Report
on comparative emissions measurements on two crude oil tanks after installation of a floating cover

1998

TÜV Ecoplan Umwelt GmbH

Friedenstrasse 6
D-93051 Regensburg

Telephone +49 941 9910-215
Telefax +49 941 9910-250

Report No. 2402 1298
TEU-E-NBG-sch, 29 Jan. 1999

Operator	Bayern Oil GmbH Raffineriestrasse 100 D-93333 Neustadt/Donau Germany
Location	Raffineriestrasse 100 D-93333 Neustadt/Donau Germany
Type of measurement	Emissions measurement on crude oil tanks
Client	Aluminium Rheinfelden GmbH Vacono Dept. D-79601 Rheinfelden Germany
Order No.	4100802072
Date of order	25 November 1998
Date of measurement	04 December 1998
Length of report	9 pages

Objectives	Comparative emissions measurement on two crude oil tanks after installation of an aluminium floating cover

Project manager	Hans Schmidt, Engineer
Telephone	+49 941 9910-215

Contents **Page**

1 Specification of measurement task

1.1 Client

Aluminium Rheinfelden GmbH
Vacono Dept.
D-79601 Rheinfelden

1.2 Operator

Bayern Oil GmbH
Raffineriestrasse 100
D-93333 Neustadt/Donau

1.3 Location

Raffineriestrasse 100
D-93333 Neustadt/Donau

1.4 System

Auxiliary equipment for installations in Category 4.4 as per Paragraph 1 of the 4th Implementing Order on the German Federal Pollution Protection Act (BImSchV)

1.5 Date of measurement

04 December 1998

1.5.1 Date of last measurements

First measurement

1.5.2 Date of next measurement

Once-only measurement

1.6 Purpose of measurement

To verify the reduced emissions due to installing an aluminium floating cover by making comparative measurements on two crude oil tanks of otherwise identical construction. The objective was to ascertain whether the guaranteed 95 % reduction in emissions could be achieved.

1.7 Task assignment

In its letter dated 25 November 1998, Aluminium Rheinfelden GmbH entrusted TÜV Ecoplan Umwelt GmbH, Unternehmensgruppe TÜV Süddeutschland, with comparative emissions measurements on the crude oil tanks TR-96 and TR-97, with the objective of determining the efficiency, i.e. the reduction in emissions, achieved by installing a floating cover.

1.8 Components measured

Total hydrocarbons
Benzene

1.9 Coordination of measurement procedure

The date for the measurements and the procedure for determining representative emissions from the installations were arranged by telephone and on site with Mr. Brockmüller (Aluminium Rheinfelden) and Mr. Siebig (Bayern Oil). Mr. Reithmeier of the Bavarian State Office for Environmental Protection (LfU) was advised in writing about the planned procedure.

1.10 Personnel on site for sampling

W. Hammer
H. Schmidt
TÜV Ecoplan Umwelt GmbH, Unternehmensgruppe TÜV Süddeutschland

1.11 Other participating institutes

No other institutes took part in this project.

1.12 Person with technical responsibility

Hans Schmidt, Engineer, Tel. +49 941 9910-215

2 Description of the installation and the materials handled

2.1 Installation type

Auxiliary equipment for installations in Category 4.4 as per Paragraph 1 of the 4th Implementing Order on the German Federal Pollution Protection Act (BImSchV)

2.2 Description of installation

Tanks

Tank IDs:	TR-96 and TR-97
Type :	crude oil tanks
Design of TR-96	closed crude oil tank
Design of TR-97	closed crude oil tank with floating cover
Diameter:	24.0 m
Height:	14.64 m
Roof height:	1.80 m
Max. liquid level:	14.14 m

Floating cover

Manufacturer:	Aluminium Rheinfelden
Type:	Vaconodeck
Tank No.:	TR-97
Cover No.	2484
Mounting:	tubular floats
Peripheral seal:	Vaconoseal RTS Teflon-covered glass fibre web

2.3 System location and description of emission sources

2.3.1 Location

Raffineriestrasse 100
D-93333 Neustadt/Donau

2.3.2 Emission source

The emissions are not channelled at source. Hydrocarbons are emitted through the pressure relief valves on the roof of the tank.

2.3.2.1	Height above ground level	16.5 m
2.3.2.2	Outlet area	not defined
2.3.2.3	Easting / northing (grid coordinates on Gauss-Krüger projection)	4481420/5405610
2.3.2.4	Design	pressure relief valves

2.3.3 State-specific classification

Not applicable

2.4 Possible products used according to planning documentation

Storage of crude oil

2.5 Operating times

2.5.1 Overall operating time

Throughout the year

2.5.2 Time of emissions as stated by user

During every filling operation

2.6 Equipment for channelling and reducing emissions

2.6.1 Equipment for emission channelling

No equipment for channelling the emissions is installed.

2.6.2 Equipment for reducing emissions

The tanks are closed and attemperated. This prevents emissions when the liquid level is static, except when large fluctuations in atmospheric pressure and slight variations in temperature occur. There is no other equipment to reduce the emissions from Tank TR-96.
Installing a floating cover in the tank TR-97 reduces the passage of hydrocarbon vapours into the tank air space. The air that is displaced when the tank is filled therefore has a lower hydrocarbon content than in the tank with no floating cover

3 Description of the sampling points

3.1 Location of the sampled stream

The air exhaust apertures of the pressure relief valves are not suitable for taking samples, the stream of gas diffusing as it emerges. Therefore before starting the measurement work, a hose connector was fitted to a flange on the tank roof that could be reached via the platform. While the measurements were being made, a large proportion of the displaced air was expelled through this hose. A partial stream was taken from the hose for sampling purposes.

3.2 Diameter of the exhaust gas pipe for the sampled stream

Not defined

3.3 Number of measurement axes and position of the sampling points in the stream

Because of the layering effect due to differences in density, differing hydrocarbon contents were anticipated in the space above the liquid. To obtain a representative series of samples, it would be necessary to take samples throughout a complete filling operation. With the installed pumping capacity this measurement would therefore have taken two weeks.
After consulting with the operator and the client, and in agreement with the Bavarian State Office for Environmental Protection (Mr. Reithmeier), a sampling procedure as described (see Section 3.1) over a period of 90 minutes was decided upon.

4 Measurement process, analytical methods and instrumentation

4.1 Determination of the exhaust gas conditions

Not necessary for the specified task

4.2 Gaseous and vapour-phase emissions

4.2.1 Continuous measurement processes

Emissions of volatile organic compounds

Data acquisition

Data acquisition	with a measurement integrator
Data storage	electronic data acquisition and storage
Make/type	LSB 36/II
Manufacturer	Linseis
Data analysis:	spreadsheet program
Presentation:	coloured printout

Measuring instrument

Medium tested:	volatile organic compounds (total carbon content)
Unit of measurement:	ppm
Measurement process:	flame ionization detector (FID)
Guidelines	VDI 3481, Part 1
Instrument	FID 123
Manufacturer	Testa GmbH, Munich
Measurement range 5	0 – 100,000 ppm C_3H_8 (= 0 - 10 % by volume)
Suitability tested	yes

Measurement point

Sampling probe	none
Dust filter	none
Gas sampling line	PTFE, length approx. 130 m, not heated as in hazardous area

Instrument characteristics

Zero gas:	purified air
Test gas:	800 ppm C_3H_8 in purified air
Test gas manufacturer	Linde AG, Unterschleissheim
Stability guarantee:	12 months (until 19 June 1999)
90 % settling time:	170 seconds
Measurement uncertainty:	approx. 2 % of full scale reading

4.2.2 Discontinuous measurement process

Emissions of volatile organic compounds

Substance tested	total carbon
Measurement process	gas sampler, gas sampling bulb (glass)
Sample point	directly on the vent hose
Sampling probe	none
Particle filter	none
Sampling device	diaphragm pump
Analytical method	flame ionization detector, integrated analysis of the collected volume, with heating and dilution with nitrogen
Measurement uncertainty	< 10 % of measurement reading

Emissions of volatile organic compounds

Substance tested	benzene
Measurement process	gas chromatography
Guidelines	VDI 2457, Part 1
Sampling probe	PTFE, length 2.5 m, not heated
Particle filter	none
Adsorption system	activated charcoal tube, Type G Drägerwerk, Lübeck
Sampling device	diaphragm pump with wet gas meter
Analytical method	desorption of activated charcoal with CS2/toluene gas chromatographic determination of components
Measurement uncertainty	< 10 % of measurement reading

5 Operating condition of system during the measurement work

5.1 Production plant

The investigations were carried out under the following operating conditions:
According to information from the user, both tanks had been filled at least once to the maximum level before beginning the measurements and after installing the floating cover, in order to take into account the wetting of the tank walls. The measurements were carried out on the basis of the same initial tank contents of 2300 m³, with the same filling rate and, subject to normal fluctuations in the batches, the same grade of crude oil.

5.2 Vent gas purification system

No secondary exhaust gas reduction system installed

6 Summary of measurement results and discussion

6.1 Evaluation of operating conditions during the measurement work

All measurements were carried out under operating conditions with maximum emission rates.

6.2 Measurement results

All the following concentration data for benzene are in terms of dry vent gas at standard temperature and pressure (273 K, 1013 hPa).

		TR-96	TR-97	TR-96	TR-97	
Measurement No.		Hydro-carbons [% by vol.]	Hydro-carbons [% by vol.]	Benzene [g/m³]	Benzene [g/m³]	Reduction in emissions %
Measurement 1		39	1.5			96
Measurement 2		40	1.6	0.28	0.006	96
Measurement 3		42	1.6			96
Mean reading		40	1.5	0.28	0.006	96
Maximum reading		**42**	**1.5**	**0.28**	**0.006**	**96**
Meas. uncertainty, abs.		4	0.2	0.03	0.0005	2
Guaranteed value		**-**	**-**	**-**	**-**	**95**

Assessment of measurement results

A measurement uncertainty, resulting from the tolerances of the measuring instruments and the influences of the substance measured, must be taken into account in the assessment of the measurement results.
The measurement corresponds to a random sample at a medium level. Differing layers of gases can give rise to a considerable variation in the concentrations in the total gas space.

6.3 Plausibility check

Taking into account the measurement accuracy/uncertainty of the measurement processes and devices used, in particular considering a possible large concentration gradient depending on liquid level and the height in the gas space, the results are plausible.

TÜV Ecoplan Umwelt GmbH
Unternehmensgruppe TÜV Süddeutschland
Measurement service as per Paragraphs 26 and 28
of the German Federal Pollution Protection Act

Report prepared by

signed: H. Schmidt

N. Kraus