Global Methane Initiative for Oil and Gas Sector

International Experts Workshops on Carbon Management and its Implications

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CAIRN INDIA LIMITED
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Cairn India - An Overview

Rajasthan (RJ-ON-90/1)

<table>
<thead>
<tr>
<th>Operator</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Cairn</td>
<td>70%</td>
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<tr>
<td>ONGC</td>
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Cambay (CB/OS-2)

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<td>ONGC</td>
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Ravva

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<td>ONGC</td>
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Sri Lanka

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<tr>
<td>Cairn Lanka</td>
<td>100%</td>
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South Africa

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<tr>
<td>Cairn SA</td>
<td>60%</td>
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<tr>
<td>Petro SA</td>
<td>40%</td>
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- Listed on BSE & NSE
- Market Capitalisation > USD10bn
- Amongst India’s top 25 companies by market cap
- In India since 1997
Rajasthan: Frontier Exploration to Production - The Journey

1997
Cairn enters PSC

2002
Guda Discovery/Shell exit

2002-4
Cairn exploration campaign

2004
Well #15: Mangala Discovery

2004-9
25 Discoveries 6.5 billion barrel resource identified

2009
First oil from Mangala

2010
World’s longest continuously heated & insulated pipeline commissioned

2011
Producing 175,000 bopd

2014
Producing ~200,000 bopd

Exploration & Appraisal

3,111 sq. km under license
25 discoveries

Development & Production

Mangala Processing Terminal

Rajasthan

Gujarat

Jamnagar/Salaya

Kandla

Kovai

Tankers to Coastal Refineries

Rajasthan: Frontier Exploration to Production - The Journey

3,111 sq. km under license
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Development & Production

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Kovai

Tankers to Coastal Refineries
GMI- Challenges to Opportunities

- Methane is an important climate change forcing greenhouse gas (GHG) which has a climate forcing effect 25 times greater on a 100 year basis than that of carbon dioxide, the primary greenhouse gas (GHG).

- There are many ways to reduce methane emissions, both fugitive (from leaks) and vented (from released-through bleeds, blow down, combustion or venting etc.) source.

- Reducing methane emissions add incremental revenue and also reduce - at no extra cost - the conventional pollutants that can harm public health and the environment.

Source: ICF International "Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries; March 2014"
Process Overview: Suvali Oil & Gas processing Unit

- **The Oil & Gas produced** from the offshore fields is processed at onshore terminal.

- Natural Gas is being **conditioned** and put in the state gas grid.

- **Crude oil & condensate** generated after **treatment** (in two separate stream) is stored in fixed roof tank.

- The processed **oil is loaded** in 20 KL / 24 KL road tankers. It is a top loading system and complete manual operation.
3-Stage Emission Reduction Program:

**STEP - I**

- Providing the flash Vapor vent system at crude loading bay area.
  - To divert vapour at crude loading bay to minimize personal exposure.

**STEP - II**

- Diverting Unstabilised condensate to Oil stabilisation unit.
  - To minimise vapor generation and losses due to flashing

**STEP - III**

- Providing Crude Tank Vapor balancing & Nitrogen blanketing in place of valuable Fuel gas:
  - For optimum utilisation of flash vapor's
  - Nitrogen blanketing provides additional safety protection for storage tanks.
STEP-I

Providing the Vapor vent system at crude loading bay (*Before Modification*):

- Flash vapors venting to atms near tanker loading area
- Flash Gas Vapour Line
- Loading Arm - Crude oil inlet line
- Loading Bay Roof
- For Dip Stick/Rod
STEP-I
Providing the Vapor vent system at crude loading bay (After Modification):

Flash vapors venting to atms in safe area/ above the loading bay roof

Reduced the vapor Exposure to crude loading personals
Crude Loading bay overview (after implementation of STEP-I):
STEP - II - Diverting Unstabilised condensate to Oil stabilisation unit.

✓ To minimise vapor generation & losses due to flashing
STEP-II: Diverting Un-stabilized condensate to Oil stabilisation unit.

Process Flow Diagram (Before Modification):
STEP-II : Diverting Un-stabilized condensate to Oil stabilisation unit.

- **Issue:**
  - Observed *Condensate not getting stabilized* due to unsteady state flow rate
  - Crude Oil Product *RVP was in the range of 4.5 to 5.0 Psig* (Ideal RVP should be < 1.0 psig).
  - Causing *more vapor flashing & emission* from the Crude Storage tank (~ 60 to 65 scm/hr) and at the loading bay.

- **Corrective Actions:**
  - Unstabilised *condensate diverted to Oil Stabilisation* Unit inlet.
STEP-II: Diverting Un-stabilized condensate to Oil stabilisation unit.

Process Flow Diagram (After Modification):

- Oil & Gas from Offshore Platform
- Slug Catcher
- Gas Treatment
- Condensate Stabilisation
- Crude storage Tank-A/B/C
- Ejector
- Flash Vapors Reinjection to system
- Crude dispatch by Road Tankers
- To Gas sales
STEP-II : Benefits

- This has resulted **drastic reduction in flash vapor generation rate up to ~ 15 to 20 scm/hr** from ~ 60 to 65 scm/hr due to reduction in Crude Oil Product RVP from 4.0 to 5.0 psig to 1.2 to 2.0 psig.

- Generation of **flash Vapors** in Oil handling section which **are being recovered by Mechanical Ejector & injected back** to natural gas stream.

- Reduction in RVP at Loading bay and Storage tank, **correspondingly reduction in HC vapor emission**.

- **Revenue generation of around ~ INR 35.0 Lakhs/Annum.** Due to vapour recovery at Oil stabilisation unit.
STEP - III - Providing Crude Tank Vapor balancing & Nitrogen blanketing in place of valuable Fuel gas:

- For optimum utilisation of flash vapor's
- Nitrogen blanketing provides additional safety protection for storage tanks.
STEP-III: Process Flow Diagram (Before Modification):

- **Oil Treatment**
- **PCV**
- **Continuous Flash Vapors To atms**
- **Tank- A**
  - Receiving
- **Tank- B**
  - Settling
- **Tank- C**
  - Dispatch
- **Fuel gas Supply for Tank Blanketing**
  - Continuous blanketing gas intake, while in tank in Dispatch
  - Continuous Flash Vapors To atms at loading bay
  - Crude dispatch by Road Tankers
STEP-III

- Providing Crude Tank Vapour balancing & Nitrogen blanketing:
STEP-III: Providing Crude Tank Vapour balancing & Nitrogen blanketing:

- Crude tank Vapour balancing across the three tank, has resulted to optimum utilisation of flash vapors generated (15 to 20 scm/hr) while crude tank is in receipt mode & while crude tank is in dispatch mode.

- Reduced the venting of flash vapors to atms at the rate of ~50 scm/hr through Crude tank PVSV, while the tank is in receipt mode. The tank when in dispatch mode consumes fuel gas at the rate ~ 120 m3 / hr.

- Nitrogen blanketing has added additional safety protection for crude storage tanks.

- By providing the low cost Nitrogen blanketing in place of natural gas. (by 8-9 times)
  
  (Cost of nitrogen production is INR 1.62/sm3. Where as cost of treated Fuel gas is INR 9.72 /sm3).
Outcomes:

- Benzene exposure level reduced to Zero PPM from 0.4 PPM, to loading personal during crude loading operations.

- Reduction in cold venting (GHG emissions) from crude storage tank & at crude loading operations.

- Nitrogen blanketing provides additional safety protection for crude storage tanks.

- Conservation of natural resource:
  - Effective utilization of flash vapors

- Revenue Generation up to ~ 60.0 to 70 Lakhs/Annum by optimization of natural gas usage and recovery of condensate vapor at Oil Stabilisation.
Lessons from this case study:

- Minimize HC exposure to personnel - In line with organisation’s commitment towards Occupational health.

- Minimize GHG emissions - Contribution towards organizational commitment to sustainable development

- Minimise Resource Depletions - Overall natural resource conservation

- In addition to the above, such programs can lead to incremental revenue Generation - Financial gains to organization & Nation
Methane Emission Reduction Programs in Other Assets

- Vapor recovery units commissioned at the Mangala Processing Terminal (MPT) to recover ~1.5 MMSCFD associated gas.

- Installation of low NOx flare tip with modified design has reduced the consumption of associated gas by ~0.5 MMSCFD. (MPT)

- Plant O&M initiatives to eliminate fugitive emissions: > 90% success in arresting flange/pipe/hose leaks (~3 mmscf/annum)

- Emission reduction targets set right upfront in the Engineering design/Std.

- No cold venting permitted and if unavoidable (high CO2) flaring is allowed thereby reducing Methane emissions.
Emission Reduction Initiatives

- Measurement key to Management - Baseline Survey completed with the help of USEPA GMI program in 2014

- Options being looked into capturing flow back gas during fracking using a DST module with oil-gas separator.

- Green completions: After drilling new wells, instead of venting the well to remove debris from around the well bore, green completions use additional separator traps and dehydrators to route gas to sales.

- Trial runs using brackish water for fracking in progress for maximum recycling and conservation of water.

- Other Initiatives includes W2E/W2R, Water Management Strategy, Emission and energy conservation Strategy, Alternate Energy use, Massive GB Development including Mangrove and Shelterbelts in about 50% of the total occupied area, partnership with IUCN for Bio-diversity/Eco-service resource Conservation etc.
Thank You