Emission measurements at Dong's pilot plant for CO_2 capture in Esbjerg

EU Project CESAR

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Overview

- Background to the CESAR project
- Dong's facilities in Esbjerg
- MEA campaign and emission sampling
- CASTOR/CESAR pilot plant flow diagram
- Compounds of interest
- Results from the emission measurements
- Results from the liquid analysis
- Conclusions
- Acknowledgement

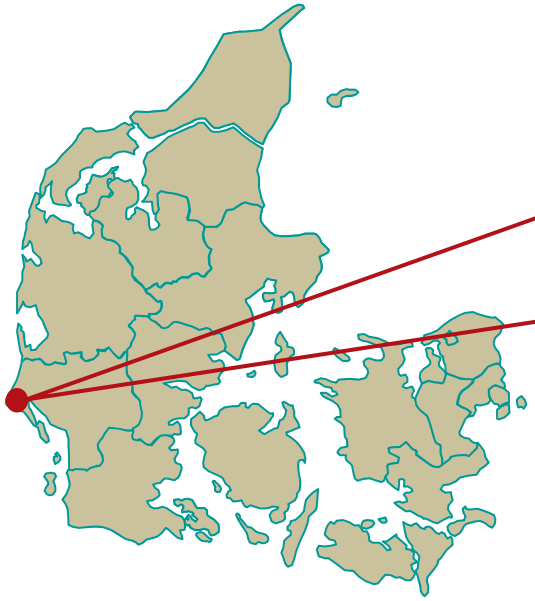
Background to the CESAR project

- CESAR aims for a breakthrough in the development of low-cost post-combustion CO_2 capture technology to provide economically feasible solutions for both new power plants and retrofit of existing power plants which are responsible for the majority of all anthropogenic CO_2 emissions.

  The primary objective is to decrease the cost of capture down to 15 €/tCO_2.

- CESAR builts on the findings from CASTOR.

Esbjerg Power Station (ESV)



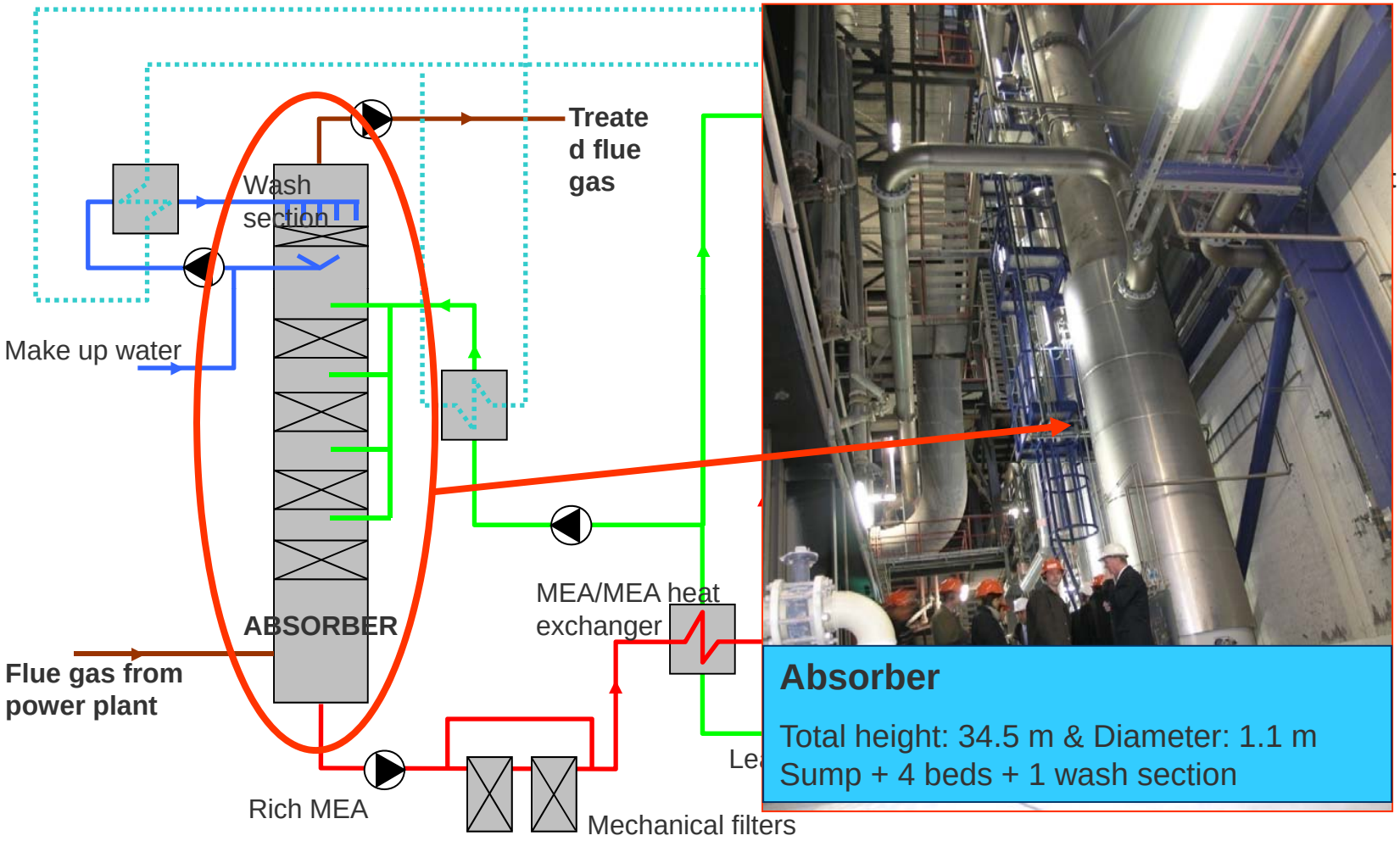
- 400 MW_e pulverized bituminous coal
- High dust SCR deNO_x plant
- 3 zones cold-sided ESP
- Wet limestone FGD (saleable gypsum)

CASTOR Pilot Plant Specifications

- Pilot plant erected and commissioned during 2005
- Design of pilot plant based on a commercial CO_2 production plant (MEA)
- Pilot plant operates on a slip stream taken directly after the wet FGD
- Design flue gas conditions: ~47°C saturated, <10 ppm SO_2, <65 ppm NO_x, <10 mg/Nm^3 dust

Parameter	*Design value*
Flue gas capacity	5000 Nm^3/h
CO_2 production (at 12% CO_2)	1000 kg/h
Absorption degree	90%
Max solvent flow	40 m^3/h
Max stripper pressure	2 bar_g
Max steam pressure	3.5 bar_g

Esbjerg Pilot Plant Absorber

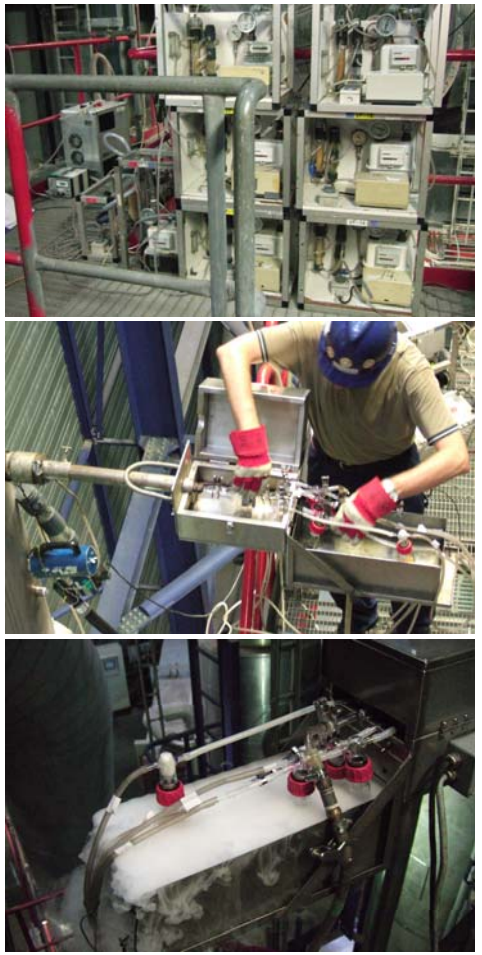


Absorber

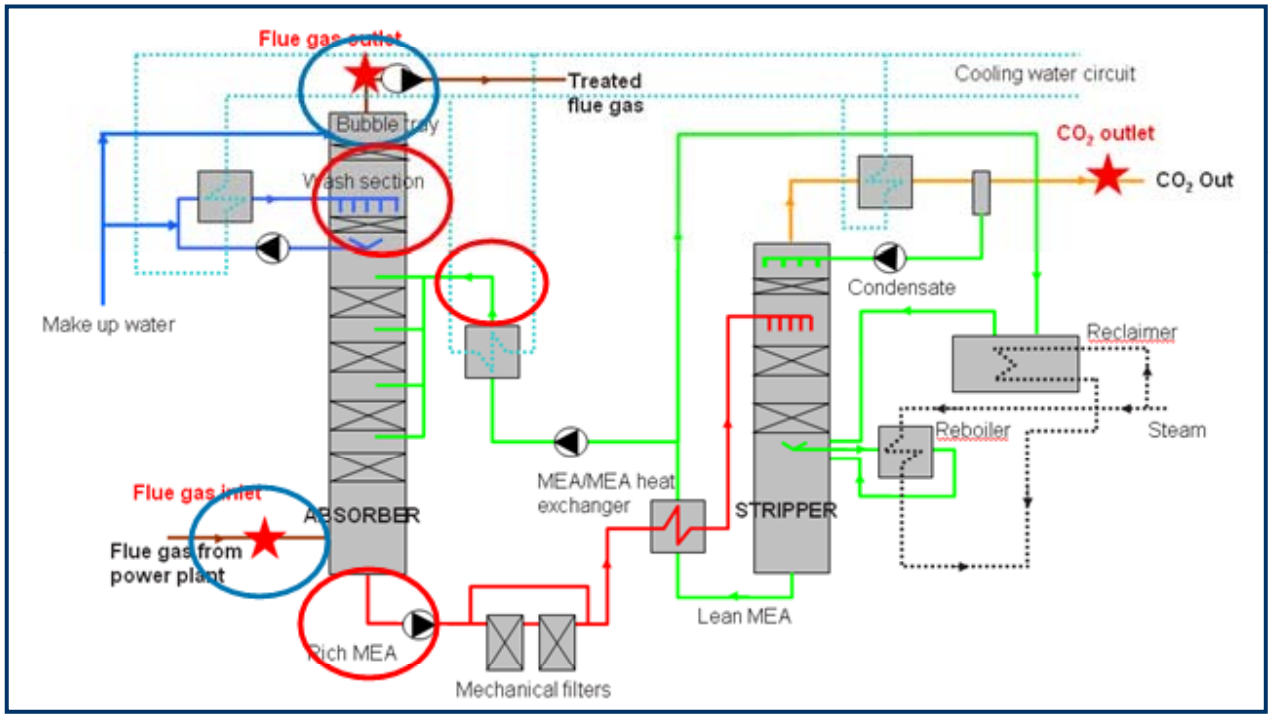
Total height: 34.5 m & Diameter: 1.1 m
Sump + 4 beds + 1 wash section

MEA campaign and emission sampling

- A test campaign using MEA was run during the spring of 2009.
- Emission sampling was carried out on the 10th-11th June, after a test run time of 700 to 800 h.
- Eurofins was responsible for emission sampling and measurements.
- Sampling was done isokinetically using liquid or solid absorbents.
- The analytical methods used for the chemical analysis were standard reference methods (ISO, VDI, MEL etc).



CASTOR/CESAR Pilot Plant Flow Diagram



Blue: gas samples
Red: liquid samples
★: sampling points CASTOR

Compounds of interest

- **Gaseous phase**:
  - MEA, DEA
  - Aldehydes
  - Alkylamines
  - Acetamide
  - Ammonia

  - Flue gas components like H_2O, TOC, VOC
  - Gas velocity measurement
  - Gas volume measurement

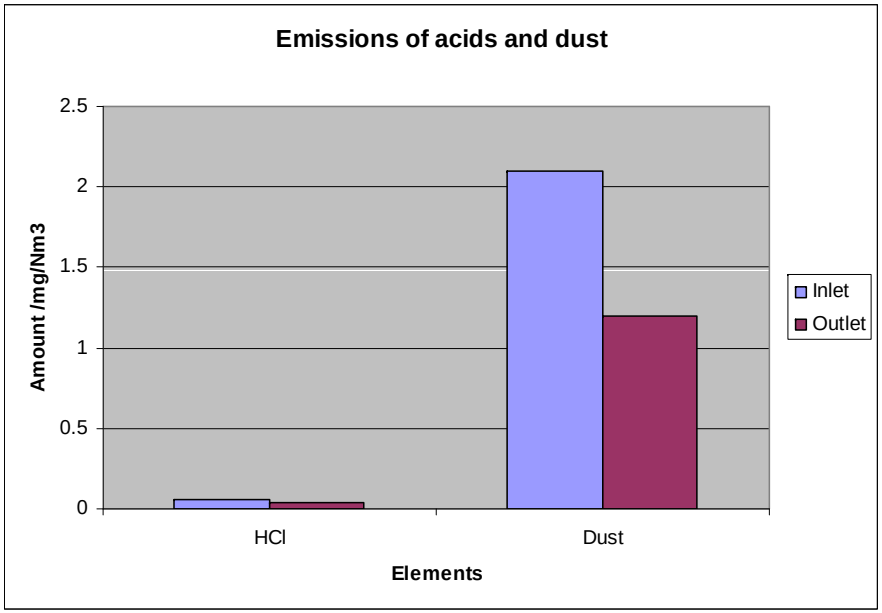
- **Liquid phase:**
  - MEA, DEA
  - Aldehydes
  - Alkylamines
  - Acetamine
  - Ammonia

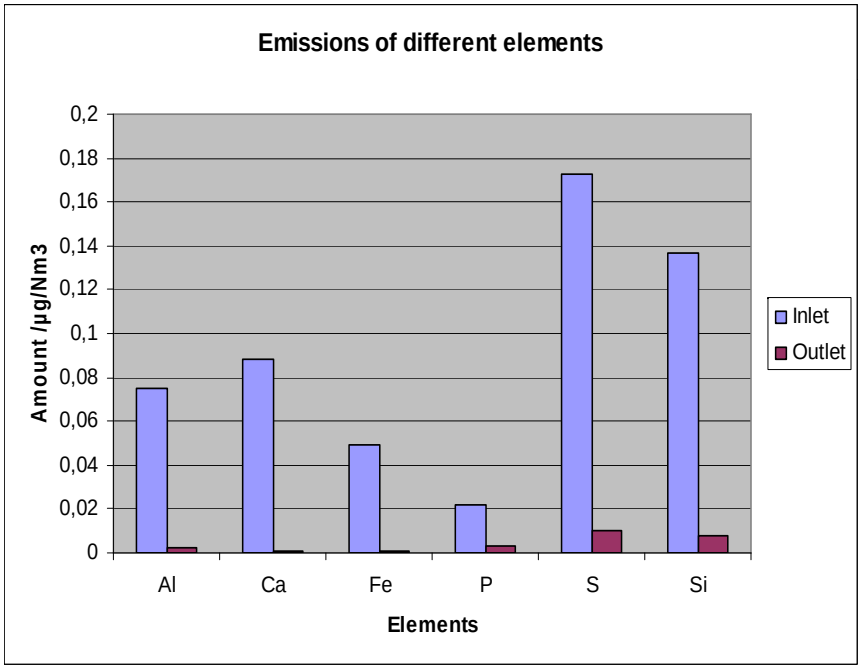
  - pH
  - Metal content
  - Heat stable salts

Results from the emission measurements 1

Compound	Unit	Inlet absorber	Outlet absorber	Outlet abs. after water wash
MEA	mg/Nm3	<0.1	**0.7**	<0.3
DEA	mg/Nm3	<0.2	<0.3	<0.2
Formaldehyde	mg/Nm3	<0.1	**0.7**	<0.1
Methylamine	mg/Nm3	<0.2	<0.3	<0.2
Acetamide	mg/Nm3	<0.6	<1.0	<1.0
Ammonia	mg/Nm3	<0.1	**23**	**20**

Results from the emission measurements 2





Comparison of emissions from CASTOR and CESAR

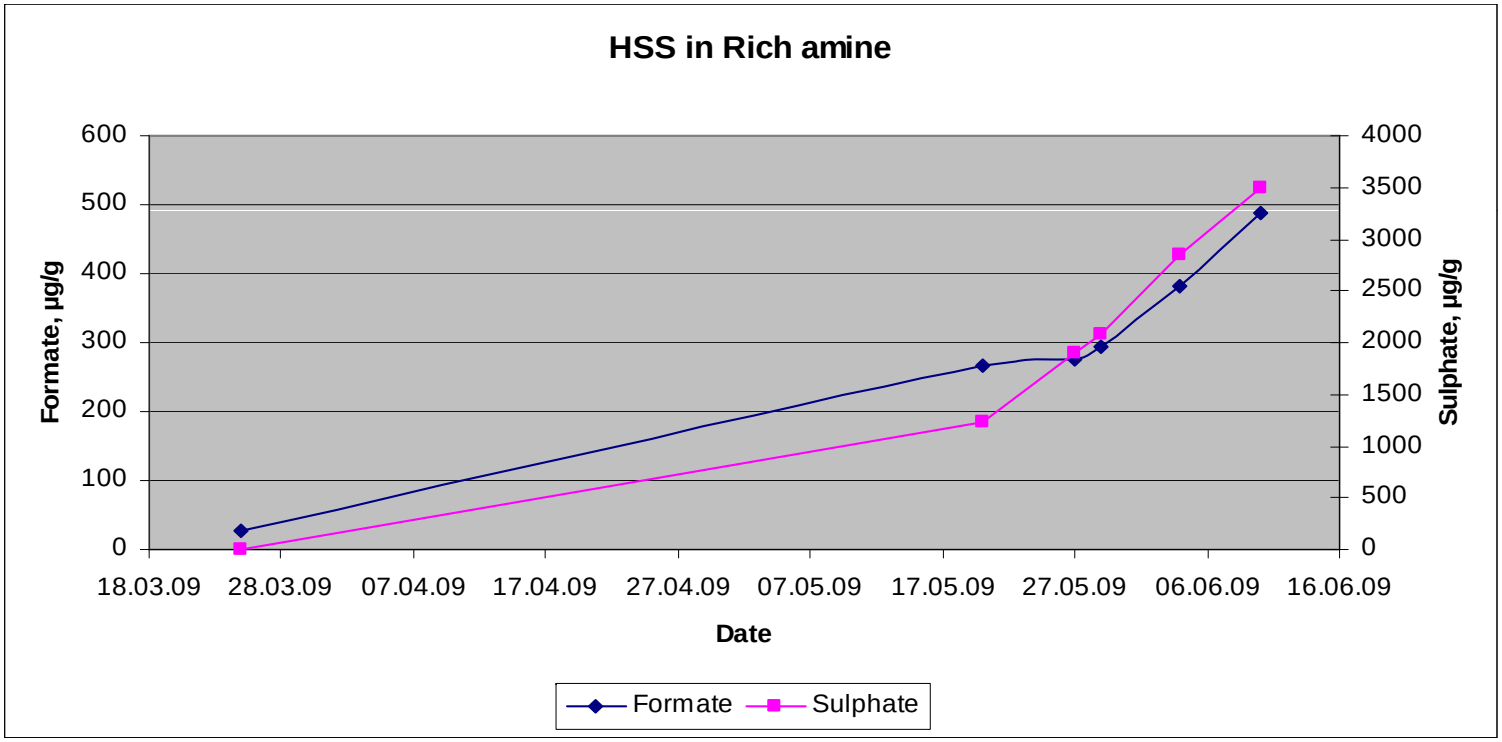
Compound	Unit	CASTOR	CESAR
SO2	mg/Nm3	<0.2	1.5
VOC	mg/Nm3	12	4.1
Ammonia	mg/Nm3	25	23
MEA	mg/Nm3	<0.02	0.7
Formaldehyde	mg/Nm3	0.059	1.1
O2	% dry	7.5	6.9
NOx	mg/Nm3	73	34.4

Results from the liquid analysis 1

Compound	Unit	Wash water
MEA	mg/l	35 000
DEA	mg/l	#
Formaldehyde	mg/l	6.4
Methylamine	mg/l	<0.3

#no measurement due to interference from MEA

Results from the liquid analysis 2



Conclusions

- Emission measurements have successfully been carried out during the MEA test campaign at the Esbjerg plant.
  - Pioneering work!
- The degradation products typical of oxidative degradation of MEA have been found in both the liquid and the gaseous phase.
- The water wash works well in that it reduces the amount of MEA and formaldehyde in the emitted flue gas.
- The bubble cap has a positive effect on the emissions in that it reduces the amount of MEA and formaldehyde in the flue gas leaving the absorber.
- The absorber has a positive effect on the total emissions as it reduces the amount of metals, dust and SO_2 in the flue gas leaving the absorber.

Thank you