Plunger Lift Lubricators and API 6A Wellhead Compliance

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1. How many different styles, specifications and types of Plunger Lift Lubricators are there on the market today?

2. Why do we need Standards to be set by API, NACE, ISO, ASME, EnForm or other governing bodies to build minimum specification requirements?

3. What is our responsibility?
API Organization

- American Petroleum Institute
- First Standards of API set in 1924
- API now maintains 500 standards covering all segments of the oil and gas industry.
- API standards program has gone global, through active involvement with the International Organization for Standardization (ISO) and other international bodies.
- API references NACE
NACE Organization

• National Association of Corrosion Engineers
• Established in 1943 by eleven corrosion engineers in the pipeline industry
• NACE International’s mission statement is to “protect people, assets and the environment from corrosion.”
• API references NACE
• International Organization for Standards (ISO is derived from the Greek meaning “equal”)
• Established in 1947
• ISO has published more than 18,500 International Standards ranging from standards for activities such as agriculture and construction, through mechanical engineering, to medical devices, to the newest information technology developments
• ISO is the world’s largest standards developing organization.
Gas Wellhead API 6A Governance

Standards Governed by API

API has not set regulations to govern Plunger Lift Lubricators
What Industry Standards should a Lubricator meet?

- A Plunger Lift Lubricator is a wellhead component like a flow tee, gate valve, tubing head spool etc.
  - So at a bare minimum it should meet industry Wellhead specifications (API 6A:ISO 10423 & use NACE MR0175:ISO 15156 Compliant materials)

- Plungers are the only foreign bodies, besides hydrate releases and rare solid releases, impacting surface equipment
  - So additional consideration of potential impact forces from high velocity arrivals and Lubricator resilience to said impacts must be considered and applied to Lubricator design (EnForm IRP 5 CDN)
What Lubricator should be on the Wellhead?
What Standard Specifications are Required for our Lubricator?

- 16” flow port spacing?
- API 16A?
- 3K?
- 5K?
- 2.5” Bowen?
  - 3/4” npt injection port?
  - Autocatch?
  - 18” flow port spacing?
- 1/2” npt injection port?
- What is max impact velocity?
- 2.5” flowport?
- Stress corrosion cracking?
- EUE Thread torque rating?
- 9 High Nitrare elastomer?
- 4130/4140 steel?
- X750 spring?
- Manual catch?
- 1500 ft/s?
- 2500 ft/s?
- Flow tee replacement?
- Flanged top cap?
- -60C/-75F Charpy tested?
- NACE MR0175 standard?
- Dual Flanged?
- How much carbon?
- Injection port location?
- EUE threads?
- 1 or 2 injection ports?
- 14” flow port spacing?
- 16” flow port spacing?
- 18” flow port spacing?
- 7.31” spacing?
- 14K?
- 10K?
- 3K?
- 5K?
- 2.5” Bowen?
- 3” Bowen?
- Soft zone cracking?
- H2S partial pressure?
- -46C/-50F Charpy tested?
- 2” npt threadolet?
- CO2 partial pressure?
- 2500 ft/s?
- 1500 ft/s?
- API 6A?
- MP35N spring?
- X750 spring?
- 17.4PH spring?
- Chlorides?
- 7.31” spacing?
- Retainer ring?
- Stepwise cracking?
- API stamped/certified?
- EUE Thread torque rating?
- 9 High Nitrare elastomer?
- 4130/4140 steel?
- X750 spring?
- Manual catch?
- 1500 ft/s?
What is the Velocity Consideration?

- **Rise Velocities**
  - Safe Operating Window < 1000 ft/min (300 m/min)
  - Running Hard 1000 ft/min to 2500 ft/min
  - Emergency Shut down (ESD) Velocity > 2500 ft/min (762 m/min)
How does Velocity affect Lubricator Specification?

Summary Example Calculation

2500 ft/min
3.5” 20lbs plunger

<table>
<thead>
<tr>
<th>Impact Force</th>
<th>Newtons (N)</th>
<th>Lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Spring (0.03 sec deceleration)</td>
<td>3900</td>
<td>890</td>
</tr>
<tr>
<td>Compromised Spring (0.005 sec deceleration)</td>
<td>23800</td>
<td>5300</td>
</tr>
</tbody>
</table>
Burst lubricator cap
EUE threaded lubricator and by pass line
Master valve nipple adapter shredded
Velocity Pressure Plot (surface vs. downhole)

ESD Zone >2500 ft/min

Caution 1000-2500 ft/min

Recommended <1000 ft/min

- Gas Rate: 175 MCFD
- Depth: 10,000 ft
- Liquid Density: 8.76 lb/gal
- Surface Temperature: 59°F
What is Critical for us to Standardize from an Operational Perspective to Reduce Impact Velocities?

- **Safe Operating Procedures for Optimization**
  - Bringing plunger to tank, blowing down, Hydrates etc.
  - Extended Shut in caused by Compressor Servicing, Line pressure changes or Turnarounds

- **Standing Valve Integral to Bottom Hole Bumper Spring**
  - To ensure fluid above plunger/hydraulic break
What is Critical for us to Standardize from an Operational Perspective to Reduce Impact Velocities?

- **Controller Alarm Flags**
  - Remote Well Monitoring
  - For quick arrivals above 1000ft/min
  - Automatic Emergency Shut Down (ESD) on single arrival above 2500ft/min followed by a spring tension check and probable spring replacement

- **Quarterly Service Routes**
  - including surface spring tension checks
What Thread Type Should we use?

Thread Pull Test Bowen vs. EUE Connection

2 3/8” Bowen Top 4.75”
c/w 4 Acme 2G Thread
  • Connection pull fail rating of 257,500 lbs.

2 3/8” EUE 8rd Thread
  • Connection pull rating 160,000 lbs.
Which API 6A Wellhead requirements do we need to apply?

API 6A Recommended PSL Levels

- **Start here**
  - Rated working pressure ≤ 103.5 MPa (15,000 psi)?
    - Yes: High H₂S concentration?
      - Yes: Gas well?
        - Yes: PSL 3G
        - No: PSL 3
      - No: PSL 3
    - No: Gas well?
      - Yes: PSL 3G
      - No: PSL 3

- ISO 15156 (all parts)?
  - Yes: High H₂S concentration?
    - Yes: Rated working pressure > 34.5 MPa (5,000 psi)
      - Yes: Gas well?
        - Yes: PSL 3G
        - No: PSL 3
      - No: PSL 2
    - No: ≤ 34.5 MPa (5,000 psi)
      - Yes: PSL 3
      - No: PSL 2

- Gas well?
  - Yes: Rated working pressure > 34.5 MPa (5,000 psi)
    - Yes: PSL 3
    - No: PSL 2
  - No: ≤ 34.5 MPa (5,000 psi)
    - Yes: PSL 1
    - No: PSL 2

- Rated working pressure > 34.5 MPa (5,000 psi)
  - Gas well?
    - Yes: PSL 3
    - No: PSL 2

Figure A.14 — Recommended minimum PSL for primary parts of wellhead and christmas tree equipment
Which API 6A Wellhead requirements do we need to apply?

API 6A Wellhead Weld Procedures

PER API/ANSI 6A/ISO 10423:2009 REVISION October 2010
## API 6A Material Class Design

<table>
<thead>
<tr>
<th>Material Class</th>
<th>Minimum Material Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>body, bonnet, end and outlet connections</td>
</tr>
<tr>
<td>AA - General Service</td>
<td>carbon or low-alloy steel</td>
</tr>
<tr>
<td>BB - General Service</td>
<td>carbon or low-alloy steel</td>
</tr>
<tr>
<td>CC - General Service</td>
<td>stainless steel</td>
</tr>
<tr>
<td>DD - Sour Service</td>
<td>carbon or low-alloy steel</td>
</tr>
<tr>
<td>EE - Sour Service</td>
<td>carbon or low-alloy steel</td>
</tr>
<tr>
<td>FF - Sour Service</td>
<td>stainless steel</td>
</tr>
<tr>
<td>HH - Sour Service</td>
<td>CRAs</td>
</tr>
</tbody>
</table>

**Notes:**

- As defined by NACE MR0175/ISO 15156. In compliance with NACE MR 0175/ISO 15156.
- In compliance with NACE MR0175/ISO 15156.
- CRA required on retained fluid wetted surfaces only; CRA cladding of low alloy or stainless steel is permitted.
- CRA as defined in clause 3 of this International Standard; NACE MR 0175/ISO 15156 definition of CRA does not apply.

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**Which API 6A Wellhead requirements do we need to apply?**

Feb. 19 – 22, 2012

2012 Gas Well Deliquification Workshop

Denver, Colorado
Which API 6A Wellhead requirements do we need to apply?

API 6A Ring Gaskets

API 6A Designations for Metallic Ring Gaskets are correlated to the appropriate seat.

Ring Gaskets must be replaced if seal is broken, they can not be reused.

PER API/ANSI 6A/ISO 10423:2009 REVISION 20 OCT 2010
Which API 6A Wellhead requirements do we need to apply?

### API 6A Temperature Class Design

<table>
<thead>
<tr>
<th>Temperature Classification</th>
<th>Operating Range</th>
<th>Celsius</th>
<th>Fahrenheit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>K</td>
<td></td>
<td>-60</td>
<td>82</td>
</tr>
<tr>
<td>L</td>
<td></td>
<td>-46</td>
<td>82</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>-46</td>
<td>60</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>-29</td>
<td>82</td>
</tr>
<tr>
<td>R</td>
<td>Room Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td>-18</td>
<td>60</td>
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<tr>
<td>T</td>
<td></td>
<td>-18</td>
<td>82</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>-18</td>
<td>121</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td>2</td>
<td>121</td>
</tr>
<tr>
<td>X*</td>
<td></td>
<td>-18</td>
<td>180</td>
</tr>
<tr>
<td>Y*</td>
<td></td>
<td>-18</td>
<td>345</td>
</tr>
</tbody>
</table>

Note: Temp Classes may be combined for a broader range * rated working pressure of equipment may be derated for temperature ratings X and Y.
Which API 6A Wellhead requirements do we need to apply?

NACE Documentation & Classification

ACE SSC regions of environmental severity
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American Petroleum Institute

Director of Global Industry Services
What is our Responsibility Today?

Safety, Environment & Optimized Production

Build internal Safe Operating Procedures (SOP) to mitigate risk exposure, reduce the environmental impact and eliminate economic losses due to failures.

Maintain the equipment through regular Service/Maintenance Schedules.

Where possible apply recognized industry standards to define metallurgical requirements, corrosion resistance, processes etc…
What is the Industry’s Responsibility?

1. Minimum Specifications and Guidelines must be set not only for the equipment but also for the safe operation of that equipment.

2. Plunger Lift Lubricator Standards must be governed like any other form of artificial lift or wellhead component.
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