DANSK TEKNOLOGI
SCR System with Digital Airless Multipoint® Urea Injection for NOx-reduction

A cooperation between
Danish Defence Acquisition and Logistics Organisation
and DANSK TEKNOLOGI
2 SCR Systems Installed on the Danish Navy Vessel P525
Why NOx-reduction?

- NO and NO₂ are toxic gases
- NOx contributes to smog, acid rain and global warming
- NOx causes human respiratory problems (e.g. asthma)

Why SCR (Selective Catalytic Reduction)?

- The most efficient solution (will be found on all next generation trucks and buses)
- 6-9% fuel and CO₂ saving potential

How does SCR technology work?

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\begin{align*}
\text{NO} + \text{NO}_2 + 2 \text{NH}_3 & \rightarrow 2 \text{N}_2 + 3 \text{H}_2\text{O} \\
4 \text{NO} + \text{O}_2 + 4 \text{NH}_3 & \rightarrow 4 \text{N}_2 + 6 \text{H}_2\text{O} \\
2 \text{NO}_2 + \text{O}_2 + 4 \text{NH}_3 & \rightarrow 3 \text{N}_2 + 6 \text{H}_2\text{O}
\end{align*}
\]
Early Prototype Test of Digital Airless System on Crash Tender
First Prototype of Digital Airless System on Danish Army Truck

**MAN 353 kW Euro 3 engine**

3,9 → 1,2 g NOx / kWh → 70% reduction

Catalyst volume 25 l single element

Urea consumption max 1,8 l/h

Dosing temperature 200-450°C

Fuel; On-road diesel S<0,001% (10 ppm)

4 trucks retro-fitted and field tested successfully
Digital Airless SCR Kit for Army Truck
SCR System on Truck versus Vessel

Army truck:
- 350 kW
- Cylinder volume 12.8 l
- Catalyst volume 25 l (factor 2)
- Sulphur contents 10 ppm
- EURO legislation

Patrol vessel:
- 2040 kW (2 engines: 4080 kW total)
- Cylinder volume 63 l
- Catalyst volume 1744 l (factor 25)
- Sulphur contents 1000-2000 ppm
- IMO MARPOL legislation
SCR Prototype Installation at Danish Navy Engine Test Bench

- Control cabinet connected to the motor control unit and a PC
- Digital Dosing pump 0-60 l/h
- Urea tank 1000 l
- Ø400 mm stainless steel piping, insulated with 100 mm alu-wiremoss
- 16 pcs catalyst elements
- Catalyst housing made of sheet metal
- 100 mm non-flammable insulation
- Flexible bellow
- Airless nozzles 6pcs
- Inspection holes in catalyst housing for inspection and cleaning of catalyst elements
- Painted steel structure with painted covering
- PC that controls dosing and log measurements. The PC is remote controlled from Dansk Teknologi
- Urea manifold
- Urea manifold
Catalyst Housing Being Assembled at the Engine Test Bench
Installation at the Engine Test Bench
Test Results from the Prototype Installed at Naval Base Korsør

• NOx reduction is better than 80% (weighted IMO E2 cycle)
• The NOx emission from the patrol vessels with SCR system installed will be better than the IMO requirements valid from 2016 and on

![NOx emission limit schedule according to IMO (Int. Maritime Organisation)](image)
DT NOx-reduction System for Diana Class Vessels

- Temp. sensor
- NOx sensor
- Sootblowing system
- Sootblowing nozzles
- SCR control unit
- Digital dosing pump
- Pressure sensor
- Urea pipe
- Urea Tank
- Pressuresensor
- Valves
- Pulsation damper
- Airless nozzles
- Marine diesel engine
- Engine control unit
Key Components in the Digital DT Airless SCR System

- Digital dosing pump
- Airless nozzle
- Multipoint exhaust module
- Catalyst elements
- Manifold
- Controller and software
- Catalyst housing
The Two Catalyst Housings
Exhaust Connection and Multipoint Urea Injection
Installation of the DT SCR System on the First Vessel
Testing the DT SCR System on the First Vessel, P525

- Test results: NOx-reduction up to 90%
- The vessel complies with IMO requirements valid from 2016 and on
Unique Benefits of the DT SCR System (1)

• High precision Digital dosing of urea
• Airless Multipoint urea injection
• No need for compressed air
• Ultra high dynamic response to engine load
• High NOx-reduction - up to 90% on P525 - without ammonia slip
• NOx-reduction better than IMO 2016 requirement
• Very compact design
• Integrated silencer and catalyst
• No need for mixer
• No need for extra space compared to traditional silencer
Unique Benefits of the DT SCR system (2)

- No extra fuel consumption due to no additional counter pressure
- Robust airless injection nozzles without electronics or moving parts
- Easy to install and service
- Proven, reliable and cost efficient components
- The DT system is based on intensive R&D, laboratory and field test of SCR technology for trucks and buses (cooperation with Grundfos)
- Ready for all heavy diesel engines running on marine diesel oil
- Modular concept easy to adapt to a wide range of applications

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Potential for 6-9% saving in fuel and CO$_2$ emission (with engine tuning)
A Wide Range of Applications for the DT SCR System
Main Activities for DANSK TEKNOLOGI

- Industrial product development
- Turn-key manufacturing systems
- Clean-tech innovation
- Manufacturing of SCR Systems

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