Materials, Fabrication, and Repair Considerations for Hydrogen Reformer Furnace Outlet Pigtails and Manifolds

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1 Scope

The American Petroleum Institute (API) Committee on Refinery Equipment, Subcommittee on Corrosion and Materials undertook a project to develop this technical report on materials, fabrication, and repair issues related to hydrogen and syngas reformer furnace outlet pigtails and manifolds. High reliability of outlet pigtails and manifold components, such as headers, tees, and fittings, is important to the successful long-term operation of hydrogen and syngas reformer furnaces. These components typically operate at high temperatures in the range of 750 °C to 950 °C (1382 °F to 1742 °F) where they are potentially subject to high-temperature creep, stress relaxation, hot corrosion, and thermal fatigue damage.

In recent years a number of reformer furnace operators have encountered problems of in-service degradation and cracking of outlet pigtails and manifold components, while others have had little or no problems of this type. Both direct experience in addressing specific cases of outlet pigtail and manifold cracking problems and indirect experience gained from surveying industry with regard to these problems were used in preparing this report.

The objective of the project was to develop an understanding, based on published literature and industry experience, of why some reformer furnaces have had problems with embrittlement and cracking of outlet pigtails and manifold components in service, while others have not had such problems.

2 Technical Approach

The project objective was achieved by reviewing relevant published literature and industry experience and then documenting the results of that review in this report. The published technical literature was reviewed using the following four databases:

— ScienceDirect (http://www.sciencedirect.com/),

— Engineering Village 2 (http://www.engineeringvillage2.org/),

— CSA Materials Research Database with METADEX (http://www.csa.com/),

— REFIN*COR 8.0 database (http://www.nace.org/).

The first two databases were available through a library service. The third database was available through The Welding Institute (TWI), while the fourth one was available through NACE International. The proceedings of AIChE Ammonia Plants & Related Facilities Symposia [1-4] were also searched because they were known to contain a number of relevant technical papers. These symposia proceedings are published as searchable CDs, which facilitated identification and review of relevant papers. In addition, literature was obtained through personal contacts with members of the API Subcommittee of Corrosion and Materials and records of roundtable presentations at past API meetings.

Industry was surveyed by sending a questionnaire to key contacts at companies who operate reformer furnaces or provide materials used in outlet pigtails and manifold components. A draft questionnaire was prepared and submitted to the API project committee for review and comment. Recommendations from that review then were incorporated into the final questionnaire. The survey was distributed in two ways. First, API sent it to select members deemed to have an interest in the topic. Second, it was sent to individuals in companies that operate reformer furnaces in other industries or in international refining companies not affiliated with API.

Section 6 of this report lists references to the published literature that is cited herein. The sources of industry comments have been kept anonymous; each respondent is simply identified by a code. The information and