Diesel Exhaust Fluid
and Your Tier 4 Final / EU Stage IV Cat® Engine

Selective Catalytic Reduction (SCR) Fundamentals

Beginning in 2014, non-road engine emissions regulations in the U. S, Canada, and EU countries require engine and equipment manufacturers to reduce emissions of oxides of nitrogen (NO_x). These regulations apply to construction and industrial equipment and engines produced on or after the regulation effective dates.

In order to achieve the emissions reductions mandated in 2014, many off road engine system manufacturers, including Caterpillar, will utilize a Selective Catalytic Reduction (SCR) system in the 130-560 kW (175-750 hp) range. The SCR system consists of a catalyst that reacts with a urea based diesel exhaust fluid (DEF) to significantly reduce oxides of nitrogen (NO_x) emissions. This SCR technology is in widespread use globally in diesel engine powered on-highway vehicles.

Diesel Exhaust Fluid (DEF) is required in all Selective Catalytic Reduction (SCR) systems. During operation, Cat engines and equipment with SCR systems consume a small amount of DEF, approximately 2 to 3% of diesel fuel consumption by volume depending on engine operation, duty cycle, geography, load, ratings, etc. A small DEF tank, mounted on the equipment, must be refilled regularly, typically at every diesel fuel refill interval.

Diesel Exhaust Fluid (DEF) Fundamentals

Diesel Exhaust Fluid (DEF) is a precisely mixed solution of 32.5% high purity chemical grade urea and 67.5% de-ionized water that is injected into the exhaust system to reduce NO_x emissions in Cat® engines equipped with an SCR system.

DEF used in Cat Selective Catalytic Reduction (SCR) systems must meet the requirements outlined in the International Organization for Standardization (ISO) standard 22241-1. ISO 22241-1 requirements are met by many brands of DEF, including those that carry the AdBlue or API certifications.

DEF is only available as a premixed solution from the supply base. Use of any fluid which does not meet the requirements outlined in ISO 22241-1 may damage Cat SCR systems.

The ideal storage temperature for DEF is between 15ºF and 77ºF (-9ºC and 25ºC). Additionally DEF should be protected from direct sunlight. Refer to ISO 22241-3 for further information regarding DEF handling, transportation and storage.

Diesel Exhaust Fluid (DEF) Fundamentals

DEF cleanliness is extremely important as contaminants can degrade the life of DEF and system components. Filtering is recommended when filling the DEF tank. Prior to filling the DEF tank, clean the blue colored DEF tank filler cap and surrounding area. Avoid filling the DEF tank from a contaminated container or funnel and overfilling of the tank.

As DEF is corrosive to many different materials, care should be taken when dispensing DEF Spills should be cleaned immediately, machine or engine surfaces should be wiped clean and rinsed with water.

***Note*:** Cat US EPA Tier 4 Final/EU Stage IV products equipped with SCR systems require DEF for proper operation.

***Note*:** To meet U.S. EPA's expectations, Caterpillar has designed its SCR-equipped engines to take a number of escalating actions if an operator runs the engine without DEF in the tank or if DEF quality problems are detected. Such actions include operator warnings, engine derates, and the eventual shutdown of the engine.

Diesel Exhaust Fluid (DEF) Frequently Asked Questions

Q. What is Diesel Exhaust Fluid (DEF)?
A. DEF is a carefully blended solution of 32.5% high purity urea and 67.5% deionized water.

Q. What is urea?
A. Urea is a nitrogen containing compound used in a variety of industries, often as a fertilizer in agriculture. When heated, urea decomposes into ammonia (NH_3) and carbon dioxide (CO_2).

Q. Is the 32.5% urea solution critical?
A. Yes, The 32.5% urea concentration is the ideal solution as it provides the lowest freeze point and the best protection in cold ambient temperatures. In addition, Cat SCR systems are calibrated to operate on a 32.5% urea solution, ensuring optimum NO_x conversion during operation.

Q. Can I purchase DEF from my Cat dealer?
A. Cat dealers offer DEF in 9.5 liter (2.5 gal) bottles for single use applications and in 1000 liter (264 gal tote) for multiple uses.

Q. Am I required to use DEF purchased from the Cat dealer?
A. No, any commercial DEF that meets ISO standard 22241-1 is approved for use in Cat SCR equipped products.

Q. Where else will DEF be available?
A. DEF can be purchased at common retail locations similar to that of fuel and oil, including retail locations such as on-highway truck fueling stations, automotive parts stores, and bulk delivery from DEF producers or fuel distributors.

Q. How large is the DEF tank on my machine?

A. Several tank sizes will be specified based on machine application and duty cycle. The specific size also ensures a diesel fuel to DEF fill ratio of 1:1 (that is, one DEF tank refill to each fuel tank refill) is met. Generally speaking, the size of the DEF tank is about 10% the size of the diesel fuel tank.

Q. What happens if the DEF tank becomes empty?

A. Engine systems that use DEF will have an indicator like a fuel gauge to alert the operator of the quantity of DEF on board. There is a DEF low level warning lamp that will illuminate when DEF is low. When the product is low on DEF, power delivered by the engine will be reduced until the operator refills the DEF tank. The engine will return to normal power levels once the tank has been refilled.

Q. How much DEF will be consumed?

A. Depending on engine operation, duty cycle, geography, load ratings, etc., DEF consumption should be approximately 2 to 3% of fuel consumption.

Q. Is any new maintenance required on the engine or SCR system?

A. A filter is installed in the DEF pump unit to ensure proper filtration of impurities such as dirt and debris. This filter must be replaced every 5,000 hours.

Q. Will there be any special fuel or oil requirements for SCR equipped vehicles?

A. Fuel and oil requirements will be the same as Tier 4 Interim/EU Stage IIIB. Ultra low sulfur diesel (ULSD) and low ash oil (API CJ-4) will be required for use in SCR equipped products.

Q. What is the freeze point of DEF?

A. DEF with a concentration of 32.5% urea will begin to crystallize and freeze at 11.3 °F (-11.5 °C). At 32.5%, both urea and water freeze at the same rate, ensuring that as it thaws, the fluid does not become diluted, or over concentrated. Freezing and unthawing of DEF will not cause degradation of the product.

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Q. How do I keep the DEF from freezing? What happens if DEF freezes while in the vehicle DEF tank?

A. SCR systems are designed to prevent DEF from freezing in the tank and supply lines while the engine is being operated. Normal operation of the product will not be inhibited if DEF freezes when the engine is shut down. The SCR system is designed to quickly thaw frozen DEF ensuring that the operation of the engine will not be impacted.

Q. How will I know if I am getting quality DEF?

A. To ensure that you are getting quality DEF you should only purchase and use DEF that meets the International Organization for Standardization (ISO) 22241-1. This will ensure the proper purity and concentration of urea. For more information on these standards, visit www.iso.org.

Q. Can I make DEF myself?

A. No, only a premixed solution of DEF available from the supply base should be used. Use of any fluid which does not meet the requirements outlined in ISO 22241-1 may damage Cat SCR systems. For more information about DEF quality standards, refer to ISO22241 which details DEF standards including, quality, handling, testing, transportation, and storage.

Q. Does DEF have any special storage requirements?

A. DEF should be stored in a cool, dry, well-ventilated area. It should never be exposed to direct sunlight as the urea will decompose. The ideal storage temperature for DEF is between 15ºF and 77ºF (-9ºC and 25ºC). For additional information refer to ISO22241-3.

Q. How long can DEF be stored?

A. The shelf life of DEF depends upon the storage temperature. DEF will degrade over time depending upon how long it is exposed to high temperatures and sunlight. ISO 22241-3 defines the minimum shelf life expectations when stored at constant temperatures and notes that if DEF is stored below 86 F (30 C), shelf life will be one year, below 77 F (25 C), shelf life will be 18 months. Refer to the standard for further information

Q. What happens if the DEF gets contaminated?

A. If the DEF or the DEF tank becomes contaminated, the life of the DEF may be reduced. Additionally, fault codes and emission system failure may occur. Prior to filling the DEF tank, clean the fill area. Never use a contaminated container to transport DEF or to fill the DEF tank.

Q. Is it necessary to clean up DEF spills?

A. DEF is corrosive to many different materials. Spills should be cleaned up immediately. Thoroughly wipe clean the surface and rinse with water.