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Standard Practice

Refinery Injection and Process Mix Points

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Foreword

Corrosion at locations where two streams mix has caused significant failures in the petroleum refining industry over the years. This NACE standard addresses the unique nature of injection points and process mix points, in both design and inspection. This standard discusses typical material selection, corrosion concerns, and successful design and inspection practices used in petroleum refinery injection point and process mix point systems.

This standard was originally prepared as a technical committee report in 2001 by NACE Task Group (TG) T-8-21, "Refinery Additives Injection Facilities," administered by Group Committee T-8, "Petroleum Refining and Gas Processing." In 2014, TG 174 (formerly T-8-21) prepared this standard to replace the previous technical committee report NACE Publication 34101. TG 174 is administered by Specific Technology Group (STG) 34 (formerly Group Committee T-8), "Petroleum Refining and Gas Processing." This standard is issued by NACE under the auspices of STG 34.

In NACE standards, the terms *shall, must, should,* and *may* are used in accordance with the definitions of these terms in the *NACE Publications Style Manual.* The terms *shall* and *must* are used to state a requirement, and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

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Contents

Section 1: General

Injection points and process mix points for several typical refinery process streams are addressed in detail. The discussion of process mix points is limited to primary process streams, and considers only changes in temperature, pH, phase changes, and the concentration of corrosive species. Additional information is included in the Appendixes A through E (Nonmandatory).

Section 2: Definitions

Caustic Compounds or Caustic—caustic, or caustic soda, or more formally, sodium hydroxide is a strong ionic chemical base. Other bases, such as potassium hydroxide, also fall into the category of caustic compounds.

Carrier or Diluent—a nonreactive stream that is combined with an injected chemical (e.g., amine neutralizer) to increase the volume flow through an injection device, improving control, distribution, mixing, and/or reducing injection device fouling.

Drop Size Distribution—the size distribution of drops, typically expressed by the size vs. cumulative volume (in percent).

Chemical Injectant—process additive or other process stream that is added to a process stream in small quantities, for control of corrosion, fouling, pH, or other chemical property of a process stream. Wash water is also a chemical injectant, but is typically added in larger quantities than other process additives.

Injection Point—locations where chemicals, or process additives, are introduced into a process stream. Corrosion inhibitors, neutralizers, process antifoulants, desalter demulsifiers, hydrogen, oxygen scavengers, caustic, and water washes are most often recognized as requiring special attention during injection point design.

Mix Points—mix points are points of joining of process streams of differing composition and/or temperature where additional design attention, operating limits, and/or process monitoring are utilized to avoid damage mechanisms (e.g., corrosion). See also definition for Process Mix Point.

Mixing Quill/Quill—hardware, including piping that intrudes into the main process stream, designed to optimize distribution of the injectant into the process stream. The quill itself is a thin hollow probe designed to deliver an injectant into a pressurized receiving stream, promoting improved dispersion/absorption of the injectant into the receiving stream.

Process Mix Point—the locations where two process streams of differing chemical or physical (e.g., temperature, pressure, and phase) properties join at a piping tie-in.

Reynolds Numbers (Re)—dimensionless parameter used to characterize flow regimes, such as laminar flow, which occurs at low Re numbers where viscous forces are dominant, or turbulent flow, which occurs at high Re numbers where inertial forces are dominant. Software programs are available that facilitate calculating Re.

Shock Condensation—condensation of liquid phase out of a vapor stream as the result of mixing a lower-temperature stream with a higher-temperature vapor stream. When the resultant local temperature drops below the water or acid gas dew point of the combined stream, condensation may occur, which may result in localized or general metal loss.

Sparger—a perforated pipe designed to promote even distribution of gas in a liquid stream.

Spray Nozzle—a precision device that facilitates dispersion of liquid into a spray. Nozzles are used for three purposes: increase liquid surface area to enhance evaporation/dispersion/mass transfer; to distribute a liquid over a cross-sectional area; and/or to wet pipe walls downstream from the injection point.

Thermal Fatigue—a cracking mechanism caused by repeated thermal cycling.

Water Wash Injection—injection of water into process streams on a continuous or intermittent basis to: introduce water upstream from the salt deposition temperature, remove salt deposits that foul and/or can cause corrosion, or dilute a condensing stream to make it less corrosive.

Section 3: Design Guidelines

3.1 Process Considerations—Injection and process mix points are process tie-ins. They differ from other process tie-ins because they have the potential to compromise mechanical integrity. They typically meet one or more of the following criteria:

(a) Mix two distinctly separate streams;

(b) Promote chemical or physical reactions when mixing the constituents of two or more process streams;

(c) Scrub or extract constituents of one stream by contact with another stream;

(d) Heat or cool one process stream by direct contact with another stream (including flashing or quenching);

(e) Adding chemical additives to a process stream to adjust pH or improve on process operations; or

(f) Wetting internal surfaces of process equipment to inhibit corrosion.

3.1.1 During initial process design, injection points and process mix point systems (including fabrication details) shall be reviewed in detail. A thorough safety review (e.g., hazard and operability [HAZOP]) should be conducted. A data sheet should be generated for all injection points. A sample is provided in Appendix C. The owner shall ensure that injection system equipment is adequate and meets plant standards. It is also the owner's responsibility to ensure that mechanical integrity of the equipment be maintained.

3.1.2 Engineering design guidelines shall be based on successful industry and user experiences. Computational fluid dynamic (CFD) simulations of injection or process mix points may be used to improve understanding of the design's impact on system integrity.

3.1.3 Process simulation of refinery operating environments may be necessary to determine the impact of the mixing of the streams on variables important to the corrosiveness of the stream (e.g., mass flow, temperature, pressure drop, nozzle positioning and orientation, fluid type, and fluid density).

3.2 Continuous vs. Intermittent Water Wash Injection

3.2.1 When corrosion control is the primary consideration, continuous water injection shall be used. Continuous water wash in overhead lines has the advantage of requiring less operator interaction, continuously washing away corrosive agents, and avoiding wet/dry cycling in high corrosion potential zones. The disadvantage is that although water was injected to reduce the concentration of corrosive species, the system is now continuously wet, allowing corrosion, albeit at lower rates, to be continuous.

3.2.2 If fouling control is the only objective, wash water availability is limited, and where there is little risk of corrosion, intermittent injection rather than continuous injection may be sufficient. When process system pressure drop limitations exist, intermittent wash water injection may be used. The use of intermittent injections, though, must consider the potential impact of increased corrosion during the cycle of injection and for the potential build-up of corrosive salts and subsequent under-deposit corrosion.

3.2.3 When water is injected into a vapor stream, designs should ensure that sufficient liquid water remains after flashing to dilute corrosive species to a manageable level at the process maximum operating temperature. Typical targets are 25% of the injected water remaining liquid after the injection point.

3.3 Carrier or Diluent Fluids

3.3.1 If limiting the injectant chemical concentration is critical, or if increasing total volumetric flow of the injectant stream is required to obtain good dispersion, then a carrier (diluent) fluid shall be used.

3.3.2 Carrier fluids should be nonreactive and maintain sufficient phase stability within the injection device. Light gas oil, heavy naphtha, water, and steam have been used successfully for various applications. Reflux slip-streams often are used as carrier fluids for injection into overhead systems.