

Detailed Operational Data as a Means to Improve Air Emissions Management

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ABSTRACT

Since 2004, PETROBRAS has been tracking its air emissions using a comprehensive Management System – SIGEA – developed in partnership with ERM and customized to cover all of its operations from well to tank. Five criteria pollutants (CO, PM, SO₂, NO_x, and NMHC) and three greenhouse gases (CO₂, CH₄, and N₂O) are being tracked for each individual piece of equipment with a specific calculation protocol per type of equipment. Besides adopting published and internationally accepted calculation protocols, material balances and operational data are used – when available – to obtain better estimates of emissions.

The use of stoichiometric calculations for combustion equipment provides a unique ability to determine mass emissions from continuous monitoring analyzers. Operational parameters like oxygen content and air temperature are used, for example, to correct NO_x emissions from boilers and furnaces.

More accurate data mean more accurate results and better tracking of any management action being implemented. A system like this demands a significant effort from operating staff to provide accurate data and, in return, provides a reliable measure of the consequences of each action taken. For example, the impact of reducing the air excess on NO_x emissions is captured either by continuous monitoring or by a set of equations that express NO_x formation based on operational conditions. Most equations are a combination of EPA protocols and experimental data.

SIGEA performs data-gathering either using automated data acquisition systems or manual friendly interfaces, and delivers emissions results (metric tones per unit of time) to corporate management systems that will consolidate all environmental performance indicators. It is a solution that provides products and accurate results that are useful at many different corporate levels, from negotiating for regional permitting to making commitments regarding greenhouse gas emissions reduction.

INTRODUCTION

The oil and gas industry faces the highest risks due to its air emissions – either atmospheric pollutants or greenhouse gases. All major oil and gas producers have implemented some kind of control system in order to track their emissions and have a clear idea on the risks they face and the opportunities associated to them. Petrobras has made an option to develop its own air emissions management system – SIGEA, seeking maximum granularity and accuracy in order to mitigate emissions based on the information provided by the system.

The tool allows for the reliable determination of key performance indicators regarding the environmental performance and energy consumption.

The development and implementation of the system in its entirety is a long term project started in 2002 and still ongoing.

Nowadays, more than 25,000 emission sources (not considering all the components listed as fugitive emission sources – more than one million) are being tracked monthly. Calculation protocols were developed (based on the best available guidelines) to monitor emissions from exploration and production, transportation, refining, distribution and gas service stations.

Sigea has been providing reliable results to all corporate levels of Petrobras for four years now and its usefulness has been expanded throughout the years.

A customized system may represent a huge investment to result in a successful implementation. However, off-the-shelf solutions have limitations when it comes to more complex calculation due to the limited resources they offer to build-up mathematical procedures in an effective way.

The decision on what path should be followed will remain being a theme for discussion for a long time. Most important, seems to be the adoption of a calculating protocol that provides realistic information that could be used not only in corporate reports but also for decision making regarding permitting, investments and efficiency control.

HISTORICAL BACKGROUND

Petrobras has been tracking its emissions since 1994 and even before. In the 2002 the company decides to initiate a corporate wide effort to track all of its most significant atmospheric emissions including greenhouse gases and criteria pollutants. A partnership with ERM was initiated in order to develop an Information Technology solution that could meet all of Petrobras requirements regarding a comprehensive air emissions inventory, corporate wide, with a specific calculation protocol based on internationally accepted guidelines but able to capture specific processes and equipment of a Latin American Company.

The project that resulted in the construction of SIGEA was devised to be implemented in 10 stages as observed in Figure 1.

Stages of SIGEA Development

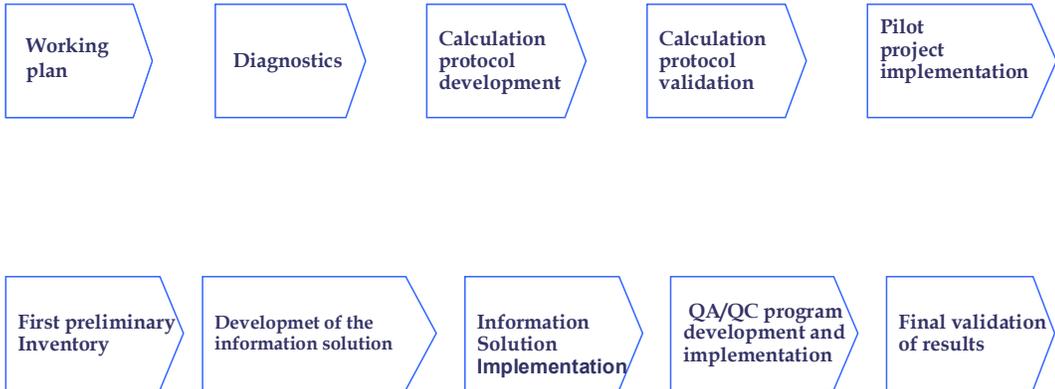


Figure 1 – The 10 stages devised by Petrobras to implement an Information Solution to run the corporate wide air emissions inventory

The activities to develop the inventory system started in September, 2002. It took nearly one year to conclude the four initial stages meaning visiting facilities in all Latin America, discussing specific operations, scope and boundaries, defining whether the inventory should be performed based on an equity share or operational basis and what approach to be adopted regarding the calculation protocols and what set of emission factors should be adopted for each emission source included in the inventory.

On the information solution side, it was necessary to understand what would be the infrastructure available at the time of implementation of the system – 2 years later – and start designing the solution including the deliverables (emission reports, automated data gathering systems, automated interfaces, etc) and the databases that would be required to store either the input data or the results.

Some of the main directives adopted to develop the system were:

1. The inventory should be as much disaggregated as possible including every individual equipment (every boiler, furnace, turbine, etc);
2. There should be no limitation in the amount of data required provided all these data would be automatically available in data acquisition systems;
3. Although automatic interfaces should be developed as much as possible, a friendly interface for manual data input should be available;
4. The inventory should be performed in a monthly basis;
5. Stoichiometric calculations and material or energy balances should be adopted as preferred methods to determine emissions assuring the highest quality;
6. Data input should be allowed in different units of measurement;
7. Whenever possible, Petrobras should improve the quality of all available databases including products characterization (vapor pressure as function of temperature), fuel composition and properties, and list of equipment per business unit.

In December, 2004 SIGEA was ready to go after 6 months of tests and one year of development, including the preparation of the corporate wide inventory using spreadsheets that later served as quality check for the information solution designed.

The 2004 inventory was the first performed using the new system. Later, the former years inventories were also loaded in the SIGEA database that now comprehends the period starting in 2002 until now.

Implementation Strategy

In order to achieve the corporative goals in terms of accuracy and completeness, Petrobras and ERM decided to implement a system that could provide useful results to all users and information providers. The corporate level is usually more concerned with aggregated results and global, energy, environmental and financial indicators and greenhouse gases related emissions. The operational level is usually more concerned with criteria pollutant emissions, energy consumption per equipment and associated efficiency and a local regulatory framework.

In order to provide all levels with appropriate and consistent results Petrobras decided to invest in a bottom-up disaggregated air emissions inventory including greenhouse gases and criteria pollutants. The adopted calculation protocols should consider specific conditions of different countries customizing solutions that could provide reliable results regardless the country or region or vintage of the facility under consideration.

This decision demanded a huge investment in terms of staff and consultancy work aiming at providing most of the facilities with realistic and accurate results. However, this effort has shown its value during the subsequent years due to the very significant interest of the information providers on the results the system could provide at the individual source level. This interest progressed concomitantly with the willingness to provide accurate and consistent operational data, discuss and understand the calculation protocols and discuss new alternatives to improve the local and overall inventory quality. Ensuring the facility level staff participation (information providers) was a means to assure accurate, reliable and comprehensive information regarding the equipment and associated operational data.

The calculation protocols should be based on best available international protocols and the API Compendium, the IPCC guidelines, the Arpel protocol, the EPA AP-42 and material and energy balances were adopted as the main source of procedures to estimate emissions. In cases continuous or semi-continuous monitoring devices were utilized and considered to provide appropriate information, these data was considered either as the source of information to determine directly the emissions or as the experimental reference to determine a local emission factor that could represent emissions of a certain pollutant or gas under specific conditions.

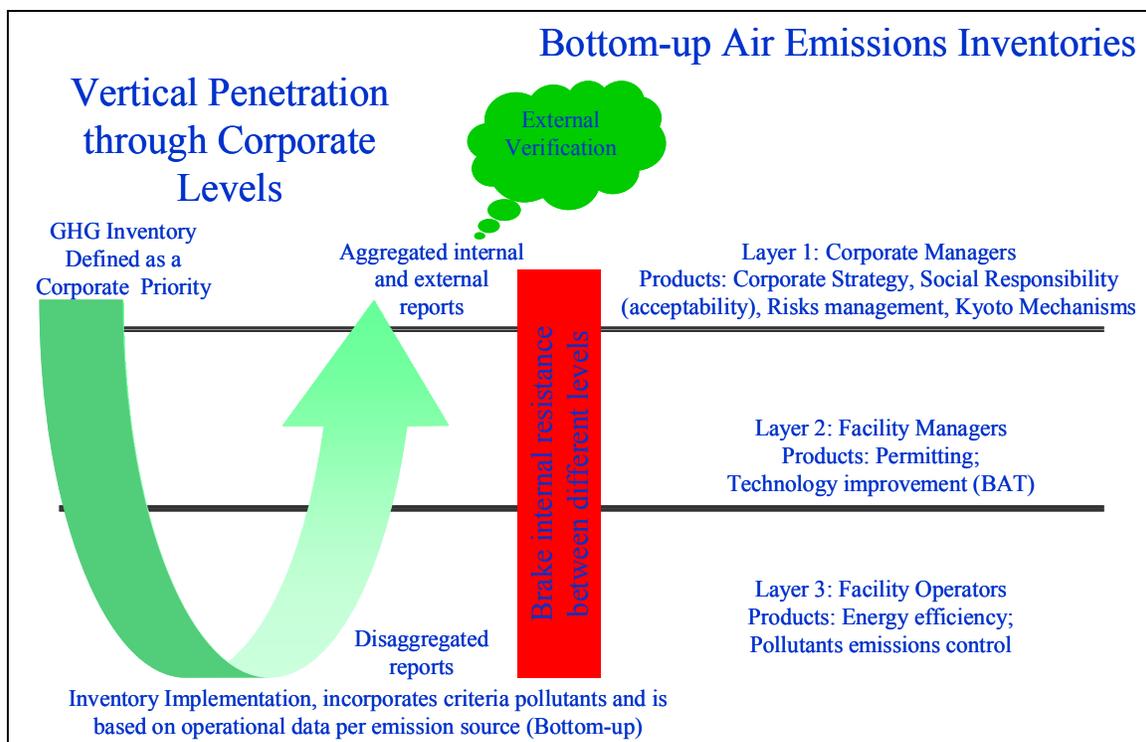


Figure 2 – The Implementation strategy adopted to achieve maximum accuracy and completeness

System abilities

SIGEA was designed to operate as a web based system adopting different languages (Portuguese, Spanish and more recently English) and calculating emissions for the following gases:

- Greenhouse gases;
 - carbon dioxide – CO₂;
 - nitrous oxide – N₂O;
 - methane.
- Criteria pollutants;

- particulate material - PM;
- carbon monoxide – CO;
- nitrous oxides – NO_x;
- sulfur oxides expressed as sulfur dioxide– SO₂;
- non-methane hydrocarbons – NMHC.

Besides calculating emissions SIGEA was designed to track fuel consumption (energy use) and to include the most comprehensive in-company database of emission sources.

Fuels and products were also included in the database allowing for the calculation of CO₂, SO₂, NO_x and tank emissions based on fuels and products properties when a suitable protocol was available. In former case the elementary analysis of the fuels and in latter case the vapor pressure curve (as function of temperature) from Petrobras' products

A calculation protocol was developed and it was named as The Petrobras Protocol. The protocol was documented and is periodically updated to include recent evolutions regarding emission factors.

More than 50 different protocols were developed or adapted from referenced international guidelines in such a way to provide calculation methods for all processes considered to generate air emissions.

EMISSION SOURCES

The Emission Sources included in SIGEA are grouped by:

COMBUSTION SOURCES

Fixed: Flare, Boilers (Steam Generators) and Furnaces; Motors; Turbines; Construction Equipment; Sour Waters (Gas burnt); H₂S and NH₃ burn in Flare.

Mobile: Truck, Helicopter, Airplane; Tanker Ship (Boiling Tanker Ship, Propulsion Motor Tanker Ship, Auxiliary Motor Tanker Ship); Vessel.

PUNCTUAL SOURCES

Process Vents: FCC regenerator (Fluidized Bed Catalytic Cracking) with Partial Coke Combustion and Use of CO Boiler; FCC regenerator (Fluidized Bed Catalytic Cracking) with Full Coke Combustion; Sulfur Recovery Unit; Nitric Acid Plant; Ammonia Production Plant; Hydrogen Plant; Urea Plant; Coke Handling and Storage; H₂S and CO₂ removal from Gases (MEA / DEA); CO₂ removal from Natural Gas; Glycol Dehydration.

Other Vents: Service Stations; Methane Ventilation in Tanks; Devices for laboratory Exhaustion; Tanks; Product loading on Trucks and Wagons; Loading of Petroleum Byproducts in Ships and Barges; Perforation and Exploration Operations; Ventilated Gas.

NON PUNCTUAL SOURCES

Fugitive Sources: Natural Gas Lines, Fugitive Emissions.

Other Sources: Mud Tanks; Cooling Towers; Water/Oil Splitters.

NON ROUTINERY SOURCES

Pouring of Products in Trays; Tank Drainage; Tank and Vessels Cleaning Operation; Solvent De-paraffin for the E&P Business Area; Depressurization of Gas Lines; PIGGING Duct Cleaning Operation; Fire Extinguishers; Abrasive Blasting.

INDIRECT SOURCES

Indirect Sources.

Example: Combustion Protocols

Many sources of combustion emissions are included in SIGEA. The first step when calculating such emissions is to define what fuel is being burned in the equipment. The following paragraphs describe the procedure to load a fuel in SIGEA. This procedure is provided as an example that allows for an understanding of the level of detail achievable when making combustion calculations.

By clicking on the Fuel field of the calculation module screen, a new fuel window will pop up. You can enter a new fuel or change an existing fuel on this screen.

Nome	Tipo
Nova Instalação Diesel	Diesel
Nova Instalação Gás	Gás

Componentes do Gás	Teor Mol [%]
Nitrogênio	1
Oxigênio	0,5
Gás Carbônico	3,5
Metano	79
Etano	11
Propano	5

Total = 100 %

Ar Estequiométrico	15,276	Adim	Teor de CO2	9,3788	%
Vazão Combustível	100	kg/h	Taxa de Emissão CO2	53301	g/GJ
Densidade Combustível	0,89973	kg/m3	Teor de SO2	0	%
Coefficiente de Ar Lb	130	%	Taxa de Emissão SO2	0	g/GJ
Teor O2 Chaminé bs	5,2035	%	PCs	48,926	MJ/kg
Vazão Chaminé	2085,9	kg/h	Mol	20,167	

A. Name screen B. Registration screen C. Output Data screen

Entering a New Fuel

Click on the sign + to add a new fuel at the Name field. Click on the name New (**Novo**) to edit and type the name of the fuel you wish to enter.

Nome	Tipo
Nova Instalação Diesel	Diesel
Nova Instalação Gás	Gás
Novo	Óleo
	Gás
	GLP
	Diesel
	Óleo
	Coque
	Carvão
	Carga FCC

screen.
of the

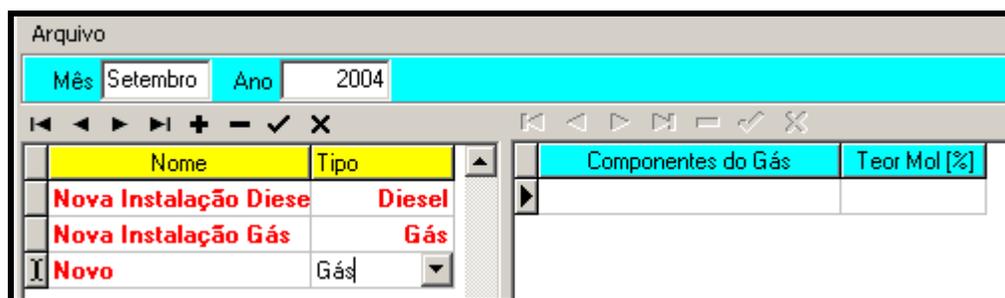
Our suggestion is to have the name of this fuel making a reference to the fuel type and facility to which it belongs. This methodology provides an easy way to link the new item to other fuels already linked to their respective Facilities and Sources of emission.

At Column TYPE (TIPO), choose the type of fuel for this new fuel: Gas, LPG, Diesel, Oil, Coke, Coal or FCC Load.

To delete a saved fuel click on the sign . Use the scroll bars or browsing arrows to browse among the saved fuels.

Entering Gas or LPG

When selecting Gas at the field Type, the following window will appear at the Registration screen.



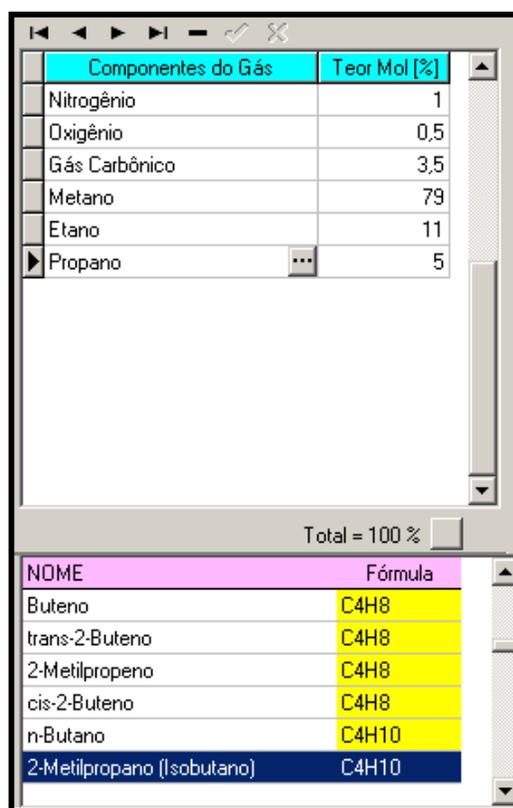
A. Name screen B. Registration screen.

The Gas components to be entered **should NOT** be typed in the **Gas Components** field, under any circumstances. There is an options menu with a dropdown list of components registered in the past to be used. User shall only register the volumetric percentage for the respective component that will be picked from the components base.

To access the options *menu*, double click on the field **Gas Components** or click on the Button . An Output data screen will pop up showing the options *menu* during the operation.

Double-click on the component desired. It automatically appear on the Registration (Cadastro) screen. Type a volumetric percentage component. User may first select all the components and then type their respective volumetric percentages. To confirm each of the percentages typed, key *Enter* on the keyboard or the Button .

For each volumetric percentage added, the will automatically show the sum registered up to Total **Cannot** exceed 100%. Upon clicking on the beside the Total , with a component selected, as example at the side, it will automatically total that is, register for the component selected, the difference between the sum registered up till then, maximum permitted, 100%.



will
for this
click on
Total
the. The
button
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100%,
and the

To exclude a component, click on the – sign. A window will appear at the side to confirm the operation. Click on **OK** or on **Cancel** to cancel.



To confirm and finalize the process, click on the confirmation sign , on the Name screen.

Clicking on the Name screen again, the options *menu* will disappear, returning to the Output Data screen. For the percentages **selected**, the Output Data screen will show the results below:

Ar Estequiométrico	15,276	Adim	Teor de CO2	9,3788	%
Vazão Combustível	100	kg/h	Taxa de Emissão CO2	53301	g/GJ
Densidade Combustível	0,89973	kg/m3	Teor de SO2	0	%
Coeficiente de Ar Lb	130	%	Taxa de Emissão SO2	0	g/GJ
Teor O2 Chaminé bs	5,2035	%	PCs	48,926	MJ/kg
Vazão Chaminé	2085,9	kg/h	Mol	20,167	

Each one of the fields above can be viewed in several options of units. Just click on the arrows to access the options *menu*.

Entering Diesel, Oil, Coke, Coal or

Upon choosing one of these Fuels, the on the side will appear. The percentages registered in the blank fields, beside each informed, and on a mass basis.

The following fields should also be registered:
Humidade (Umidade bu) - Humidity -
 PCs - High Heat Value
 Cp - Average specific heat at constant
 Density

H	22.5	%	Umidade bu		%
C	75.85	%	PCs	52.945	MJ/kg
O	1.65	%	Cp	0.46037	kcal/kgK
N		%	Densidade	0.86517	kg/m3
S		%	<input type="checkbox"/> Total = 100 %		
Z		%			

FCC Load.
window
should be
element

registered:
wet base

pressure

The totaling button works in the same manner as used for registration of Gas or LPG, and the sum cannot exceed 100%. There is no options *menu* in this case.

After loading the fuels in the specific database, it will be possible to select one of them and perform the combustion emissions calculation.

The following paragraphs describe an example on calculating emissions for either a boiler or a furnace and the protocols developed to perform the calculation.

Boilers are auxiliary equipments that generate steam to be used in different production processes. Boilers are combustion sources that burn different kinds of fuels in the following states: solid (coal, wood), liquid (diesel, fuel oils, process wastes) or gaseous (acid gas, CO, natural gas, refinery gas).

Furnaces are equipments that heat oil for distillation, load heating in several processes, separators, oil treatment devices, etc. Similarly to flares, boilers and furnaces are combustion sources that can also use several kinds of fuels.

When estimating gas emissions for Boiler or Furnace, the factors and algorithms used in the calculation are basically the same, that is, the calculation module uses the same protocol for both,

except for NOx releases. NOx emissions are calculated separately for Boiler and Furnace based on the following parameters: burner type [conventional or Low NOx (low NOx emission burners)], type of gas exhaust in the stack (natural or forced / induced / balanced), kind of fuel burned (gas or oil), excess combustion air (based on the amount displayed for oxygen in combustion gases) and temperature of the combustion air. The release factors for the same kind of equipment change as a result of the kind of fuel used and of the thermal capacity (rated in small and large size).

For Boilers and Furnaces, the estimates for CO₂ and SO₂ releases are made by combustion stoichiometry, as shown in Attachment I to this Manual. The estimates are made based on the elementary or chromatography analysis of the fuels and from the flow rate of such fuel. The conversion efficiencies of C into CO₂ or S into SO₂ adopted in this **RELEASE INVENTORY AND MANAGEMENT SYSTEM** for estimating releases are of 100% for both pollutants.

For the use of natural gas or refinery gas as fuel, the equipment items (Boiler or Furnace) are split into two kinds:

1. Large (industrial) – capacity > 29 MW;
2. Small (commercial) – capacity ≤ 29 MW.

As default values it is accepted that these equipments operate with a mix of 2% of oxygen in combustion gases, and that gas exhausting and burners are conventional..

Method to Estimate the Emissions - CO₂ and SO₂

CO₂ and SO₂ releases are calculated based on stoichiometry calculations (see Attachment I to this Manual).

Independently from the size of the equipment, the equations used to determine these releases are:

$$E_{CO_2} = \frac{\%C}{100} * \dot{Q} * \frac{Mol_{CO_2}}{Mol_C} \quad e \quad E_{SO_2} = \frac{\%S}{100} * \dot{Q} * \frac{Mol_{SO_2}}{Mol_S}$$

Where:

E = Pollutant release (Mg/month);

$\%C$ = Mass carbon fraction in fuel gas (intake);

$\%S$ = Mass sulfur fraction in fuel gas (intake);

\dot{Q} = Mass flow rate of fuel gas (Mg/month);

Mol_{CO_2} = Molecular mass of carbon dioxide (44.011 kg/kmol);

Mol_C = Atomic mass of carbon (12.011 kg/kmol);

Mol_{SO_2} = Molecular mass of sulfur dioxide (64.06 kg/kmol);

Mol_S = Atomic mass of the sulfur (32.06 kg/kmol).

Method to Estimate the Emissions

CO, MP, HCNM, HCT, N₂O and CH₄

These releases are calculated based on the direct application of factors, as provided by AP-42. The equation used to determine these releases is:

$$E_i = \frac{f_i * Q}{1000}$$

Where:

E_i = Pollutant i release (Mg/month);

Q = Volume flow rate for the fuel gas (m³/month);

f_i = Emission factor in relation to pollutant i (kg/10⁶ m³ gas used).

	Pollutant (kg/10 ⁶ m ³)					
	CO	MP	HCNM	N ₂ O	CH ₄	HCT
Large	1344	121.6	139.2	35.2	36.8	176
Small	1344	121.6	139.2	35.2	36.8	176

N.B. In order to use the above equation the volume in m³ of the gas should be at 15.56°C and 1 tm. In the Calculation Module the volume is used at 0°C and 1atm, and therefore, in order to enter data into the module, one should first correct the volume.

Method to Estimate the Emissions - NO_x

These releases are calculated based on the direct application of factors, as provided by AP-42. The equation used to determine these releases is:

$$E_i = \frac{f_i * Q * Y}{1000}$$

Where:

E_i = Pollutant i release (Mg/month);

Q = Volume flow rate for the fuel gas (m³/month);

f_i = Emission factor in relation to pollutant i (kg/10⁶ m³ gas used);

Y = NO_x factor correction that depends on the characteristics of the equipment and the burners.

	Pollutant (kg/10 ⁶ m ³)
	NO _x
Large	3040
Small	1600

N.B. In order to use the above equation the volume in m³ of the gas should be at 15.56°C and 1 tm. In the Calculation Module the volume is used at 0°C and 1atm, and therefore, in order to enter data into the module, one should first correct the volume.

CORRECTED NO_x RELEASE

The **PETROBRAS** Combustion Laboratory, located at UN-SIX in the city of São Mateus of the Sul, has been carrying out tests with continuous monitoring of air pollutant releases with several kinds of fuels (gas and liquid) produced by **PETROBRAS** itself. Apart from fuels, other operating parameters, such as pre-heating of the air and kinds of burners were tested in order to assess air releases, such as NO_x releases.

PETROBRAS created a database with operating and emission data, based on the countless lab tests. The ERM, along with **PETROBRAS** has prepared a series of multiplying factors with the aim of correcting the NO_x emission obtained through release factors for conventional burners operating

with natural exhaust and the ambient air temperature (between 15° and 30°C) and with an air surplus of up to 20%.

With PETROBRAS comments, ERM suggested the use of these factors to correct NOx releases calculated based on the equation described above, due to the incorporation of new operating parameters that interfere in the NOx release. These new parameters are:

- Burner type (conventional or low NOx emission - “Low NOx”);
- Natural or forced gas exhaust in the stack (other types of exhaust including induced and balanced);
- Kind of Fuel Burned (gas or oil);
- Combustion Air Surplus (based on the amount displayed for oxygen in combustion gases);
- Temperature of combustion air.

The equation used to correct NOx releases is:

$$E_{NO_x \text{ Corrected}} = E_{NO_x} * y$$

Where:

$E_{NO_x \text{ Corrected}}$ = Corrected NOx release due to new operating parameters (Mg/month);

E_{NO_x} = NOx release obtained through the emission factor (Mg/month);

y = Multiplying Factor to correct NOx release factors.

The table below shows the combination of parameters that interfere in the releases ¹.

Source	Burner Type	Gas Exhaust	Surplus Air (%)	Multiplying Factor (y) ²
Boiler	Conventional	Natural	<20	- 5 th and 4 th degree polynomial equations whose variable (x) is the temperature of the combustion air. - Gas Fuel: total of 16 (sixteen) 5 th degree polynomial equations. - Liquid Fuel: total of 14 (fourteen) 5 th degree polynomial equations and 2 (two) 4 th degree polynomial equations. - Polynomial coefficients are the property of PETROBRAS.
			>20	
		Forced/ balanced/ induced	<20	
			>20	
	Low NOx	Natural	<20	
			>20	
Forced/ balanced/ induced	<20			
	>20			
Furnaces	Conventional	Natural	<20	
			>20	
		Forced/ balanced/ induced	<20	
			>20	
	Low NOx	Natural	<20	
			>20	
Forced/ balanced/ induced	<20			
	>20			

Note:

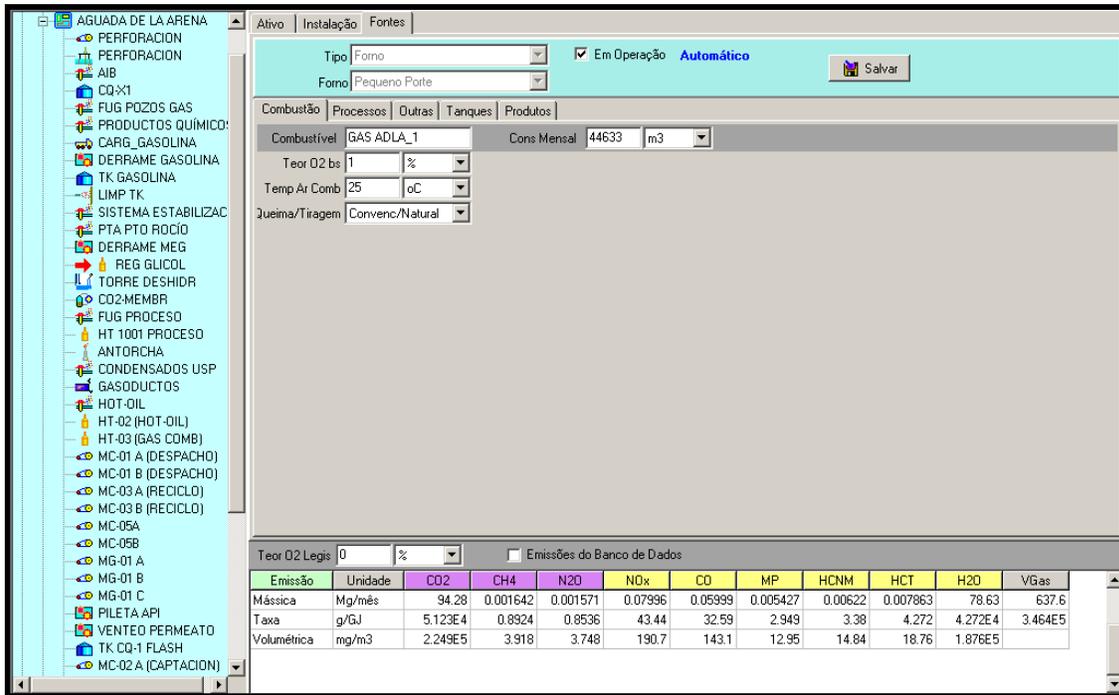
1 There are two similar tables in total: one for gas fuels and another for liquid ones;

- 2 It is important to point the fact that the (y) polynomial items for the correction of the factors are different for boilers and furnaces in all of the parameters shown in the table above.

For other emission sources and processes, similar calculation protocols were developed based on international guidelines selected according to their adequacy to Petrobras operations and data availability.

VIEWING THE ATMOSPHERIC EMISSIONS

The Atmospheric Emissions screen shows the results of the Emissions for the Source selected.



A. Assets/Facilities screen B. Data Input screen C. Atmospheric Emissions screen.

If the Atmospheric Emissions screen does not show values, one of the following situations may be occurring:

The option Under Operation (Em Operação) **Is not** marked Em Operação ;

The Monthly (Mensal) Cons Field shows zero value t

The fuel selected has **No** data or these were not correctly entered.

It is possible to view the Atmospheric Emissions in the following output units, always on a mass basis:

kg/s	Kilograms per second	kg/min	Kilograms per minute
kg/h	Kilograms per hour	kg/month	Kilograms per month
kg/year	Kilograms per year	t/h	Tons per hour
t/day	Tons per day	t/month	Tons per month
t/year	Tons per year	lb/s	Pounds per second
lb/min	Pounds per minute	lb/h	Pounds per hour

The Atmospheric Emissions are also shown on a mass basis per unit of energy and per volume of combustion gas.

Mass basis per unit of energy

Emissão	Unidade	CO2	CH4	N2O	NOx	CO	MP	HCNM	HCT	H2O	VGas
Mássica	Mg/mês	94.28	0.001642	0.001571	0.07996	0.05999	0.005427	0.00622	0.007863	78.63	637.6
Taxa	g/GJ	5.123E4	0.8924	0.8536	43.44	32.59	2.949	3.38	4.272	4.272E4	3.464E5
Volumétrica	mg/m3	2.249E5	3.918	3.748	190.7	143.1	12.95	14.84	18.76	1.876E5	

Clicking on the arrow, an options menu will open, where the user can select the output unit desired.

kg/kJ	Kilogram per KiloJoule	kg/MJ	Kilogram per MegaJoule
g/GJ	Gram per GigaJoule	kg/GJ	Kilogram per GigaJoule
t/GJ	Tons per GigaJoule	kg/kcal	Kilogram per Quilocalorie
t/Gcal	Tons per Gigacalorie	lb/BTU	Pounds per BTU

Note that the three (3) forms of viewing the results of the Atmospheric Emissions, **Mass basis per unit of time, per unit of energy and per volume of combustion gas** are individualized by type of pollutant registered. Each Source of Emission (Protocols) emits one or more types of pollutants, intrinsic to the Source selected.

CALCULATION MODULE IN THE SIMULATION MODE

The Calculation Module in the Simulation Mode allows the user to simulate actual situations for the Sources of Emission desired, **without changing or implying any risk to the original database of the Atmospheric Emissions Management System**. In practice, it has the same screens as in the Real Mode. The user has the possibility of creating and excluding **Areas, Units, Assets, Facilities** and **Sources of Emission** in the Calculation Module by associating the fuel desired.

SIGEA BENEFITS

The Air Emissions Management System allows for the calculation of emissions generated by each item of equipment (disaggregated approach). In this way, PETROBRAS will be ever more able to conduct specific technological analyses of its equipment, with a view to controlling their efficiency and air emissions levels.

Air Emissions Management System Interface

- Various ways of aggregating and disaggregating results;
- Protocols refined and disaggregated per emissions source;
- Control, management and reduction of emissions, ecoefficiency;
- Technical support in negotiating limits with regulatory agencies;
- Creation of an internal greenhouse gas emissions market;
- Viability of participation in global carbon credits markets;
- Greater competitiveness of company products on global markets, as a result of the elimination of technical barriers regarding atmospheric pollutant emissions.

In keeping with some of the most important values of the company –social responsibility, continuous improvement and openness -all phases of the project were validated through meetings with the project implementation committee (with representatives of all Business Areas) and disclosure seminars. This project not only provided PETROBRAS with the opportunity to take a great step forward along the path of attaining environmental excellence, but it also allows ERM to consolidate its technical excellence in developing products with outstanding added value.

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