Management of Air Emissions in Kuwait Oil Company

Emissions Reduction and Control Strategy – Gas Facilities
Agenda:

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- KOC Operations
- Visions, Mission and HSE Strategic Objective
- Air Emission
- Air Compliance Management Program
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- Baseline of Air pollutants Emissions
- Emissions Index
- Overview of Emissions Index in All Areas
- Analysis of 2016-2017 Emissions Index
- Emission Trend For (GHG / CP) and (VOC / HAPs) in NK, WK, And S&EK
- Emissions Reduction and Control Strategy – Gas Facilities
- The Way Forward For the Control Strategy Implementation
- Conclusion
1.0 Introduction

- Kuwait Oil Company (KOC) is a major subsidiary of the Kuwait Petroleum Corporation and involve the Exploration, Drilling, and Production of oil and gas within the State of Kuwait.

- All the company’s activities have impact to health, safety and environment either beneficial or adversely. The company is committed to managing the risks associated with its activities and products.

- Furthermore, Health, Safety and Environment (HSE) policy and management system has been established and designed as a comprehensive set of requirements that set a framework for management and personnel to achieve the HSE goals and target.

- KOC is managing resources responsibly and taking care of the environment is embedded in our organization. However, management of the air emissions is one of the approach for KOC to be complied with the company’s HSEMS and to be reduced the emissions which emitting from the facilities.
1.1 KOC Operations

- **Spread over 3 Assets**
  - South and East Kuwait
  - West Kuwait
  - North Kuwait

- **Producing Assets**
  - Gathering Centers
  - Booster stations
  - Well heads
  - Water Injection Plants
  - Water disposal plants
1.1 KOC Gas Operations

- The Gas Assets are spread in all Kuwait Area (West, North and S&EK) as per the following:

- West Kuwait (BS 170, BS 171)
- North Kuwait (BS 131, BS 132)
- S&EK Kuwait (BS 180, BS 160, BS 150 & BS 140)
1.2 Visions, Mission and HSE Strategic Objective

KOC HSE VISION
KOC will maintain high industrial standards and continuous commitments towards the health, safety, and environmental performance in its operations to create a work and business culture of HSE leadership practices.

KOC HSE MISSION
KOC will provide a safe and healthy work environment by implementing a high quality and cost effective health, Safety and Environmental Management System.

KOC 2030 HSE STRATEGIC OBJECTIVE
To achieve world class Health, Safety and Environmental performance.
2.0 Air Emission

- **KOC has along history in managing Air Emissions through Gas Flaring reduction.**

- **Started in 1990’s with an inventory of 6 major pollutants “CO₂, CO, CH₄HC, Non-CH₄HC, SOₓ, NOₓ” and estimated from “Gas Flaring” in all GC’s.**

- **Currently a range of sources are included with about 21 pollutants.**

- **Main drivers for Emission Management and Inventory are to preserve the environment, Conserve Energy and Safeguard human health as “Air Pollution” can cause chronic health impacts for the local population and other global Environmental complications like Ozone Depletion & Global Warming, etc...**
3.0 Air Compliance Management Program

- "Kuwait Oil Company (KOC) has been developed a program entitled Air Compliance Management Program – ACMP" in order to monitor emissions from KOC gas facilities and ensure the compliance with national/local regulations and legislations.

- The ACMP includes the following: collecting the data from the facilities, identifying significant sources of emissions and recommending the control measures to reduce the emissions to environment.
3.0 Air Compliance Management Program

- This ACMP established with best available technology for emission reduction as well as monitoring in gas facilities. This presentation highlights the strategy for air emission reduction and controlled manner for KOC gas facilities to comply the company’s requirement.

The primary sources of atmospheric emissions from the operations arise from: Flaring, venting and purging gases:

- Combustion process such as diesel engines and gas turbines.
- Fugitive gases from loading operations and losses from process equipment
- Airborne particulates from soil disturbances during construction and from vehicle traffic
Emissions Reduction and Control Strategy – Gas Facilities

Gas & condensate pipelines

Large quantity of chemical used as additive for finished products

Dehydrators

Separators (Glycol)
# 3.0 Air Compliance Management Program

Air Emissions of 21 Pollutants using US EPA AP-42 methodologies

<table>
<thead>
<tr>
<th>Greenhouse Gases</th>
<th>Hazardous Air Pollutants</th>
<th>Criteria Pollutants</th>
<th>VOCs and Hydrocarbons</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Carbon Dioxide</td>
<td>• Benzene</td>
<td>• Carbon Monoxide</td>
<td>• VOC Total</td>
</tr>
<tr>
<td>• Methane</td>
<td>• Hydrogen Sulphide</td>
<td>• Nitrogen Oxides</td>
<td>• Total Hydrocarbon</td>
</tr>
<tr>
<td>• Nitrous Oxide</td>
<td>• Toluene</td>
<td>• Sulphur Dioxide</td>
<td>• Total Non Methane</td>
</tr>
<tr>
<td></td>
<td>• Xylene (Mixed Isomers)</td>
<td>• PM10</td>
<td>Hydrocarbons</td>
</tr>
<tr>
<td></td>
<td>• Acetaldehyde</td>
<td>• PM2.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ethyl benzene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Formaldehyde</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hexane</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Naphthalene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Polyaromatic hydrocarbons</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.1 Emissions Inventory Data

Gas facility emissions have been estimated by:

- first collecting a series of fixed and variable data from a total of individual source or process types. Fixed data includes, for example, the dimensions of hydrocarbon storage tanks or the maximum heat input rating for a boiler, which do not change from month to month. Variable data includes, for example, the number of operating hours in the month or throughput of product.

- Air Emissions of 21 Pollutants using US EPA AP-42 methodologies. These fixed and variable data were then used as inputs to various US EPA AP-42 prediction methods that provide formulas and factors for calculating emissions for a wide range of pollutants.

- The Air Emission is calculated for the major sources: Heaters, Flares, Burning Pits, Vents, Turbines, and Equipment leaks.
### 3.2 Baseline of Air pollutant Emissions

<table>
<thead>
<tr>
<th>Emissions Source</th>
<th>GHG</th>
<th>CP</th>
<th>VOC</th>
<th>HAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline (2013-2015 Average ; Ton/yr)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiler/Heater</td>
<td>433,226</td>
<td>784</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Burning Pit/Flare</td>
<td>1,085,045</td>
<td>64,310</td>
<td>-</td>
<td>2,475</td>
</tr>
<tr>
<td>Compressor</td>
<td>105,345</td>
<td>2,595</td>
<td>86</td>
<td>48</td>
</tr>
<tr>
<td>Gas Turbine</td>
<td>1,385,312</td>
<td>4,970</td>
<td>26</td>
<td>12</td>
</tr>
<tr>
<td>Process (Dehydration, Surge, Incinerator)</td>
<td>-</td>
<td>30,363</td>
<td>3,747</td>
<td>3,553</td>
</tr>
<tr>
<td>Equipment Leaks</td>
<td>90,707</td>
<td>-</td>
<td>1,555</td>
<td>-</td>
</tr>
</tbody>
</table>
### 3.3 Emissions Index:

\[
\text{Emission Index (Year)} = 100 \times \frac{2016 - 2017 \text{ Yearly Emission}}{\text{Baseline Emission}}
\]

<table>
<thead>
<tr>
<th>El Group Value Range</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>El &lt;100</td>
<td>Green</td>
<td>Yellow</td>
<td>Orange</td>
<td>Red</td>
<td>Violet</td>
</tr>
<tr>
<td>100 &lt; El ≤ 105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>105 &lt; El ≤ 120</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>120 &lt; El ≤ 150</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>El &gt; 150</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
### 3.4 Overview of Emissions Index in All Areas:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>S&amp;EK</th>
<th>WK</th>
<th>NK</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHG</td>
<td>130</td>
<td>112</td>
<td>111</td>
</tr>
<tr>
<td>CP</td>
<td>105</td>
<td>182</td>
<td>97</td>
</tr>
<tr>
<td>VOC</td>
<td>104</td>
<td>42</td>
<td>109</td>
</tr>
<tr>
<td>HAPs</td>
<td>106</td>
<td>109</td>
<td>70</td>
</tr>
</tbody>
</table>
3.5 Analysis of 2016-2017 Emissions Index:
3.5.1 Emission Trend (GHG / CP) in NK:
3.5 Analysis of 2016-2017 Emissions Index:

3.5.2 Emission Trend (VOC / HAPs) in NK:
3.5 Analysis of 2016-2017 Emissions Index:
3.5.3 Emission Trend (GHG / CP) in WK:
3.5 Analysis of 2016-2017 Emissions Index:
3.5.4 Emission Trend (VOC / HAPs) in WK:
3.5 Analysis of 2016-2017 Emissions Index:
3.5.5 Emission Trend (GHG / CP) in SK:
3.5 Analysis of 2016-2017 Emissions Index:
3.5.6 Emission Trend (VOC/HAPs) in SK:
4.0 Emissions Reduction and Control Strategy – Gas Facilities
4.1 The Abatement Strategy for the Emission Reduction:

Pollutants

VOCs

The pollutants of concern pertaining to Gas Facilities

Volatile Organic compounds (VOC’s); Organic chemicals that are released into the environment by evaporation (i.e: hydrocarbon storage tanks, equipment leaks, glycol vents)
4.1 The Abatement Strategy for the Emission Reduction:

- Undertaking Leak Detection and Repair (LDAR) surveys at the Gas Booster Stations: "LDAR" is a work practice designed to identify leaking equipment so that emissions can be reduced through repairs.

- Install Incineration or oxidation System to Glycol Vents.
4.1 The Abatement Strategy for the Emission Reduction:

**Pollutants**

- **SO$_2$**

**The pollutants of concern pertaining to Gas Facilities**

Sulphur dioxide (SO$_2$); emitted into ambient air by means of burning fossil fuels (i.e. incinerators, flares, burning pits).
4.1 The Abatement Strategy for the Emission Reduction:

- participation in Gas Flaring Reduction Program (GFRP).
- Pursue further flare gas reduction measures.
4.1 The Abatement Strategy for the Emission Reduction:

**Pollutants**

**$NO_x$**

- Nitrogen dioxide ($NO_2$); Emitted into ambient air thru burning fuel (i.e. compressors, turbines, heaters, flares).
4.1 The Abatement Strategy for the Emission Reduction:

- Install Selective Catalytic Reduction (SCR) to KOC Compressor Engines.
- Install Dry Low NOx (DLN) Combustors to KOC Turbines.
**LDAR Program**

1) Process equipment such as Valve, Flange, Drain, Pump seal, etc.
2) Portable monitoring device (PID, FID, or Optical Gas Imaging camera)
3) Repair work within designated period (ex: 15 days)
4) Ensuring repair below leak definition and Data management & record
5.0 The Way Forward For the Control Strategy Implementation:

- Improve the assumptions & data quality regarding emissions. (Current: EPA AP-42 Guideline).

- Review the Recommended Practices to upgrade inventory quality and minimize the pollutants Emissions.

- Pilot Studies for LDAR shall be developed for one of the identified facility.

Determine reasonableness of analysis and recommendations and identify the reasonable available control technology for the facilities.
5.0 The Way Forward For the Control Strategy Implementation:

- Results of Pilot study shall be analyzed and used to update Air Emissions Abatement Recommendations Report.

- Continue to Investigate other Abatement Options and Update Emissions Abatement Strategy on Annual basis
6.0 Conclusion

• Kuwait Oil Company (KOC) has been developed a program entitled Air Compliance Management Program – ACMP” in order to monitor emissions from KOC gas facilities and ensure the compliance with national/local regulations and legislations.

• The ACMP includes the following: collecting the data from the facilities, identifying significant sources of emissions and recommending the control measures to reduce the emissions to environment.

• Managing our Emissions will Strengthen our Commitment to the Environment & thus will contribute directly to the health of our people and others abroad.