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Subject: Environmental and social impact study of the Taboth thermal power plant project, Côte d´Ivoire - additional: air quality monitoring results (revision 3)

1. Context and General Approach

The ERANOVE group contracted ERM at the end of 2018 for the environmental and social study of the Taboth gas-fired power plant project.

The methodological proposal agreed between ERANOVE and ERM included the performance of air quality measurements, relating to nitrogen oxides (NOx), over a period of three months using a passive sampling device, to provide a first indicative assessment of air quality in the project area.

The passive sampling devices were installed at five points during three periods of one month, covering the months of January, February and March 2019. They were then analyzed in the laboratory, to deduce the concentrations of nitrogen oxides from ambient air in the project area.

For timing reasons, the results were not included in the main environmental and social impact study report, finalized in April 2019.

This document presents a summary of the results, as a supplement to the environmental and social impact study report.

2. Methodological Approach

The sampling devices used are passive diffusion tubes for the measurement of nitrogen dioxide (NO2) and nitrogen monoxide (NO) supplied by the company Passam, based in Switzerland (see detailed documentation on Passam tubes in the end of this document).

Passive diffusion tubes allow the sampling of the desired compounds in the ambient air, for a relatively long period (for the needs of this project, approximately one month per sampling episode), without any device for forcing the air to through the device (hence the term "passive" sampling). The desired compounds are adsorbed on a membrane.
Once exposed, the sampling tubes are collected, packaged and returned to the supplier's laboratory for analysis. The analysis relates to the total of the compounds adsorbed on the membrane.

The result is then converted into the concentration of the compound in ambient air, averaged over the sampling period.

Five sampling points were used, seeking to fulfill the following conditions:

- relative proximity to the future site of the Project and to the area potentially subject to impacts on the air quality associated with emissions from the thermal power plant;
- location so as to characterize the downstream of the site in relation to the prevailing winds (see section "climate and meteorology" of the impact study report;
- location to characterize the air quality in inhabited areas near the site of the project, and
- absence of sources of atmospheric emissions in the immediate vicinity of the measurement point (in order to measure only "background" concentrations and not emissions from a particular existing source).

The location of the measurement sites is specified on the map on the next page.

3. Results of monitoring measures of air quality in the baseline state

Results are presented in the table below

All concentrations in µg/m^3	January 2019			February 2019			March 2019		
	From 27/12/2018 to 25/01/20			From 25/01/2019 to 25/02/201			From 25/02/2019 to 25/032019		
Measurement Points/Coordinates	NO	NO_2	NOx	NO	NO_2	NOx	NO	NO_2	NOx
AQ1 5°15'23.08"N 4°19'37.80"W	< 1	1,8	1,8	< 0.9	2,2	2,2	< 1	2,1	2,1
AQ2 5°14'38.46"N 4°19'57.42"W	< 1	1,1	< 1.3	< 0.9	1,6	1,6	< 1	0,9	< 1.3
AQ3 5°14'53.34"N 4°19'3.24"W	< 1	0,8	< 1.3	< 0.9	1,3	1,3	< 1	1,3	1,3
AQ4 5°15'25.10"N 4°18'8.37"W	< 1	1,3	1,3	< 0.9	1,4	1,4	< 1	1,5	1,5
AQ5 5°14'38.17"N 4°17'44.25"O	< 1	1,8	1,8	< 0.9	2,2	2,2	Unavailable (tubes stolen from site)		

In the absence of an Ivorian standard for ambient air quality, these results should be compared to the concentration limit of nitrogen dioxide in ambient air on an annual average of 40 µg / m3, as defined by the EHS directive of the International Finance Corporation (IFC), based on the air quality standard of the World Health Organization (WHO) of 2005 (these quality measures are comparable to measures indicative of concentration "long-term" rather than "instant" or "short-term exposure" measurements)[1].

[1] La directive européenne 2008/50/CE définit les « mesures indicatives » comme des mesures collectées selon des méthodes simples ou sur un temps restreint qui respectent des objectifs de qualité des données moins stricts que ceux requis pour les mesures continues de haute qualité, mais qui restent exploitables pour l'étude de la qualité de l'air. La durée minimale requise par la directive pour ces mesures indicatives correspond à 14 % de la période de référence. Trois mois représentent 25% de l'année, ainsi des concentrations moyennes sur trois mois peuvent être raisonnablement considérées comme représentatives de concentrations moyennes de « long terme » pour des conditions météorologiques relativement uniforme (dans le cas du présent document, pour la saison sèche dans le sud de la Côte d'Ivoire)

These measurement results over 3 consecutive months can be considered as representative of dry season conditions (January-March) in the Project area.

They show that the maximum NO2 concentration measured is 2.2 µg / m3, or 5.5% of the standard.
These results suggest that the ambient air in the study area is little polluted with regard to nitrogen dioxide, illustrating a rural environment without significant sources of urban or industrial emissions.

4. Impact of plant emissions with respect to the measured ambient concentrations

The modeling study of the impact of the project on air quality, presented in the project ESIA report (Chapter 7, Environmental and social impacts, section 7.2.4 Quantitative impact assessment, supplemented by the Appendix A, Detail of the air quality modeling study), concluded that the impact of the emissions from the operating plant on air quality is negligible to minor, with:

- a maximum NO2 concentration on an annual average of 0.71 µg / m3 (i.e. 1.77% of the applicable standard of 40 µg / m3 mentioned above); and
- a maximum hourly average NO2 concentration of 30.82µg / m3 (i.e. 15.41% of the air quality standard for the protection of public health of 200 µg / m3, defined by the Company's EHS directive International Finance, based on the air quality standard of the World Health Organization in 2005.)

These modeled maximum concentrations refer to the entire modeling domain (that is to say, these are the predicted maxima for the entire time series of the model, throughout the study area).

The maximum NO2 concentration measured following the on-site sampling campaign is 2.2 µg / m3.

The maximum cumulative concentration between measured ambient concentrations and predicted concentration would therefore be 0.71 + 2.2 = 2.91 µg / m3, i.e. 7.27% of the applicable standard of 40 µg / m3.

These elements suggest that the impact of the operation of the project on ambient air quality will be low compared to the applicable air quality standard.

5. Recommendations

Our recommendations remain as detailed in Chapter 8, Environmental and Social Management Plan, of the ESIA report, in particular section 8.5.2 establishing the terms of an air quality management plan. These recommendations revolve around:

- The implementation of good industrial practices to limit the emissions of the project, both in the construction phase (dust removal in particular) and in operation (turbine emissions).
- Continued measurements of the ambient air quality in the initial state, making it possible to characterize any variations linked to seasonal changes in the environment of the project area (meteorological conditions in particular).
- During the operational phase, continuous monitoring of the plant's emissions and, for the first three years of plant operation, of the ambient air quality.

Map of sampling point locations, numbered AQ1 to AQ5

Technical specifications of Passam diffusion tubes for NOx

(téléchargé depuis www.passam.ch le 8 avril 2020)

Performance

Diffusive Sampler for Total Nitrogen NO_x

Effects and Limit values

NO_2 and NO_x have implications for acidification of ecosystems and formation of ozone. It is pointed out that synergistic effects are very important and the guideline is given for NO_x rather than NO_2 alone.

WHO recommended a guideline to protect vegetation as an annual average of 30 µg/m³; for NO_x, calculated as the sum of NO and NO_2 in ppb and expressed as NO_2 in mg/m³

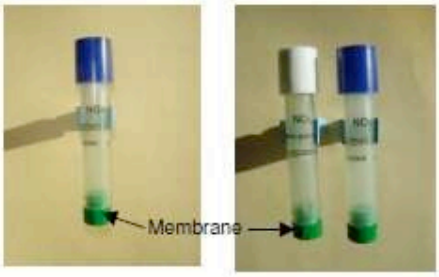
Annual limit value for the protection of vegetation	30 µg/m3	[1]

Sampler design

The sampler is based on that of Palmes. The absorbing medium contains an oxidant, which transform NO to NO2. The amount of NOx is trapped as total nitrite

The measurement of NO_x is carried out with two different samplers: firstly NO_2 is assessed with Triethanolamine and secondly NO + NO_2 is trapped after transforming NO into NO_2 with an oxidizing agent in the TEA

The samplers are placed in a special shelter to protect them from rain and minimize the wind influence. To avoid the influence of vertical air turbulences at high trafficked roads, Membranes shall be used.



Direct measurement as NO_2 equivalents

Indirect measurement via NO measurement

Direct Measurement

NO_x is determined as the total amount of nitrite

$$C_{NOx} = \frac{Q_{NOx}\ [\mu g] \cdot 10^6}{SR_{NOx}\ [ml/min] \cdot t\ [min]} \quad [1]$$

C_{NOx} is expressed in NO_2 equivalents in µg/m³

Indirect measurement

The measurement is done by NO_2 and NO_x tube simultaneously.

First,
the NO_2 concentration is calculated according to [1]

Second:
Based on the difference NO_x and NO_2 as nitrite, the concentration of NO is calculated

$$C_{NO} = \frac{(\ Q_{NOx} - Q_{NO2}\ )\ [\mu g] \cdot 10^6}{SR_{NO}\ [ml/min] \cdot t\ [min]} \quad [1]$$

The concentrations of NO_2 and NO are added:

$$C_{NOx} = C_{NO2} + C_{NO} \quad [\mu g/m^3]$$

C_{NOx}:	ambient concentration	[µg/m³]
Q:	mass absorbed	[µg]
SR:	sampling rate	[ml/min]
CF:	Conversion Factor	µg/m³ → ppb

Accredited according ISO/IEC 17025 STS 149

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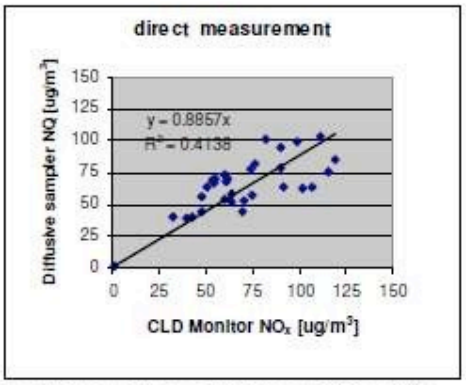
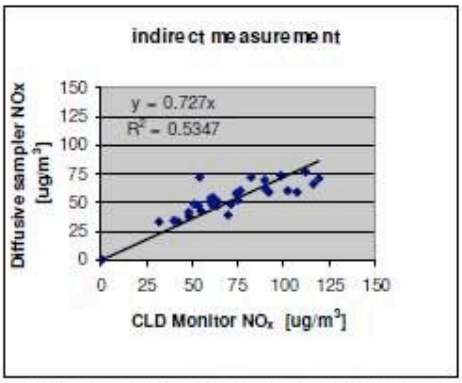
Specifications



The diagram shows the comparison of NO_2 diffusive samplers and NO_x (sum of NO + NO_2 in µg/m3) measurements of different continuous monitoring sites in Switzerland 2006.



There is a underestimation of the diffusion tube measurement. This might be due to the fact, that CLD monitors collect also higher Nitrogen oxides

Sampling rate Nitrogen dioxide	0.7432 ml/min at 20°C equipped with membrane	
Sampling rate Nitrogen monoxide	0.9566 ml/min at 20°C equipped with membrane	
Working range	2 – 200 µg/m³	
Sampling time	2 to 4 weeks	
Detection limit	1 µg/m³	for sampling periods of one month
External influences: wind speed	influence of wind speed < 10% up to 4.5 m/sec use of membranes at highly trafficked sites recommended	
temperature	no influence between	10 to 30°C
humidity	no influence between	20 to 80%
Storage	before use:	6 months
	after exposure:	6 months
Cross sensitivity	Specific method	
Expanded uncertainty*	30.1 %	

*according to GUM; subject to change without notice

revised 5.1.2012

References

Council Directive 1999/30/EC relating of limit values for SO_2, NO_2 and oxides of Nitrogen, 22 April 1999

[2] Validation report passam ag VP1206_01 (2006)

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