ScandeNOx & AAG Engineering Technologies

SN+CR Technology
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THE TECHNOLOGY

Combined SNCR and SCR is not a new invention – far from it! In ScandeNOx's founder worked on a pilot plant with this technology as early as in 1987. The first trials were conducted on a system with SCR catalyst installed in a rotating regenerative air preheater (Ljungström type), where the upper (hottest) 500 mm of heat exchange elements were replaced with catalyst modules.

The idea was to facilitate utilising the full potential of the SNCR technology by using an SCR catalyst to eliminate the ammonia slip.

When the SNCR technology was new, the ammonia slip at high NOx reduction figures was often unacceptable due to the high SO2 concentration in the flue gas and consequent condensation of ammonium bisulphate.

By installing the catalyst in the air preheater, no reactor was needed, and costly downtime during installation could be greatly reduced.

Since the catalyst replaced some of the heat exchange elements, the only operational cost caused by the catalyst was a slightly increased pressure loss, and an insignificantly reduced heat transfer potential.

THE FIRST PLANT

Pilot plant for 10,000 Nm3/h of flue gas at power station Stigsnesværket, DK.

The pilot plant treated real flue gas from the adjacent power station and could operate at different temperatures.

The Danish catalyst manufacturer Haldor Topsøe A/S supplied the catalyst which resembles corrugated card board – particularly suitable for the “orange boat” shaped catalyst modules.

The amount of catalyst was only about 20 % of what would be installed in a normal full scale SCR installation, but still the results were very promising:
The results

...may not seem impressive, but the catalyst did in fact remove app. 90 % of the injected ammonia.

At district heating plant Boliden in Uppsala, Sweden, the following results were obtained with a urea-based SNCR system:

At this plant only 5 [ppmv, d, 0 % O2] of ammonia slip was permitted, so without a “Slip Brake”, only about 50 % NOx reduction could be achieved. With a catalyst to remove 90 % of the ammonia slip, the allowable slip from the SNCR system would be 50 [ppmv...] – so the NOx reduction by SNCR could be increased to some 65 – 70 %.

Since the initial NOx concentration was low, the 45 [ppmv...] of ammonia removed by the catalyst would remove so much NOx that the total NOx reduction would amount to more than 90 %.
For a number of reasons it is not always possible to install the SCR catalyst in the air preheater.

At the power plant Fyriskraft in Uppsala, Sweden, the air preheater was turned “upside down” due to height restrictions – so the catalyst would have to be placed in the flue gas duct outside of the air preheater to reduce the mechanical stress on the modules and to facilitate cleaning of the heat exchange elements without having to take all elements out of the air preheater.

CFD & physical modelling of such systems is obviously crucial for the performance, so ScandeNOx uses leading modelling experts for this task and cooperates closely with the Danish catalyst manufacturer Haldor Topsøe.
In a rotating air preheater the catalyst only treats the gas 50% of the time, and the fluctuating temperature is tough on the catalyst.

Even though the results were promising, the natural development was thus a solution with full catalyst utilisation and fairly constant temperature.

In some cases – like at Enakraft in Linköping, Sweden – the temperature in the air preheater is too low for the SCR catalyst, so the economiser has to be split in two to give room for a “Slip Brake”:

In some cases operational changes can raise the temperature at part load sufficiently, in other cases an “ECO Umwaltz” system is the most feasible way to control the temperature. ScandeNOx does not recommend flue gas by-passes if they can be avoided.
ScandeNOx’s founder has worked with SN+CR technology since it was first introduced and has participated in the continued development of this technology ever since.

As late as in the spring of 2010, he invented the SN+CR concept for cement plants presented on the following page.
ScandeNOx’s founder and CEO was for a period of 9 years employed in the World’s leading manufacturer of cement plants, FLSmidth, where he advanced to the position of Emissions Technology Manager and held the following subordinate positions:

- Chairman of the Monthly Group on Emissions
- Head of the Emissions Technology Group
- Member of the R&D Steering Committee
- Member of the Patent Evaluation Board

ScandeNOx’s founder thus has the necessary experience to advise our clients on virtually all emission related matters concerning cement plants.

Problems with raw meal derived ammonia emissions on a number of cement plants inspired him to combine the Slip Brake concept known from the power plant industry with the medium dust SCR technique recently tested in Italy.

The result was the SN+CR concept for cement plants presented on this page.

Since the raw materials absorb most of the ammonia slip when the raw mill is ON, the catalyst can often be installed in the raw mill bypass.

Ammonia in the flue gas inhibits the formation of Dioxins/Furans through the denovo synthesis, and the catalyst can burn out the Dioxins/Furans as well as VOC, TOC, PAH - and oxidize Mercury.

Advantages:
- Lower dew point & pressure loss
- Lower secondary emissions
- Lower cost & maintenance
- Lower life cycle CO₂ footprint
PROJECTS EXECUTED

WASTE TO ENERGY BOILER PROJECTS

- 3 sets of new improved injectors for Hangzhou, China
- 2 x SCR Reagent Storage & Injection Systems, Amager Bakke, Denmark
- 3 x SNCR injectors of new design for 3 x MSW boilers, Pinghu I, China
- SNCR NH4OH for Ningbo, China, 600 tpd MSW boiler, Sanfeng Covanta
- 3 x SNCR NH4OH for Hangzhou, China, 3 x 200 t/d MSW boiler, Tianlan
- 2 x SCR NH4OH Storage & Injection Systems, Amager Bakke, Denmark
- 3 x SNCR NH4OH injectors for 3 x MSW boilers, Pinghu I, China
- SNCR NH4OH for Ningbo, China, 600 tpd MSW boiler, Sanfeng Covanta
- 3 x SNCR NH4OH for Hangzhou, China, 3 x 200 t/d MSW boiler, Tianlan
- 2 x SCR NH4OH Storage & Injection Systems, Amager Bakke, Denmark
- 3 x SNCR NH4OH injectors for 3 x MSW boilers, Pinghu I, China
- SNCR NH4OH for Ningbo, China, 600 tpd MSW boiler, Sanfeng Covanta
- 3 x SNCR NH4OH for Grandtop, China, 3 x 500 t/d MSW boiler, Grandtop Group
- SNCR NH4OH for Esbjerg L90, Denmark,
- 30 t/h MSW boiler SNCR NH4OH for Sornival, Nevers, France,
- 15 t/h MSW boiler 4 x SNCR NH4OH for Amagerforbraending #1 - 4, Denmark,
- 4 x 12 t/h MSW boilers SNCR Tests at Vestforbraending #3, Denmark,
- 12 t/h MSW boilers SNCR NH4OH for Vestforbraending #5, Denmark, 26 t/h MSW boiler
- SNCR NH4OH for Fuchunjiang #2, China,
- MSW boiler, Fuchunjiang
- 3 x SNCR NH4OH for Dalian, China,
- SNCR NH4OH for Har Tuv, Israel, 1600 tpd Lepol Grate Kiln, Nesher Israel Cement Enterprise
- SNCR NH4OH for 3202 tpd grey cement kiln #3 at Cimentos Izmir, Turkey
- SNCR NH4OH for 2169 tpd grey cement kiln #1 at Cimentos Izmir, Turkey
- SNCR NH4OH for 1250 tpd grey cement kiln at Cimentos Kasr, Turkey
- SNCR NH4OH for 4500 tpd grey cement kiln at Adana Cement, Turkey
- SNCR NH4OH for 900 tpd white cement kiln at Adana Cement, Turkey
- SNCR NH4OH for Hubel, China, 5000 tpd ILC Cement Plant, Hubei Cement Plant
- SNCR NH4OH for Xiling, China, 2500 tpd ILC Cement Plant, Xiling Cement plant
- 3 x SNCR NH4OH for Esheng # 3 - 5, China, 3 x 4600 tpd ILC Cement Plant, Jiehua
- SNCR NH4OH for Jinyuan, China, 4000 tpd ILC Cement Plant, Jiehua
- SNCR NH4OH for Jinglan, China, 4000 tpd ILC Cement Plant, Jiehua
- SNCR NH4OH for Jutiai, China, 2000 tpd ILC Cement Plant, Zhejiang Design Institute
- SNCR NH4OH for Shangfeng, China, 2500 tpd ILC Cement Plant, Haiyuan Environmental Co.
- SNCR NH4OH for Yunshi, China, 2900 tpd ILC Cement Plant, Shaoshan
- 2 x SNCR NH4OH for Esheng # 1 - 2, China, 2 x 5000 tpd ILC Cement Plant, Jiehua
- SNCR NH4OH for Jingshan, China, 2500 tpd ILC Cement Plant, Nanda
PROJECTS EXECUTED

CEMENT KILN PROJECTS

- SNCR NH4OH for Changshan, China, 5500 tpd ILC Cement Plant, Zhejiang Design Institute
- SNCR NH4OH for Nanyan, China, 1500 tpd ILC Cement Plant, C-Hope
- SNCR NH4OH for RDL 1, 6000 tpd SLC Cement Plant, Nesher Israel Cement Enterprises Ltd.
- SNCR Upgrade for RDL 2, 6000 tpd SLC Cement Plant, Nesher Israel Cement Enterprises Ltd.
- SNCR NH4OH for Djebel Ressas, Tunesia, 5800 tpd ILC Cement Plant
- SNCR NH4OH for OJSC Shurovsky Cement, Russia, 5500 tpd ILC Cement Plant
- SNCR NH4OH for Grupa Osarow S.A., Poland, Kiln2, 7000 tpd ILC Cement Plant
- SNCR NH4OH for Cementos Molins Industrial S.A., Spain, 4100 tpd ILC Cement Plant
- SNCR NH4OH for St. Genevieve MA, USA, 12000 tpd ILC Cement Plant (Sale only)
- SNCR NH4OH for Nesher Israel Cement Enterprises Ltd., RDL 2, 6000 tpd SLC Cement Plant
- SNCR NH4OH for Spenner Zement G.m.b.H & Co. KG, Germany, Kiln2, 2800 tpd ILC Cement Plant
- SNCR NH4OH for Production Association Kokshe Cement, Khazakstan, 5500 tpd ILC Cement Plant

POWER PLANT & INDUSTRIAL BOILER PROJECTS

- Low-budget SNCR Urea for 25 tph biomass-fired boiler, Neame Lea #1, UK. Order start 2019.06.01
- 2 x SNCR Urea for 2 x 8 MW biomass-fired boilers, Neame Lea #283, UK. Order start 2019.06.01
- 2 x SNCR NH4OH for 2 x 15 MW biomass-fired boilers, Aminteo, Greece. Order start 2019.03.18
- 2 x SNCR Urea for 2 x 20 MW biomass fired boilers, Imantas, Latvia. Order start 2019.01.25 Micro SNCR Urea for Midtangeland Fjernvarme, 8MW biomass-fired boiler, Denmark
- Micro SNCR Urea for Datatherm biomass boiler, Slovakia
- 2 x Micro SNCR Urea for 2 x 25 tph biomass boilers Kangshifu, China
- Micro SNCR Urea for biomass boiler Seda Olam, Spain
- SCR Reactor, Mixer & Catalyst, Delayed Coker, Kilburn Engineering, India
- 2 x SNCR NH4OH for 2 x 116 MW CFB boilers at Changchun, China SNCR NH4OH for 234 t/h CFB boiler at Stora Enso Guangxi Forest Pulp-and-Paper, China
- SNCR NH4OH for 220 t/h CFB boiler at Xiamen, China
- 3 x SNCR NH4OH for 3 x 75 t/h CFB boilers at Zhongche Rubber, China
- 2 x SNCR NH4OH for CBB & CFB boilers at Zhongche Jiande, China
- 4 x SNCR NH4OH for Nordic Sugar, Denmark, oil & gas fired boilers, Nordic Sugar
- 4 x SCR Reagent Injection Systems, HRSG, B D Heat, USA
- 1 x SCR Injection System, Boiler, B D Heat, USA
- SNCR Urea for Haerbin, China, Haerbin Boilers
- SNCR NH4OH for Dushanzi, China, 410 t/h CFB, Tianlan
- 3 x SNCR NH4OH for Hongbao, China, 3 x 130 t/h CFB, Hongbao
PROJECTS EXECUTED

POWER PLANT & INDUSTRIAL BOILER PROJECTS

- Micro SNCR Urea for Morgan Sindall 350 kW biomass boiler, UK, Peerless
- 2 x SN+CR NH4OH for Daelim, Saudi Arabia, Thermax India
- 2 x SCR for 85 t/h Off Gas Fired Boilers, Takreer, Abu-Dhabi Oil Refinery, Thermax India
- SNCR NH4OH for Zhejiang Jiahua Chem. #1, China, 450 t/h CFB, Jiehua
- SNCR NH4OH for Zhejiang Jiahua Chem. #2, China, 450 t/h CFB, Jiehua
- 3 x SNCR NH4OH for Zhejiang Jiahua Chem. #4 - 6, China, 3 x 450 t/h CFB, Jiehua
- 3 x SNCR NH4OH for Liaocheng #1 - 3, China, 3 x 130 t/h CFB, Tianlan
- SNCR NH4OH for Runtu #1, China, 150 t/h CFB, Tianlan
- 2 x SNCR NH4OH for Haifeng #2 - 3, China, 2 x 75 t/h CFB, Tianlan
- 3 x SNCR NH4OH for Ji’an #1 - 3, China, 3 x 130 t/h CFB, Tianlan
- 2 x SNCR NH4OH for Ji’an #4 - 5, China, 2 x 150 t/h CFB, Tianlan
- 2 x SNCR NH4OH for Yanjiang #1 - 22, China, CFB, Covanta
- 3 x SNCR NH4OH for Yongtai #1 - 3, China, CFB
- SNCR NH4OH for Sanxing #8, China, 220 t/h CFB
- 4 x SNCR NH4OH for Sanxing #4 - 7, China, 4 x 150 t/h CFB
- 3 x SNCR NH4OH for Sanxing #1 - 3, China, 3 x 130 t/h CFB
- 4 x SCR Reagent Injection Systems, HRSG, B D Heat, USA
- 1 x SCR Injection System, Boiler, B D Heat, USA
- SNCR NH4OH for Fushunjiang #9, China, 240 t/h CFB
- SNCR NH4OH for Fushunjiang #6, China, 240 t/h CFB 2 x SNCR NH4OH for Fushunjiang #3 - 4, China, 2 x 240 t/h CFB
- SNCR NH4OH for Xinjiang Chuanning, China, 240 t/h CFB
- 2 x SNCR NH4OH for Xinjiang Chuanming #1 - 2, China, 2 x 410 t/h CFB
- SNCR NH4OH for Fushunjiang #9, China, 240 t/h CFB SNCR Urea for Shuangzhou #2, China, 240 t/h CFB
- SNCR Urea for Kholbach, Italy, Biomass Power Plant
- 2 x SN+CR for Baqiao, China, 2*300 MWe Power Plant
- SNCR Urea for Laiwu, China, 2*300 MWe Power Plant
- SNCR NH4OH for Ljungby, Sweden, gratefired industrial boiler, wood chips
- SNCR NH4OH for Enköping Energi AB, Enakraft (H&P), Sweden, 25 MWe, wood chips on grate
- SCR Demonstration plant, 10.000 Nm3/h, Highdust, Lowdust, Slipbrake, Stigsnæsværket, Denmark
- SNCR NH4OH for Rockwool International, Aquila, Denmark, 10 tpd Rockwool Plant

MISCELLANEOUS PLANTS

- SNCR NH4OH for 18000 Nm3, @/h glass furnace at Jushi Chendu, China
- R&D Project "SNCR Enhancers & Additives"
- SNCR NH4OH for Rockwool International, Aquila, Denmark, 10 tpd Rockwool Plant

WASTE-TO-ENERGY BOILERS, MISCELLANEOUS PROJECTS

- R&D Project, Furnace Temperature Control, Knudmoseværket, Denmark
- Temperature Control System, I/S REFA Kraftvarmeværk, Nyköbing Falster, Denmark
## PROJECTS EXECUTED

### CEMENT KILNS, MISCELLANEOUS PROJECTS
- Consultancy re. Ammonia Dilution System, Nesher Israel Cement Enterprises Ltd.
- SNCR Tests at Shree Cement Ltd., Beawar, India
- Conceptual Design & Pricing, Urea Dissolving Plant, Har Tuv Cement, Israel
- Emissions audit Report, Ballyconnell Plant, Quinn Cement, Ireland
- SNCR Tests, Har Tuv Site, Nesher Israel Cement Enterprises Ltd.
- Parametric SNCR Tests on RDL 1, Nesher Israel Cement Enterprises Ltd.
- SNCR Pre-Engineering for Quinn Cement Ltd., Ireland, Kiln 2, 4200 tpd ILC Cement Plant
- SNCR Tests at Finnsementti, Lappeenranta, ILC, Finland
- SNCR Tests at Lyon Cement, Colorado, USA
- SNCR Tests at ICL Limerick Works #6, 3300 tpd ILC-E cement kiln, Ireland.

### POWER PLANTS, MISCELLANEOUS PROJECTS
- SNCR NH4OH tests on front wall fired boiler at Asnæsværket, Denmark, 144 MWe, coal
- SNCR NH4OH tests on tangentially fired boiler at Skærbækværket, Denmark, 392 MWe, gas
- SN+CR Feasibility Study for Uppsala Energi AB, Fyriskraft Power Plant, Sweden, 100 MWe, peat-fired
- SNCR Development Project at Fyriskraft, Uppsala, Sweden, 100 MWe, peat-fired
- SNCR Urea Tests at Uppsala Energi AB, The Hot Water Central, Sweden, 100 MWfuel, peat-fired
- SCR Project Study, Coal-fired Power Plant Unit #4, Vesterås, Sweden
- SCR Project Study, Coal-fired Power Plant Unit #2, NEFO, Elsam, Denmark
- SCR Project Study, 225 MWe + 330 MWt Coal-fired, Avedøreværket #1, Elkraft, Denmark
- SNCR Urea Tests at Asnæsværket Unit #4, DK.
- SNCR Demonstration at Asnæsværket, unit no. 4, Denmark, 265 MWe, coal-fired with lowNOx-burners
- SNCR Urea Tests at Asnæsværket Power Station, unit no. 3, Denmark, 265 MWe, coal-fired

Projects carried out by ScandeNOx’s CEO for ScandeNOx

Projects carried out by ScandeNOx’s CEO while employed by Flow.Visio

Projects carried out by ScandeNOx’s CEO while employed by FLSmidth

Projects carried out by ScandeNOx’s CEO while employed by Babcock & Wilcox Vølund

Projects carried out by ScandeNOx’s CEO while employed by Burmeister & Wain Energy
## CONTACTS AND ENQUIRIES

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Thank you

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