Flame Arresters in Piping Systems

API RECOMMENDED PRACTICE 2028
THIRD EDITION, FEBRUARY 2002

REAFFIRMED, JUNE 2020

AMERICAN PETROLEUM INSTITUTE

Flame Arresters in Piping Systems

Downstream Segment

API RECOMMENDED PRACTICE 2028
THIRD EDITION, FEBRUARY 2002

REAFFIRMED, JUNE 2020

AMERICAN PETROLEUM INSTITUTE

SPECIAL NOTES

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations under local, state, or federal laws.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. Sometimes a one-time extension of up to two years will be added to this review cycle. This publication will no longer be in effect five years after its publication date as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Standards Department [telephone (202) 682-8000]. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this standard or comments and questions concerning the procedures under which this standard was developed should be directed in writing to the API Standards Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the general manager.

API standards are published to facilitate the broad availability of proven, sound engineering and operating practices. These standards are not intended to obviate the need for applying sound engineering judgment regarding when and where these standards should be utilized. The formulation and publication of API standards is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

FOREWORD

This recommended practice was prepared under the direction of the API Safety and Fire Protection Subcommittee. This third edition of API 2028 *Flame Arresters in Piping Systems* has been extensively rewritten and updated from the previous edition. Appendices to the document are intended to provide additional supplementary information.

This guide was prepared to help provide a basic understanding of flame arresters used in piping systems. The information presented is based primarily upon experience in the petroleum industry. It is not intended to exclude or limit the use of other approaches of comparable merit. Because of the special nature of flame arresters, especially those used for detonation protection, this recommended practice strongly encourages dialogue with the equipment supplier and the use of sound engineering judgement in flame arrester selection and application.

CONTENTS

Page

1 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope 1
1.3 Concept of Hazard vs. Risk 1
1.4 Retroactivity 1

2 REFERENCED PUBLICATIONS 1

3 DEFINITIONS 2

4 COMBUSTION AND FLAME PROPAGATION 3
4.1 General 3
4.2 Combustion Rates and MESG 3
4.3 Deflagration 4
4.4 Detonation 4

5 FLAME ARRESTER FUNCTION AND CONCERNS FOR USE IN PIPING SYSTEMS 4
5.1 Flame Arrester Function 4
5.2 Pressure Concerns and Maintenance 4
5.3 Potential Effects of Installation Geometry 5
5.4 Flame Arresters Not Using Metal Elements 5
5.5 Pyrophoric Iron Sulfide Concerns 6
5.6 Unilateral and Bilateral Flame Arresters 6

6 LIMITATIONS OF FLAME ARRESTERS ON TANK VENTS 6

7 FLAME ARRESTER TESTING AND CERTIFICATION 7
7.1 General 7
7.2 Deflagration and Detonation Testing 7
7.3 Flame Retention Testing 7
7.4 Significance of MESG 7
7.5 Use of Established Test Procedures 7

8 SUMMARY 7

APPENDIX A BIBLIOGRAPHY 9
APPENDIX B GASES OR VAPORS WITH A MAXIMUM EXPERIMENTAL SAFE GAP (MESG) < 0.90 MM 11

Flame Arresters in Piping Systems

SECTION 1—INTRODUCTION

1.1 PURPOSE

This recommended practice is intended to inform industry about limitations of flame arresters installed in piping systems. Concerns about potential environmental effects of hydrocarbon and chemical vapor emissions have led to regulations requiring the installation of vapor control systems. In the United States, for marine transfer of oil or hazardous materials, United States Coast Guard regulations require installation of flame arresters (suitable to interrupt a detonation) in vapor control piping. These USCG regulations specifically direct (in detail) where to install these flame detonation arresters in the vapor control systems. An independent laboratory must test detonation arresters installed to meet these regulations.

The diversity of commercial flame arresters can lead to the installation of these arresters in piping systems where the conditions within the piping may be significantly different from the conditions for which they were designed, or tested and listed by testing laboratories. Under certain conditions, flames propagating through piping systems can reach velocities and pressures at which detonation can occur. Unless a flame arrester has been designed and tested for a detonation, it may not stop the progression of a combustion wave in the piping. Guidance is provided concerning the important factors involved in the selection, installation and maintenance of appropriate flame arresters. The intent is to assist the user of this recommended practice in developing the awareness of review needs, and to encourage discussions with flame arrester manufacturers regarding specific applications and test results.

1.2 SCOPE

The scope of this recommended practice is the use and limitations of flame arresters installed in piping systems in the petroleum and petrochemical industries. It provides a general overview of flame arresters currently in use and some potential concerns or limitations. Applicable combustion and flame propagation parameters are discussed including the distinction between arresting flames versus arresting detonations.

This recommended practice is neither a design manual nor a regulatory compliance document. It does provide reference to more detailed technical discussions of flame arresters and combustion. Various standards, codes, and regulations are noted in the Section 2 references and in the Appendix A Bibliography.

1.3 CONCEPT OF HAZARD VS. RISK

Hazards are properties of materials with the inherent ability to cause harm. Flammability, toxicity, corrosivity, stored chemical or mechanical energy all are hazards associated with various industrial materials. Risk requires exposure. The flammability of a material transported in piping is an inherent hazard, but becomes a risk only when having access to an oxidizer and being exposed to an ignition mechanism. There is no risk of ignition when there is no potential for those exposures. Determining the level of risk involves estimating the probability and severity of exposure conditions that could lead to harm.

1.4 RETROACTIVITY

Any provisions in this recommended practice related to design are intended for reference when designing new facilities or when considering major revisions or expansions. It is not intended that any recommendations in this recommended practice be applied retroactively to existing facilities unless deemed appropriate based on facility review. Each facility must make their own determination regarding how to comply with any applicable regulations.

SECTION 2—REFERENCED PUBLICATIONS

The most recent edition or revision of each of the following standards, codes, and regulations are cited in this recommended practice. Additional references not specifically cited in this document are listed in the Bibliography, Appendix A.

API[1]

Std 2000 *Venting Atmospheric and Low-Pressure Storage Tanks*

RP 2210 *Flame Arresters for Vents of Tanks Storing Petroleum Products*

ASTM[2]

F 1273 *Standard Specification for Tank Vent Flame Arresters*

[1]www.api.org

[2]American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania, USA 19428. www.astm.org