Reducing Fugitive Emissions from Valves – An India Perspective

1. Background

Climate change caused by anthropogenic greenhouse gases has emerged as one of the most important environmental concerns of the day. Responses to the issue include a multitude of international regulatory programs, such as the Kyoto Protocol and regional regulatory programs such as the US Clean Air Act. India, the world’s fourth-largest carbon emitter with a population of 1.3 billion people, ratified the Paris Agreement on climate change in October 2016 to become the 21st nation to join the community. As India moves towards implementing Euro VI (BS VI) emission standards for all automobiles by 2020 that require refinery upgrades to meet the stringent requirements, it is appropriate to take a wholesome look at the state of emissions from a typical chemical plant/refinery.

2. Fugitive emissions from valves – Global update

Fugitive emissions (FE) are emissions of gases/vapors due to unanticipated leaks from pressurized equipment such as valves and pumps in an industrial site. FE are classified as volatile organic compounds (VOC) and hazardous air pollutants (HAP). VOCs, chemical industries contribute to 50% of the VOC and HAP emissions and valves in these installations are a large source of focus in FE control as they contribute to 60% of emissions out of which 80% are from valve shafts [2].

To limit fugitive emissions from valves, many federal laws and standards have been introduced over the years. While EPA-91 and TA-LIUT are list-setting federal specifications for USA and Germany respectively, standards such as ISO 15848, API 624 and API 641 specify leakage values based on parameters such as pressure, temperature, mechanical and thermal cycles and test methods. API and ISO fugitive emissions standards are based on different philosophies – while API 624/641 are prescriptive, ISO 15848 standard offers a variety of options. API 624/641 standards were drafted to augment EPA’s consent decree program and to ensure that any valve (with graphite packing) installed in a process plant meets the <100 ppm requirement without the need for any gland adjustments. ISO 15848-1, on the other hand, is applicable to isolation and control valves, has multiple endurance classes and allows testing with either nitrogen or helium, thus making it a flexible standard that can be adopted for myriad requirements.

3. US EPA and its Relevance to India

Environmental protection agency (EPA), the regulatory body in the US, has been harping on the change, bringing fugitive emission levels down from 10,000 ppm in the 1990s to the current levels of 100-350 ppm. The EPA in 2008 required all end users not complying with leak detection and repair (LDR) requirements implement enhanced LDR programs (ELP) using certified low-leak valves and sealing technologies (meeting 100 ppm) and these ELPs were mandated in 100% of the refineries. The identification of leaks was conducted with the introduction of 1 ppm LEAK 622, 624, 641 standards addressing the concerns of both EPA and India regulatory agencies.

- MoECC (Oil Industry Safety Directorate), OISD-CNLD-222, Monitoring & Control of Volatile Organic Compounds Emission, 2006

4. Way forward

- The Indian environment impact assessment (EIA) guidance manuals state the use of control technologies to reduce fugitive emissions such as “low leak valves in new installations and “leak emission packing” but the current leak definition of 2000 ppm VOC is not commensurate with the control technologies mentioned.
- The benefits of installing low emission valves would be significant in reducing the carbon footprint from Indian refineries. Theoretically, if all 23 refineries in India operated at the level of 100 ppm VOC, India with 16 refineries fewer than US, would be emitting approximately 16 times the amount of VOCs released by US refineries (Refer table 2).
- Concrete actions are required from all stakeholders – the regulatory body, end users and valve manufacturers – to implement low emission technology in our refineries. The MoECC should change the leak definition for valves (in line with EPA) and redefine low leak valves as valves emitting ≤100 ppm when tested as per an international FE standard.
- End users should install low emission valves in all their new plants and plan to change over old valves to low emission valves in existing installations in stages. This would prompt end-users to look at valve and seal manufacturers that are qualified as per an internationally recognized FE standard. End-users should also introduce LDR to assess current emission performance of valves and draw up a time bound program to bring up emission performance to the best, in line with global practices.
- Valve manufacturers have to adopt good engineering and manufacturing practices, ensure conformance to GDTT and surface roughnesses to manufacture low emission valves on a mass scale.

- Preferred FE standards: API 624 has become integral to valve standards such as API 600 (Gate), API 622 (Cage, Globe & Angle) and potentially API 623 (Globe). Thus complying with API 624 would become a requirement and not an option anymore (with an API program, non-compliance could have much wider implications). Similar wave of changes are expected in quarter-turn valve standards such as API 608 (ball valves) and API 599 (plug valves) in 2017, following the release of new API 624 in October 2016.

5. Reference(s)


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Table 1: depicts the key differences among the different FE standards.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>API 624</th>
<th>API 641</th>
<th>ISO 15848-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicability</td>
<td>Gate, Globe valves</td>
<td>Quarter turn valves</td>
<td>Isolation &amp; Control valves</td>
</tr>
<tr>
<td>Units</td>
<td>ppmv</td>
<td>ppmv</td>
<td>He-atm.cm²/sec or Methane - ppmv</td>
</tr>
<tr>
<td>Stem Leakage</td>
<td>≤ 100 ppmv</td>
<td>≤ 100 ppmv</td>
<td>Helium - Class AH, BH, CH</td>
</tr>
<tr>
<td>Method</td>
<td>Sniffing</td>
<td>Sniffing</td>
<td>Methane - Class AM, BM, CM</td>
</tr>
<tr>
<td>Mechanical cycles</td>
<td>310</td>
<td>610</td>
<td>Vacuum (AH); Bagging (BH, CH)</td>
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<tr>
<td>Thermal cycles</td>
<td>3</td>
<td>3</td>
<td>Sniffing (AM, BM, CM)</td>
</tr>
<tr>
<td>Max temp (°C)</td>
<td>260</td>
<td>260</td>
<td>User defined</td>
</tr>
<tr>
<td>Gland adjustment</td>
<td>0</td>
<td>0</td>
<td>≤1(CO₂), ≤2(CO₂), ≤3(CO₂)</td>
</tr>
<tr>
<td>Link to other valve standards</td>
<td>API 600, API 602, potentially API 623</td>
<td>Potentially API 608, API 609, API 599</td>
<td>ISO 15848-2 (Production standard)</td>
</tr>
</tbody>
</table>

Table 2: Average no. of valves/Refineries

<table>
<thead>
<tr>
<th>Country</th>
<th>Average no. of valves/ Refineries</th>
<th>Operable refineries</th>
<th>ISO 15848 Emission category</th>
<th>Leakage rate (atm. cc/second/mm diameter)</th>
<th>Kilograms of VOC’s released/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>7400</td>
<td>139</td>
<td>Class BH</td>
<td>1.76E-06</td>
<td>X</td>
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<tr>
<td>India</td>
<td>7400</td>
<td>23</td>
<td>Class CH</td>
<td>1.76E-04</td>
<td>16X</td>
</tr>
<tr>
<td>India</td>
<td>7400</td>
<td>23</td>
<td>Class BH</td>
<td>1.76E-06</td>
<td>0.16X</td>
</tr>
</tbody>
</table>

*Average number of valves/refinery is assumed to be 7400 based on an EPA estimate [3]

**Class BH of ISO 15848 is comparable to ≤100 ppm and class CH comparable to 3000 ppm

Leak definition for Valve, USA
- 10,000 ppm (up to 1993)
- 500 ppm (1994 to now)
- 250 ppm (E-LDAR)

Leak definition for Valves, Petroleum refineries, India
- 10,000 ppm - VOC - 3000 ppm - Benzene (up to 2008)
- 1000 ppm - VOC - Benzene (2009 to now)

Leak definition for Valves, Petrochemical complexes, India
- 10,000 ppm - HAP - 2000 ppm - VHAP (2007-2010)
- 1000 ppm - HAP - 1000 ppm - VHAP (2010 to now)