Mobile Compression Solutions for Gas Pipeline Evacuation

Natural Gas STAR Annual Implementation Workshop

November 16-18, 2015
Sheraton Pittsburgh at Station Square
Pittsburgh, PA
Gas Evacuation - method

- Hot Tapping & Plugging
- Flaring
- Release to Atmosphere

prepared by Jochen Pernsteiner
Gas Evacuation product portfolio

Mobile Units for Gas Pipeline Evacuation

LMF P-Pack 475

LMF P-Pack 750

LMF P-Pack 100

prepared by Jochen Pernsteiner
LMF compressor BS604-213 S7.5, rated power 638 kW
Electric power supply: 24V 2x60A
Gas engine CAT3512G, 1400 rpm, 750 kW
Cooling fan driven by CAT via gear box
Suitability for – 40°C to + 35°C
Total weight incl. truck and trailer 38 t
Overall length 13,427 mm
width 2,520 mm / height 4,000mm
Motivation for PipelineEvacuation Technology LMF P-Pack 750

Pipeline section of 28 km (17 miles), 1420mm (56") diameter and filled with 70 bar (1015 psi)

Gas transfer process from 70 bar (1015 psi) to 10 bar (145 psi)

Environmental Aspect:

- Emission of Methane is #1 in greenhouse gas effect

1 Nm³ CH₄ (35.32 ft³) ~ 0.671 kg (1.48 pounds)

Volume saved gas – 2,419,475 m³ (85,443,034 ft³) ~ 1,623,468 kg CH₄ (3,579,134 pounds)

Greenhouse Gas Equivalencies faktor CH₄ to CO₂ 21

Saved CO₂ 34,092,828 kg CO₂ (75,161,819 pounds)

Actual market price for Emission Allowance 5.27 € / to CO₂

Summ Emission Allowance ~ 179,670 €
# Motivation for Pipeline Evacuation Technology LMF P-Pack 750

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<td>Greenhouse Gas Equivalencies faktor CH₄ to CO₂</td>
<td>21</td>
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<tr>
<td>Saved CO₂</td>
<td>34.092.828 kg CO₂ (75.161.819 pounds)</td>
</tr>
</tbody>
</table>

- **3,836,258** gallons of gasoline consumed
- **7,177** Passenger vehicles
- **81,173,400** Miles/year driven by an average passenger vehicle
- **12,220** Tons of waste sent to the landfill
- **79,286** barrels of oil consumed
- **3,111** homes' energy use for one year
- **36,619,579** Pounds of coal burned
- **4,690** homes' electricity use for one year

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prepared by Jochen Pernsteiner
System Description – LMF P-Pack 475

- LMF compressor BS604-213 S7.5, rated power 450 kW
- Gas engine CAT3412G, 1800 rpm, 475 kW
- Cooling fan electrical driven by Diesel Genset
- Suitability for –40°C to +50°C (-40°F to +122°F)
- Total weight incl. truck and trailer 38 t (83.776 pounds)
- Overall length 14,860 mm (48.75 ft) width 2,543 mm (8.33 ft) / height 4,000mm (13.12 ft)

prepared by Jochen Pernsteiner
For optimized efficiency the compressor is operating as a single stage compressor in the beginning of the evacuation process.

Single Stage Operation:

- 4 cylinder operation for high volume delivery
- Ratio in compression up to 1:3.5
- High efficiency in volume for the beginning of the evacuation process
LMF P-Pack 475 & 750; 2-Stage Operation

- For optimized efficiency the compressor is operating as a 2-stage compressor at the end of the evacuation process

Two Stage Operation:

- 1st stage / 3 cylinder,
- 2nd stage / 1 cylinder for high pressure delivery
- ratio in compression up to 1:12
- high pressure efficiency
- at the final phase of the evacuation process

LMF patent for better performance
System Description – LMF P-Pack 100

- LMF compressor BS102, rated power approx. 100 kW
- Gas engine CAT3306G, Diesel engine CAT or similar, Electrical motor WEG or similar
- Cooling fan direct driven by main drive
- Suitability for – 5°C (-40°C) to + 50°C (-40°F to +122°F)
- Total weight approx. 15 t (33.069 pounds)
- Overall length 6,058 mm (19.88 ft)
  \ width 2,543 mm (8.33 ft) /
  \ height 2,500 mm (8.20 ft)
- Pressure range 30 bar (435 PSI) to 1 bar (14.5 PSI) [0.1 bar] [1.45 PSI]
Guatelli S.p.A.

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prepared by M. Bettoni
EVACUATION

Evacuation 2013/2014/2015

P&I connection and photos

Layout

Sketch connection

Equipment

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EVACUATION

COMPRESSORS

ADVANTAGES

• **Big Reduction Pollutants Gas**
  in atmosphere
  through
  utilizes of engines natural gas

• **Big Reduction Jobsite Spaces**
  through
  utilizes mobile compressors of little dimensions

• **Big Reduction Noise**
  through soundproofing mobile compressors

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**FLOW**

- min. 1500 Nm³/h (52.980 ft³/h)
- max. 50000 Nm³/h (1.766.000 ft³/h)
- medium
  - 9000 Nm³/h (317.880 ft³/h)
  - 11000 Nm³/h (388.520 ft³/h)

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7 – 75 bar
0 – 30 bar
102 – 1.088 PSI
0 – 435 PSI

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EVACUATION

ELECTRIC GENERATORS
METHANE GAS
380 V  90 KW

Compressor's engine and Electric Generator takes natural gas from the line of transfer

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Sketch connection N° 1 compressor

Pressure 75 bar (1.088 PSI) → 7 bar (101 PSI)
Medium Flow 10,000 m³/h (353,200 ft³/h)

prepared by M. Bettoni
EVACUATION

LAYOUT

Sketch connection N° 2 compressors -SERIAL-

Pressure 75 bar (1.088 PSI) → 0,5 bar (7 PSI)
Medium Flow 10.000 m³/h (353.200 ft³/h)

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Sketch connection N° 2 compressors -PARALLEL-

Pressure 75 bar (1.088 PSI) → 7 bar (101 PSI)
Medium Flow 20.000 m³/h (706.400 ft³/h)

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EVACUATION

P&I N°1 COMPRESSOR

prepared by M. Bettoni
EVACUATION
P&I N°2 COMPRESSORS

prepared by M. Bettoni
EVACUATION

P&I N°2 COMPRESSORS

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P&I N°2 COMPRESSORS

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VALVE and CHECK VALVE

prepared by M. Bettoni
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PRESSURE SAFETY VALVE 90 BAR

prepared by M. Bettoni
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FLOW METER

prepared by M. Bettoni
## Evacuation 2013

<table>
<thead>
<tr>
<th>Location</th>
<th>Methane Transferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coriano</td>
<td>81,237 Nm³ (2,869,291 ft³)</td>
</tr>
<tr>
<td>Casalborsetti</td>
<td>400,000 Nm³ (14,128,000 ft³)</td>
</tr>
<tr>
<td>Ponte Rio</td>
<td>200,000 Nm³ (7,064,000 ft³)</td>
</tr>
<tr>
<td>Sergnano</td>
<td>580,000 Nm³ (20,485,600 ft³)</td>
</tr>
<tr>
<td>Porto S. Elpidio</td>
<td>155,000 Nm³ (5,474,600 ft³)</td>
</tr>
<tr>
<td>Cattafi</td>
<td>1,061,875 Nm³ (37,505,425 ft³)</td>
</tr>
<tr>
<td>Serro</td>
<td>462,000 Nm³ (16,317,840 ft³)</td>
</tr>
<tr>
<td>Larino</td>
<td>150,209 Nm³ (5,305,382 ft³)</td>
</tr>
<tr>
<td>Misano</td>
<td>177,609 Nm³ (6,273,150 ft³)</td>
</tr>
</tbody>
</table>

**Total Methane Transferred**: 3,267,930 Nm³ (115,423,288 ft³)

Prepared by M. Bettoni
Motivation for Pipeline Evacuation

2013

<table>
<thead>
<tr>
<th>Volume</th>
<th>Equivalencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Nm³ CH₄ (35.32 ft³)</td>
<td>~0.671 kg (1.48 pounds)</td>
</tr>
<tr>
<td>Volume saved gas – 3.267.930 m³ (115.423.288 ft³)</td>
<td>~2.192.781 kg CH₄ (4.834.249 pounds)</td>
</tr>
<tr>
<td>Greenhouse Gas Equivalencies faktor CH₄ to CO₂</td>
<td>21</td>
</tr>
<tr>
<td>Saved CO₂</td>
<td>46.048.401 kg CO₂ (101.519.226 pounds)</td>
</tr>
</tbody>
</table>

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- 6,168,507 gallons of gasoline consumed
- 130,522,679 miles driven by an average passenger vehicle
- 127,487 barrels of oil consumed
- 58,882,411 pounds of coal burned
- 19,649 tons of waste sent to the landfill

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prepared by M. Bettoni
## EVACUATION 2014

<table>
<thead>
<tr>
<th>N° 8 Evacuations</th>
<th>Methane transferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zimella</td>
<td>129.000 Nm° (4.556.280 ft³)</td>
</tr>
<tr>
<td>Pressana</td>
<td>217.300 Nm° (7.675.036 ft³)</td>
</tr>
<tr>
<td>San Sebastiano</td>
<td>343.200 Nm° (12.121.824 ft³)</td>
</tr>
<tr>
<td>Itri</td>
<td>254.772 Nm° (8.998.547 ft³)</td>
</tr>
<tr>
<td>Furci</td>
<td>811.392 Nm° (28.658.365 ft³)</td>
</tr>
<tr>
<td>Sergnano</td>
<td>143.000 Nm° (5.050.760 ft³)</td>
</tr>
<tr>
<td>Potelle</td>
<td>517.447 Nm° (18.276.228 ft³)</td>
</tr>
<tr>
<td>St. Pourcain</td>
<td>700.000 Nm° (24.724.000 ft³)</td>
</tr>
</tbody>
</table>

**Total Methane Transferred**

3.116.111 Nm³

110.061.040 ft³

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## Motivation for Pipeline Evacuation

### 2014

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<tr>
<th>1 Nm³ CH₄ (35,32 ft³)</th>
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<tbody>
<tr>
<td>Volume saved gas – 3,116,111 m³ (110,061,040 ft³)</td>
<td>~2,090,911 kg CH₄ (4,609,664 pounds)</td>
</tr>
<tr>
<td>Greenhouse Gas Equivalencies faktor CH₄ to CO₂</td>
<td>21</td>
</tr>
<tr>
<td>Saved CO₂</td>
<td>43,909,131 kg CO₂ (96,802,944 pounds)</td>
</tr>
</tbody>
</table>

### Equivalencies:

- **5,881,937** gallons of gasoline consumed
- **124,458,988** miles driven by an average passenger vehicle
- **121,565** barrels of oil consumed
- **56,146,912** pounds of coal burned
- **18,736** tons of waste sent to the landfill

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Prepared by M. Bettoni
Evacuations 2013/2014/2015

EVACUATION
2015

N° 8 Evacuations

<table>
<thead>
<tr>
<th>Location</th>
<th>Methane Transferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ronco all’Adige</td>
<td>373.819 Nm³ (13.203.287 ft³)</td>
</tr>
<tr>
<td>Sergnano</td>
<td>2.043.000 Nm³ (72.158.760 ft³)</td>
</tr>
<tr>
<td>St. Pourcain</td>
<td>460.000 Nm³ (16.247.200 ft³)</td>
</tr>
<tr>
<td>Chagny</td>
<td>502.500 Nm³ (17.748.300 ft³)</td>
</tr>
<tr>
<td>Roussines</td>
<td>399.238 Nm³ (14.101.086 ft³)</td>
</tr>
<tr>
<td>Cerville</td>
<td>243.582 Nm³ (8.603.316 ft³)</td>
</tr>
<tr>
<td>St. Pourcain</td>
<td>696.158 Nm³ (24.588.301 ft³)</td>
</tr>
<tr>
<td>Grafendorf</td>
<td>444.950 Nm³ (15.715.634 ft³)</td>
</tr>
</tbody>
</table>

Total Methane Transferred 5,163,247 Nm³
182,365,885 ft³

prepared by M. Bettoni
Motivation for Pipeline Evacuation 2015

<table>
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<tr>
<th>Volume</th>
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<tbody>
<tr>
<td>1 Nm³ CH₄ (35.32 ft³)</td>
<td>≈0.671 kg (1.48 pounds)</td>
</tr>
<tr>
<td>Volume saved gas – 5.163.247 m³ (182.365.885 ft³)</td>
<td>≈3.464.539 kg CH₄ (7.637.992 pounds)</td>
</tr>
<tr>
<td>Greenhouse Gas Equivalencies factor CH₄ to CO₂</td>
<td>21</td>
</tr>
<tr>
<td>Saved CO₂</td>
<td>72.755.319 kg CO₂ (160.397.832 pounds)</td>
</tr>
</tbody>
</table>

Evacuations 2013/2014/2015

| Gallons of gasoline consumed | 9,746,087 |
| Miles driven by an average passenger vehicle | 206,222,560 |
| Barrels of oil consumed | 201,427 |
| Pounds of coal burned | 93,032,734 |
| Tons of waste sent to the landfill | 31,044 |

prepared by M. Bettoni