# AMMONIA WASTE HANDLING

Processing ammonia rich gas in the
Stoichiometry- Controlled Oxidation (SCO) unit

## $NH_3$ WASTE AND $NO_x$ EMISSIONS

Processing ammonia ($NH_3$) rich streams is increasingly becoming a challenge in refineries and petrochemical plants. Sour water quantities, containing large amounts of $NH_3$, keep increasing and nitrogen oxides ($NO_x$) emission limits are tightened worldwide to protect the environment and public health.
Sales of (waste) ammonia produced in typical plants generally is not economically feasible due to impurities or a lack of local demand. Incineration of $NH_3$ is an option, but will lead to unacceptable $NO_x$ emission levels when traditional incinerator technology is applied. That is why the treatment of this waste stream asks for a stable and reliable solution.

## PROCESSING $NH_3$ IN THE SRU

In a sulphur recovery unit (SRU), hydrogen sulphide ($H_2S$) rich gas is processed to recover sulphur and minimise $SO_2$ emissions of the plant. Sour water stripper acid gas, containing both H2S and $NH_3$, is typically routed here as well. In the thermal stage of the SRU, $NH_3$ can be decomposed effectively provided high intensity mixing, a high operating temperature and sufficient residence time are applied. Improper decomposition will result in ammonia salt formation in downstream parts of the SRU plugging heat exchangers and increasing corrosion rates. Furthermore, the associated air demand with ammonia decomposition lowers the sulphur recovery efficiency and limits the $H_2S$ processing capacity.

## THE SCO UNIT

To meet the increasing demand for a suitable solution to above challenges, Duiker Combustion Engineers developed a unit which decomposes $NH_3$ rich streams to nitrogen ($N_2$) and water while keeping $NO_x$ emission levels low. The solution is named after the basic principle of the unit, Stoichiometry- Controlled Oxidation. The unique and patented control system ensures precise, staged incineration, where the air supply is controlled dynamically. Control of the air supply is key in combustion of $NH_3$ to prevent $NO_x$ from being formed.
Older technology based on static staged combustion may be suitable for systems with very stable flow rates and feed compositions. However, in reality these conditions are rarely met. Subsequently, the slightest change in flow rate or feed gas composition will lead to excessive $NO_x$ formation. The SCO unit, and specifically its control system, has been designed to withstand the changing conditions upstream of the unit in order to guarantee low and stable $NO_x$ emissions.

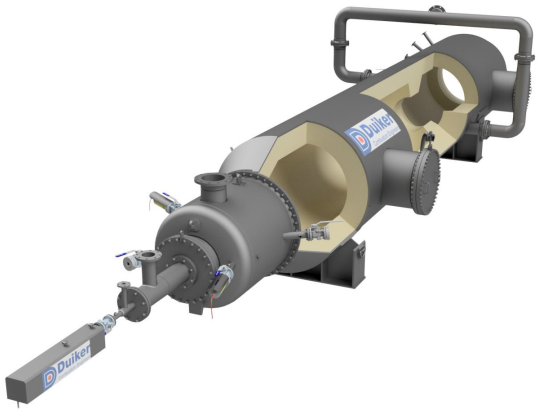


Figure 1 – SCO unit (single vessel design)

## KEY CHARACTERISTICS

- $NH_3$ destruction efficiency of 100%
- $NO_x$ emission level of 50 ppm feasible (3% $O_2$ dry basis)
- SCR, SNCR or other de$NO_x$ not required to meet emission limits
- No CO formation
- Developed to unburdun sulphur recovery units
- Suitable for any $NH_3$ waste process
- SRU debottlenecking
- Handles fluctuating flows and compositions
- Insensitive to impurities
- Patented technology
- 5 units supplied since 2011

## COMPATIBILITY

Since Duiker is a burner supplier specialised in SRU equipment, the SCO unit has initially been developed for implementation in (or alongside) the SRU. However the system is also compatible with other process units or industrial applications (e.g. Urea, bio diesel, steel plants) where disposal of $NH_3$ rich gas is required. Figure 2 shows that the SCO unit can be placed as a stand- alone unit, connecting to an existing or new stack.

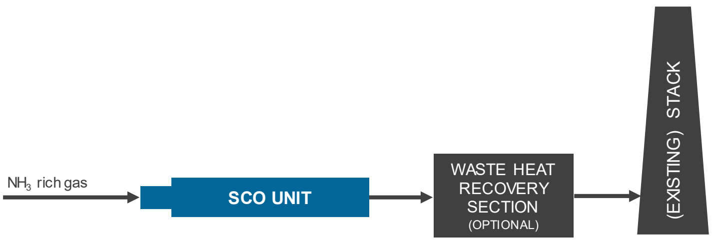


Figure 2 – PFD of basic SCO unit implementation

## THE SCO UNIT AND THE SRU

Various configurations are possible when implementing the SCO unit in new and existing SRUs. In most cases, the SCO unit can replace the SRU tail gas incinerator. The two vessel- design will then be applied. The $NH_3$ rich stream is oxidized in the first (top) section. The heat produced in the first section will be used to incinerate the SRU tail gas in the second (bottom) section. The bottom section includes a fuel gas burner to provide additional heat when required. With this setup, significant OpEx savings are accomplished, since a lower amount of fuel gas is needed to incinerate the SRU tail gas. In case of lower supply or absence of $NH_3$ gas to the unit, the bottom section can be operated as an independent incinerator to process the SRU tail gasses.

The images below show two configurations combined with a two stage (figure 4)- and single stage (figure 5) sour water stripper arrangement.

Figure 3 – SCO unit (double vessel design)

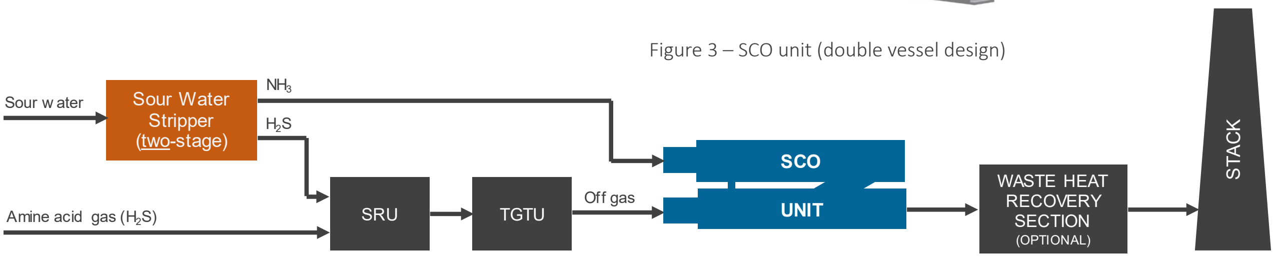


Figure 4 – PFD of SCO unit with SRU and two- stage sour water stripper

Figure 4 shows the implementation of the SCO unit in an existing or new plant operating with a two- stage sour water stripper (SWS) upstream of the SRU. The $NH_3$ rich stream coming from the SWS is oxidized in the top section of the SCO unit. This exothermic reaction generates heat which is utilized to incinerate the TGTU off gasses.

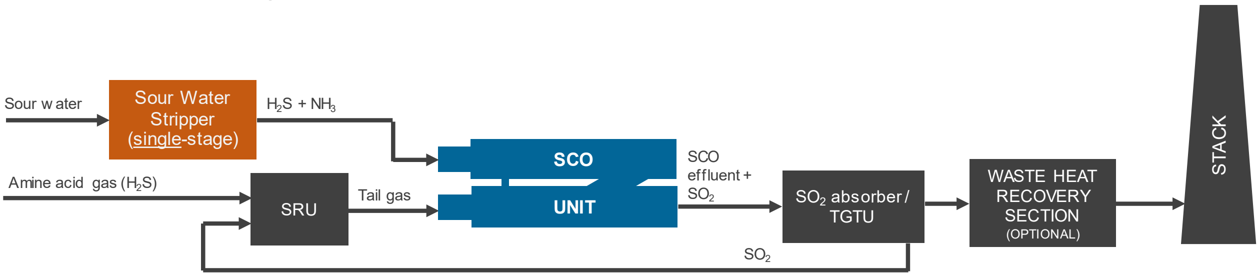


Figure 5 – PFD of SCO unit with SRU and single- stage sour water stripper

Figure 5 shows the implementation of the SCO unit in an existing or new plant operating with a single- stage sour water stripper (SWS) upstream of the SRU. Initially, the SWS stream -containing both $H_2S$ and $NH_3$- would be sent to the thermal stage of the SRU, now the SWS stream is sent directly to the SCO unit. There, the $NH_3$ oxidizes to $N_2$ and $H_2O$. $H_2S$ reacts to $SO_2$, which can be captured by an absorber or TGTU before the stream is lead to the stack. The captured $SO_2$ can be recycled to the thermal stage of the SRU.

## SRU DEBOTTLENECKING

The SCO unit can also be used to debottleneck the SRU. As mentioned before, $NH_3$ is typically sent to the SRU. The additional hydraulic load of the SRU (and TGTU) required when processing $NH_3$ on top of $H_2S$, is substantial compared to the hydraulic load when only processing $H_2S$. Refineries on average can process 20% more $H_2S$ in the SRU, when not routing the $NH_3$ stream to the SRU. More $H_2S$ can be processed in the SRU by replacing the existing incinerator with the SCO unit, and rerouting the $NH_3$ stream directly to the new unit. Additionally, a positive side effect is that operation of the SRU and TGTU will become less complex.


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