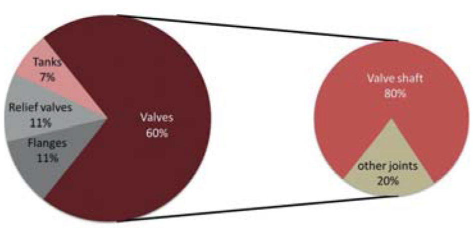
Reducing Fugitive Emissions from Valves – An India Perspective

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 62nd nation to join the community. As India moves towards implementing Euro V1 (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). O&G, chemical industries contribute to 50% of the VOC and HAP emissions and valves in these installations are given a lot 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-21 and TA-LUFT are limit-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 methane or helium, thus making it a flexible standard that can be adopted for myriad requirements.

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

Parameters	API 624	API 641	ISO 15848-I
Applicability	Gate, Globe valves	Quarter turn valves	Isolation & Control valves
Medium	Methane	Methane	Helium or Methane
Units	ppmv	ppmv	He-atm.cm³/sec or Methane - ppmv
Stem Leakage	≤ 100 ppmv	≤ 100 ppmv	Helium - Class AH, BH, CH Methane - Class AM, BM, CM
Method	Sniffing	Sniffing	Vacuum (AH); Bagging (BH, CH) Sniffing (AM, BM, CM)
Mechanical cycles	310	610	205(CO_1), 1500(CO_2), 2500 (CO_3) CO: Endurance class for Isolation valves
Thermal cycles	3	3	2(CO_1), 3(CO_2), 4(CO_3)
Max temp (°C)	260	260	User defined
Gland adjustment	0	0	1(CO_1), 2(CO_2), 3(CO_3)
Link to other valve standards	API 600, API 602, potentially API 623	Potentially API 608, API 609, API 599	ISO 15848-2 (Production standard)

3. US EPA and its Relevance to India

Environmental protection agency (EPA), the regulatory body in the US, has been the harbinger of change, bringing fugitive emission levels down from 10,000 ppm in the 1990's to the current levels of 100-250 ppm. The EPA in 2008 required that all end users not complying with leak detection and repair (LDAR) requirements implement enhanced LDAR programs (ELP) using certified low-leak valves and sealing technologies (meeting <100 ppm) and these ELPs were mandated in consent decrees. The ELP slowly but surely led to the introduction of <100 ppm API 622, 624, 641 standards addressing the concerns of both EPA and end users in the US.
In India, the Ministry of Environment, Forests and Climate Change (MoEFCC) is responsible for the implementation and enforcement of the Environment Protection Act, 1986 including the EIA (Environment Impact Assessment) notification. The following documents list the valve leak definitions and procedures for LDAR and Figure 2 depicts the leak definition comparison between US EPA and Indian regulations.

- OISD (Oil Industry Safety Directorate), OISD-GDN-224, Monitoring & Control of Volatile Organic Compounds Emission, 2006
- MoEFCC, Technical EIA guidance manual for Petroleum refining industry and Petrochemical complexes, 2010

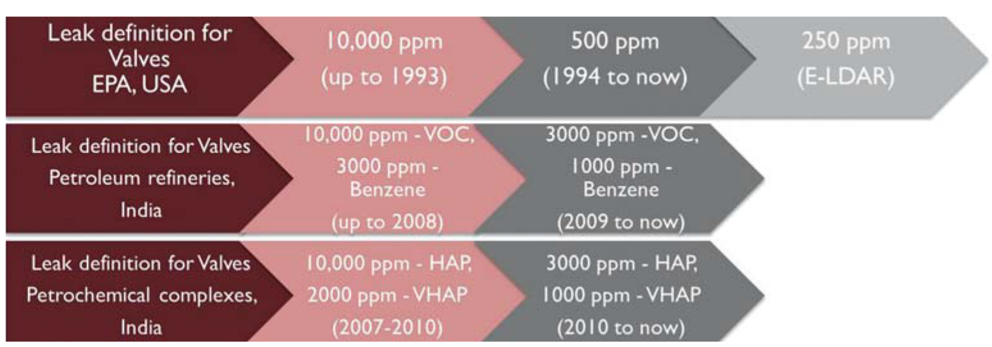
4. Way forward

- 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 "low emission packing" but the current leak definition of 3000 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 3000 ppm VOC, India with 116 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 MoEFCC should change the leak definition for valves (in line with EPA) and redefine Low leak valves as valves emitting <100 ppm FE 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 LDAR to assess current emission performance of valves and draw up a time bound program to bring up emission performance to be the best, in line with global practices.
  - Valve manufacturers have to adopt good engineering and manufacturing practices, ensure conformance to GD&T 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 602 (Gate, Globe ,4") and potentially API 623 (Globe). Thus complying with API 624 would become a requirement and not an option anymore (with an API monogram 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 641 in October 2016.

Table 2

Country	Average no. of valves/ refinery*	Operable refineries [4] [5]	ISO 15848 Emission category⁺	Leakage rate (atm. cc/second/mm stem diameter)	Kilograms of VOC's released/year
USA	7400	139	Class BH	1.76E-06	X
India	7400	23	Class CH	1.76E-04	16X
India	7400	23	Class BH	1.76E-06	0.16X

***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



5. Reference(s)

[1] http://time.com/4515957/paris-climate-change-agreement-india/
[2] Monitoring and Containment of Fugitive Emissions from Valve Stems, James E. MacKay and Kevin J. Smith
[3] http://www.indiaenergy.gov.in/supply-sector.php
[4] http://www.eia.gov/dnav/pet/pet_pnp_cap1_dcu_nus_a.htm
[5] http://www.indiaenergy.gov.in/supply-sector.php

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