Service Solutions

HOW TO STORE AND HANDLE DIESEL EXHAUST FLUID EFFECTIVELY

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Selective catalytic reduction (SCR) technology has been utilized globally for more than 50 years to reduce emissions of nitrogen oxides (NO_x). Since the EPA mandated its use for diesel-powered vehicles and equipment in 2010, SCR has become increasingly commonplace in the United States and in many other regions. SCR systems require replenishing diesel exhaust fluid (DEF) on a periodic basis to ensure emissions system performance. Understanding a few simple tips on how to store and handle DEF will help keep your SCR system running efficiently.

What is SCR?

SCR is an advanced aftertreatment system that treats exhaust gas downstream of the engine. Small quantities of DEF are injected into the exhaust upstream of a catalyst, where it vaporizes and decomposes to form ammonia and carbon dioxide. When the NO_x from the engine exhaust reacts inside the catalyst with ammonia, harmful NO_x molecules in the exhaust are converted to harmless nitrogen and water, which are released from the tailpipe as steam.

A Rolls-Royce solution

SCR System

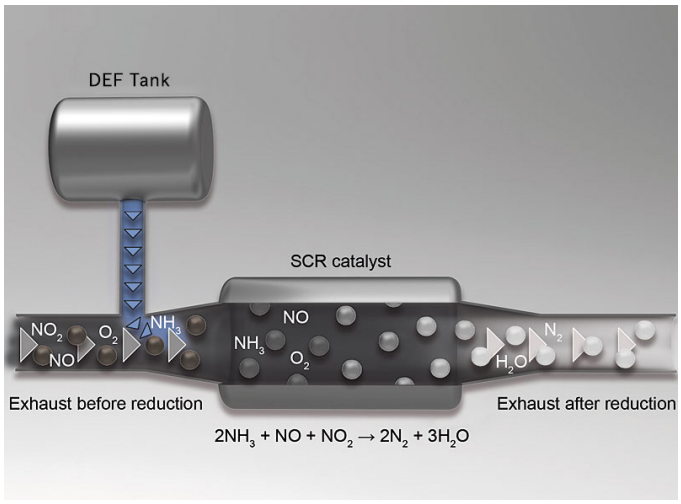

Figure 1

Shelf life of DEF

Shelf life depends on the temperature of your storage facility. According to ISO22241 standards, ideal storage temperatures for DEF should be between 12°F and 86°F. When stored at lower temperatures, shelf life is extended.

ISO22241 DEF Storage Specifications

Constant ambient storage temperature (°C/°F)		Minimum shelf life (Months)
≤ 10	50	36
≤ 25[a]	77	18
≤ 30	86	12
≤ 35	95	6
> 35	95	— [b]

Note: The main factors considered to define the shelf life in this table are the ambient storage temperature and the initial alkalinity of AUS 32. The difference in evaporation between vented and non-vented storage containers is an additional factor.

[a] To prevent decomposition of AUS 32, prolonged transportation or storage above 25°C should be avoided.

[b] Significant loss of shelf life: check every batch before use.

Storing DEF in a climate-controlled environment and out of direct sunlight is recommended. Note that the chart shows recommended shelf life at a constant temperature. When calculating shelf life at your site, consider daily temperature fluctuations, as well as seasonal. In general, the shelf life for DEF will be a minimum of one year in most U.S. areas. Proactive monitoring and maintaining recommended concentration specifications will help prevent issues when operating beyond ISO guidelines. In most markets and applications, DEF will be consumed before the shelf life expires. Based on more than ten years of using DEF in the U.S. and Europe, storage requirements for DEF have not been a concern.

Cold conditions

Proper storage of DEF is required to prevent the liquid from freezing at temperatures below 12°F. The 32.5% concentration of urea in DEF was determined as ideal by the ISO committee because it has the lowest freeze point of any other urea/water mixtures. DEF's composition enables it to freeze and thaw just like water and ice. When frozen 32.5% urea DEF thaws, it will not leave any solids behind or change the effectiveness of the fluid. When operating at extreme cold temperatures, it's important to keep DEF from freezing. If the DEF freezes, it will not allow the unit to be in compliance, and for Tier 4-certified equipment, inducement shutdowns will be implemented.

Formulated to last

Diesel exhaust fluid is formulated with 32.5% urea and 67.5% deionized water. Engines with SCR are specifically engineered for optimal performance at this ratio. If stored too long, theoretically the DEF can become off-spec. However, formaldehyde, biuret, or any other metal ions are not going to appear in the solution while the product sits in storage for an extended period of time. The only change that could occur is alkalinity as ammonia, therefore these items that could theoretically come out of spec are not a concern as ammonia is the target.

Over time and at higher temperatures, a portion of the urea can react with the water to form ammonia and CO_2. However, these compounds will quickly dissolve. While it is possible for DEF to decompose and lose ammonia, this does not impact the quality of the DEF. Field-testing DEF is fairly easy and similar to checking coolant. It's typically preferred to use a refractometer to check the concentration of urea.

Handling

DEF is a non-hazardous, easy-to-use operating fluid. It is not a fuel, nor a fuel additive, but a high purity urea solution that must be stored within a dedicated DEF tank (separate to the diesel tank), that is refilled as/when required. In most cases, the DEF tank and fuel tank are sized proportionally, and will empty at about the same rate. To maintain a proper supply, operators should refill the DEF tank every time they refuel.

A 32.5% urea concentration must be maintained in the DEF solution for optimal operation of the emissions control system. SCR reduces levels of NO_x using ammonia as a reductant within the catalyst system. If the concentration is lower, less ammonia is produced. Precise controls for the injection of DEF for the SCR system must be in place to automatically inject DEF to get the proper NO_x reduction, while controlling NH3 slip.

The best solutions to maintain optimal DEF concentration are closed loop control systems that continuously monitor inlet and outlet NO_x emissions. Most injection control systems can handle minor concentration fluctuations. If an operator notices the concentration of the urea is out of spec and needs to be adjusted, consult with your DEF supplier on the best method for your site to correct this issue. Below are several general guidelines.

If the urea concentration is 40-50%, it is best to add deionized water to the tank in increments of 10% of the volume of DEF in the tank, until it is within specification. Do not use tap water. If the DEF concentration is above 50% (generally crystalized urea is present in the tank), it is best to clean out the DEF system and begin with fresh DEF.

Use heated lines and a heated tank to keep the DEF above the freeze point during the winter months. Often the DEF tank is insulated to lower the heating requirements for the tank. It is ideal to use a vacuum/pressure vent that opens and closes when there is a change in pressure. This will limit evaporation of the water in the DEF and help keep the concentration constant over time.

Always store DEF in High Density Polyethylene (HDPE) or stainless-steel tanks. Since DEF reacts with copper, make sure even connections use the appropriate materials like stainless steel. If copper is used on a connection it can easily be seen, as the DEF will change to a blue color quickly. DEF may seep through connections. If DEF dries and forms crystals, simply use warm water and a rag to remove.

Consumption

DEF is an integral part of the emissions control system and must be present in the tank at all times to assure continued operation. This is important to maximize uptime for equipment in construction, farming, marine, rail, and power generation applications. In the standby generator market, DEF consumption is fairly minimal since units generally only operate a few hours per year, usually for maintenance/readiness checking. However, during an outage there may be several hours—or days—of operation at full load of fuel and DEF on site. Make sure DEF is topped off periodically to ensure there is enough to operate in an emergency. Mission-critical applications may be put at risk if ample supply is not readily available.

Conclusion

SCR systems use DEF to limit the NOx emitted from the equipment's exhaust system. To ensure your SCR system continues to perform effectively and is protected from the risk of damage, you need to follow some simple storage and handling guidelines to prevent your DEF from being compromised.

When working on new installations, it is recommended to discuss all aspects of DEF and SCR systems with your local Rolls-Royce Solutions representative or factory rep. Selecting the proper solution for your equipment's specific needs ensures maximum reliability for the most demanding applications.

Rolls-Royce provides world-class power solutions and complete lifecycle support under our product and solution brand ***mtu***. Through digitalization and electrification, we strive to develop drive and power generation solutions that are even cleaner and smarter and thus provide answers to the challenges posed by the rapidly growing societal demands for energy and mobility. We deliver and service comprehensive, powerful and reliable systems, based on both gas and diesel engines, as well as electrified hybrid systems. These clean and technologically advanced solutions serve our customers in the marine and infrastructure sectors worldwide.

Within its Net Zero at Power Systems program, Rolls-Royce has set out to sustainably reform its product portfolio so that by 2030, new technologies can save 35% of greenhouse gas emissions compared to 2019. This near-term target plays a significant role in Rolls-Royce Group's ambition to achieve net zero by 2050 at the latest. A key element in achieving these goals is the release of the highest volume ***mtu*** engine products and systems to run on sustainable fuels as quickly as possible.