


# Amine Emissions Abatement

## CO<sub>2</sub> Capture Facility

### Kårstø, Norway

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## Contents

<b><u>Section</u></b>	<b><u>Page</u></b>
<b>1.0 Introduction</b>	<b>3</b>
<b>2.0 Discussion</b>	<b>3</b>
<b>3.0 Conclusion</b>	<b>4</b>

## Amine Emissions Abatement

### 1.0 INTRODUCTION

This document describes the studies conducted and measures included to limit the amine emissions to the atmosphere.

### 2.0 DISCUSSION

The CCC Plant utilizes a 35 weight percent monoethanolamine (MEA) in water solution, or “lean amine solution” to absorb Carbon Dioxide from the flue gas through direct contact in the Absorber Towers (MV-101/MV-102). This introduces the possibility that MEA will be emitted to atmosphere with the exhaust gas leaving the absorber towers through evaporation or entrainment.

The following measures are included in the design to minimise the emission of MEA to atmosphere from the CO<sub>2</sub> Absorber stacks;

- a. Gravity distribution of lean amine solution to packing beds
- b. Mist eliminator above the Top Amine Bed to limit entrainment to wash water section and maintain as low MEA concentration in the wash water as possible.
- c. Circulating wash water and cooling section which washes MEA from the flue gas exiting the amine treatment section
- d. Process water wash section which washes the MEA with a cleaner wash water
- e. Mist eliminator above the Process Wash Water Bed to limit entrainment from the wash water section to atmosphere

The benefits of each of these measures and the MEA content in the exhaust gas leaving the absorber towers after each measure is given below

- a. Addition of a trough type distributor over the structured packing in the absorber towers. The MEA entrainment reduction benefits of a trough type distributor are outlined below:

‘Orifices in the sidewalls of the troughs are positioned to deliver liquid against an enhanced baffle that spreads the liquid in the direction perpendicular to the orientation of the top layer of the structured packing. This increase in effective drip point density provides the ability to use a large orifice diameter contributing to increased fouling resistance.

The baffle plate distributor has excellent distribution performance characteristics particularly at low liquid rates. Total wetting of the packing surface is completed in only one layer of the packing. Vapor passage is provided by the space between the troughs. The baffle also acts to shield the liquid from the vapor stream to avoid

entrainment, thereby making this excellent distributor choice when operating at high vapor rates.

In addition, the enhanced baffle also acts to shield the liquid from the vapor stream to avoid entrainment, thereby making this an excellent distributor choice when operating at high vapor rates such as vacuum columns.

- b. Addition of a mist eliminator above the Top Amine Bed to limit entrainment to wash water section and maintain as low MEA concentration in the wash water as possible.

Installing a mist eliminator will limit the liquid entrainment to 99.9% at 4 micron droplet size. (The 100 kg/h entrained MEA is small compared to the 2300 kg/h in the vapour at equilibrium conditions)

- c. Use of circulating wash water and a cooling section which washes MEA from the treated flue gas exiting the amine treatment section

The concentration of MEA in the wash water is expected to stabilize at 1.53%wt MEA with a constant purge of 5% of the circulating volume to make-up the circulating aqueous MEA solution. The make-up water is from the Process Water wash bed above and has an MEA concentration of 1.24%wt MEA.

- d. Addition of a process water wash section which washes the MEA with process wash water.

The concentration of MEA in the process wash water at the top of the bed is 1.24%wt and this will be the MEA concentration in entrained liquid from the CO<sub>2</sub> Absorber.

- e. Mist eliminator above the Process Wash Water Bed to limit entrainment from the wash water section to atmosphere

Installing a mist eliminator will limit the entrainment to 99.9% at 4 micron droplet size (The 4 kg/h entrained MEA is small compared to the 16 kg/h in the vapour at equilibrium conditions). In a total flow of  $2.41 \times 10^6$  kg/h, this is 8ppmwt or 3ppmv.

### **3.0 CONCLUSION**

A number of process and mechanical schemes have been included in the FEED stage design to reduce MEA emissions to atmosphere.

The provision of mist eliminators enable the concentration of MEA in the wash water to be minimized and the entrainment of wash water (containing low levels of MEA) to atmosphere. Mist eliminators increase the column pressure drop and their contribution has been accommodated within the allowable column pressure drop.

The wash water systems provided enable the MEA vapour content in the flue gas to be reduced substantially from 400ppm after the amine treating to <3ppm after the water washing.

Additional measures are also employed to minimise fugitive emissions from sources other than the CO<sub>2</sub> Absorber Stack. These sources include tank vents and rotating equipment seals. These measures are detailed in Discharge and Emission Data Forms, Document 10112936 - PB - S - HSE - 0004.