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Some Aspects Concerning the Combat of the Emissions Generated on the Maritime Platforms

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Abstract

The global preoccupation regarding the Green House Gases emissions conducted us to analyze and identify the opportunities to reduce the amount of emissions from the self elevating drilling platforms.

Initially, we followed the fuel consumption in 12 months (2010), for Unit A (5 Caterpillar D 399, Total power: 5.875 kW) and Unit B (4 Caterpillar 3516BDITA). Based on this consumption, we calculated the specific emissions by adopting the methodology of the international guidelines EMEP / EEA and IPCC.

Mainly, these are the emissions of CO_2, CH_4 and NO_x, estimated for Diesel and Marine Diesel Oil, on three sources: Electric Power Generator (EPG), Internal Combustion Engine (ICE) and Boiler (BO). Using the above methodology and having as input data the fuel consumption and meters drilled, it has resulted a decreasing of 4.8 % from GHG/ 1000 meters drilled for unit B, equipped with the modern 4 Caterpillar 3516BDITA.

An important conclusion: the decease of the air emissions could be obtained by the replacement of the old power generation systems of the drilling rigs with power generator systems made of new generation diesel engines and electric power generators.

Key words: *Green House Gases emissions, offshore drilling platforms, diesel engine.*

Premises

The global preoccupation regarding the Green House Gases emissions conducted us to analyze the emissions generated by the offshore self elevating drilling platforms and the possibilities of decreasing the amount of these emissions.

We are considered two drilling platforms which are operating within the Persian Gulf, in the same area: *Unit A* and *Unit B*. Unit A has the following characteristics: self elevating drilling platform; design type - Marathon Class 116C, built in 1980 (classification ABS); power system generators: 5 Caterpillar D 399, 1.175 kW, 600 V, 60 Hz; total power: 5.875 kW. Unit B is a self elevating drilling platform too, built in 2007: classification ABS+A1, design type Baker Pacific Class 375; power system generators**:** 4 Caterpillar 3516BDITA & 1 3516C, 2,150 HP each, driving 5 Kato generators, 2,150 kvA

It was monitored the fuel consumption for 12 months (2010) considering the reports of consumption at every 3 months. Based on the fuel consumption were calculated the corresponding emissions [1 - 4].

Emissions Calculation Methodology

International Guidelines that were adopted in emissions calculation methodology are EMEP/EEA and IPCC. The first, EMEP/EEA, is issued by the United Nations, formerly referred to as the EMEP CORINAIR emission inventory guidebook, basically for the estimation of NO_X. The IPCC is the Guidelines for National Greenhouse Gas Inventories (issued by the United Nation Environmental Programme) for the estimation of GHG.

Greenhouse gas emission and removal estimates are divided into main sectors, which are groupings of related processes, sources and sinks: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), Waste, Other (e.g., indirect emissions from nitrogen deposition from non-agriculture sources). Each sector comprises individual categories (e.g. transport) and sub-categories (e.g. cars).

The basic equation for emissions calculation is a combination of information on the extent to which a human activity takes place (called activity data) with coefficients which quantify the emissions or removals per unit activity:

$$E_i = EF_i \cdot A \tag{1}$$

where: E_i represents the emission of pollutant *i*, [kg]; EF_i - emission factor of pollutant *i*, [kg/GJ]; A - activity data (fuels consumption).

In the energy sector, for example, fuel consumption would constitute activity data and mass of sulphur dioxide emitted per unit of fuel consumed would be an emission factor.

For the determination of specified SO_2 emission factors the following general equation should be used:

$$EF_{RSO_2} = 2\,C_{Sfuel}\left(1-\alpha_S\right)\frac{1}{H_u}\cdot 10^6\left(1-\eta_{\sec}\ \beta\right), \tag{2}$$

where: EF_{RSo_2} is the specific emission factor [g/GJ]; C_{Sfuel} - sulphur content in fuel [$kg_{sulphur}/kg_{fuel}$]; α_s - sulphur retention coefficient in ash; H_u - lower heating value of fuel [MJ/kg] = [GJ/t]; $\eta_{\sec}$ - reduction efficiency of secondary measures; β - availability of secondary measure.

This equation can be used for all fuels, but for liquid and gaseous fuels the sulphur retention in ash is not relevant ($\alpha_s = 0$).

The secondary measures are processes/treatment systems designed to remove SO_2 from the fuel gas resulting from combustion installations. In the table 1 are presented the secondary measures for SO_2 reduction.

Main and emergency generators for power supply, maritime engines for propulsion, boilers, internal combustion engines for machineries, and incinerators – the equipment on offshore drilling rigs acting as sources of air emissions – were organized similar to EMEP/EEA and IPCC sources as follows: (1) - Electric Power Generator (EPG); (2) Internal Combustion Engine (ICE); (3) - Boiler (BO).

Table 1. The secondary measures for SO_2 reduction

No.	Types of secondary measures		Reduction efficiency, η_{sec}	Availability, β
1	WS	Wet Scrubbing	0.90	0.99
2	SDA	Spray Dryer Absorption	0.90	0.99
3	DSI	Dry Sorbent Injection	0.45	0.98
4	LIFAC	Special type of DSI, mostly used in Finland	0.70	0.98
5	WL	Wellmann-Lord	0.97	0.99
6	WAP	Walter Process	0.88	0.99
7	AC	Activated Carbon Process	0.95	0.99
8	DESONOX	Type of simultaneous process for SO_2 and NO_x removal based on catalytic reaction	0.95	0.99

In the table 2 are presented the emission factors in CO_2, CH_4, NO_x and SO_x for the case of Electric Power Generator (EPG) (Diesel and Marine Diesel Oil). For the emission factor calculation of CO_2 and CH_4, it was used the table 2.3, volume 2 [3], and for NO_x – the table 3.38 (non-residential sources) [2]. Factor for SO_x assumes no SO_2 abatement and is based on 0,3 % mass sulphur content using EF calculation from subsection 4.3.2 of the chapter 1.A.4 of EMEP/EEA [2].

Table 2. Emission factors for Electric Power Generator (EPG)

Combustible	**U.M**	**CO_2**	**CH_4**	**NO_x**	**SO_x**
Diesel	kg/t	3 164	0.128	61.9	6.0
Marine Diesel Oil	kg/t	3 105	0.126	60.8	20.0

Similarly, in the table 3 and table 4 are presented the emission factors for the case of Internal Combustion Engines (ICE) and Boiler (BO), respectively (Diesel and Marine Diesel Oil).

Table 3. Emission factors for Internal Combustion Engines (ICE)

Combustible	**U.M**	**CO_2**	**CH_4**	**NO_x**	**SO_x**
Diesel	kg/t	3 160	0.055	32.8	6.0
Marine Diesel Oil	kg/t	-	-	-	-

Table 4. Emission factors for Boiler (BO)

Combustible	**U.M**	**CO_2**	**CH_4**	**NO_x**	**SO_x**
Diesel	kg/t	3 164	0.128	4.27	6.0
Marine Diesel Oil	kg/t	3 105	0.126	4.19	20.0

In the table 5 are presented the results for energy consumption, production and energy consumption per 1 000 meters drilled.

In the table 6 are presented the emissions value of CO_2, CH_4, NO_x and SO_x for 1 000 m drilled and the total drilled (Unit A and Unit B). The total Green House Gases emissions for the two units are presented in table 7.

Based on the above mentioned methodology and having as inputs the fuel consumptions and the meters drilled resulted a decrease with 4.8 % of the Green House Gases emissions / 1000 meters drilled in favor of the Unit B, equipped with the modern power generator system 4 Caterpillar 3516BDITA & 1 3516C, 2,150 HP each, driving 5 Kato generators, 2,150 kvA

Table 5. Results for energy consumption, production and energy consumption per 1 000 m drilled

Drilling Unit	Energy consumption			Production	Energy consumption / 1 000 m drilled
	Diesel, t	Marine Diesel Oil, t	Total, toe*	Drilled length, m	
Unit A	0,00	1 580,00	1 738,00	1 837	946,11
Unit B	4 367,00	0,00	4 519,85	5 323	849,09

**toe = tons oil equivalent*

Table 6. CO_2, CH_4, NO_x and SO_x emissions

Drilling unit	CO_2		CH_4		NO_x		SO_x	
	Total, t	CO_2 / 1 000 m drilled, t	Total, t	CH_4 / 1 000 m drilled, t	Total, t	NO_x / 1 000 m drilled, t	Total, t	SO_x / 1 000 m drilled, t
Unit A	0.19	0.10	4 941.37	2 689.91	74.86	40.75	31.60	17.20
Unit B	0.52	0.10	13 657.57	2 565.70	206.91	38.87	87.34	16.41

Table 7. Total Green House Gases (GHG) emissions

Drilling unit	GHG (tons CO_2 eq.)	GHG / 1000 meters drilled
Unit A	4 946.11	2 692.49
Unit B	13 670.68	2 568.16

GHG (tons CO_2 eq.) = $1*CO_2 +25*CH_4$

Conclusions

1. Reduction of the Green House Gases emissions represents (or should represent) a constant preoccupation for the decision factors in all fields. This paper analyzes and identifies some opportunities to reduce the amount of emissions from drilling platforms offshore.
2. It was monitored the fuel consumption for 12 months (2010) considering the reports of consumption at every 3 months for two self elevating units (Unit A and Unit B). Based on the fuel consumption were calculated the corresponding emissions.
3. Main and emergency generators for power supply, maritime engines for propulsion, boilers, internal combustion engines a.s.o., were organized similar to EMEP/EEA and IPCC sources in Electric Power Generator (EPG), Internal Combustion Engine (ICE) and Boiler (BO). For each case were then calculated the emission factors for CO_2, CH_4, NO_x and SO_x.
4. Finally resulted a decrease with 4.8 % of the Green House Gases emissions/ 1 000 meters drilled in favor of the Unit B, equipped with the modern power generator system 4 Caterpillar 3516BDITA.
5. The decease of the air emissions could be obtained by the replacement of the old power generation systems of the drilling rigs with power generator systems made of new generation diesel engines and electric power generators.

References

1. * * * – *AP42 Compilation of Air Pollutant Emission Factors*, Issued by the Environmental Protection Agency, 2011;
2. * * * – *EMEP/EEA Air Pollutant Emission Inventory Guidebook*, Issued by the European Environment Agency, 2009;
3. * * * – *IPCC Guidelines for National Greenhouse Gas Inventories,* Issued by the United Nation Environmental Programme, 2006;
4. * * * – *Standards for Green House Gases Accounting and Verification*, ISO 14064, 2006.

Câteva aspecte privind combaterea emisiilor de gaze generate pe platformele marine

Rezumat

Preocupările actuale mondiale privind emisiile de gaze cu effect de seră ne-au determinat să analizàm şi să căutăm soluţii de reducere a acestora pentru cazul platformelor marine autoelevatoare.

Într-o primă fază am urmărit consumurile de carburanţi pentru Unitatea A (5 Caterpillar D 399, cu puterea totalà de 5,875 kW), respectiv pentru Unitatea B (4 Caterpillar 3516BDITA), pe o perioadà de 12 luni (2010). Pe baza acestor consumuri am calculat emisiile specifice, în conformitate cu metodologia reieşită din directivele internaţionale EMEP/EEA (Ghidul de inventariere a emisiilor de poluanţi ai aerului – Agenţia Europeană de Mediu) şi IPCC (Ghidul pentru inventarierea naţională a gazelor cu efect de seră – Programul Naţiunilor Unite pentru Mediu).

În esenţă este vorba de emisiile de CO_2*,* CH_4*,* NO_x *şi* SO_x *aferente motorinei şi motorinei marine, pentru trei surse principale, sintetizate astfel: sistemul generator de energie electricà (EPG), motoarele cu ardere internà (ICE) şi cazanele (BO). Cu ajutorul metodologiei prezentate mai sus, având ca date de intrare consumurile de carburanţi şi metrii foraţi, a rezultat o scădere a emisiilor de gaze cu efect de seră, pentru 1 000 de metri foraţi, de 4,8% în favoarea unităţii B, echipată cu sistemul modern 4 Caterpillar 3516BDITA.*

O concluzie importantă: reducerea emisiilor de gaze cu efect de seră în atmosferă, în cazul activităţilor de foraj marin, poate fi obţinută prin înlocuirea sistemelor vechi de producere a energiei electrice, cu sistemele moderne de motoare diesel şi generatoare de ultimă generaţie.