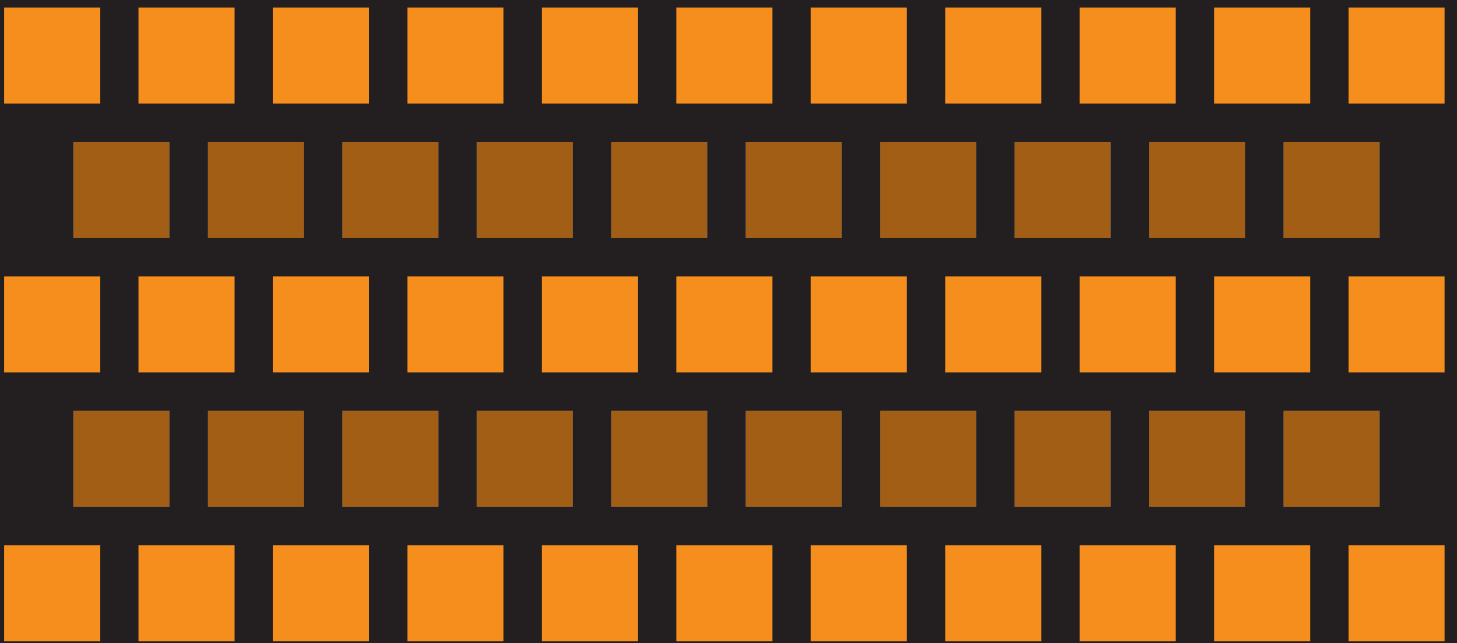


STP-NU-038

INTERMEDIATE HEAT EXCHANGER (IHX)



STP-NU-038

**ASME CODE
CONSIDERATIONS FOR THE
INTERMEDIATE HEAT
EXCHANGER (IHX)**



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TABLE OF CONTENTS

Foreword	vii
Abstract	viii
PART I	1
1 INTRODUCTION	2
2 SCOPE	3
3 REVIEW OF DIFFERENT IHX CONCEPTS	4
3.1 Tubular Helical Coil Heat Exchanger (THCHE)	4
3.1.1 KVK Tubular Helical Coil IHX	4
3.1.2 HTTR Tubular IHX	6
3.2 Compact IHX	7
3.2.1 PSHE	7
3.2.2 PMHE	9
3.2.3 PFHE	10
3.2.4 Two Stage IHX Concept	11
4 Maturity of the Concepts	12
4.1 Tubular Helical Coil Heat Exchanger Maturity	12
4.1.1 Design	12
4.1.2 Fabricability	14
4.1.3 Component Testing	15
4.1.4 Feasibility of AREVA Concept	17
4.2 PSHE Maturity	17
4.2.1 Design	17
4.2.2 Fabricability	18
4.2.3 Component testing	19
4.2.4 Discussion on Feasibility	19
4.3 PMHE Maturity	20
4.3.1 Design	20
4.3.2 Fabricability	20
4.3.3 Component Testing	20
4.3.4 Discussion on Feasibility	20
4.4 PFHE Maturity	21
4.4.1 Design	21
4.4.2 Fabricability	21
4.4.3 Component Testing	21
4.4.4 Discussion on Feasibility	21
5 SURVEY	22
6 MATERIAL CANDIDATES FOR IHX APPLICATIONS	23
6.1 Identification of Candidate Materials	23
6.1.1 Recommendations of Reactor Vendors	23
6.1.2 Other Alternatives	23
6.2 Primary Issues in Materials Selection	26
6.2.1 Core Outlet Temperature	26
6.2.2 Creep Rupture	26

6.2.3	Creep-Fatigue.....	27
6.2.4	Weldability.....	27
6.2.5	Microstructural Stability	27
6.2.6	Corrosion	27
6.3	Issues to be Addressed for Codification	28
6.3.1	Acceptable Materials of Construction	28
6.3.2	Maximum Temperature	29
6.3.3	Maximum Design Life.....	29
6.3.4	Nonclassical Creep	29
6.3.5	Environmental Effects	30
6.3.6	Possible New Failure Mode.....	30
7	Conclusions	31
	References - PART I.....	32
	PART II.....	34
1	INTRODUCTION.....	35
2	CONSIDERED DESIGNS FOR HTR IHX	36
2.1	Helical Tube Design	36
2.2	Compact Stacked Plate IHX designs	36
3	KEY FEATURES OF A CONSTRUCTION CODE	37
3.1	Introduction.....	37
3.2	High Temperature Code Development in the U.S.	37
3.3	High Temperature Code Development in Germany	39
3.4	High Temperature Code Development in Japan	41
3.5	Other Heat Exchanger Code Development.....	42
3.6	Considerations on Safety Classification of the IHX	43
3.7	Issues Raised By the NRC in the Context of High Temperature Design.....	43
3.8	Discussion on the Key Features to be Introduced.....	44
3.8.1	Design	44
3.8.2	Material.....	45
3.8.3	Fabrication	50
3.8.4	Examination of Joints (NDE).....	52
4	TESTS REQUIRED FOR THE QUALIFICATION OF DESIGN METHODS.....	53
4.1	Standard Tests and Extension of Corresponding Database.....	53
4.2	Tests After Thermal Aging	53
4.3	Tests in HTR Helium Environment	53
4.4	Tests on Weldments.....	53
4.5	Mock-Ups to be Tested.....	53
5	REQUIRED IN-SERVICE INSPECTION AND ASSOCIATED NDE.....	54
5.1	Introduction.....	54
5.2	Current PWR ISI Requirements.....	55
5.3	KVK (German) HTR Heat Exchanger ISI Experience	55
5.4	Feasibility of NDE for the Shell and Tube IHX	56

5.5 Compact Heat IHX	56
5.6 Conclusion of ISI Requirements	57
6 ADEQUACY OF EXISTING ASTM SPECIFICATIONS	58
6.1 Standards for Materials	58
6.1.1 Chemical Composition	59
6.1.2 Mechanical Properties	59
6.1.3 Dimensions	60
6.1.4 Heat Treatment	61
6.1.5 Conclusions for Material Specifications	61
6.2 Standards for Testing	63
6.2.1 Time-Independent Data	63
6.2.2 Time-Dependent Data	63
6.2.3 Toughness Data	64
6.2.4 External Pressure Data	64
6.2.5 Cyclic Service Data	65
6.2.6 Other Data	65
6.2.7 Conclusions for ASTM Testing Specifications	67
7 RECOMMENDATIONS IN TERMS OF CODE INFRASTRUCTURE	69
8 CONCLUSIONS	70
References - PART II	71
Appendix A - RETURNED SURVEYS	73
Appendix B - PERTINENT DOCUMENT LIST	79
Acknowledgments	81
Abbreviations and Acronyms	82

LIST OF TABLES

Table 1 - Parameters of KVK Tubular IHX	5
Table 2 - HTTR Tubular IHX Parameters	7
Table 3 - Compositions of Candidate Materials for IHX	25
Table 4 - Mechanical Tests on Hastelloy XR	42
Table 5 - Specified Chemical Analysis of HTR IHX Alloys	47
Table 6 - Code Status of the Different IHX Alloys	47
Table 7 - Selected ASTM Specifications for Alloys 617 and 230	58
Table 8 - ASTM Standards for Measuring Time-Independent Properties of Materials	63
Table 9 - ASTM Standards for Measuring Time-Dependent Properties of Materials	64
Table 10 - ASTM Standards for Measuring Toughness Properties of Materials	64
Table 11 - ASTM Standards for Measuring Stress-Strain Curves of Materials	65
Table 12 - ASTM Standards for Measuring Cyclic Service Properties of Materials	65
Table 13 - ASTM Standards for Measuring Thermal Properties of Materials	66
Table 14 - ASTM Standards for Measuring Elastic Properties of Materials	67

LIST OF FIGURES

Figure 1 - Typical Flow of the Tubular IHX	5
Figure 2 - JAERI Tubular IHX Design	6
Figure 3 - PSHE	8
Figure 4 - PMHE	9
Figure 5 - PFHE	10
Figure 6 - Dual Stage IHX	11
Figure 7 - Misdistribution	12
Figure 8 - Hot Header	14
Figure 9 - Possible Weld Type in a Tubular IHX	15
Figure 10 - View of 10MWth Mock-up for KVK Facility	16
Figure 11 - Stamped Plate	19
Figure 12 - Ceramic Compact Heat Exchanger Using Ceramatec's LOM Process	25
Figure 13 - Creep-Rupture Strength of Alloys 617 and 230 as a Function of Temperature and Time to Fail	26
Figure 14 - Schematic of Classical Creep Strain as a Function of Time	29
Figure 15 - Schematic of Nonclassical Creep Strain as a Function of Time	30
Figure 16 - Comparison Creep Stress to Rupture	41
Figure 17 - Typical Compact IHX Module Arrangement	54
Figure 18 - Typical Tubular IHX	55
Figure 19 - Schematic of KVK Eddy Current Delivery in the Helical IHX	56

FOREWORD

This document is the result of work resulting from Cooperative Agreement DE-FC07-05ID14712 between the U.S. Department of Energy (DOE) and ASME Standards Technology, LLC (ASME ST-LLC) for the Generation IV (Gen IV) Reactor Materials Project. The objective of the project is to provide technical information necessary to update and expand appropriate ASME materials, construction and design codes for application in future Gen IV nuclear reactor systems that operate at elevated temperatures. The scope of work is divided into specific areas that are tied to the Generation IV Reactors Integrated Materials Technology Program Plan. This report is the result of work performed under Task 7 titled “ASME Code Considerations for the Intermediate Heat Exchanger (IHX).”

ASME ST-LLC has introduced the results of the project into the ASME volunteer standards committees developing new code rules for Generation IV nuclear reactors. The project deliverables are expected to become vital references for the committees and serve as important technical bases for new rules. These new rules will be developed under ASME’s voluntary consensus process, which requires balance of interest, openness, consensus and due process. Through the course of the project, ASME ST-LLC has involved key stakeholders from industry and government to help ensure that the technical direction of the research supports the anticipated codes and standards needs. This directed approach and early stakeholder involvement is expected to result in consensus building that will ultimately expedite the standards development process as well as commercialization of the technology.

ASME has been involved in nuclear codes and standards since 1956. The Society created Section III of the Boiler and Pressure Vessel Code, which addresses nuclear reactor technology, in 1963. ASME Standards promote safety, reliability and component interchangeability in mechanical systems.

Established in 1880, the American Society of Mechanical Engineers (ASME) is a professional not-for-profit organization with more than 127,000 members promoting the art, science and practice of mechanical and multidisciplinary engineering and allied sciences. ASME develops codes and standards that enhance public safety, and provides lifelong learning and technical exchange opportunities benefiting the engineering and technology community. Visit www.asme.org for more information.

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ABSTRACT

Part I - Review of Current Experience on Intermediate Heat Exchanger

This report will first review the different concepts of intermediate heat exchanger (IHX) that could be envisioned for HTR/VHTR applications in a range of temperatures from 850 to 950°C. This will cover shell-and-tube and compact designs (including the plate-fin concept). The review will then discuss the maturity of the concepts in terms of design, fabricability and component testing. This report will also discuss material candidates for IHX applications and will discuss specific issues that will have to be addressed in the context of the HTR design.

Part II - Recommended Code Approach for Intermediate Heat Exchanger

This report is providing recommendations in terms of Code approach for the Intermediate Heat Exchangers envisioned for High Temperature Gas-Cooled Reactors. The report will address the following:

- Recommend key features of a construction code needed to address the unique issues associated with the VHTR IHX and associated equipment
- Identify the tests which should be required to establish cyclic life or to calibrate design methods
- Identify required in-service inspection and associated NDE
- Review the adequacy of existing ASTM specifications for materials, testing, examination, etc. to determine if any new standards will need to be developed to support IHX design, fabrication, operation or inspection.
- Provide recommendations in terms of Code infrastructure.

PART I

Review of Current Experience on Intermediate Heat Exchanger

1 INTRODUCTION

This report reviews the current experience on various high temperature reactor intermediate heat exchanger (IHX) concepts. There are several different IHX concepts that could be envisioned for HTR/VHTR applications in a range of temperatures from 850 to 950°C. The concepts that will be primarily discussed herein are:

- Tubular Helical Coil Heat Exchanger (THCHE)
- Plate-Stamped Heat Exchanger (PSHE)
- Plate-Fin Heat Exchanger (PFHE)
- Plate-Machined Heat Exchanger (PMHE).

The primary coolant of the NGNP is potentially subject to radioactive contamination by the core as well as contamination from the secondary loop fluid. Intermediate heat exchangers (IHXs) have been proposed as a means of separating the primary circuit of the NGNP or other process heat application from the remainder of the plant in order to isolate the radioactivity and minimize radiation doses to personnel as well as protect the primary circuit from contamination.

2 SCOPE

This report will first review the different concepts of IHX that could be envisioned for HTR/VHTR applications in a range of temperature from 850 to 950°C. This will cover shell-and-tube and compact designs (including the plate-fin concept). The review will then discuss the maturity of the concepts in terms of design, fabricability and component testing (or feedback from experience when applicable). Particular attention will be paid to the feasibility of developing the IHX concepts for the NGNP with operation expected in 2018-2021. This report will also discuss material candidates for IHX applications and will discuss specific issues that will have to be addressed in the context of the HTR design (thermal aging, corrosion, creep, creep-fatigue, etc). Particular attention will be paid to specific issues associated with operation at the upper end of the creep regime.