Methane Emission Detection, Quantification and Mitigation, In-Plant Measurement Audit as a Foundation for a Methane Emissions Reduction Program: the Poza Rica Gas Processing Complex

Pemex Gas and Basic Petrochemicals
Division of Production

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4. Poza Rica Energy Diagnostic
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On March 24, 2006, the EPA, USAID (Agency of the United States for the International Development) and the Office of the Secretary of Environment and Natural Resources (SEMARNAT), signed a letter of cooperation to collaborate to set in motion projects of methane. Under the terms of this agreement, the two agencies work with the local government and the private sector in order to share and to bring to light the use of technologies for the capture and the use of methane, which commonly is sent to the atmosphere.

In the framework of this agreement of cooperation, were established in Mexico four national subcommittees: Sanitary landfill, Farm Wastes, Coal Mines and Petroleum and Gas.

SEMARNAT is the agency in charge of the M2M program in Mexico, and PEMEX co-presides the International M2M Oil and Gas Subcommittee with the Russian Federation and Canada.
PEMEX is the public agency responsible for the exploration, extraction and processing of petroleum and gas in Mexico.
## PGPB Infrastructure

<table>
<thead>
<tr>
<th>Process</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas (MMpcd)</td>
<td>3,963</td>
</tr>
<tr>
<td>Condensates (Mbd)</td>
<td>107</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Production</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas (MMpcd)</td>
<td>3,144</td>
</tr>
<tr>
<td>Liquids of gas (Mbd)</td>
<td>451</td>
</tr>
<tr>
<td>LPG (Mbd)</td>
<td>225</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sweetening Plants</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sour gas capacity (MMpcd)</td>
<td>4,503</td>
</tr>
<tr>
<td>Sour condensates capacity (Mbd)</td>
<td>144</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cryogenic Plants</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (MMpcd)</td>
<td>4,992</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LPG Distribution Stations</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipelines (km)</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>9,109</td>
</tr>
<tr>
<td>Products</td>
<td>3,181</td>
</tr>
</tbody>
</table>
The main PGPB activities are processing natural gas and developing basic petrochemical products and liquefied gas in its nine Gas Processing Centers.

PGPB has installed nine Gas Processing Centers along the Coast Gulf of México: three located in the north of the country, one in the center and five in the southeast region.
In close collaboration with the Methane to Markets Partnership, PEMEX has carried out on-site measurement studies in different gas processing complexes in order to identify methane and other GHG emissions reduction options, as well as energy efficiency opportunities.

The goals of the Partnership are to reduce global methane emissions to:
- Enhance economic growth
- Strengthen energy security
- Improve air quality and industrial safety
- Reduce emissions of greenhouse gases

In the petroleum and gas sector, Petróleos Mexicanos (PEMEX) and M2M identified two pilot projects with a significant potential to reduce the emissions of methane. The objective of these projects is to bring the latest compressor technology used in gas processing and to demonstrate and evaluate the reduction of fugitive methane emissions from equipment and from petroleum storage tanks.
How does Methane to Markets support PEMEX Gas?

**Step 1 - On-site Measurement Study**
- For gas processing complexes seriously considering implementing emission reduction project, on-site measurement studies, leak & vent detection for proposed projects are performed.
- M2M uses methane emission identification and measurement equipment to quantify methane emissions.

**Step 2 - Develop estimated Methane emissions inventory**
- The gas complex provides operational data to a consultant provided by M2M with EPA funds that is used to estimate methane emissions and to propose methane reduction opportunities.
- Consultant delivers a report detailing economic, operational and environmental benefits from emissions reduction.
- Helps prioritize opportunities

**Step 3 - “Desktop” Project analysis**
- Using results from estimated inventory, consultant and the gas processing complex can further evaluate priority projects with high economic and environmental potential.
- Consultant can do further analysis to provide more specific project recommendations (detailed technical, economic, etc.).
Upon analyzing an installation in search of profitable opportunities of reduction of emissions of CH₄ and energy improvement, the maximum benefit is obtained by adopting a holistic focus, which considers all the natural gas loss reduction opportunities, of wastes and of unnecessary consumption. This focus allows maximum advantage to be derived from the team of experts in different areas, and increases the economic impact and the benefit of this analysis.

Some of the key reasons so we have emissions reduction opportunities of CH₄ and of improvement in energy efficiency in gas and petroleum process installations are the following:

1. Progressive deterioration of installations.
2. Changes in conditions of operation compared to design values.
3. Previous designs based on low energy costs.
5. Lack of quantitative information that would allow establishment of the economic value of the emissions reduction opportunities of CH₄ and of improvements in energy efficiency.
Advantages of an integrated emissions and energy study

The main advantages to carry out a study integrated of emissions and energy are:

1. Different perspectives complemented with experience and expert knowledge of the work team.
2. Greater probability of identification of profitable opportunities for reduction of CH₄ emissions through a complete analysis of the installation.
3. Potential synergies among several disciplines for an identification optimized of opportunities.
4. Utilization to the maximum of the experience of the technical team.
5. Independent verification of the performance of the installation.
6. Transparent decisions on the development of the emissions baseline and other data required to design carbon credits projects by a third party.
7. Opportunities of technology transfer and training of the staff of the installation.

Additionally, the study provides the basis for monitoring the plant performance over the long term by comparing it against the baseline established with the first studies in the installation.

This process, or benchmarking, can be applied at the facility level or to individual process units.
On February 2008 Clearstone Engineering Ltd., and PA Government Services Inc., subsidiary of PA Consulting Group, funded by the M2M Program of United States Environmental Protection Agency (USEPA), conducted the study: Detection of Opportunities for Methane Emission Reduction and energy diagnostic in Poza Rica GPC, located in Poza Rica, Veracruz, México.

This measurement campaign was conducted in order to generate a GHG emissions inventory and reduction opportunities by methane emissions control programs and energy efficiency improvement.

Specific emissions control opportunities were identified, and an economic assessment for opportunities was prepared. The measurement campaign included: inventory of leaking components, process vents and flares, and gas process heater efficiency measurement.

These results have been integrated into action plans to implement preventive and corrective actions of energy optimization in the processes in order to reduce methane and CO₂ emissions.
GPC Poza Rica Emissions Inventory

The measurement work resulted in the development of an inventory of annual total emissions based on the conditions observed, and utilizing process information to extrapolate the results to an annual base.

- It is estimated that the emissions of methane to the atmosphere are around of 13,200 ton/year, and the emissions of GEI total of the plant are near of 0.5 million equivalent tons of CO$_2$ (CO$_2$e). These values are based on consumption of fuel, volumes of vent gas and/or gas sent to flare, and fugitive emissions in equipment and components, which were identified and measured during the elaboration of the study.

- The flow to the flares was estimated at approximately the 0.78% of the gas that enters to the plant, or a 0.97% of the sales of total gas, with an annual value of $2.2 million dollars.

- The vents of seals compressors including oil tanks were reviewed and quantified to include them in the total emissions of Hydrocarbons (THC’s) with an annual value reckoned in US$1.58 millions.

- In the case of the sulfur recovery units, a balance of mass of CH$_4$ and CO$_2$ was carried out and to determine the GHG emissions of the acid gas incinerator. The emissions of this unit is 92,265 ton CO$_2$e / year.
The greatest source of GHG emissions is the combustion of gas, primarily in the boilers of Facility Services, that consume total of 374,000 m³/day of fuel gas, contributing annual GHG emissions of some 0.3 million tons of CO₂e.

The emissions of the gases of combustion of the three gas heaters were also determined. It was found that the three heaters operate with unnecessarily high excess air, and with thermal efficiencies under the optimum values. The high excess air and the resulting unburned fuel imply losses by additional consumption of gas of some US $750,200.

Of the total of 187 components identified with leaks, it was found economically attractive to repair 131 of them. The implementation of the repair of these last components represents a net financial gain of US$407,960; reducing the annual GHG emissions by 9,270 ton of CO₂e, and resulting in annual savings of US$150,320, based on the value of the hydrocarbons lost.
5. - DETECTION OF PROJECT OPPORTUNITIES

Project opportunities\(^1\) at Poza Rica GPC

**Methane Emissions**

- 88%
- 2%
- 10%

**CO\(_2\) Measurement results**

**CO\(_2\) Emissions**

- Heaters: 66%
- Flares: 23%
- Sulphur recovery: 5%
- Fractionation: 3%
- Auxiliary services: 1%
- Compressor building #6: 2%

4,704 tonCH\(_4\)/year

401,318 tonCO\(_2\)/year

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\(^1\) This figures are based on measurements performed during the inventory on fuel consumption, volumes of vented and/or burned gas, and fugitive emissions in components and equipment.
Summary GHG Inventory at GPC Poza Rica

Total CO$_2$e emissions at Poza Rica GPC

CO$_2$e Emissions

- Fugitive emissions: 53%
- Fractionation: 17%
- Flares: 4%
- Auxiliary services: 2%
- Compressors vents: 2%
- Sulphur recovery: 3%
- Compressors building #6: 18%
- Heaters: 1%

Total emissions = 500,100 ton CO$_2$e/year
# Emissions reduction potential CO\textsubscript{2}e at GPC Poza Rica

<table>
<thead>
<tr>
<th>Source</th>
<th>Contribution</th>
<th>Control Technology</th>
<th>Reduction Potential [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heaters</td>
<td>4%</td>
<td>A/F management.</td>
<td>10-15</td>
</tr>
<tr>
<td>Flares</td>
<td>4%</td>
<td>Purge gas optimization and flare valve leak detection program or flare gas recovery system.</td>
<td>95</td>
</tr>
<tr>
<td>Fugitive Emissions</td>
<td>2%</td>
<td>DI&amp;M program.</td>
<td>70-80</td>
</tr>
<tr>
<td>Compressor Venting</td>
<td>17%</td>
<td>Vapor recovery system.</td>
<td>95</td>
</tr>
<tr>
<td>Sulphur Recovery</td>
<td>18%</td>
<td>Review sweetening plant</td>
<td>95</td>
</tr>
<tr>
<td>Fractionation</td>
<td>2%</td>
<td>Regular inspection/tuning.</td>
<td>10-15</td>
</tr>
<tr>
<td>Auxiliary Services</td>
<td>53%</td>
<td>Regular inspection/tuning.</td>
<td>10-15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
PGPB has developed detailed work plans for the GP Poza Rica, generated from the energy diagnostic performed by Clearstone Engineering and PA Consulting Group.

**Complejo Procesador de Gas Poza Rica**

Proposal of initiatives to integrate Clean Development Mechanism projects (MDL) from the M2M inventories

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**TABLE OF ACTIVITIES**

<table>
<thead>
<tr>
<th>Activity</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.- Reception of the technical report of energy diagnosis and reduction of emissions</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>2.- Presentation and diffusion of the results</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>3.- Verification by the CT of the data indicated in the technical reports</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>4.- Analysis of results and programs elaboration elaboration</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

**PROGRAMA DE EJECUCION**

<table>
<thead>
<tr>
<th>Activity</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminating the fugitive emissions detected in team of process of TF, Girbotol and Cryogenic, by order of magnitude, considering the replacement of components (to see note under observation)</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Replacing the components susceptible, identifying transmitters of repair rentable, under observation</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Improving the efficiency of combustion of the boilers, by means of adjust of the relation Air/Fuel</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Reducing I air of the seals and of the graseras of the compressors in the cryogenic plant</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Adjusting the combustion of heaters and ovens in the cryogenic plants, sulfur and fractioning</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Establishing a leaks detection program in the valves to QW ó to install a gases recovery system in QW.</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Optimizing the flow of purge to QW’s of flares, implementing their measurement</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Reducing vents of the units GB-602 TO/B/C</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>Analysis of causes-root of the losses of methane in the sweetening plant</td>
<td>P</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>

The proposals of improvement that require investment, will depend to the budgetary availability of PGPB.
Next Steps

- Follow up on implementation of opportunities identified.
- Replicate the success cases in Pemex Facilities where it applies.
- Request M2M support for implement valve maintenance training at the GPCs.
- Propose feasible CDM projects and take advantage of the carbon market.
- Share experiences with other countries.

Oil & Gas Systems
At PEMEX Gas we are integrating these kinds of energy diagnostic measurements into our Operational Discipline at our gas processing complexes by buying detection and measurement equipment for methane and CO₂ equipment and training our personnel.

These diagnostics will not only promote the development of CDM projects, but also form the basis for a permanent program to sustain and replicate these actions throughout PEMEX Gas.
Pemex Gas and Basic Petrochemicals

Production Subdivision

¡Thank-You!

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