SAFETY MEMO

March 20th, 2023 – Pressure Relief Scenarios

Did you know?

*This is **the final installment** of a multi-part series on Pressure Safety Valves. Always ensure you are following appropriate jurisdictional codes and standards when designing systems with pressure safety valves.*

Pressure Relief Scenarios

Pressure relief devices are specialized equipment designed to protect equipment from failure of high pressure resulting from an emergency or abnormal operating condition. These are referred to as pressure relief scenarios. Depending on the jurisdiction, safety codes provide guidance on determination of pressure relief scenarios. This memo is specific to the guidance provided in API 521[1] and defines 16 common relief scenarios and includes guidance on determining relief rates. Additional reference guides include CSA B52 and the Mechanical Refrigeration Code.

16 Common Relief Scenarios

1. **Closed Outlet on Vessel:** usually caused by a closed valve but can also be caused by plugging or similar condition.
2. **Cooling Water Failure:** typically, on a condenser where there is a loss of condensing but can apply to other equipment. Loss of condensing causes excess vapor load, increasing pressure.
3. **Top-Tower Reflux Failure:** applicable to a distillation column where reflux is occurring. Loss of reflux causing excess vapor load, increasing pressure.
4. **Sidestream Reflux Failure:** same as scenario #3 but in a side stream.
5. **Lean-Oil Failure to Absorber:** applicable when absorbing / loss of absorbent causes excess vapor load, increasing pressure. An example of it would be in an acid gas removal unit in which large quantities of the inlet vapor can be removed in the absorber (25% or more).
6. **Accumulation of Non-condensables:** Can be caused by air blows, nitrogen blanketing, or any other addition of non-condensable gas which builds up and causes an increase in pressure.
7. **Entrance of Highly Volatile Material:** typically, this is water into hot oil, but can also be a lighter oil or other volatile liquid into hot material. The lighter material is rapidly vaporized, increasing pressure.
8. **Overfilling Storage or Surge Vessel:** when pumping into a tank and there is a controls or instrumentation failure, the vessel may overfill.
9. **Failure of Automatic Controls:** This scenario is any control failure which can cause an increase in pressure. It can be considered for individual controls (such as failed level instrument or failed valve) or global failure, such as complete failure of plant network, PLC, or other large-scale failure.
10. **Abnormal Heat or Vapor Input:** typically, too much heating is applied through a heat exchanger, such as a steam valve failing open.
11. **Heat Transfer Equipment Failure:** this scenario is for a shell and tube heat exchanger or any exchanger with an internal leak, causing material from the high-pressure side enter the low-pressure side.
12. **Internal Explosions:** need to consider either flammable / combustible liquid or dusts igniting and causing an explosion inside equipment. Rupture disk or vent panels should be used in this situation.
13. **Chemical Reaction:** this scenario is any chemical reaction that can occur inside equipment with loss of process control, resulting in heat, vapor, and thus pressure increase.
14. **Hydraulic Expansion:** this scenario can be caused by an increase in liquid volume caused by an increase in temperature. Typically caused by blockage in equipment filled with cold liquid that is than heated (either by ambient heat gain or a heating fluid)
15. **Exterior Fire:** this scenario is considering a fire that occurs on the ground near equipment leading to boiling of liquid content or decomposition reaction.
16. **Power Failure:** similar to a control failure but for power. It must be considered for individual equipment or global failure such as plant wide power failure.

Summary

The above relief scenarios are just a guide; engineering judgement needs to be used to determine which scenarios apply to equipment and if any scenarios are additional to the examples. For all valid cases, calculations must be performed to determine the required relief rate and thus size the appropriate relief device. For jurisdictions which do not require adherence to API 521, the local safety codes must be referenced for guidance on pressure relief scenarios.

Figure 1:example of tank failure (iStock image)

[1] American Petroleum Institute. 2020. API Standard 521. Seventh Edition. API Publishing Services.