# TWIN DOSING UL4-THE NEXT INNOVATION IN SCR DOSING

cummin

### **TWIN DOSING UL4.**

Cummins has proven that improved engine performance, increased fuel efficiency and near-zero emissions can be achieved simultaneously through the use of Selective Catalytic Reduction (SCR) technology in an emissions system. Customers across all industries from on-highway trucks and buses to off-road mining, marine, farming and construction equipment have witnessed improved performance with exceptional dependability and durability.

That's good – but not good enough. At Cummins, our continuous improvement process demands that we look for new and innovative ways to make engines run even cleaner, stronger and longer. That's exactly what our new twin dosing UL4 technology does.

Building on thousands of hours of real-world experience and the expertise of Cummins Emission Solutions, we've developed a twin dosing system that takes advantage of residual heat from the engine to increase the effectiveness of NOx conversion, driving it down to levels well below current EPA and EU regulations and complying with anticipated reductions in the coming years. It also helps our customers achieve greenhouse gas (GHG) emission goals.

### FUTURE AFTERTREATMENT ARCHITECTURE.

#### **CLOSE-COUPLED SCR WITH DUAL DOSING**

#### **Benefits**

- Fast warm-up to start of dosing
- First SCR located before Diesel Particulate Filter (DPF)

#### **Opportunities**

- Reduction of heat losses in the downpipe
- Increased Diesel Particulate Filter (DPF) dosing flexibility
- Reduce deposit risk with divided dosing (UL4H)
- Ability to manage downstream NO2 generation across Diesel Oxidation Catalyst (DOC)
- Turbo-Doser-Integration

### EXPERTISE THROUGH EXPERIENCE.

Cummins Emission Solutions is a leading global aftertreatment and engineered-component supplier. We leverage our unrivaled technical understanding of aftertreatment systems to offer the right technology and support to meet constantly evolving emissions standards for on- and offhighway markets, committing millions of dollars every year to R&D to stay in front of these constantly evolving industries.

Our continued commitment to meeting the highest standards has earned us a strong reputation for providing the right solutions for our customers. Cummins helps customers meet tomorrow's emissions standards today with innovative, flexible and integrated components technology for light-medium, heavy-duty and high-horsepower commercial on- and off-highway markets.

We offer aftertreatment systems designed for easy customization and vehicle integration to meet customer needs.

- The UL4 system is a liquid dosing system commercially available that helps reduce oxides of nitrogen (NOx) in both low-flow and high-flow (SCR) systems and is capable of meeting dosing rates of up to 16 kg/hr.
- The UL4 system is particularly robust against vibrations and tolerates wider temperature ranges. Furthermore, the UL4H and UL4I dosers are more compact with respect to size and weight. These key product benefits enable new installation options.
- Both of the dosers can be controlled independently.
- UL4I is the primary doser, and we maintain dosing accuracy through the pressure sensor mounted on UL4I.

## CAPACITY AND CAPABILITY.

Engineering and innovation are only as good as a company's ability to manufacture and deliver the highest quality product at the best value. Cummins Emission Solutions has unrivaled dosing production capacity, currently projected to deliver approximately 700,000 dosing units in America, 500,000 in Europe and another 550,000 units in China and India by 2021. This enables economies of scale that others can't match. The proximity of manufacturing centers to our global customers helps to lower transportation costs and ensure timely delivery.

## THE HEAT OF THE MATTER.

To fully appreciate why Cummins is implementing this change, it's helpful to understand what DEF is, how it converts oxides of nitrogen into harmless water vapor and nitrogen and the role temperature plays in the conversion process.

DEF (also known as AdBlue in Europe/China/India and ARLA in Brazil) is a very specific concentration of 67.5% distilled water (H2O) and 32.5% purified urea (NH3). When sprayed under pressure into the hot exhaust stream of an SCR system, it breaks down the NOx to form nitrogen and water vapor – harmless elements commonly found in nature.

This chemical process is most effective when temperatures are higher than the evaporative temperature of DEF.

That is why, with our new twin dosing UL4 system, we've added an initial dosing unit next to the turbocharger inside the engine compartment to take full advantage of the heat generated during the combustion process and enhance NOx conversion. This system also requires the "close-coupling" of the SCR units upstream in the exhaust flow for optimum effectiveness.

The twin dosing system in the UL4 delivers superior fuel efficiency results compared to alternative methods of adding heat (like electric heating of the exhaust, injection of additional fuel or throttling the engine) for cold start and low engine speed/load operations.



#### TWIN DOSING SYSTEM OVERVIEW WITH UL4 PUMP AND UL4H AND UL4I DOSERS

# THESE TWINS AREN'T IDENTICAL.

The two DEF dosing units are similar in that they both feed off of the same DEF tank and DEF pump, using a pressure sensor to determine the correct dosage. However, the upstream UL4H doser (located nearest to the turbo) is designed to handle consistent temperatures of 180° C (200° C for short periods). Being located close to the turbo, UL4H enables fast warm-up and therefore an accelerated start of the dosing. It also incorporates high resistance to frost and freezing thanks to a constant recirculation of the fluid. A variety of nozzles enables a variety of spray patterns, flow rates and spray angles. A pressure-swirl atomizer ensures small droplet size, preventing crystallization and eliminating the potential for deposits. Its jacket design provides for cooling of the doser unit without adding complexity to the engine's cooling system.

The UL4I dosing unit, which is positioned downstream, utilizes stringent sensors working with the engine's electronic controls to enable the precise delivery of DEF to remediate any NOx that isn't too converted by the first spray. A cooling sleeve counteracts heating effects of the exhaust – but it's far away from the engine and only handles temperatures of up to 150° C. Like the UL4H doser, it uses recirculated DEF with the same anticrystallization and clogging properties. Installation is accomplished with just three screws. Both units are available in your choice of 12V and 24V options, with an easyaccess filter for simplified service.

#### METHODS TO REACH LOW NOX

#### Low Temperature SCR





### **PRESSURE AND PERFORMANCE.**

The heart of the UL4 twin dosing system is its electronically controlled pumping unit, which constantly recirculates DEF and maintains a consistent pressure to prevent crystallization and clogging. Based off of the proven UL2.2 design, the current model has a simplified design that makes filter maintenance quick and easy. While a simple flapper valve ensures stable fluid flow over the life of the system at the different customized flow rates, electronic actuation provides the precise management needed to properly match DEF flow to real-time measurements of pressure/amperage and includes speed error monitoring. It can operate at temperatures up to 221° F (105° C) and is available as a 12V or 24V option.

### **EVERY SECOND MATTERS.**

The most critical time in the life of any engine is a cold startup. This is especially true when looking at controlling emissions. Positioning the SCR system close to the engine allows for earlier activation, as it takes significantly less time to reach operating temperatures. Test data shows that in a situation where our current Single Module aftertreatment system located under the body can take just 400 seconds to reach 180° C, the same engine and equipment with close-coupled SCR will reach the same temperature in just 220 seconds.

The close-coupled SCR also reduces the amount of heat loss in the downpipe, giving greater flexibility to manage NO2 generation across the DOC.

# CUSTOMIZED AND OPTIMIZED.

The UL4 system can be readily adapted to meet specific needs of different applications and working environments.

- A pressure-swirl atomizer offers customized spray angles and flow rates.
- A choice of multiple nozzle designs allows for the exact spray pattern desired.
- Reduction of droplet size to as low as 24 microns SMD promotes improved NOx conversion efficiency.
- A higher electric motor speed in the pump for high-horsepower usage allows more urea to be released for high-flow optimization.

#### VALUE OF CLOSE-COUPLED SCR



#### BENEFITS

- Early activation on SCR possible
- Less time to reach operating temperature
  - Less upstream thermal mass
  - Less heat loss from downpipe
  - Potential for tailored low temp SCR

### **CRYSTAL CLEAR BENEFITS.**

Separating the DEF dosing into two events and using a fully pressurized, constantly recirculating fluid path virtually eliminate the potential for urea crystal formation. Accomplishing this without additional heating elements enhances simplicity, installation ease and reliability.

To learn more about the twin dosing UL4 system, visit cummins.com/components.

	UL4 Dosing Unit		UL4 Supply Unit
Parameter	UL4H Dosing Unit	UL4I Dosing Unit	UL4/UL2.2 Pump
Filter Inlet	90µm or 50µm	90µm or 50µm	190µm
Temperature (Ambient)	-40 until +180° C (temporarily up to 200° C )	-40 until +130° C (temporarily up to +160° C )	-40 until 105° C
Sensor	No	Yes	No
Frost protection	Integrated in doser housing	Integrated in doser housing	
Space L x B x H	DU with connector: ca. 62.7x57.4x94.9 cm	DU without connector: 56x56x107cm DU with connector: 116x82.5x92cm	ca. 233x148.2x93cm
Flow	Depending on nozzle + ~8kg/h Backflow - K4 nozzle: ~5kg/h - S5 nozzle: ~12kg/h	Depending on nozzle + ~8kg/h Backflow - K4 nozzle: ~5kg/h - S5 nozzle: ~12kg/h	4500rpm + Flapper: ~29kg/h 3500rpm + Flapper: ~25kg/h
Installation	V-Clamp	3 Screws	2 Screws

### FUTURE AFTERTREATMENT ARCHITECTURE

#### **CLOSE-COUPLED SCR WITH DUAL DOSING**

Turbocharger options to counteract impact of bypassing to aftertreatment system

- Efficiency improvements
- Thermal insulation
- Gas bypass around the turbine (RTC/WG/ VGT)
- Oil leakage improvements

Aftertreatment optimization

- Doser position and temperature control
- Aero optimization of turbine outlet flow
- Bypass gas reintroduction aerodynamics
- Close-coupled SCR





#### **Cummins Emission Solutions**

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