

Materials for Storing and Handling Commercial Grades of Aqueous Hydrofluoric Acid and Anhydrous Hydrogen Fluoride

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of AMPP.

Materials for Storing and Handling Commercial Grades of Aqueous Hydrofluoric Acid and Anhydrous Hydrogen Fluoride

This AMPP technical report represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he or she has adopted the technical report or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this technical report. Nothing contained in this AMPP technical report is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by letters patent, or as indemnifying or protecting anyone against liability for infringement of letters patent. This technical report represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this technical report intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this technical report in specific instances. AMPP assumes no responsibility for the interpretation or use of this technical report by other parties and accepts responsibility for only those official AMPP interpretations issued by AMPP in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this AMPP technical report are responsible for reviewing appropriate health, safety, environmental, and regulatory documents and for determining their applicability in relation to this technical report prior to its use. This AMPP technical report may not necessarily address all potential health and safety problems, or environmental hazards associated with the use of materials, equipment, and/or operations detailed or referred to within this technical report. Users of this AMPP technical report are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities, if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this technical report.

CAUTIONARY NOTICE: AMPP technical reports may be revised or withdrawn at any time in accordance with AMPP standards committee procedures. The user is cautioned to obtain the latest edition. Purchasers of AMPP technical reports may receive current information on all AMPP publications by contacting AMPP Customer Support, 15835 Park Ten Place, Houston, TX 77084-5145 (Telephone: 281-228-6200, email: customersupport@ampp.org).

Document History:

- 2022-09-20: Revised by AMPP Standards Committee (SC) 06, Process Industries
- 2007: Revised by NACE International Task Group (TG) 358
- 2001: Revised by NACE TG 140
- 1995: Revised by NACE TG T-5A-36
- 1993: Revised by NACE TG T-5A-23
- 1971: Prepared by NACE Work Group T-5A-11b, a component of Task Group (TG) T-5A-11 and Unit Committee T-5A on Corrosion in Chemical Processes

AMPP values your input. To provide feedback on this standard, please contact: standards@ampp.org

NACE TR5A171-2022

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved.

Materials for Storing and Handling Commercial Grades of Aqueous Hydrofluoric Acid and Anhydrous Hydrogen Fluoride

Foreword, Scope, Rationale	5
Referenced Standards and Other Consensus Documents	6
Introduction	7
Safety	7
Materials Commonly Used	8
HF Manufacture	8
Storing and Handling	8
Materials Characteristics—Metals and Alloys.....	9
Aluminum and Its Alloys.....	9
Carbon and Low-Alloy Steel	10
Cast Irons	13
Stainless Steel	13
Copper Alloys.....	13
Nickel-Rich Alloys	14
Nickel-Based Alloys	14
Reactive Metals	15
Precious Metals	15
Cast Alloys.....	15
Materials Characteristics—Nonmetallic Materials	16
Organic Materials	17
Inorganic Materials	19
Other Referenced Documents.....	19
Bibliography	21
Appendix A Metals and Alloys Mentioned in Text	22
Appendix B Corrosion Rate Data	23
Figure 1	
Figure 1 Metals and Alloys for HF Service: Regions Where Observed Corrosion Rates Are 0.51 mm/y (20 mpy) or Less.....	9
Figure 2 HF Corrosion Data for Carbon Steel at 21 to 38 °C (70 to 100 °F).....	10
Figure 3 Corrosion of Carbon Steel in AHF Liquid and Vapor over a Range of Temperatures	11

Figure 4	Stainless Steel, Nickel-Rich, and Nickel-Based Alloys for HF Service.....	14
Figure 5	Plastics and Elastomers in HF Service	16
Figure B1	Temperature Calculated to Induce Corrosion Rate of 20 mpy (0.5 mm/y) in Reagent Grade HF Solution (up to 30 wt.%).....	28
Figure B2	Temperature Calculated to Induce Corrosion Rate of 20 mpy (0.5 mm/y) in Reagent Grade HF Solution (up to 48 wt.%).....	28
Tables		
Table 1	Materials Commonly Used for Storing and Handling Commercial Grades of AqHF and AHF	8
Table A1	UNS Numbers of Metals and Alloys Mentioned in the Text.....	22
Table B1	Corrosion Rate Data for Various Metals and Alloys in HF Service mm/y (mpy).....	23
Table B2	Corrosion Rate of ALLOY 400 Alloy in Reagent Grade HF	29
Table B3	Corrosion Rate of C-276 Alloy (N10276) in HF Acid	30
Table B4	Corrosion Rate of C-22 Alloy (N06022) in HF Acid	31
Table B5	Corrosion Rate of C-2000 Alloy (N06200) in HF Acid	32
Table B6	Corrosion Rate of C-22HS Alloy (N07022) in HF Acid	33
Table B7	Corrosion Rate of HYBRID-BC1 Alloy (N10362) in Reagent Grade HF	34

Foreword

Scope

This AMPP technical report presents general information on materials commonly used for storing and handling commercial grades of aqueous hydrofluoric acid (AqHF) and anhydrous hydrogen fluoride (AHF). Some materials generally avoided are also discussed. This report is intended for end users, designers, and suppliers of equipment for use with AqHF and AHF. These include, among others, workers in process industry plants, engineering and construction designers, and suppliers of equipment such as pumps, valves, and hoses. This information is useful for initial design and for cost estimates of equipment to handle most commercial AqHF and AHF. The report addresses AqHF and AHF purchased to normal commercial quality that do not contain impurities liable to affect their inherent corrosion characteristics. Testing in the service environment typically indicates a material's suitability for use with AqHF and AHF. This report does not include all materials that might be resistant and is not intended to limit the consideration and testing of other materials.

Rationale

This report replaces NACE Publication 5A171 (2007 version). This version updates information related to non-metallic performance, aligned with updates to API 751 and introduces additional corrosion rate tables.

The chemical symbol for hydrogen fluoride is HF. Throughout this report, the term "HF" is used to mean the presence of hydrogen fluoride in any form or as a component in any stream. The term "AqHF" is used to mean a solution of some percentage of HF dissolved in water. If a percentage designation is associated with the term "AqHF," it denotes the weight percentage concentration of HF in the water (aqueous) solution. The term "AHF" is used to mean a commercial grade of anhydrous HF as a liquefied gas with only specification levels of water present. The term "HF service" is used to mean AqHF and AHF services. It is recognized that both AqHF and AHF sometimes exist in streams with organics or other materials present, which would change the apparent concentrations but have only small effects on the corrosiveness of the HF. In these cases, the context provides an understanding of the resulting effects.

In this report, concentrations of solutions or alloy compositions are understood to be weight percentages unless otherwise indicated.

AMPP technical reports are intended to convey technical information or state-of-the-art knowledge regarding corrosion. In many cases, they discuss specific applications of corrosion mitigation technology, whether considered successful or not. Statements used to convey this information are factual and are provided to the reader as input and guidance for consideration when applying this technology in the future. However, these statements are not intended to be recommendations for general application of this technology and must not be construed as such.