Reliable Bolted Connections in LNG and Refinery Operations

INDUSTRY CHALLENGES

Unplanned shutdowns in LNG, GTL, and refinery environments introduce elevated risk during restart, particularly across critical bolted flange connections. While systems may appear intact following an event, underlying changes in joint behavior can significantly impact sealing performance and long-term reliability.

Restart conditions often combine thermal cycling and pressure fluctuations, creating an environment where the effects of differential thermal expansion, creep, and relaxation can lead to loss of preload, leakage, reduced efficiency, or unplanned downtime.

SOLUTION

To address these challenges, engineered solutions focus on maintaining consistent bolt preload and joint integrity during restart conditions:

1. Compensating for Preload Loss

Solon® Flange Washers (Belleville washers) introduce a controlled spring force into the joint, allowing it to dynamically respond to changes in load. They maintain bolt or gasket stress above the level necessary to prevent leaks, even under embedment, pressure fluctuations, and differential thermal expansion. They help:

- Maintain clamping force during thermal cycling
- Reduce the effects of embedment relaxation
- Preserve gasket seating stress
- Improve resistance to vibration-induced loosening

2. Enhancing Flange Stability

In critical flange applications, incorporating elastic elements such as Belleville washers preserves bolt tension over time, eliminating the need for retightening and minimizing the risk of leaks during startup. These washers are proven to maintain joint integrity in LNG, GTL, and refinery applications under high temperature and high-pressure conditions.

3. Managing Gasket Performance

Proper gasket performance depends on correct material selection and achieving the required initial preload. If preload is insufficient or reduced over time, gasket seating stress can fall below critical levels, increasing the risk of leakage during restart. Incorporating flange washers helps maintain more consistent bolt load, preserving gasket sealing stress and improving long-term joint reliability.

4. Reducing Bolt Load Variation

When bolts are tightened in sequence, each new bolt load causes the flange to rotate or deflect slightly, redistributing stress across the joint. By the time you've gone around the bolt circle, the first bolts may have lost 30–50% of their target load. Multiple tightening passes reduce this, but never eliminate it entirely.

Belleville increased elasticity means each bolt behaves more like a "load-controlled" element rather than a "displacement-controlled" one. When adjacent bolts are tightened and cause flange deflection, the washer in the previously tightened bolt compresses or extends slightly, absorbing the displacement without shedding as much load.

Solon® Flange Washers

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