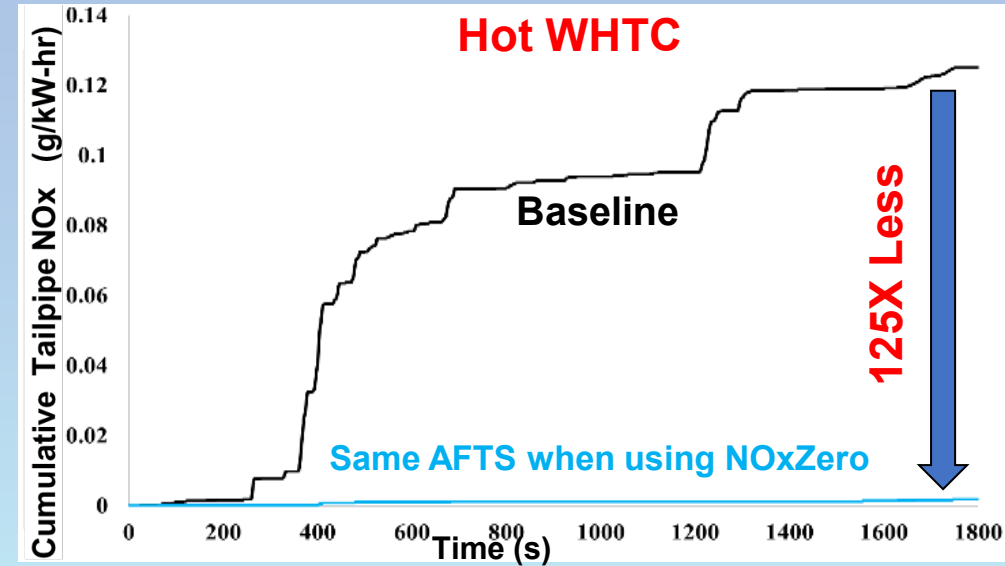
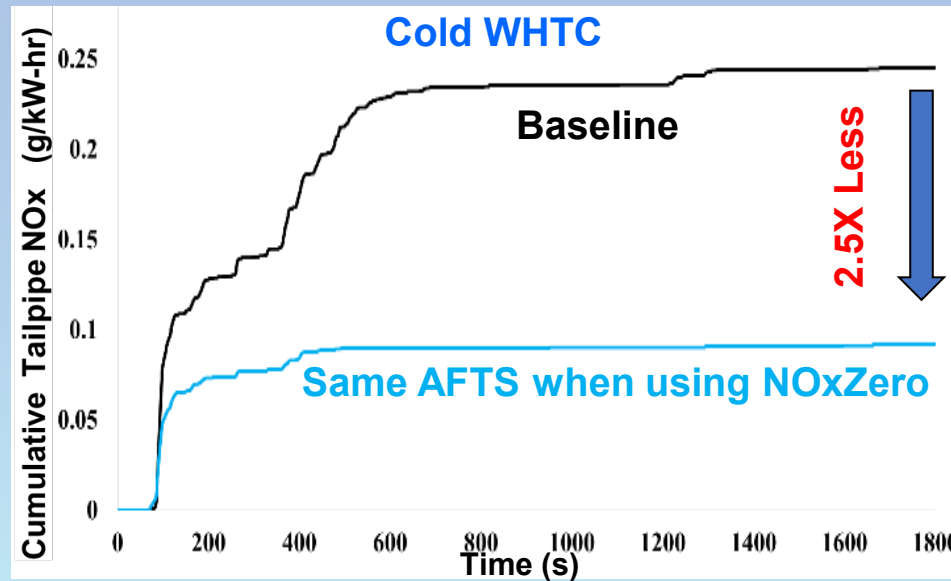
- Additional Benefits: Enables

Urea Injection in < 130 °C exhaust for optimal NH_3 storage

Urea Injection in $\sim 130 - 200$ °C exhaust for additional SCR efficiency

Examples: 2.5X to 125X Lower Tailpipe NOx (compared to standard systems)

- On *fully-aged* aftertreatment system; Cummins engine.



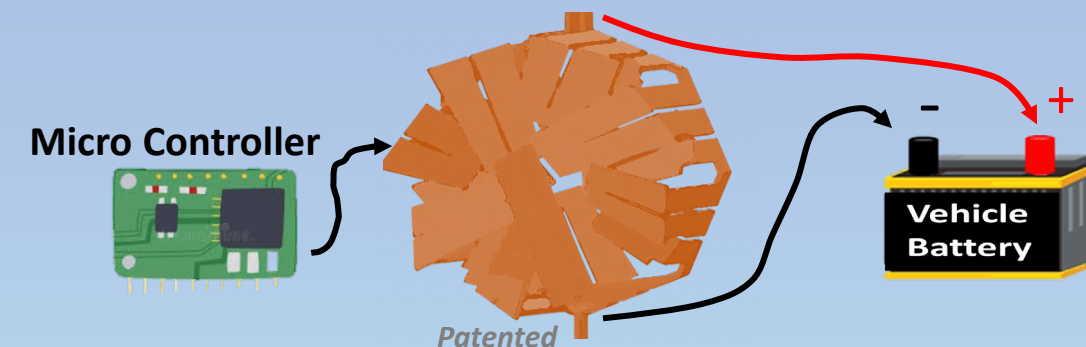
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Examples

- Test Results
- 3- to 22-Fold *Additional* NOx Reduction**



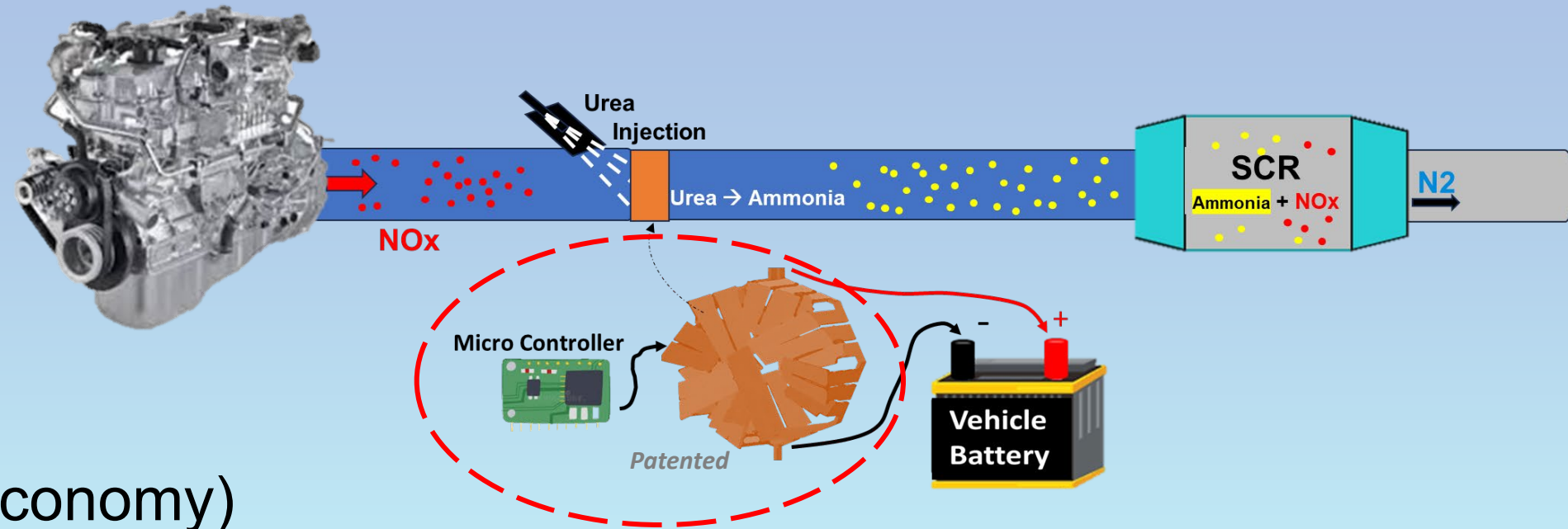
All Cycles on Fully Aged Aftertreatment System

Examples of Full Cycles	Tailpipe NOx WITHOUT NOxZero™ (g/hp-hr)	Tailpipe NOx WITH NOxZero™ (g/hp-hr)	Additional Reduction
FTP Cycle	0.06	0.018	3 X ↓
Low-Load Cycle	0.716	0.032	22 X ↓
WHTC Cycle (in g/kw-hr)	0.142	0.014	10 X ↓

Looking for Mining/ Non-Road Demonstration Partner
for: NRTC, Non-Road Steady Cycle (NRSC), Other Cycles

** Frontiers | Meeting future NOX emission regulations by adding an electrically heated mixer (frontiersin.org)

Next: Fuel savings with NOxZero™



- **Fuel savings** (fuel economy)
 - **Lower CO₂**
(via higher engine-out NOx strategy)
- **with AI for ~ 0 ppm tailpipe NOx**
(team formed)

For Global Powertrains

- NOxZero works with all Diesel engine utilizing SCR
- Also retrofit

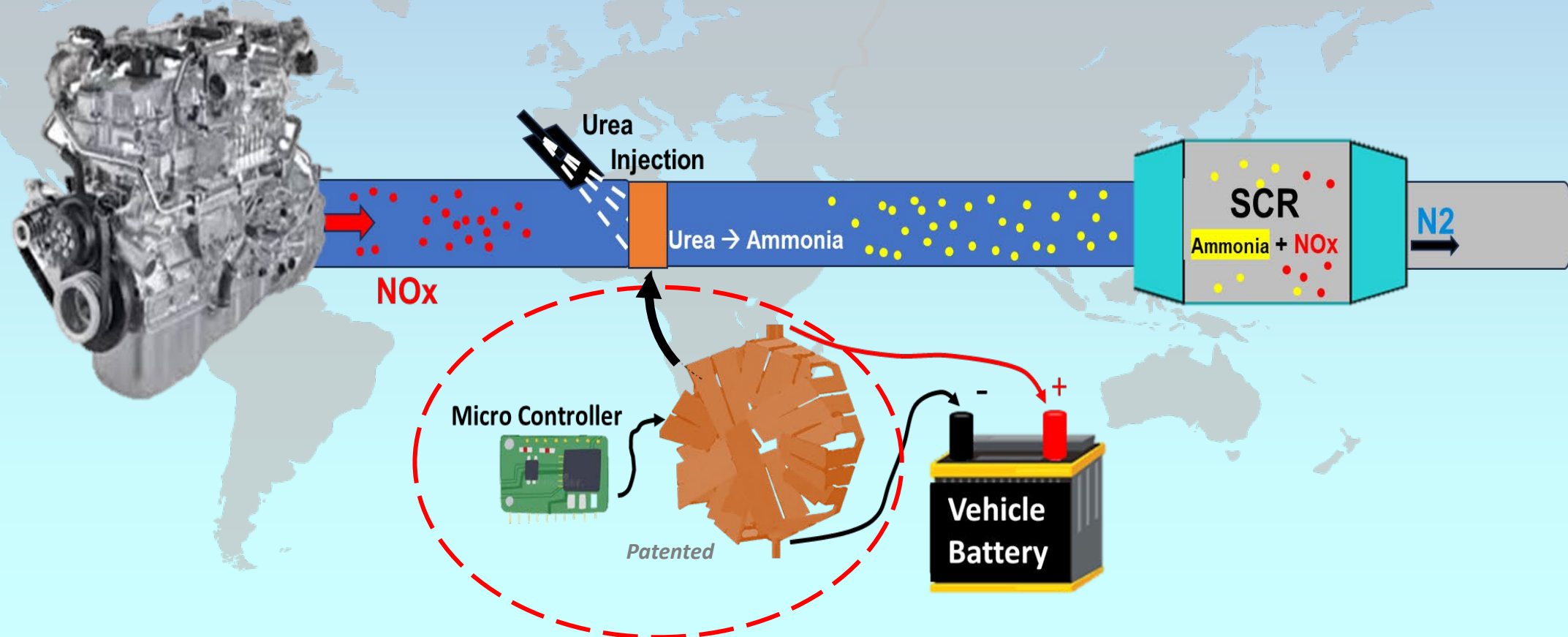


Data Centers



Summary

- NOxZero™ : Novel solution for Ultra-Low NOx emission
- Low-effort packaging
- Low power
- Low cost
- Lower fuel consumption
- Lower CO₂



Awards: US, EU & Global



SAE *Create the Future*
(Finalist, global contest 2025)



SAE Johnson Award
(2024)



R&D-100 Finalist
(2022)



German Innovation Award
(2023)



**Featured CLEPA
Innovation (2025)**

European Association of Automotive Suppliers

For Cleaner Air!



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