Trevi Test Method (In-situ PSV Testing)

Overview

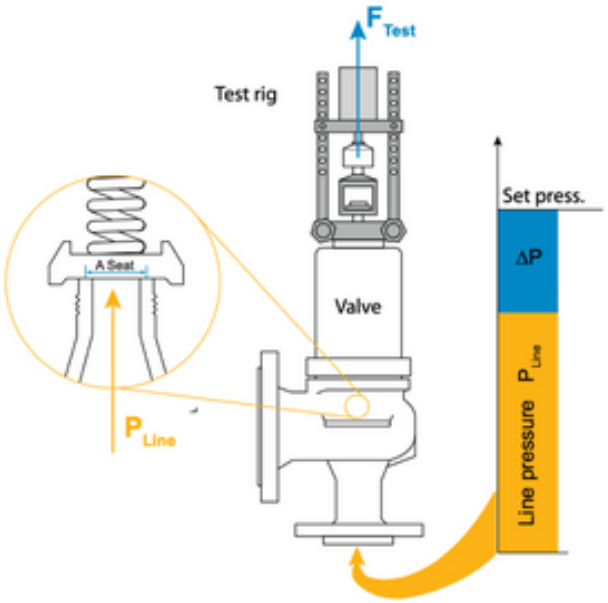
The Trevi Test is an in-situ pressure safety valve testing method that verifies valve set pressure without removing the valve from service and without applying full system pressure [1].

The method employs a hydraulic actuator clamped onto the valve spindle to simulate the spring force required for valve lifting. The set pressure is defined as the value of the increasing inlet static pressure at which a measurable lift of the disc occurs, or at which the discharge of fluid becomes continuous, as determined by direct observation (visual, tactile, or acoustic) [2].

Online/on-site safety valve testing is a win-win solution for the plant operators and the maintenance department. It sustains plant safety and reduces direct testing costs and shutdown times, extending the shutdown interval (plant operation) at the same time.

Technical Introduction

Different online safety valve testing systems follow different technical approaches. Those might be good an efficient or complicated and clumsy, but all of them follow the same physical principle. Every safety valve has a set point that is defined as the moment when it starts to lift. When online, there is a pressure—line pressure—under the safety valves disk. The line pressure is known—it is measured directly by sensors or manometers.



$$P_{set} = P_{line} + \Delta P$$

$$P_{set} = P_{line} + \frac{F_{test}}{A_{seat}}$$

If the pressure difference DP between line pressure and set pressure can be found out, the set pressure can be calculated from:

PSet = PLine + DP

To find DP, lifting equipment – a test rig - is mounted on the safety valve. Pulling on the safety valve spindle, this lifting equipment will overcome the pressure difference DP between line pressure and set pressure and the disc will lift.

Knowing the seat area of the safety valve (from OEM data sheet) and the lifting force, DP as well as the set point is calculated according to above figure. The more line pressure is to be found under a safety valve, the less force will be required to overcome DP. But it is not required to have line pressure.

If there is no pressure, online safety valve technicians talk of a **"cold"** test. Tests carried out with line pressure are called **"hot"** test. Even though testing a safety valve online during plant operation (hot testing) offers the biggest benefits, cold testing during shutdowns offers a significant cost-saving potential as well. Especially in the case of large safety valves that would require a lot of manpower and lifting gear to be moved, the on site test (cold test) is a much better choice.

Numerous technologies are used for determining the opening point and correlation of the applied load. These technologies range from simple audible notification to software-based data analysis, displacement, and acoustic sensors.

Acceptance in the Field

- Trevi Test is recognized in the power generation and process industries as a reliable hot and cold verification method for PSV set pressures [3].
- It is widely applied in line with the guidance of API 576 – Inspection of Pressure-Relieving Devices [4] and consistent with ASME BPVC Section VIII principles for pressure relief devices [5].

API 576 Recommended Practice, 4th edition, 2017, clause 6.2.9.8

After the valve has been adjusted, it should be actuated at least once to prove the accuracy of the setting. Some manufacturers recommend a valve be actuated (popped) at least three times, as the first cycle helps align all of the components after the overhaul while the successive cycles verify the set pressure. Normally, for ASME *BPVC* Section VIII valves, the deviation of the as-found set pressure from the nameplate set pressure should not exceed ±2 psi (±15 kPa) for pressures less than or equal to 70 psi (500 kPa) or ±3 % for pressures greater than 70 psi (500 kPa) [see ASME *BPVC* Section VIII, Division 1, Paragraph UG 134(d)(1)]. For pressure-relief valves that comply with ASME *BPVC* Section VIII, Division 1, Paragraph UG 125(c)(3), the deviation shall not be less than 0 % or greater than +10 %. Any allowance for hot setting should be made in accordance with the manufacturer's data. Any adjustment to the CDTP required to compensate for in-service backpressure, service temperature, or test media should be made in accordance with the manufacturer's or user's valve specification data.

- Independent notified bodies such as Lloyd's Register, TÜV, and Bureau Veritas have validated and accepted Trevi Test results for PSV compliance verification in the industry [6].

Benefits

- Valve removal is not required, thereby reducing outage time, lifting/rigging costs, and risk of flange leakage after reinstallation [2], [6].
- Cost-effective compared to shop testing due to reduced downtime and logistics [3].
- Fast execution – multiple valves can be tested within a single outage window [2].
- Safe, since the system does not need to be pressurized to operating levels [4].
- Traceability – test results are digitally recorded and archived for compliance audits [2], [6].

Limitations

1. To test a safety valve, it must be possible to lift the disk and measure the force when doing so. If a safety valve has a spindle, it is possible in 95% of all cases to test it online. Some valves might require a simple spindle modification. This depends on the valve and the adapter solution for how to “connect“ the test rig. Valves that do not have a spindle at all cannot be tested.
2. If the test is conducted under cold conditions, then actual operating effects such as temperature, back pressure, and system dynamics are not fully replicated [4], [5].
3. Results may differ slightly from hot operating performance, which is why critical valves should also undergo hot testing during service conditions [3].
4. Back-pressure-dependent valves (e.g., balanced bellows type) may not provide accurate results if minimum back pressure cannot be simulated [2].
5. Trevi Test verifies only the set pressure—it does not evaluate seat tightness, blowdown, or complete mechanical integrity of the valve [5].
6. If a safety valve has a spindle, it is possible in 95% of all cases to test it online. Some valves might require a simple spindle modification. This depends on the valve and the adapter solution how to “connect“ the test rig. Valves that do not have a spindle at all can not be tested.

API 576 Recommended Practice, 4th edition, 2017, clause 6.3

> **Caution—This method of checking the set pressure and functioning of a safety valve identifies the opening pressure and should not be considered a routine activity for determining the integrity of the pressure-relieving device. The lift assist test method of checking the set pressure of a pressure-relief valve does not satisfy the need to check for inlet/outlet line fouling or to remove a valve for physical inspection and verification that all of its components are in satisfactory and safe working condition. The lift assist test method also does not verify the valve blowdown setting and seat leakage at 90 % of set pressure of the valve.**

Conclusion

The Trevi Test provides a practical, safe, and industry-accepted method for verifying PSV set pressures in the field [3], [6].

References

1. Trevitest International – Technical Overview of In-situ PSV Testing Methodology https://trevitest.com/
2. Meggitt Sensing Systems – Trevitest Hydraulic Test System Technical Manual https://meggittsensing.com/trevitest/

3. EPRI (Electric Power Research Institute) – Field Validation of In-situ PSV Testing Methods https://www.epri.com/research/products/000000000001024519
4. API 576: Inspection of Pressure-Relieving Devices, American Petroleum Institute- https://www.api.org/products-and-services/standards/important-standards/api-576
5. ASME Boiler & Pressure Vessel Code, Section VIII – Pressure Vessels https://www.asme.org/codes-standards/find-codes-standards/bpvc-viii-1-pressure-vessels
6. TÜV & Lloyd's Register – Certification and Acceptance of In-situ Trevi Test for PSV Verification, TÜV: https://www.tuvsud.com/en/industries/energy/pressure-equipment/pressure-relief-devices, Lloyd's Register: https://www.lr.org/en/insights/articles/pressure-relief-valves-testing-certification/