API 521 8th Edition Ballot Item 2

Sweep Gas for Flare Network
(Work Item 10)

Instructions to Voters/Commenters

- Please limit your comments to the red- or blue- lined portions of the ballot only. Note that red indicates modifications to the existing wording, whereas blue indicates new text.
- If you are voting negative with multiple comments, please indicate which comment(s) is the reason for your negative vote, otherwise API's balloting system will categorize all of your comments as negative.
- **Important Note:** This is the first ballot on this work item, and it is expected to be primarily for comments.

Thanks to Justin Poepsel and the work group for their efforts.

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API 521 Task Force Chairs

Proposed Modification 1: Add New Definition in Section 3.1:

3.1.xx
sweep gas
Non-condensable flammable or inert gas added at the flare header collection system extremities or at individual flow sources to move (i.e., sweep) undesirable material (e.g., moisture, corrosive chemicals, etc.) out of the flare system (e.g., laterals from PRDs and other vents, subheaders, or flare headers). This gas may also serve as purge gas. Compare to **purge gas**.

NOTE 1: Sweep gas is defined here for consistent usage within the context of this standard. Individual owner/operators and manufacturers may use different terms to refer to sweep gas and sweep gas usage.

NOTE 2: Local regulations may define and use the term sweep gas differently than the definition and usage in this standard.

Proposed Modification 2: Revise Definition in Section 3.1.59:

3.1.59
purge gas
~~Flammable gas or noncondensable inert gas added to the flare header to mitigate air ingress and burnback.~~

Non-condensable flammable or inert gas added upstream of the flare stack to ensure positive flow out of the flare tip to mitigate air ingress and burnback. Compare to **sweep gas**.

NOTE 1: Purge gas is defined here for consistent usage within the context of this standard. Individual owner/operators and manufacturers may use different terms to refer to purge gas and purge gas usage.

NOTE 2: Local regulations may define and use the term purge gas differently than the definition and usage in this standard.

Proposed Modification 3: Add Definition to Section 3.1 for Makeup Gas:

3.1.xx
makeup gas
Non-condensable flammable or inert gas added at the flare header collection system extremities or at individual flow sources to add volume to counter vacuum formation after rapid cooling or condensation of flare gas to prevent air ingress from the flare tip which may create a flammable air-hydrocarbon mixture inside the flare system.

NOTE 1: Makeup gas is defined here for consistent usage within the context of this standard. Individual owner/operators and manufacturers may use different terms to refer to makeup gas and makeup gas usage.

NOTE 2: Local regulations may define and use the term makeup gas differently than the definition and usage in this standard.

Proposed Modification 4: Revise Section 5.7.6 Purging:

5.7.6 ~~Purging~~ Purge Gas, Sweep Gas, and Makeup Gas

Refer to Fig. X.

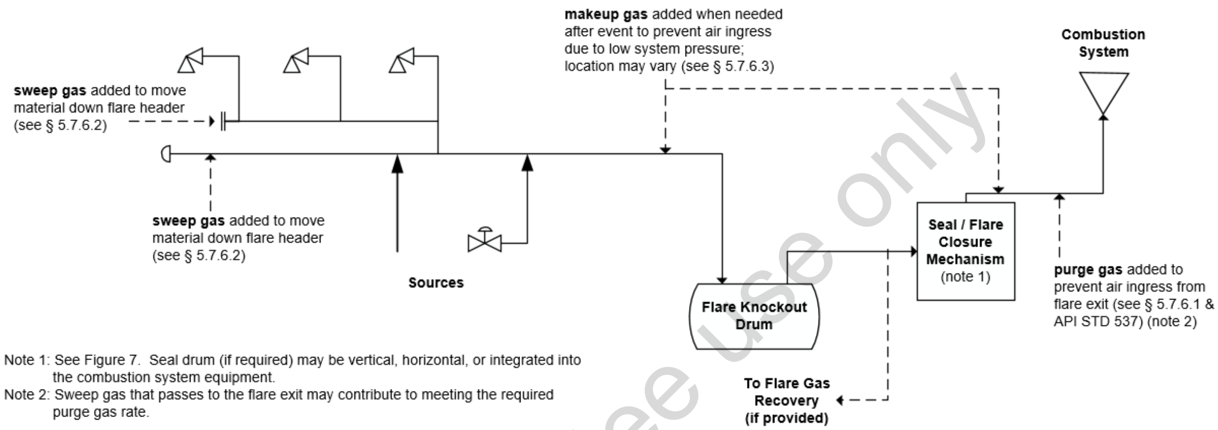

Figure X: Example of purge gas, sweep gas, and makeup gas addition.

5.7.6.1 Flare Stack Purge

See API 537.

~~5.7.6.2~~ 5.7.6.1.1 Other Purging Requirements

Note that purge rates higher than those ~~given by API 537~~ provided by continuous sweeps or continuous flare burner purges may be required for the following reasons:

a) to establish an initial, air-free condition during start-up;

b) ~~in transient conditions associated with a passing rainstorm cooling down header exposed to the sun;~~ to maintain adequate positive system pressure, limiting air ingress to prevent combustible conditions while performing maintenance activities on an operating flare system;

c) ~~after venting a hot condensable release into the flare header;~~ to mitigate undesirable conditions (e.g., presence of combustibles, oxygen, condensables, corrosives) between flaring events on flares that are designed to operate intermittently without a continuous purge (e.g., post-purge of a staged flare downstream of the stage isolation valves).

~~d) after venting a stream containing significant amounts of compounds that are easily detonated or have unusually wide flammability limits.~~

Gases or vapors with unusually high burning velocities, such as hydrogen and acetylene, should be evaluated for the possibility of flashback (see API 537).

5.7.6.2 Sweep Gas

Sweep gas provides gas flow into the system during normal operation from the source toward the flare equipment. The flow of gas may be added at the flare header piping extremities or individual sources (e.g., at the outlets of individual PRDs or vents connected to the flare header). Sweep gas may be continuous or intermittent (e.g., after actuation of a PRD or other device that discharges undesirable material into the header). The gas used may be either an inert gas (such as nitrogen) or a flammable gas (e.g., facility fuel gas or natural gas).

Sweep gas may be used for the following purposes:

- Assist in the evaporation of residual liquids within the flare piping to keep the system dry
- Reduce internal corrosion by diluting the concentration of corrosive gases and moving these gases into downstream systems
- Reduce internal fouling and deposits due to interaction between chemical components within streams entering the flare system
- Provide indication of flare collection system obstructions

- Sweeping discharge piping after venting a stream containing significant amounts of compounds that are easily detonated or have unusually wide flammability limits;
- Remove residual traces of oxygen that may be present in the flare header piping (for example):
  - leakage or addition into the flare from processes containing oxygen e.g.,
    - air ingress into vacuum systems
    - nitrogen generated through membrane separation or Pressure Swing Adsorption (PSA) of air
  - in-leakage from flange connections in flare header piping and valves that may see vacuum, (e.g., through gaskets, stem packing, body seals, or damaged bellows).

Sweep gas can also provide a baseline flow for meeting the flow requirements of purge and assist gas at the flare drum and stack. However, when a flare gas recovery system is present, the flare closure mechanism will prevent sweep gas from reaching the flare tip so purge gas addition downstream of the closure mechanism may be required. Note: The effect of inert sweep gases on flare gas heating values when using inert sweep gas as a baseline flow should be evaluated as it could result in low heating value gasses reaching the flare.

Velocity criteria are typically used for setting sweep gas rates and are dependent on the process service and purpose. It is up to the user to determine the most suitable criteria when considering the above guidelines. Minimizing the flow rate while still achieving the necessary sweep performance lessens the impact of the added sweep gas on flare gas recovery systems and/or flare emissions.

5.7.6.3 Makeup Gas

A flare header system is subject to vacuum formation and/or reverse flow from the flare exit after hot relief when the flare gases rapidly cool and/or condense (e.g., rainstorm). Makeup gas should be provided to prevent air ingress from the flare tip which may create a flammable air-hydrocarbon mixture inside the header. The pilot or active ignitor provides a source of ignition. A continuous purge for the seal (if any) is usually not sufficient for rapid cooling cases, but can help reduce the required makeup gas. Cold releases which can warm in the header generally do not require makeup since the gas expands as it warms. API-537 discusses alternative mitigation such as seal drums or flare burner staging valves but the alternative designs should be analyzed and provide for the effects of cooling or condensation.

The primary cooling mechanisms are from ambient air/rain or from a cold header.

a) Cooling from ambient temperature or rain with only gas cooling is limited by the inside heat transfer coefficient. If condensation of the gas occurs, the outside heat transfer coefficient (e.g., from rain) becomes more important

b) Cooling from a cold header may occur when a warmer gas is released to a colder header. Typically, the header had been cooled by a previous cold relief. This situation is most common in plants processing cryogenic fluids such as LNG and ethylene. Condensation may also occur which increases the makeup gas rate

The addition of makeup gas performs three functions:

a) Makeup gas will compensate for volume contractions due to cooling and condensation

b) Makeup gas will mix with header gas and potentially increase the dew point range, thus avoiding full or partial condensation

c) Makeup gas injected upstream, if cooler than the header gas, will lower the temperature of the header gas reduce the cooling effect

The designer should consider six design parameters. Dynamic simulation is a preferred method for the analysis.

a) The cooling mechanisms

b) Types of sensors to detect relief. In general, pressure and oxygen sensors are not recommended since they measure the existing condition of vacuum and oxygen. Temperature and/or temperature differences are preferred. Flow measurement may supplement other parameters

c) Location of sensors should be as close to the source of cooling, generally at the location of the hot release into the header

d) Location of makeup gas injection should be upstream and as close to source of cooling, generally at the location of the hot release into the header

e) Starting and stopping of makeup gas. Dynamic simulation facilitates the decisions. Starting as injection depends on the mechanism and parameters used to measure. The gas injection can be stopped after a predetermined time or based on other factors

f) Makeup gas flow rates depend on above decisions. The makeup gas rate will not generally equal to the rate of air ingress due to effects of mixing with header gas

The makeup gas should be highly reliable, and the injection rate should be controlled to ensure the supply is not subject to instrument malfunction or maladjustment. See API-537.

~~6.7.6.3 Control of Purge Rate~~ 5.7.6.4 Control of Purge Gas and Sweep Gas Rate

Once the required quantity of purge gas and sweep gas has been established, the injection rate should be controlled by a fixed orifice, rotameter, or other device that ensures the supply remains constant and is not subject to instrument malfunction or maladjustment. ~~Consult the vendor to determine purge rates to prevent burning inside the flare tip.~~

Facilities required for the control of continuous purge gas addition may be different than those required for intermittent gas addition.