CATERPILLAR EMISSIONS SOLUTIONS

Frequently Asked Questions - Selective Catalytic Reduction

? How does SCR work?

An aqueous urea solution is injected in the exhaust air stream, where it evaporates into ammonia. Mixers are utilized after the injection to insure an even blend. Once the exhaust gas and ammonia mixture hits the SCR catalyst surface, a reduction reaction occurs, breaking down the NOx (NO or NO_2) and NH_3 into N_2 and H_2O. Any ammonia slip is reduced by using an Oxidation Catalyst or AMOX catalyst, which produce NO or N_2, respectively.

? What is the NO_x reduction capability of an SCR system?

NOx reduction is determined based on site requirements, and the actual engine and SCR and control system equipment involved. SCR systems have successfully demonstrated reductions of up to 90% and beyond.

? How long have SCRs been around? Will they be a part of future diesel engine applications?

SCR system technology has been utilized successfully for decades. They were originally used in central power plants on gas turbine and reciprocating engine applications. SCR technology is and will be a key component to meet future emissions standards in a variety of applications including construction equipment, on-highway trucks, and stationary engine applications.

? Can SCRs reduce Carbon Monoxide (CO) and Hydrocarbons (HC) emissions as well?

A SCR can only reduce NOx, however; the addition of a diesel oxidation catalyst (DOC) will independently reduce CO and HC emission levels.

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Does SCR reduce formaldehyde?

Yes, if an Oxi-cat is utilized.

What is the physical size of the system?

Drawings are available in our Technical Submittal package and Special Instructions. A standard SCR system can range from 50% to 60% the size of the power generation system.

Does the SCR system start up with the engine?

The SCR system can only be manually started. Before the engine can be started, there are certain conditions that have to be met: greater than 200°C exhaust temperature, pressure drop across the catalyst (must be under a maximum value, dependent on catalyst type), and a specified engine load factor.

What kind of system controls are needed?

The only system controls needed is the Cat Electronic Technician (ET), which is contained in the dosing control cabinet.

What are the electric power requirements?

Voltage? Two sources: 24V supply cabinet (straight from engine battery) and 230V/120 V (urea dosing pump).

Amp Draw? Less than 15 A at 120V (dependent on the application).

What kind of air and air capacity is needed?

The air must be dry, filtered and supplied at 60 PSI / 10CFM (225-290 l/min).

What is the effect of ambient temperature on the SCR system?

In an open loop system, NOx production or ammonia slip can be expected to rise as the ambient temperature increases or decreases, respectively. In a closed loop system, the same relation can be expected, but the increases in NOx production or ammonia slip will be smaller than those of an open loop system.

Does SCR affect fuel economy or power loss?

No. If the SCR is sized correctly and backpressure is at the acceptable level, there should be no loss in fuel economy. The Cat engineered solution ensures proper backpressure and system integration.

How many people it will take to operate the system?

One; the Cat ET will continually monitor the critical operations of the system.

Is there an estimation of man-hours per month/week required?

Approximately one hour per month is needed, mainly to check on the level of the urea tank.

Are the SCR parts serviceable and available?

Yes, the parts will be available beginning 1Q of 2008 in Morton through the Morton Parts System (ANTARES).

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What service is neeeded for the SCR system?

A regular maintenance schedule is available in the submittal package. Parts that need maintenance or scheduled replacement include: the pump diaphragm, injection nozzle tip, and the catalyst.

Who will provide the services?

Your local Cat® dealer.

What is the level of ammonia slip for the SCR system?

The level of ammonia slip is dependent on how rigorously NOx must be controlled. Typical for a 90 to 95 percent reduction is 5 to 25 ppm ammonia (at 15 percent O2 correction), respectively.

What are the dosage requirements?

Dosing ranges from 5-15 gallons per hour, depending on the NOx reduction and other factors such as exhaust temperature, space velocity, and exhaust flow rate.

What is the amount of urea that is needed?

Urea tanks can usually hold 4000 gallons.

Where is urea available?

Urea is available throughout the United States. A list of suppliers is provided in the special instructions.

How often does the urea tank need to be refilled?

Refill time is depended on size of the main urea tank and rate of use. Approximately one gallon of urea is used for every 15 to 20 gallons of diesel fuel.

How long does it take to fill up a container of urea? What is the average fill rate?

Consult Urea supplier for urea tank fill times and fill rates.

How long can urea stand for?

Urea decomposition is dependent on temperature, and becomes a serious consideration at higher than ambient temperatures. Urea suppliers can provide more detailed information about urea storage and decomposition.

How much does urea cost?

The price of urea can range from approximately $0.8 to 3.00 per gallon (4Q 2007, ISO 2006 compliant) depending on volume and location.

Does AMOX convert ammonia back to urea? Why is there an oxidation catalyst after SCR?

No, the AMOX does not convert ammonia back to urea. The oxidation catalyst after the SCR is in place to reduce the ammonia slip of the system.

What are the physical characteristics of urea?

The physical characteristics of Urea are dependent on the solution used. The 32.5% solution has a pH of 9.0 to 9.5 and has a freezing point of 11.3°F. The 40% solution his more alkaline and has a freezing point of 33°F. Urea for SCR system must comply with ISO 2006 standards.

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What are the mechanics of non-hazardous urea injection?

Urea (32.5% or 40% by weight) is pressurized using a dosing pump. This pressurized urea is injected in to the exhaust air stream with the help of specialized spraying system.

Is there continuous monitoring? How do we know if the system is working? Is the SCR system NOx sensing?

Continuous monitoring is available, and involves a gas analyzer measuring a constant sample of exhaust gas after the SCR catalyst for NOx concentrations. The NOx concentration is shown on the display panel of the dosing control cabinet.

What are the costs associated with SCR catalyst module?

The catalyst module lasts up to 20,000 hours and costs; on average, 10,000 to 20,000 dollars to replace.

What are the average operating costs (SCR and urea)?

Close Loop G3412 (550 kW) – G3516 (1750 kW) = Approximately $290 - $91 / kW
Open Loop D3412 (800 kW) – 3516 (2200 kW) = Approximately $125 - $45 / kW
Open Loop D3520 (3000 kW) – 3616 (5320 kW) = Approximately $34 - $60 / kW

Is the SCR system a plug & play design?

Yes, with the Cat ET system utilizing Data Link.

Can the unit be mounted?

Yes, the unit can be ground mounted as well as separate skid mounted on the side, on a rack, or on the rooftop of enclosure.

How will Cat package this system?

To be determined, based on voice-of-customer.

How sensitive is the system to vibration?

Vibration sensitivity is dependent on stiffness/flexibility of the package.

What are the effects of fuel BTU?

No data currently exists for fuel BTU effects. Fuel BTU may have an impact on the combustion characteristics of the engine, resulting in an increase or decrease of NOx production.

Where do I get more information on the Cat SCR system?

For North American Cat dealers, please go to our website located at:
https://nacd.cat.com/infocast/frames/prodsupp/emissions/

How do I submit a request for quotation for a Cat SCR project?

Given the importance of matching the SCR to your engine and site conditions, Cat dealers may request a quotation by going to our website located under “Reference Information” . Request forms are also located under the “Stationary Engine Solutions” section.

Ammonia Slip – Ammonia that is not used in the SCR catalyst or oxidized by the AMOX and is carried out with the exhaust. Typically expressed in parts per million (ppm) at a specified O_2 correction (15% United States, 5% Europe).

AMOX – Ammonia Oxidizing Catalyst, which is located after the SCR catalyst and is used to reduce ammonia slip. AMOX converts the majority of ammonia to nitrogen.

BTU – British thermal unit, a measure of heat. Commonly defined as the amount of energy needed to raise the temperature of one pound of water by 1°F.

Closed Loop – An SCR control system that uses active measurement of NOx to determine urea injection quantity. NOx could be measure before and/or after the SCR catalyst through the use of a NOx sensor.

Engine Load Factor – percent of engine load (torque) at a given speed (rpm)

ET – Electronic Technician, Caterpillars proprietary electronic software used to diagnose the system.

NOx – Nitric Oxide (NO) or Nitrogen dioxide (NO_2), a pollutant and product of the combustion process.

O_2 Correction – Provides a baseline comparison between different emissions sources.

Defined as: $$\%O_2 = \left[\frac{21 - O_{2\ reference}}{21 - O_{2\ stack}}\right] PPM_{stack}$$ where PPM stack is the engine emission.

Open Loop – An SCR control system that has no NOx feedback and results in minimal performance.

SCFM – Standard cubic feet per minute, a measure of volumetric flow. Measured at 68°F, 36% relative humidity, and 1 atm pressure (sea level).

SCR – Selective Catalytic Reduction. A system used to reduce the emissions of NOx through the use of urea.

Space Velocity – Volumetric flow of exhaust gas through the catalyst, expressed in standard $ft/hr \,/\, ft^3$.

Urea – A non-hazardous aqueous solution, also used as a fertilizer, that decomposes in the exhaust stream to form ammonia (NH_3) at temperatures above 200°C. Urea is available in different grades and is used in fertilizer, cosmetics, food additives, and industrial processes.