Thermal Reactors for Sulfur Recovery Units in General Refinery Services

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Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

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Introduction

Thermal reactors in sulfur recovery units have the primary function of generating the necessary reactants to maximize sulfur conversion in downstream catalytic reactions.

The high-level reliability and operating goals of a thermal reactor in a sulfur recovery unit are summarized as follows:

a) to ensure pressure containment of hydrogen sulfide, other acid gas, and sulfur-laden streams as they undergo high temperature reactions;

b) to ensure the operating reliability and protection of personnel, the environment, and the equipment through provision of properly designed process control, burner ignition, flame stability, and protective systems;

c) to ensure provision of a burner that is capable of generating the desired amount of SO_2 for the process reaction and accomplish sufficient destruction of contaminants, e.g., ammonia, hydrogen cyanide, hydrocarbons; maintain stable flame over operating range; achieve adequate mixing of inlet streams; and provide the proper means to fire with fuel gas for warm-up, dryout, startup, shutdown, and turndown operations;

d) to ensure an optimal process design that, in addition to modified-Claus process reactions, fully oxidizes all hydrocarbons and destroys sufficient ammonia (NH_3), hydrogen cyanide (HCN), and associated contaminants, while minimizing side reactions that would produce compounds such as carbonyl sulfide (COS), and carbon disulfide (CS_2);

e) to ensure provision of a refractory lining system for the burner, the reaction chamber, the thermal reactor steam generator (TRSG) inlet tubesheet, and the external thermal protective system (ETPS) and any reaction chamber internals that will operate reliably and with a high degree of integrity commensurate with the performance, reliability, integrity, and operating expectations for the sulfur recovery unit.

The fundamental design elements that are required to provide the expected acceptable risk level, reliability, and performance requirements for thermal reactors in sulfur recovery unit (SRU) service specified and supplied using this standard include the following:

— process definition;
— process performance;
— mechanical definition of components and refractory lining systems;
— instrumentation, control, and protective system definition.

A thermal reactor design basis is developed in consideration of the performance expectations, the functional requirements, mechanical details, and instrumentation, control, and protective system definition required to fulfil the operating goals established for each application. The development of a design specification can be advanced using the requirements, guidance and recognized good engineering practice that are identified in this standard.

Sections 5 and 6 provide the basis for design and functional requirements critical to fulfilling these operating goals.

Sections 7 through 11 provide requirements more specific to the equipment components, mechanical details of design, fabrication, and testing.

Section 12 provides the minimum requirements for the design, operation, and maintenance of the instrumentation, control, and protective systems that contribute to the reliable burner ignition and operation of the thermal reactor and associated equipment.

The functional requirements in this standard are supported by the technical guidance provided in Annexes A through G. The technical guidance provided in the informative annexes addresses alternative designs or techniques and provides good practices on the basis of which, through sound engineering judgment, the practitioner can make appropriate design decisions and selections.

Annex D contains a recommended practice for the design, supply, installation, and quality control for burner and thermal reactor refractory lining systems based on a maximum continuous operating temperature of 1565 °C (2850 °F). This maximum continuous operating temperature and refractory lining system specification is considered appropriate for SRU thermal reactors in both air-only and oxygen enrichment operations.

Data sheets and the purchaser's checklist are provided in Annexes H and I, respectively, to properly communicate and preserve the finalized basis of design and requirements.

Users of this standard should be aware that further or differing requirements may be needed for individual applications. This standard is not intended to inhibit a supplier from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the supplier should identify any variations from this standard and provide details.

In API standards, the SI system of units is used. In this standard, where practical, US Customary (USC) units are included in parentheses for information.

A bullet (●) at the beginning of a clause or sub-clause indicates that either a decision is required, or further information is to be provided by the purchaser. This information should be indicated on the purchaser's checklist (see Annex I) or stated in the inquiry or purchase order.

Thermal Reactors for Sulfur Recovery Units in General Refinery Services

1 Scope

This standard provides recognized industry requirements and guidance for the design, specification, fundamental operation, instrumentation, control, safeguarding, and maintenance of sulfur recovery unit (SRU) thermal reactors used in general refinery services.

The scope of this standard includes application in both air-only and oxygen-enriched modified-Claus process operations.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Standards 6FA, *Standard for Fire Test for Valves*

API Standard 598, *Valve Inspection and Testing*

API Standard 607, *Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats*

API Standard 936, *Refractory Installation Quality Control—Inspection and Testing Monolithic Refractory Linings and Materials*

ANSI [1]/FCI [2] 70-2, *Control Valve Seat Leakage*

ASME BTH-1 [3], *Design of Below-the-Hook Lifting Devices*

ASME B30.20, *Below-the-Hook Lifting Devices*

ASTM A123/A123M [4], *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*

ASTM A143/A143M, *Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement*

ASTM A153/A153M, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A307, *Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength*

ASTM A384/A384, *Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies*

ASTM A385/A385, *Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)*

ASTM B633, *Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel*

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2 Fluid Controls Institute, 1300 Sumner Avenue, Cleveland, OH, 44115, www.fluidcontrolsinstitute.org.
3 ASME International, 2 Park Avenue, New York, NY 10016-5990, www.asme.org.
4 ASTM International, PO Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428, www.astm.org.