FINAL
DRAFT

INTERNATIONAL
STANDARD

**ISO/FDIS
5146**

ISO/TC **27**/SC **1**

Secretariat: **SA**

Voting begins on:
**2023-07-17**

Voting terminates on:
**2023-09-11**

# Coal and coke — Coal preparation plant — Density tracer testing for measuring performances of coal density separators

*Charbon et coke — Installation de préparation du charbon — Essais des traceurs de densité pour la mesure des performances des séparateurs de charbon en fonction de la densité*

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e64970470/iso-5146

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

Reference number
ISO/FDIS 5146:2023(E)

© ISO 2023

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e64970470/iso-5146

**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland



© ISO 2023 – All rights reserved

# Contents

Page



iTeh STANDARD PREVIEW
(standards.iteh.ai)
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e6497047 0/iso-5146

© ISO 2023 – All rights reserved

# 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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 27, *Coal and coke*, Subcommittee SC 01, *Coal preparation: Terminology and performance.*

ISO 5146

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.


© ISO 2023 – All rights reserved

# Introduction

The objective of this document is to provide the coal-preparation industry with an accurate, safe, rapid and site-based method for determining the density partitioning performances of density separators and to utilize statistical and mathematical procedures to avoid personal biases in fitting partition curves to the observed data. To meet the second objective, this document includes a number of formulae which can be incorporated in a user spreadsheet.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e64970470/iso-5146

© ISO 2023 – All rights reserved

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e64970470/iso-5146

# Coal and coke — Coal preparation plant — Density tracer testing for measuring performances of coal density separators

## 1 Scope

This document specifies the requirements for testing the performances of coal density separators using density tracers and provides a method for the presentation of test results.

This document is partly based on AS 5213.

This document is applicable to dense medium cyclones (DMCs) and dense medium baths, as follows:

a) for a single separator;

b) for a group of separators where the feed is distributed between them at a point downstream of density tracer insertion;

c) for density tracers of any size; but rarely used for particles with maximum dimension less than 2 mm.

This document also provides guidance for testing the performances of other types of density separators with density tracers.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

## 2 Normative references

ISO 5146

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.

AS 2418, *Coal and coke — Glossary of terms*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in AS 2418 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**
**cutoff time**
time which follows the time of last *density tracer* (3.3) *insertion* (3.5) by 5 min plus the greater of *floats transit time* or *sinks transit time*Note 1 to entry: Floats transit time is the average time in minutes since insertion into a separator feed for particles collected from, or detected in, a separator floats stream. Sinks transit time is the average time in minutes since insertion into a separator feed for particles collected from, or detected in, a separator sinks stream.

**3.2**
**density separator**
device for the cleaning of coal, in which particles are separated into two or more streams according to their densities

© ISO 2023 – All rights reserved

**3.3**
**density tracer**
non-porous particle of defined shape and density that is not easily broken or abraded

Note 1 to entry: Types include radio frequency identified (RFID) density tracers and non-RFID recoverable density tracers.

**3.4**
**average probable deviation**
écart probable moyen
$E_{pm}$
half of the difference between the densities corresponding to the 75 % and 25 % partition coefficients as obtained from the partition curve

**3.5**
**insertion**
placement of a *density tracer* (3.3) into a separator feed stream, typically by dropping into a feed preparation screen oversize launder

# 4 Test method

## 4.1 General

The test method specified in 4.2 to 4.5 covers the following:

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e64970470/iso-5146

a) generation and capture of density tracer test data utilizing either:
   1) retrieved, re-usable non-RFID density tracers; or
   2) automatically detected RFID density tracers;
b) use of those data to estimate density partition coefficients;
c) presentation of those data and results in tabular and graphical forms;
d) fitting one of two alternative mathematical forms for the partition curve to the density partition coefficients;
e) determination, from the partition curves, of key partitioning criteria.

## 4.2 Apparatus

### 4.2.1 Density tracers

For the purposes of this document, density tracers shall have the following properties:

a) Shape and dimensions: any that can be fully described in the density tracer test report.

   EXAMPLE Cubic, with edge length 13 mm.

b) Tolerance on dimensions: 100 % within ±10 % of nominal.
c) Nominal densities: any.
d) Tolerances on density, for cubic tracers of 8 mm edge length and larger:
   1) for nominal relative density (RD) values up to 1,60: 99 % within ±0,006 RD of the nominal value;


© ISO 2023 – All rights reserved

2) for nominal RD values greater than 1,60: 99 % within ±0,011 RD of the nominal value.

e) Density designation:

1) non-RFID density tracers: by engraving or colour-coding;

2) RFID density tracers: electronically written to an internal memory chip.

NOTE See Annex A for details of suitable density tracers.

#### 4.2.2 Density tracer retrieval or detection equipment

If a test is to be conducted using non-RFID density tracers, apparatus for use as aids for retrieval shall be suitable for the circumstances (see Annex B).

If a test is to be conducted using RFID density tracers, radio equipment shall be present for retrieval of data from each density tracer in the floats and sinks streams from the density separator(s) (see Annex B).

### 4.3 Procedure

#### 4.3.1 Density tracer selection

Density tracer selection shall be as follows.

a) Decide on one or more nominal sizes.

b) For each nominal size, decide the nominal densities (guidance is provided in Annex C).

c) For each nominal size, decide the number of density tracers to be used at each nominal density, being:

1) no less than 30;

2) equal to the number selected at every other nominal density.

d) Assemble those density tracers.

#### 4.3.2 Insertion of density tracers

The following procedure shall be used for the insertion of density tracers.

a) Decide on the insertion point and required test duration and calculate the required interval between density tracer insertions as the test duration in seconds divided by the total number of density tracers selected.

NOTE Annex B provides further information on test durations.

b) Ensure that retrieval personnel or detection equipment are in place and activated.

c) Record the time at which the first density tracer was inserted.

d) At approximately the calculated intervals, insert or drop the density tracers into the feed stream of the density separator(s) to be tested (see Figure 1), either manually or using a mechanical dispenser. The density order of density tracer insertions shall be either:

1) pseudo-random, by mixing the selected density tracers prior to one-by one selection and insertion; or

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7c1-4dc7-a168-d40e64970470/iso-5146

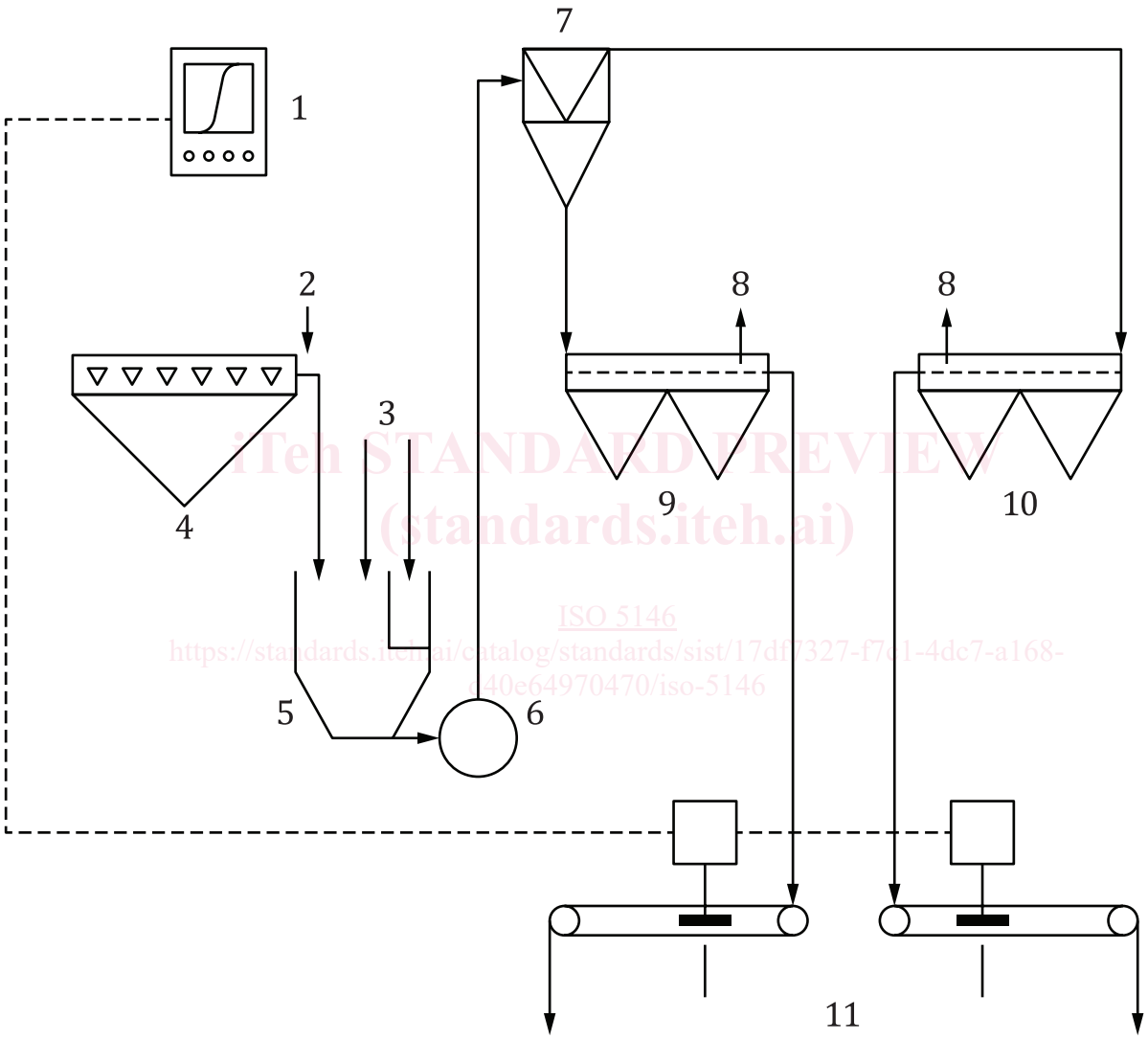
© ISO 2023 – All rights reserved

2) following a protocol whereby one density tracer of every selected size and density is inserted, one-by-1, followed by a second density tracer of every selected size and density, etc.

e) Record the time at which the last density tracer was inserted.

Unplanned interruptions to plant feed of up to 10 min duration can be tolerated, but tracer insertion shall be stopped, restarted when feed is resumed and documented.

Figure 1 shows typical locations for the insertion of density tracers and for the retrieval or detection of density tracers.




iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/17df7327-f7e1-4dc7-a168-d40e64970470/iso-5146

**Key**

1 real-time display of partition curve
2 typically, density tracers would be added here
3 medium
4 de-sliming screen
5 sump or wing tank
6 pump
7 DMC module
8 non-radio density tracers would be retrieved here
9 sinks drain and rinse screen
10 floats drain and rinse screen
11 detectors for radio density tracers

NOTE 1 This is a simplified typical flowsheet showing points of addition and retrieval of density tracers. In this case, the separator is a dense medium cyclone.

NOTE 2 In this case, the separator is a dense medium cyclone.


© ISO 2023 – All rights reserved

NOTE 3 For RFID density tracers, alternative locations for detectors are at the drain-and-rinse screens.

**Figure 1 — Example of a simplified density separator flowsheet**

### 4.3.3 Density tracer retrieval or detection and data capture

#### 4.3.3.1 Non-RFID density tracers

The procedure shall be as follows.

a) Retrieve density tracers from the material on the floats drain and rinse screen(s) (see Figure 1) by hand or using a scoop or net or magnets. Place them in one or more containers marked “Floats” (see Figure 1, NOTES 1, 2 and 3).

b) Retrieve density tracers from the material on the sinks drain and rinse screen(s) by hand or using a scoop or net or magnets. Place them in one or more containers marked “Sinks” (see Figure 1, NOTES 1, 2 and 3).

c) Sort the density tracers retrieved from floats before the cutoff time according to their densities and record the number at each density.

d) Sort the density tracers retrieved from sinks before the cutoff time according to their densities and record the number at each density.

In some circuits, screens cannot be readily accessed for density tracer retrieval, and alternative retrieval points should be sought. For example, primary density separator sinks may be fed directly to a secondary density separator without passing a drain-and-rinse screen. In that case, density tracers retrieved from secondary density separator floats and sinks should be reported as primary density separator sinks.

Any density tracers retrieved from the screens after the cutoff time should not be included in the test data.

If the density tracers are to be retrieved by magnets, they should be ferromagnetic.

#### 4.3.3.2 Automatically detected RFID density tracers

The procedure shall be as follows.

a) Detect and record the densities of RFID density tracers in the floats stream using RFID apparatus located downstream of the density separator (see Figure 1). In some cases, circuit configuration may dictate that two or more detection points are required.

b) Detect and record the densities of RFID density tracers in the sinks stream using RFID apparatus located downstream of the density separator (see Figure 1). In some cases, circuit configuration may dictate that two or more detection points are required.

Any density tracers detected after the cutoff time shall not be included in the test data.

If access to suitable locations for detector placement is limited, alternative locations should be sought. For example, primary density separator sinks may be fed directly to a secondary density separator without passing a conveyor. In that case, density tracers retrieved from both floats and sinks of a secondary density separator should be reported as primary density separator sinks.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 5146
https://standards.iteh.ai/catalog/standards/sist/d40e64970470/iso-5146

© ISO 2023 – All rights reserved

## 4.4 Data processing

### 4.4.1 Data acceptability

#### 4.4.1.1 Selection of tracer densities

To be acceptable, the selected density tracer densities shall include the following eight RDs from Table 1:

a) the four RDs which are closest to the $d_{50}$;

b) at least one RD in the range 0,05 to 0,10 lower than the $d_{50}$ (unless the $d_{50}$ is less than 1,31 RD);

c) at least one RD in the range 0,05 to 0,10 higher than the $d_{50}$;

d) at least one RD in the range 0,10 to 0,20 lower than the $d_{50}$ (unless the $d_{50}$ is less than 1,36 RD);

e) at least one RD in the range 0,10 to 0,20 higher than the $d_{50}$.

See Annex A for more information.

**Table 1 — Typical densities and density tolerances of density tracers for coal operations (8 mm and larger)**

| Nominal density RD units | Tolerance 99 % RD units | Nominal density RD units | Tolerance 99 % RD units | | Nominal density RD units | Tolerance 99 % RD units |
|---|---|---|---|---|---|---|
| 1,26 | ±0,006 | 1,44 | ±0,006 | | 1,62 | ±0,011 |
| 1,27 | ±0,006 | 1,45 | ±0,006 | | 1,64 | ±0,011 |
| 1,28 | ±0,006 | 1,46 | ±0,006 | | 1,66 | ±0,011 |
| 1,29 | ±0,006 | 1,47 | ±0,006 | | 1,68 | ±0,011 |
| 1,30 | ±0,006 | 1,48 | ±0,006 | | 1,70 | ±0,011 |
| 1,31 | ±0,006 | 1,49 | ±0,006 | | 1,72 | ±0,011 |
| 1,32 | ±0,006 | 1,50 | ±0,006 | | 1,74 | ±0,011 |
| 1,33 | ±0,006 | 1,51 | ±0,006 | | 1,76 | ±0,011 |
| 1,34 | ±0,006 | 1,52 | ±0,006 | | 1,78 | ±0,011 |
| 1,35 | ±0,006 | 1,53 | ±0,006 | | 1,80 | ±0,011 |
| 1,36 | ±0,006 | 1,54 | ±0,006 | | 1,82 | ±0,011 |
| 1,37 | ±0,006 | 1,55 | ±0,006 | | 1,84 | ±0,011 |
| 1,38 | ±0,006 | 1,56 | ±0,006 | | 1,86 | ±0,011 |
| 1,39 | ±0,006 | 1,57 | ±0,006 | | 1,88 | ±0,011 |
| 1,40 | ±0,006 | 1,58 | ±0,006 | | 1,90 | ±0,011 |
| 1,41 | ±0,006 | 1,59 | ±0,006 | | 1,95 | ±0,011 |
| 1,42 | ±0,006 | 1,60 | ±0,006 | 2,00 | ±0,011 | |
| 1,43 | ±0,006 | | | 2,10 | ±0,011 | |

For density tracers smaller than 8 mm cubes wider 99 % density tolerances may be accepted, but those tolerances shall be determined and recorded on the density separator performance report.

#### 4.4.1.2 Collection/detection rate

To comply with this document, the collection or detection rate for density tracers over all densities employed shall be not less than 70 %.

NOTE 1 Tracer losses or non-detections influence the fitted curve parameters. For collection/detection rates of 90 % or more, the data acceptability provisions are intended to achieve more than 95 % confidence that, by ignoring those losses or non-detections, the fitted values of:


© ISO 2023 – All rights reserved