

Measurement of and Specifications for Proppants Used in Hydraulic Fracturing and Gravel-packing Operations

API STANDARD 19C
SECOND EDITION, AUGUST 2018

ERRATA 1, SEPTEMBER 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.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications 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.

Copyright © 2018 American Petroleum Institute. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, NW, Washington, DC 20005.

Foreword

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 patents.

Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

May: As used in a standard, “may” denotes a course of action permissible within the limits of a standard.

Can: As used in a standard, “can” denotes a statement of possibility or capability.

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 publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. 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, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

	Page
1 Scope	1
2 Normative References	1
3 Abbreviations	1
4 Standard Proppant Sampling Procedure	2
4.1 General	2
4.2 Particle Segregation	2
4.3 Equipment	2
4.4 Number of Required Samples-Bulk	6
4.5 Sampling-Bulk Material	6
4.6 Sampling-Sacked and Bagged Material	6
5 Sample Handling and Storage	6
5.1 Sample Reduction	6
5.2 Sample Splitting	6
5.3 Sample, Record Retention, and Storage	6
6 Sieve Analysis	7
6.1 Purpose	7
6.2 Description	7
6.3 Apparatus and Materials	7
6.4 Procedure	8
6.5 Specifications-Sieve Analysis of Proppants	9
6.6 Sieve Calibration	13
7 Proppant Sphericity and Roundness	16
7.1 Purpose	16
7.2 Description	16
7.3 Apparatus Capability	17
7.4 Procedure	17
7.5 Alternate Method for Determining Average Sphericity and Roundness	18
7.6 Specifications-Proppant Roundness and Sphericity	18
8 Acid Solubility	18
8.1 Purpose	18
8.2 Description	18
8.3 Apparatus and Materials	19
8.4 Procedure	20
8.5 Specifications-Acid Solubility	21
9 Turbidity	21
9.1 Purpose	21
9.2 Description	21
9.3 Apparatus and Materials	22
9.4 Apparatus Calibration	22
9.5 Procedure-Turbidity Measurement	22
9.6 Specification-Turbidity	22
10 Procedures for Determining Proppant Loose Pack Bulk Density, Apparent Density, and Absolute Density	22
10.1 Purpose	22

Contents

	Page
10.2 Description	23
10.3 Loose Pack Bulk density (ρ_{bulk})	23
10.4 Apparent Density (ρ_{ap})	23
10.5 Absolute Density (ρ_{abs})	29
11 Proppant Crush Resistance	30
11.1 Purpose	30
11.2 Description	30
11.3 Apparatus	30
11.4 Sample Preparation	35
11.5 Assemble and Set Up the Crush Cell and Pluviator Loading Device	36
11.6 Procedure-Crush Resistance Testing	38
11.7 Specification-Crush Resistance of Fracturing Proppants	39
11.8 Specification-Crush Resistance of Gravel-packing Proppants	40
12 Loss on Ignition (LOI) of Whole Grain Proppant	41
12.1 Purpose	41
12.2 Apparatus and Materials	41
12.3 Procedure	41
Annex A (informative) ASTM E11 Sieve Table	44
Bibliography	47
Figures	
1 Typical Box Sampling Device	3
2 Typical 16:1 Sample Reducer	4
3 Typical Sample Splitter	5
4 Graphical Method for Determination of Median Diameter	13
5 Chart for Visual Estimation of Sphericity and Roundness	17
6 Loose Pack Bulk Density Device	24
7 Design of the Crush Cell	32
8 Assembled View of Pluviator Device	33
9 Exploded View of Pluviator Device	34
10 Dimensional View of the Pluviator Device	35
Tables	
1 ASTM Test Sieve Sizes	7
2 Example Sieve Analysis and Calculations (Fracturing 16/30 Proppant)	10
3 Example Calculation of Median Diameter (Fracturing 16/30 Proppant)	12
4 Example of Absolute Relative Difference Calculations	16
5 Suggested Magnification	18
6 Proppant Maximum Acid Solubility	21
7 Density of Water at Various Temperatures	26
8 Pluviator Cell Loading Device, Parts, and Accessories	33
9 Wire Cloth Sizes Used in the Pluviator Device	37
10 Guidelines for Testing Various Proppant Types	38
11 10 % Crush Classification Table for Fracturing Proppants	40
12 Maximum Fines for Gravel-packing Proppant	41

Introduction

The procedures presented in this document have been developed to improve the quality of proppants delivered to the well site. They are for use in evaluating certain physical properties used in hydraulic fracturing and gravel-packing operations. These tests should enable users to compare the physical characteristics of various proppants tested under the described conditions and to select materials useful for hydraulic fracturing and gravel-packing operations. Each section contains proppant specifications and replaces API 19C, First Edition.

The procedures presented in this document are not intended to inhibit the development of new technology, material improvements, and improved operational procedures. Qualified engineering analysis and judgment are required for their application to a specific situation.

As with any laboratory procedure requiring the use of potentially hazardous chemicals and equipment, the user is expected to have received proper training and knowledge in the use and disposal of these potentially hazardous materials. The user is responsible for compliance with all applicable local, regional, and national requirements for worker and local health, safety, and environmental liability.

This document uses a format for numbers that follows the examples given in API Document Format and Style Manual, First Edition, June 2007 (Editorial Revision, January 2009). This numbering format is different than that used in API 19C, Second Edition. In this document, the decimal mark is a period and separates the whole part from the fractional part of a number. No spaces are used in the numbering format. The thousands separator is a comma and is only used for numbers greater than 10,000, i.e. 5000 items, 12,500 bags.

In this document, where practical, U.S. Customary units are included in parentheses for information.

The units do not necessarily represent a direct conversion of metric units (SI) to U.S. Customary units, or U.S. Customary to SI. Consideration has been given to the precision of the instrument making the measurement. Consideration has also been given to the nature of the measurement, determining if it is critical or simply informational. The document was originally based on API RP 56, API RP 58, and API RP 60, which are no longer in effect.

Measurement of and Specifications for Proppants Used in Hydraulic Fracturing and Gravel-packing Operations

1 Scope

This document provides specifications and standard testing procedures for evaluating proppants used in hydraulic fracturing and gravel-packing operations.

The objective of this document is to provide specifications and a consistent methodology for testing performed on hydraulic fracturing and/or gravel-packing proppants. Methodologies and specifications (where applicable) are provided for:

- sieve analysis and median diameter determination;
- sphericity and roundness;
- acid solubility;
- turbidity;
- loose pack bulk density, apparent density, and absolute density;
- crush resistance;
- loss on ignition.

Proppant size designation is as per industry standard. It is based on the maximum and minimum size determination by sieve analysis and ASTM # sieve number (and not as per standard opening expressed in micrometers).

Proppants in this document are sand, ceramic media, resin-coated proppants, gravel-packing media, and other similarly used materials for hydraulic fracturing and gravel-packing operations.

2 Normative References

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

ASTM E11, *Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves*

3 Abbreviations

ANSI – American National Standards Institute

API – American Petroleum Institute

¹ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, www.astm.org

² ANSI (Operations), 25 West 43rd Street, 4th Floor, New York, NY 10036, www.ansi.org