



**International
Standard**

ISO 13503-2

**Oil and gas industries including
lower carbon energy — Completion
fluids and materials —**

**Part 2:
Measurement of properties of
proppants used in hydraulic
fracturing and gravel-packing
operations**

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Fluides de complétion et matériaux —

Partie 2: Mesurage des propriétés des agents de soutènement utilisés dans les opérations de fracturation hydraulique et de remplissage de gravier

**Second edition
2024-12**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 3, *Drilling and completion fluids, well cements and treatment fluids*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Oil and gas industries including lower carbon energy*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 13503-2:2006), which has been technically revised. It also incorporates the Amendment ISO 13503-2:2006/Amd 1:2009.

This document supplements API Std 19C, 2nd edition (2018).

The technical requirements of this document and API Std 19C used to be identical. In the meantime API Std 19C has been technically revised as API Std 19C, 2nd edition (2018). The purpose of this edition of ISO 13503-2 is to bring it up to date, by referencing the current edition of API Std 19C and including supplementary content.

The main changes are as follows:

- a new stand sampling device has been used for proppant packed in bags;
- proppant on the sieves has been removed and directly weighed in sieve analysis testing;
- the average diameter calculation has been added;
- the remaining total amount on the last sieve and in the pan has been updated to not exceed 2 % by mass of the total tested proppant sample;
- PropPaver loading device has been used instead of Pluviator loading device;
- the upper and lower designating sieve sizes have been kept for sample preparation and after pressurizing in crush resistance test;
- shaking duration of 10 min has been maintained for both sample preparation and after pressurizing in crush resistance test.

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Oil and gas industries including lower carbon energy — Completion fluids and materials —

Part 2:

Measurement of properties of proppants used in hydraulic fracturing and gravel-packing operations

1 Scope

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

NOTE Proppants mentioned in this document refer to sand, ceramic, resin-coated, gravel packing proppants, and other materials used for hydraulic fracturing and gravel packing operations.

This document supplements API Std 19C, 2nd edition (2018), the requirements of which are applicable with the exceptions specified in this document.

This document provides consistent methodology for testing performed on hydraulic fracturing and/or gravel packing proppants.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Std 19C, 2nd edition (2018), *Measurement of and Specifications for Proppants Used in Hydraulic Fracturing and Gravel-packing Operations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in API Std 19C, 2nd edition (2018) and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

PropPaver

loading device for laying out proppant samples for crush resistance test, primarily used to ensure the proppant pack laid flat within the crush cell, and reducing the potential for operator-induced variability

4 Supplements to API Std 19C, 2nd edition (2018)

4.1 General requirements

The requirements specified in API Std 19C, 2nd edition (2018) shall apply, with the exceptions specified in [4.2](#) to [4.4](#).

[Annex A](#) provides a comparison of clauses in API Std 19C, 2nd edition (2018) versus those in this document.

4.2 Sampling device

The requirements specified in API Std 19C, 2nd edition (2018), [4.3.1](#) shall apply with the following exceptions.

The stand sampling device shall be used in place of box sampling device for proppants packed in 1,5 t bags. For the sampling criteria, the number of bags to be randomly sampled should not be less than 2 bags per 10. Insert the sampling device at three different points in the upper, middle, and lower sections of the bag until 3/4 of the device length is in the bag; and take samples at not less than 3/4 of the length of the sampling device. The total mass of sample should be not less than 25 kg, which can be divided into 3 kg portions by using the sample splitter. The stand sampling device is shown in [Figure 1](#).

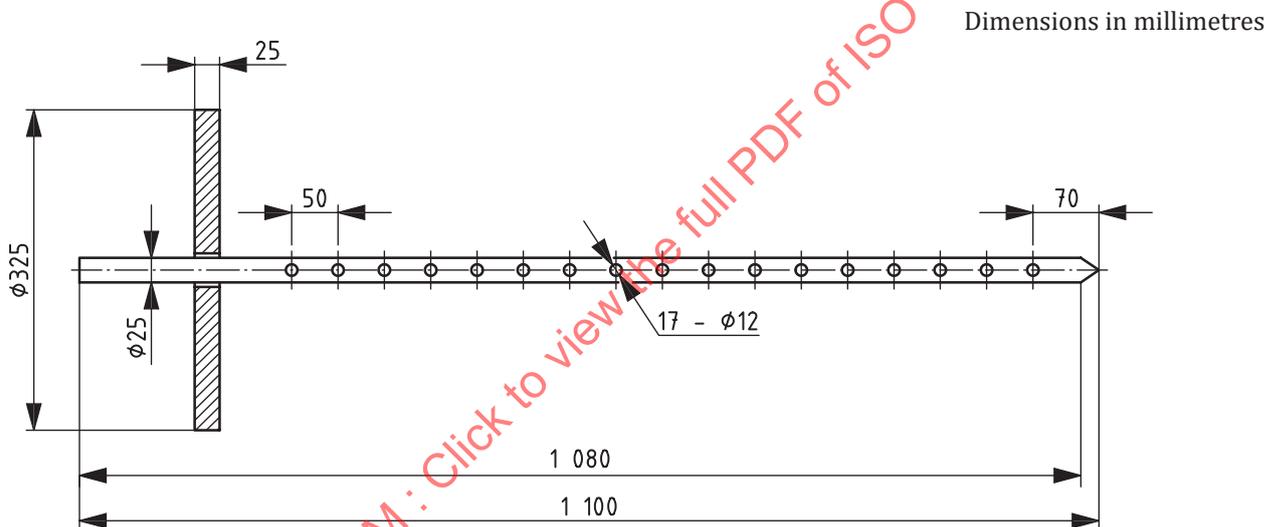


Figure 1 — Stand sampling device

4.3 Sieve analysis

4.3.1 Procedure

The following procedure shall be used in place of API Std 19C, 2nd edition (2018), 6.4.6.

- Invert the sieve on a collection device and remove the proppant by thoroughly brushing the sieve to ensure that grains are not adhering to the wire cloth.
- Weigh and record the mass of proppant retained on each of the sieves and in the pan, m_i .

4.3.2 Specifications — Sieve analysis of proppants

The following shall apply in place of API Std 19C, 2nd edition (2018), 6.5.1.

- A minimum of 90 % by mass of the tested proppant sample should pass through the coarse designated sieve and be retained on or above the fine designated sieve, i.e. 1 700/850 μm , 850/425 μm , or 425/250 μm .

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- b) A maximum of 0,1 % by mass of the total tested proppant sample should be larger than the first sieve in the stack, and a maximum of 2,0 % by mass of the total tested proppant sample should be retained on the last sieve and in the pan.

For example, with 850/425 µm proppant samples, a maximum of 0,1 % by mass should remain on the 1 180 µm sieve, with the combined total on the last sieve and in the pan (300 µm) not over 2 %.

Calculate the average diameter, d_{av} by [Formula \(1\)](#):

$$d_{av} = \frac{\sum n \cdot d}{\sum n} \quad (1)$$

where

d_{av} is the average diameter, in µm;

d is the mid-size diameter, in µm;

n is the frequency of occurrence.

EXAMPLE A simulation analysis of a 16/30 proppant sample

Size analysis

Sieve aperture 1,700 µm (No. 12 mesh) =	0,00 %
Sieve aperture 1,180 µm (No. 16 mesh) =	1,24 %
Sieve aperture 1,000 µm (No. 18 mesh) =	37,9 %
Sieve aperture 850 µm (No. 20 mesh) =	48,7 %
Sieve aperture 710 µm (No. 25 mesh) =	11,9 %
Sieve aperture 600 µm (No. 30 mesh) =	0,25 %
Sieve aperture 425 µm (No. 40 mesh) =	0,00 %
In the pan =	0,00 %
TOTAL	99,99 %

Table 1 — Parameters for average diameter calculation

Particle size Interval µm	Mid-size diameter d µm	Frequency of occurrence n mass fraction (%)	$n \cdot d$
1 700 to 1 180	1 440	1,24	1,786
1 180 to 1 000	1 090	37,9	41,311
1 000 to 850	925	48,7	45,048
850 to 710	780	11,9	9,282
710 to 600	655	0,25	164
600 to 425	512	0,00	0,00
TOTAL		99,99	97,591

$$d_{av} = \frac{\sum n \cdot d}{\sum n} = \frac{97\,591}{99,99} = 976 \text{ µm}$$

4.4 Proppant crush resistance

4.4.1 Equipment and materials

The PropPaver crush cell loading device shall be used in place of the Pluviator crush cell loading device in API Std 19C, 2nd edition (2018), 11.3.9, with parts and accessories shown in Figure 2. All parts shall be made of stainless steel. The PropPaver is aimed to produce repeatable results and ensure the proppant pack laid flat within the crush cell.

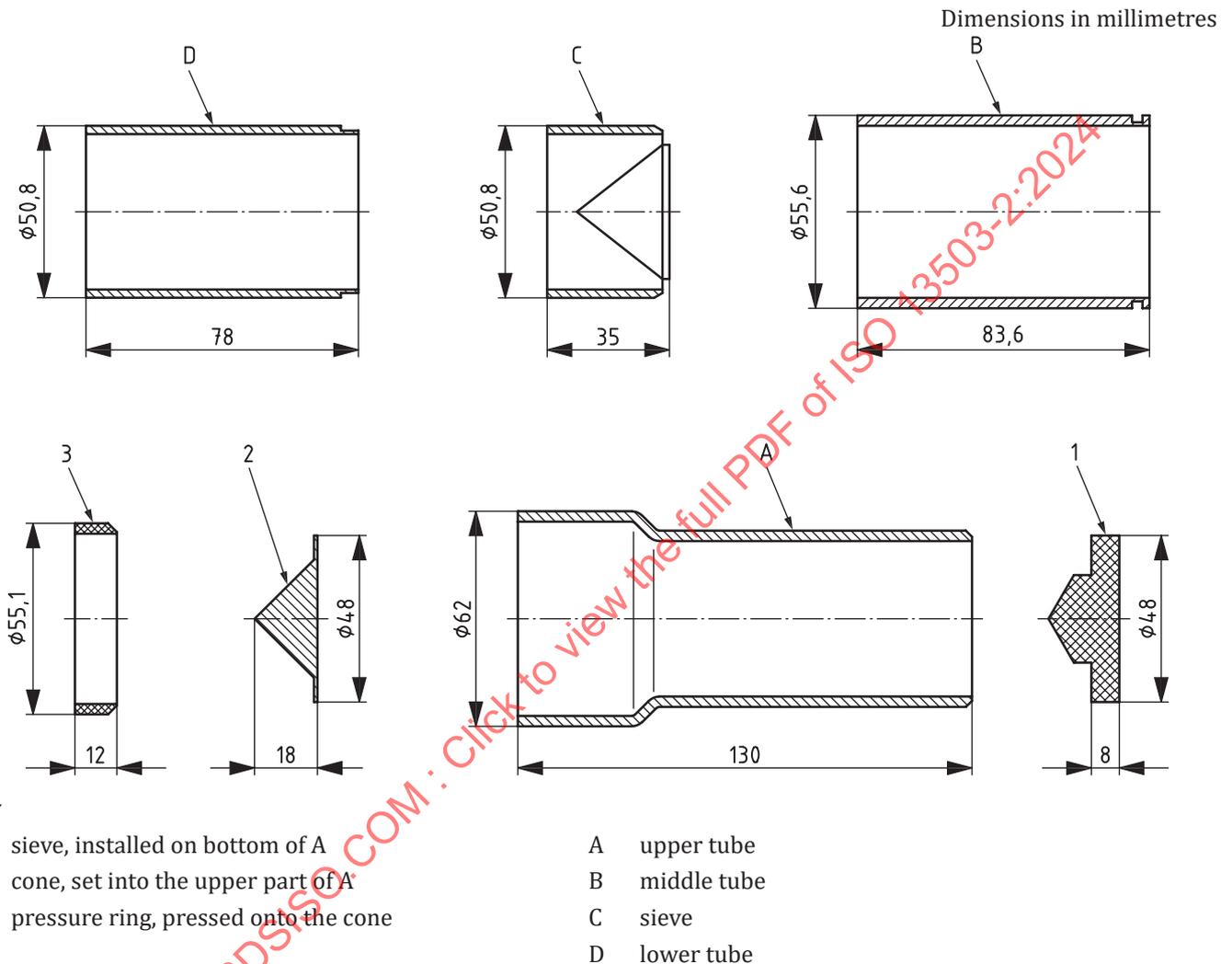


Figure 2 — PropPaver loading device

4.4.2 Sample preparation

4.4.2.1 4.4.2.2 to 4.4.2.7 shall apply in place of API Std 19C, 2nd edition (2018), 11.4.

4.4.2.2 Using the sample splitter, reduce the sample size to $150 \text{ g} \pm 10 \text{ g}$.

4.4.2.3 Refer to Table 1 and select the upper and lower designating sieve sizes appropriate for the proppant being tested. Prepare the sieve stack in the normal order by placing the sieve stack in the sieve shaker.

4.4.2.4 Pour the reduced sample into the top sieve, cover with the lid, and place the sieve stack in the sieve shaker.

4.4.2.5 Properly secure the sieve stack in the shaker and shake for 10 min.

4.4.2.6 Remove the sieve stack from the shaker. Discard all material retained on the upper sieve and in the pan. Only the material retained on the lower designating sieve is used in the crush test.

4.4.2.7 Determine the exact weight of proppant to be used in the crush resistance test. The objective of the following procedure is to determine the amount of proppant, of any loose bulk density, required to provide a proppant pack concentration in the crush cell of approximately 1,953 g/cm² of the piston area. If the loose bulk density of the proppant being tested is known, skip to [Formula \(2\)](#) and determine the mass required; otherwise, proceed as follows.

- a) Determine the loose pack bulk density of the proppant sample using the procedure in API Std 19C, 2nd edition (2018), 10.3.
- b) The cross-sectional area of the crush cell is $(\pi/4) \times (5,08 \text{ cm})^2 = 20,27 \text{ cm}^2$. The proppant mass needed to achieve the targeted proppant pack concentration is $1,953 \text{ g/cm}^2 \times 20,27 \text{ cm}^2 = 39,59 \text{ g}$. Using a loose pack bulk density constant of $1,60 \text{ g/cm}^3$, the volume of sand required per unit of piston area of the test cell is $39,59 \text{ g} / 1,6 \text{ g/cm}^3 = 24,7 \text{ cm}^3$.

Other proppants with different bulk densities require different masses. The mass, m_p , expressed in grams, of proppant material needed for each test, to the nearest 0,01 g, is calculated according to [Formula \(2\)](#):

$$m_p = 24,7 \times \rho_{\text{bulk}} \quad (2)$$

where

24,7 is the volume of proppant required for a single crush test, expressed in cubic centimetres;

ρ_{bulk} is the proppant bulk density, expressed in grams per cubic centimetre.

- c) Using the sample splitter, reduce the sieved sample to the calculated m_p with a tolerance of +5 g.
- d) From the material prepared in [4.4.2.7 c\)](#), weigh the sample mass determined in [4.4.2.7 b\)](#), m_p , to the nearest 0,01 g, and retain for crush testing.

4.4.3 Assemble and set up the crush cell and PropPaver loading device

4.4.3.1 4.4.3.2 to 4.4.3.7 shall apply in place of API Std 19C, 2nd edition (2018), 11.5.

4.4.3.2 Place the upper tube vertically into the crush cell (see step 1 of [Figure 3](#)).

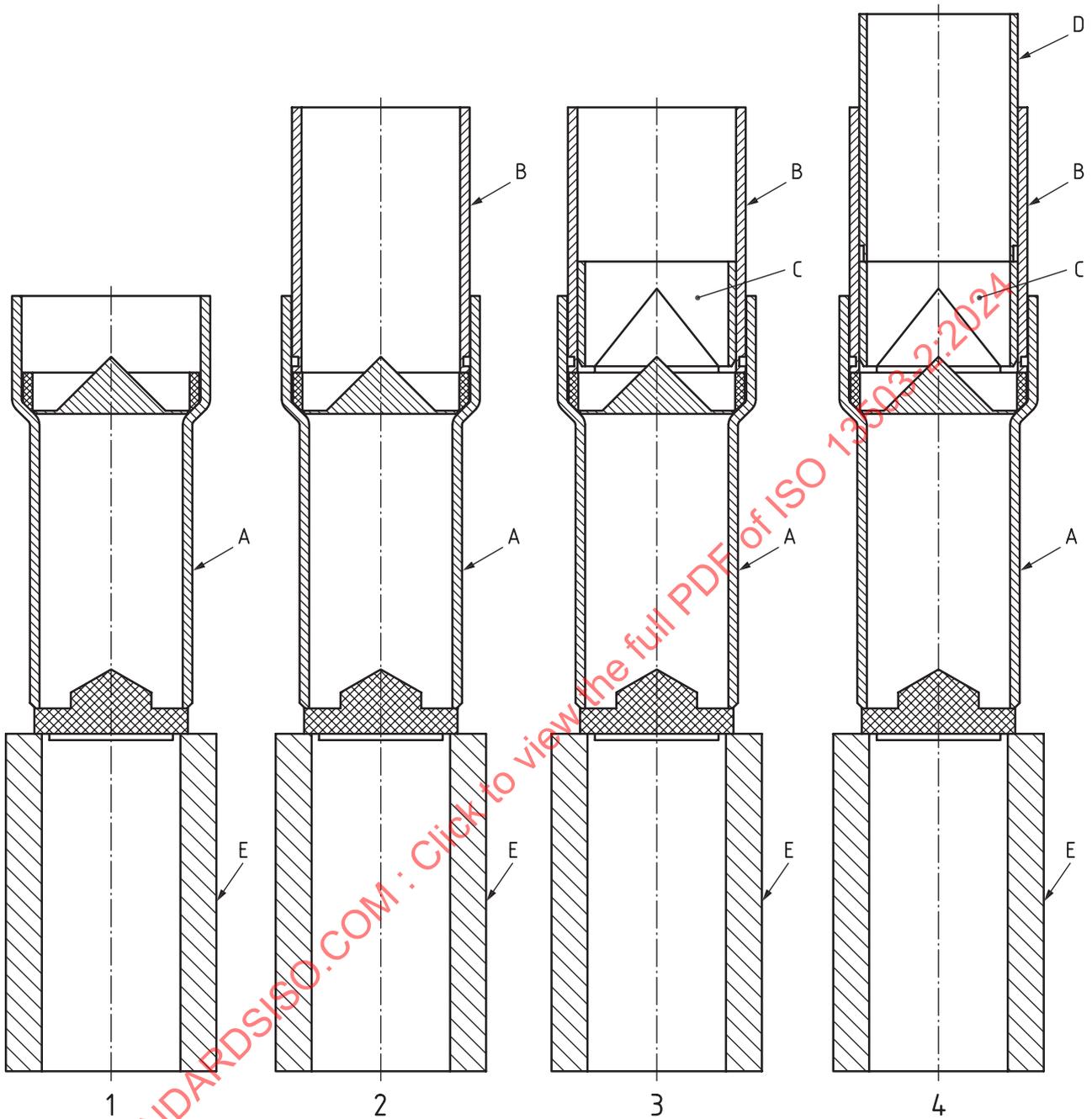
4.4.3.3 Place the middle tube vertically into the upper tube (see step 2 of [Figure 3](#)).

4.4.3.4 Place the sieve (the sieve has different sizes, i.e. 16/20 μm , 20/40 μm , 30/50 μm , 40/70 μm , and 70/140 μm) vertically into the middle tube (see step 3 of [Figure 3](#)). Determine the specific sieve sizes from [Table 2](#).

4.4.3.5 Place the lower tube vertically into the middle tube (see step 4 of [Figure 3](#)).

4.4.3.6 Pour the proppant sample into the lower tube and flatten it with a brush.

4.4.3.7 Remove the contents from the lower tube. Allow the proppant sample in the sieve to flow out completely, and clean the interior of the PropPaver using a brush.



Key

- A upper tube
- B middle tube
- C sieve
- D lower tube
- E cell
- 1 step 1
- 2 step 2
- 3 step 3
- 4 step 4

Figure 3 — Assemble the crush cell and PropPaver loading device