

CHARACTERIZATION OF ENERGY FLOWS AND GREENHOUSE GASES IN OFFSHORE FACILITIES

Edgar Amaral Silveira

Armando de Azevedo Caldeira-Pires

Universidade de Brasília, Campus Universitário Darcy Ribeiro, S/N - Asa Norte Brasília - DF, 70910-900

edamaral@hotmail.com

armandcp@unb.br

Abstract. With the biggest challenges inserted in oil offshore exploration and production activity, it is essential to increase knowledge of the environmental impact sources thus leading to new management tools and methodologies development. These will enable the activities performance monitoring, evaluation and control through a more precise description of their interactions with the environment. The main object of this study is the environmental performance diagnosis by identifying the main mass and energy flows within unit processes of a generic technological model of an offshore primary oil processing plant. This allowed the GHG emissions evaluation in a FPSO platform, using secondary data and different technologies combinations, through simulations and sensitivity analyzes in different scenarios that identified in which stages of the fossil fuel cycle the resources, energy consumption and pollutant emissions are more significant. The study uses the systems and processes flows diagram characterization in an offshore primary processing plant through the Life Cycle Assessment methodology and the CML2001 environmental impacts system. The main treatments modules in the model were divided into processes linked either directly (Internal Processes), and indirectly (External Processes), with the oil and gas production process. Internal Processes are Separation, Oil Treatment, Water Treatment, Gas Treatment, Power Generation and Gas Flare. External processes are those related to the chemicals production for all the processes and fuels for power generation. The results showed that gaseous emissions from internal and external processes are dominated by the power generation plant, 100% CO, N₂O and NO₂ and 23% CO₂. The Gas Treatment presented 73% of CO₂ emissions and 99% of CH₄ emissions. The Water Treatment appears with 83% of the terrestrial ecotoxicity potential and 36% of aquatic ecotoxicity potential (seawater) due to emissions of organic and inorganic compounds and heavy metals into the sea. In the scenario where natural gas is used in cogeneration, the flaring process is used only in emergencies and in the case of surplus gas flaring being its contribution negligible compared to other systems.

Keywords: life cycle assessment, Oil E&P, offshore

1. INTRODUCTION

The lifestyle as we know is dependent of Oil, Gas and its derivatives for power generation, transportation and production of various petrochemical consumer goods. Highlighted as a high pollution segment, the offshore petroleum E&P has the potential to generate a large range of environmental impacts. Being a substantial economic activity for Brazil and for the rest of the world, offshore Oil and Gas E&P is under expansion and growth in Brazil. New technological challenges comes with deeper drilling exploration, as in the Pre-Salt layer.

With the biggest challenges for this sector, it is essential to improve the environmental impact knowledge thus leading to new management tools and methodologies development. These tools will allow the system performance monitoring, evaluation and control through a more precise description of their environmental interactions. In this context, this work aims an environmental performance diagnosis by identifying the main unit processes that composes an Oil and Gas offshore primary processing plant model. This model will be able to simulate a greenhouse gas emissions and toxicity balance for a FPSO primary processing plant using secondary data.

The simulation was performed in GaBi, a Life Cycle Assessment software. Based on this, air emissions characterizations, toxicity analysis and external process description was developed for each unit system. The sensitivity analysis in different scenarios was performed identifying in which fossil fuels production steps, energy and pollutant emissions are more relevant.

The computational model, structured with a range of primary processing technologies existing in operation in the Brazilian ultra-deep waters coast, will provide other simulations possibilities with different technological processing combinations in FPSO (Pre-Salt Layer or not) units. As the computational model has a different range of technological processes of FPSO units to be explored, the reproducibility can be stipulated by inserting the data from these different platforms within the stipulated computational model. The confidentiality of the primary data did not allow the analysis of a real unit. The case of study model was supplemented with secondary data obtained from the literature available to the public.

2. OBJECTIVE

This work aims performing an environmental diagnosis, through the main mass flows identification of the principal systems that integrates an offshore oil and gas primary processing plant. To this end, a generic model for an Oil and Gas primary processing plant in FPSO platforms was structured. With this, a greenhouse gas emissions and toxicity simulation was performed using secondary data with Life Cycle Assessment approach. An input and output compounds and emissions investigation for the six main treatment processes was developed allowing the life cycle inventory construction. The main treatment process are Separation, Oil Treatment, Gas Treatment, Water Treatment, Waste Treatment and Power Plant.

For this, a quantitative characterization through emissions factors and systems effluents used in the processes was evaluated. These data allowed the emissions and effluents characterization in the oil and gas primary production leading to different scenarios sensitivity analysis identifying in which fossil fuel cycle step the greenhouse gases and the toxicities emissions are more significant.

3. METHODOLOGY

A national FPSO's unit analysis was made to build a national technologies scenario map. The analyzed units were: FPSO BW Cidade de São Vicente, FPSO - Cidade de Ilhabela, FPSO - Cidade de Rio das Ostras, FPSO - Dynamic Producer, FPSO - OSX-3 e FPSO - P-62. From this, it was possible to generate a generic technological model that encompasses a plurality of multiphase flow processing systems possibilities Fig.1.

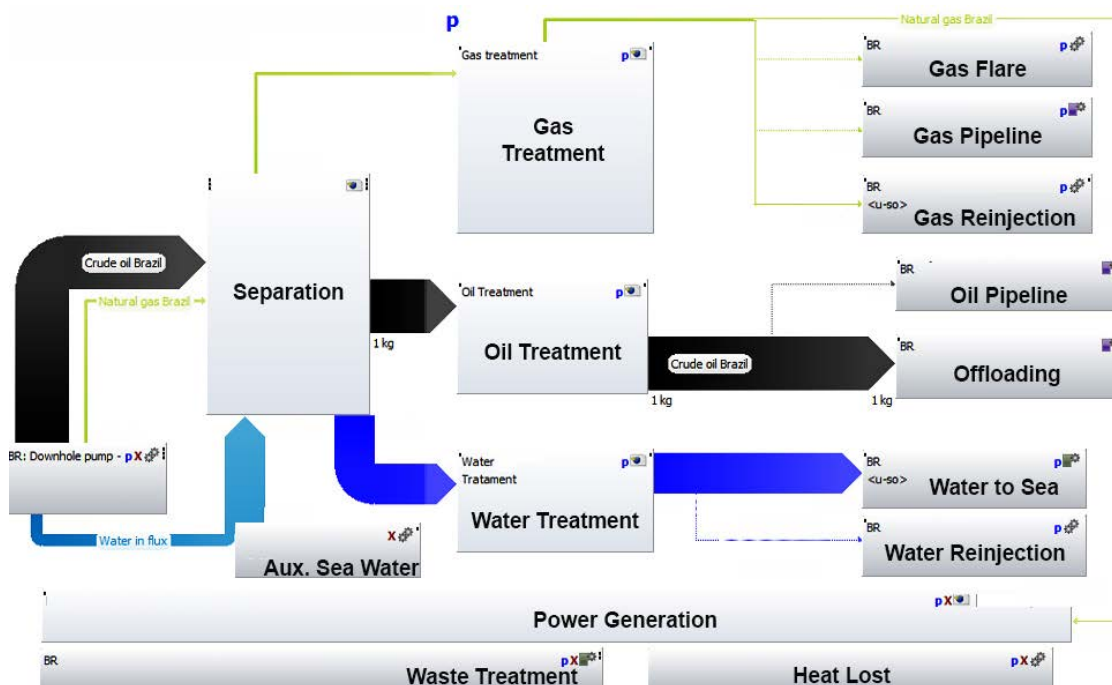


Figure 1. Primary Processing Plant

Based on Life Cycle Assessment concept, a characterization and quantification of mass flows and materials consumed and discarded to the environment were performed. LCA was performed according to the current ISO standards recommendations. The system in question is replicable for a model of a FPSO primary processing plant operating on Scenario II of production.

The processes directly related to the production were named Internal Processes. These are installed and operated systems in the platform and featured the FPSO physical configuration. The indirectly related processes were named External Processes and are the ones that comprises the supply chain of each auxiliary element for the FPSO operation, as presented in Tab. 1. Each External Process has its participation in a particular Internal Process.

It is extremely important to point out that all external processes and internal processes flows were taken from the Software GaBi database. Thus, secondary data obtained in the bibliographic study only quantified existing flows from

that database. This care is important because to create extra-software flows undertakes the evaluation model adopted, since currents created by the user does not contain predefined weights related to the impact of categorical adopted by a particular valuation model. The data for this model comprises the environmental aspects identification of all the subsystems involved in this study.

Table 1. Identification of internal (gray) and external processes (white) technologies

Treatment	Model Technologies Possibilities (Emissions/Compositions)
Separation	- Test Separators ; - Three-phase and biphasic horizontal separators (low and high pressure).
Oil Treatment	- Heater; - Venting (VOC, CH ₄ and CO ₂); - Pneumatic pumps (VOC, THC, CH ₄ and CO ₂); - Connectors and flanges; - Electrostatic treatment (Pre-treater and electrostatic treater); - Pressure controller (VOC, THC, CH ₄ and CO ₂); - Oil Storage (VOC).
Gas Treatment	- Pumps (VOC, THC, CH ₄ and CO ₂); - Connectors and flanges; - Dehydrator (molecular sieves or absorption tower); - Sweeting (fixed bed reaction or countercurrent reaction gas stream); - CO ₂ removal (permeation through membranes); - Compressors (3 main stages, booster and scrubbers compression vessels).
Water Treatment	- Desalter; Filter; Sand trap.
Power Plant	- Natural Gas Turbine (VOC, SO ₂ , NO _x , PM, CO, CH ₄ , N ₂ O and CO ₂); - Natural Gas or Diesel engines (VOC, SO ₂ , NO _x , PM, CO, THC, CH ₄ and CO ₂); - Boilers and Heaters;
Solid Waste Treatment	- Non-hazardous Waste (Class I) - Hazardous Waste (Class II A and B)
Chemicals Production	- Antifoam Polan PJJ Sol – Silicone 30%, Solvent 70%; - Demulsifier DISSOLVAN 40 - 25% Ethanol, 30% Xylene, 45% Water; - Inhibitor fouling POLAN GONE 150 - Ammonium Sulphate 38%, Ethylene glycol 22%, Water 40%; - Corrosion Inhibitor - Methanol 50%, Ammonium Sulphate 20% and Water 30%; - Diethylene Glycol;
Fuel	- Diesel; Gasoline; Heavy fuel oil; Natural gas.

It was only quantified the input and output system processing data, also considering the generation and effluents impacts treatment. The work performed is a gate-to-gate analysis, delimiting the system boundary to the processing and production stage in the E&P upstream segment, particularly, the primary processing plant. The other fossil fuel cycle phase's impacts as geophysical, drilling, completion, exploratory unit construction, oil and gas offloading, abandonment and final disposal of equipment were not as counted.

Petroleum compositions impacts are take into account when the data's to the model are established and will influence the gas/oil/water ratio in the separation process and the possible contaminants such as gases and sand. The functional unit of one (01) kg of treated oil was established. This unit was used as a factor for calculating the main system unit processes inputs and outputs discussed. In the processing plant case, the allocation procedure was performed based on the mass criteria for the oil, gas and water.

It was adopted a midpoint pointers impact profile to provide a more concise picture of the products environmental performance evaluation. Among the existing models was selected that one focused on intermediate impact categories, which considers the impacts from the environmental intervention primary point. After evaluating some models available in the GaBi software, it was decided to use the CML 2001 method, proposed by researchers at the Centre of Environmental Science - CML, Leiden University - Netherlands.

Environmental impact categories have been selected in order to adequately represent the environmental profile. These categories are:

i) Global Warming Potential that generates the Earth's surface thermal radiation increase, raising its temperature and bringing ecological imbalances. This temperature rise is mainly increasing by the amount of CO₂, N₂O, CH₄, aerosols and other gases in the atmosphere. The conversion factors for greenhouse gases in equivalent CO₂ transformation are called Global Warming Potential (GWP). The substance potential is the ratio between the contribution to the radiant heat absorption resulting from the instantaneous 1 kg greenhouse gas emission and an equal integrated CO₂ at a given time (Santos, 2006).

ii) Human Toxicity Potential are the factors that characterize human toxicity, described as Human Toxicity Potential (HTP). They are calculated using models whose time horizons are usually infinite (Kulay, 2004). HTP value for a given substance, according Chehebe (1998) is measure as the human body weight that was expose to an acceptable toxicological limit for one kg of substance.

iii) Ecotoxicity Potential: Chehebe (1998) explains that the Aquatic Ecotoxicity Potential (AEP) results refers to the polluted water amount to a critical level per substance kilogram, while the Earth Ecotoxicity Potential (EEP) results refers to polluted soil mass to a critical level per substance kilogram. Such indicators can be applied to local, regional, continental and even global scale (Kulay, 2004).

To improve the different impact data categories comparability, the indicators were normalized. The data was parameterized and modified in order to be compatible with the GaBi6.0 software and proportional to the unit functional of 1 kg of treated oil. It were taken the necessary data reliability and representativeness precautions according to the ISO 14040 quality criteria. All data used to build the LCI model were secondary data from public theses and academic papers, companies quantitative performance reporting and public Environmental Impact Assessment (EIA), in Tab. 2.

For not obtained data, the modeling was carried out in consultation to the Gabi 6.0 database. It was utilized the main data that by assumption and literature review were considered the ones that most affect to the environment. The LCA construction included the processes linked directly and indirectly to the final product and the transport processes (sea and road). The LCI show the quantities related to operations mass flows and the main pollutants generated.

Table 2. Secondary data sources used to compose the life cycle inventory (LCI)

Secondary Data	Publication Title	Author
Atmospheric Emissions	- "Offshore Oil and Gas Platform Report, Final Report".	- Texas Commission on Environmental Quality.
Chemicals	- "Review of potential technologies for the removal of dissolved components from produced water"; - "Ficha de Informações de Segurança de Produto Químico".	- HANSEN, B.R., - DAVIES, S.R.H. - http://licenciamento.ibama.gov.br
Fuel and Electricity	- "Otimização Ambiental de um Sistema de Produção de Petróleo Baseada em Critérios de Produção Mais Limpa"; - GaBi Software.	- OLIVEIRA, J. A.
Water	- "Abordagem de Ciclo de Vida da Avaliação de Impactos Ambientais no Processamento Primário Offshore"; - "Otimização Ambiental de um Sistema de Produção de Petróleo Baseada em Critérios de Produção Mais Limpa".	- CAMPOS, M. G. - OLIVEIRA, J. A.
Solid Waste	- "Caracterização e pirólise dos resíduos da Bacia de Campos: análise dos resíduos da P-40".	- OLIVEIRA, M. L.

4. RESULTS AND DISCUSSION

It was determined that the LCA results would be represented by greenhouse gases emissions (CO, CO₂, NO₂, N₂O, CH₄) and environmental impact categories related to toxicology and Global Warming. A Greenhouse Gases emission analysis was developed from emission factors for the treatment systems described in the case of study.

From this analysis, it was possible to characterize each unit treatment system from secondary data. In Fig. 2 can be identified that the power generation system is more significant than other processes having 100% of CO, NO_x and N₂O and 23% CO₂ emissions. These values are a consequence of the internal combustion equipment arrangement and of the fuels production processes. The Oil Treatment appears in the organic air emissions due to the oil storage process. This treatment has also 1% of the CH₄ emission. The Gas treatment has 73% of CO₂ emissions in consequence of the necessary

chemicals production and 99% of CH₄ emissions due mainly to the venting internal process. Analyzing CO₂ emissions in the Fig.3, 62% are related to chemical production processes used by Gas and Oil treatments.

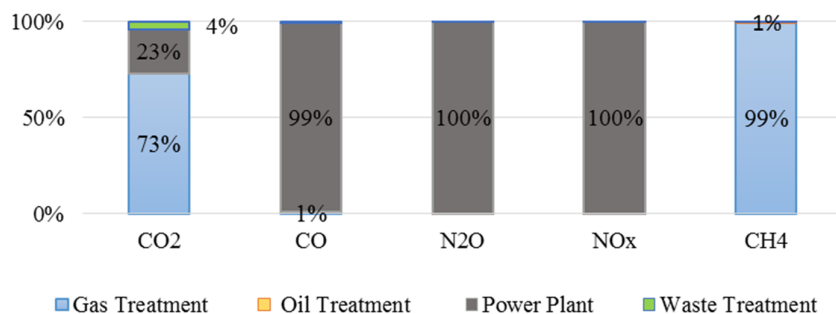


Figure 2. Greenhouse emissions performance in the FPSO main processes

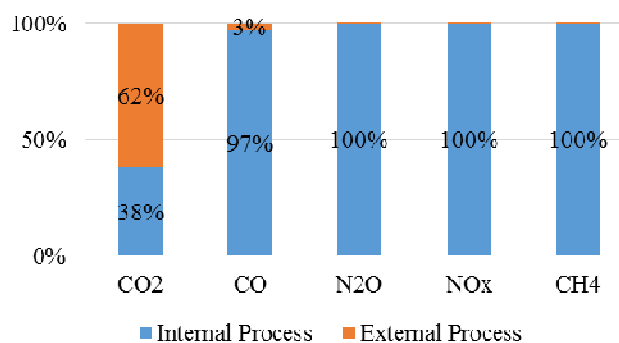


Figure 3. Greenhouse gases Comparison for the internal and external production unit processes

Impact categories related to effluents are displayed by Fig.4, whereas the Power Generation process has 19% of the Freshwater Aquatic Ecotoxicity Potential and 13% of the Marine Aquatic Ecotoxicity Potential (resulting from external fuels production).

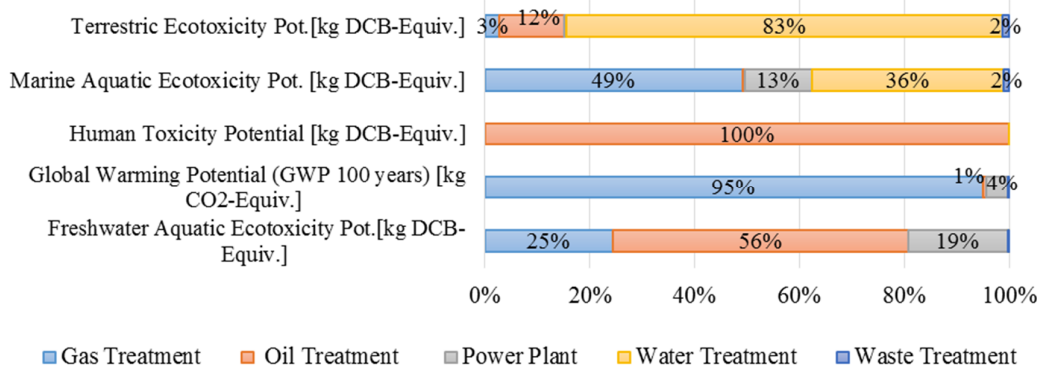


Figure 4. Systems participation percentage in the categories of impacts

Oil Treatment represents 100% of the Human Potential Ecotoxicity and 56% of the Freshwater Ecotoxicity Potential. Water Treatment has 83% of the Terrestrial Ecotoxicity Potential and 36% of the Sea Water Ecotoxicity Potential due to organic and inorganic compounds and heavy metals emissions. Gas Treatment appears with 95% of the Global Warming Potential due to organic compounds released, particularly CH₄ at the Venting internal process and 49% of the Sea Water Ecotoxicity Potential due to the Diethylene Glycol and Methanol chemicals external production processes.

Figure 5 shows the internal and external processes impact categories percentage. The external processes represents 63% of the Marine Aquatic Ecotoxicity Potential and 38% of the Freshwater Aquatic Ecotoxicity Potential. In the comparative environmental assessment performed between internal and external production processes is depicted a significant external processes contribution in each treatment system.

In this study, the gas burning in the Flare system is used only in emergencies. The contribution of the flaring process is considered negligible in the scenario where natural gas is used for cogeneration. Comparing the modeling with and without chemicals and fuels transport to the FPSO and solid waste transport to the coast, it is depicted that their contribution is negligible inside the CML 2001 impact categories. The chemicals, fuels and solid waste transport has 20% of total particulate matter emissions to the air.

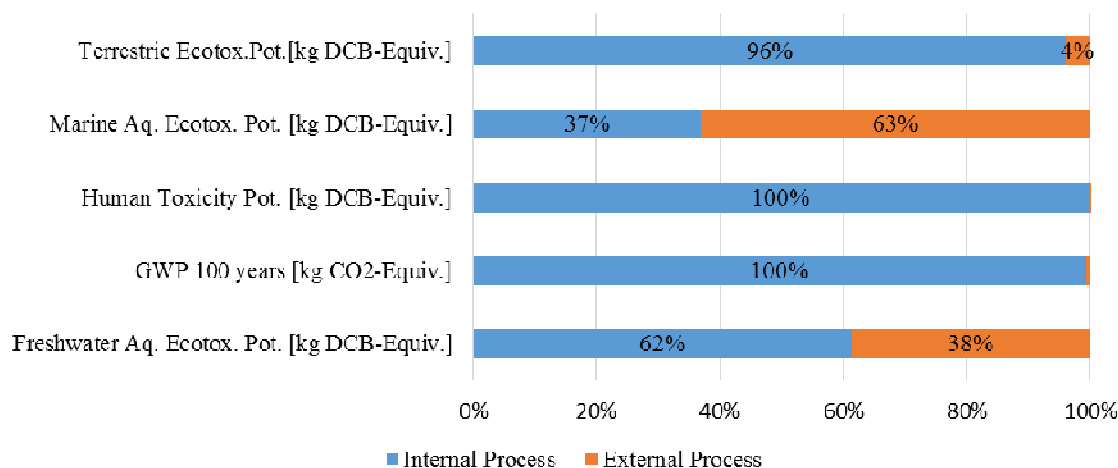


Figure 5. Percentage of internal and external processes participation in the impact categories

5. CONCLUSIONS

The results interpretation and the Life Cycle Inventory development for the Oil and Gas offshore production segment demonstrate the diagnostic and monitoring capacity of the Life Cycle Assessment tool. The Life Cycle Assessment allowed visualization and identification in the production system of the critical and impactful points in the production chain. With GaBi6.0 software was possible to characterize Greenhouse Emissions and by 2001 CML methodology, obtain environmental indicators relating to these issues and point out the most relevant impact categories in the Oil and Gas production sector. The lack of work related to the same subject prevents the comparison of results with other studies.

Concluding this Oil and Gas production process environmental performance analysis, is noted that a more precise and complete primary data description would mean a more precise impacts characterization associated with each processes, as well as each of the main products. In this context, the technological model would be able to be replicated in other production units. Some recommendations were taken from that case study: collect the primary data of all processes belonging to the scope of the study; Apply the technological model developed in existing production units and compares the exploration technologies; Validate the technological model drawn from primary data; Build an greenhouse emissions inventory for the national offshore exploration and production; Expand the study border to other phases in the E&P segment; Compare Oil and Gas upstream and downstream segments; Apply environmental management practices based on the results presented; Coupling to study social and economic issues.

6. REFERENCES

- ABNT, 2004. "ABNT NBR 10004". Maio de 2004. Rio de Janeiro, Brasil.
- BRASIL, 1997. "Lei N° 9.478". *Diário Oficial da República Federativa do Brasil, Poder Executivo*, Brasília, Brasil.
- CANTARINO, A. A. A., 2003. *Indicadores de Desempenho Ambiental como Instrumento de Gestão e Controle nos Processos de Licenciamento Ambiental de Empreendimentos de Exploração e produção de Petróleo nas Áreas Offshore*. Ph.D. thesis, COPPE/ UFRJ, Rio de Janeiro, Brasil.
- CALDEIRA-PIRES, A.; RABELO, R.R.; XAVIER, J. H., 2002. "Uso potencial da análise do ciclo de vida associada aos conceitos da produção orgânica aplicados à agricultura familiar". *Cadernos de Ciência & Tecnologia*, v. 19, p. 149–178.

- CAMPOS, M. G. DE., 2012. *Abordagem de Ciclo de Vida da Avaliação de Impactos Ambientais no Processamento Primário Offshore*. Projeto Final de Curso, Escola Politécnica, UFRJ, Rio de Janeiro, Brasil.
- CHEHEBE, J. R. , 1998. “Análise do Ciclo de Vida de Produtos - Ferramenta Gerencial da ISO 14.000”. *Qualitymark*, p. 104.
- EC-JRC, 2010. “Analysis of existing Environmental Impact Assessment methodologies for use in Life Cycle Assessment - background document”. *ILCD Handbook - International Reference Life Cycle Data System*, European Union.
- ELCOCK, D., 2007, “Life-cycle thinking for the oil and gas exploration and production industry” *Argonne National Laboratory*.
- EPE, 2013. “Balanço Energético Nacional 2013: Ano base 2012”. p. 182.
- FERREIRA, J. V. R. , 2004. *Análise de ciclo de vida dos produtos*. Tese de D.Sc., GESTÃO AMBIENTAL/ Instituto Politécnico de Viseu. Viseu, Portugal.
- GUINÉE, J. B. (ED. . ET AL), 2002. “Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards”. *Kluwer Academic Publishers*.
- HANSEN, B.R., DAVIES, S.R.H., 1994. “Review of potential technologies for the removal of dissolved components from produced water”. *Transactions of the Institution of Chemical Engineers*, London, v. 72, p. 176-188.
- ISO, 2009. “14040. Gestão Ambiental - Avaliação de ciclo de vida - Gestão e Estrutura”.
- ISO/TR. 14047, 2012. “Environmental management - Life cycle assessment - Illustrative examples on how to apply ISO 14044 to impact assessment situations Management”. Genebra, Suíça.
- ISO, 2006a. “International Organization for Standardization, ISO 14040:2006 Environmental Management - Life Cycle Assessment - Principles and Framework”. Genebra, Suíça.
- ISO, 2006b. “International Organization for Standardization, ISO 14044:2006 - Environmental Management - Life Cycle Assessment - Requirements and Guidelines”. Genebra, Suíça.
- ISO, 2006c. “International Organization for Standardization, ISO/TR 14049:2012 - Environmental Management - Life Cycle Assessment - Illustrative Examples on How to Apply ISO 14044 to Goal and Scope Definition and Inventory Analysis”. Genebra, Suíça.
- ISO, 2006d. “International Organization for Standardization, ISO/TS 14048:2002 -Environmental Management - Life Cycle Assessment - Data documentation format”. Genebra, Suíça.
- KULAY, L., 2004. “Uso da análise de ciclo de vida para comparação do desempenho ambiental das rotas úmida e térmica de produção de fertilizantes fosfatados”. Ph.D. thesis, Escola Politécnica / EPUSP, Universidade de São Paulo – USP, São Paulo, Brasil.
- MARIANO, J. B., 2007. *Proposta de Metodologia de Avaliação Integrada de Riscos e Impactos Ambientais para Estudos de Avaliação Ambiental Estratégica do Setor de Petróleo e Gás Natural em Áreas Offshore*. Ph.D. thesis, Programa de Planejamento Energético/ UFRJ, Rio de Janeiro, Brasil.
- MARTINS, A. A. B. , 2008. “Estudo de Caso Aplicado ao Gerenciamento de Resíduos Sólidos em Instalações Marítimas de Produção de Petróleo da Bacia de Campos”. *Revista Perspectivas Online*, v. 5.
- MMA, 1997. “Resolução CONAMA N° 237 de dezembro de 1997. Dispõe sobre a revisão e complementação dos procedimentos e critérios utilizados para o licenciamento ambiental”. Brasília, Brasil.
- MONTEIRO, M. F., 2008. *Avaliação do Ciclo de Vida do Fertilizante Superfosfato Simples*. Dissertação de M.Sc., Escola Politécnica, UFBA. Salvador, Brasil.
- OGX, 2011. “Desenvolvimento e Escoamento da Produção de Petróleo nos Blocos BM-C-39 e BM-C-40, Bacia de Campos”. , p. 112.
- OLIVEIRA, J. A., 2006a. *Otimização Ambiental de um Sistema de Produção de Petróleo Baseada em Critérios de Produção Mais Limpa – Estudo de Caso*. Dissertação de M.Sc., Departamento de Engenharia Ambiental/ UFBA. Salvador, Brasil.
- OLIVEIRA, M. L., 2006b. *Caracterização e pirólise dos resíduos da Bacia de Campos: análise dos resíduos da P-40*. 192f. Dissertação de M.Sc – Instituto de Química, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brasil.
- OLIVEIRA, S. DE; HOMBEECK, M., 1997. “Exergy Analysis of Petroleum Separation Processes in Offshore Platforms”. *Elsevier, Energy Convers.*
- PETROBRAS, 2007. “Processamento Primário de Petróleo”. p. 53.

- PETROBRAS, 2010a. “Sistema de Produção e Escoamento de Óleo e Gás Natural nos Módulos 3 (P-55) e 4 (P-62) do Campo de Roncador, Bacia de Campos”. , p. 218.
- PETROBRAS, 2010b. “Sistema Piloto de Produção para Teste de Longa Duração no Reservatório Quissamã, Concessão BM-C-36, Bloco Exploratório Aruanã, Bacia de Campos”.
- PETROBRAS, 2013. “Atividade de Produção e Escoamento de Petróleo e Gás Natural do Polo Pré-Sal da Bacia de Santos - Etapa 2”.
- RIBEIRO, F. M., 2003. “Inventário de ciclo de vida da geração hidrelétrica no Brasil - Usina de Itaipu: primeira aproximação”. Dissertação de M.Sc., Escola Politécnica, Universidade de São Paulo, Brasil, p. 243.
- SALABERRY, R. R., 2009. *Emprego da Avaliação do Ciclo de Vida para Levantamento dos Desempenhos ambientais do Biodiesel de Girassol e do Óleo Diesel*. Dissertação de M.Sc., Programa de Pós Graduação em Recursos Hídricos e Saneamento Ambiental/UFRS. Porto Alegre, Brasil.
- SANT’ANNA, A. A., 2005. *Simulação de Processamento de Gás Natural em Plataforma Off-Shore*. Projeto Final de Curso, Escola de Química/ UFRJ. Rio de Janeiro, Brasil, p.126.
- SANTOS, L. M. M. DOS., 2006. *Avaliação Ambiental de Processos Industriais*. Signus Editora, São Paulo, 2nd edition.
- SETAC, 2005. “The road from analysis to practice”. , p. 89.
- SILVEIRA, E.A.,2014. *Caracterização dos fluxos energéticos e gases de efeito estufa em instalações offshore*. Dissertação de M.Sc., Programa de Pós Graaduação em Ciências Mecânicas/UnB, Brasília, Brasil, 125 p.
- TCEQ (TEXAS COMISSION ON ENVIRONMENTAL QUALITY), 2010. “Offshore Oil and Gas Platform Report, Final Report”. Preparado por *Eastern Research Group, Inc.*, *ERG No. 0227.03.025*. Carolina do Norte, EUA.
- THOMAS, J. E. et al., 2001. “Fundamentos de Engenharia do Petróleo”. *Editora Interciência*, Rio de Janeiro, Brasil.
- US EPA, 2000. “United States Environmental Protection Agency, Associate Waste Report: Crude Oil Tank Bottoms and Oily Debris”. *Office of Solid Waste*. Washington, EUA.
- US EPA, 2006. “United States Environmental Protection Agency, Life Cycle Assessment: Principles and Practice”. *National Risk Management Research Laboratory Office of Research and Development*. Cincinnati, EAU.
- VAZ, J. C., 2009. *Síntese de Controle e Análise de Cenários em Plantas Offshore de Óleo e Gás*. Dissertação de M.Sc., Escola de Química/ UFRJ, Rio de Janeiro, Brasil, 167 p.

7. RESPONSIBILITY NOTICE

The authors are the only responsible for the printed material included in this paper.