



BSI Standards Publication

Natural gas upstream area — Determination and calculation of shale brittleness index

Part 1: Determination of shale mineral characteristics
based on X-ray diffraction method

National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Natural gas upstream area —
Determination and calculation of
shale brittleness index —**

**Part 1:
Determination of shale mineral
characteristics based on X-ray
diffraction method**

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Foreword

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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 193, *Natural gas*, Subcommittee SC 3, *Upstream area*.

A list of all parts in the ISO 24835 series can be found on the ISO website.

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.

Introduction

This document has been developed to address the need for evaluating shale brittleness in the production of shale gas. In order to boost shale gas production, it is essential to create flow paths within shale gas reservoirs through hydraulic fracturing. The shale brittleness index, serving as a crucial parameter for forecasting the complexity of hydraulic fracturing cracks, is a vital benchmark for identifying high-quality shale gas reservoirs. Therefore, a standardized approach for calculating the shale brittleness index can assist stakeholders (e.g. oil companies, oilfield service providers, investment firms and governments) to accurately pinpoint "sweet spots" within shale gas reservoirs, select promising areas with development potential, and facilitate efficient shale gas development.

In the global shale gas production industry, two types of optimal methods for characterizing shale brittleness index are preferred: the mineral composition method and the rock mechanics method. This is due to their theoretical effectiveness, operational generality and result reliability. The ISO 24835 series has been developed on the basis of these two methods.

Natural gas upstream area — Determination and calculation of shale brittleness index —

Part 1:

Determination of shale mineral characteristics based on X-ray diffraction method

1 Scope

This document specifies the principles, instruments, materials, experimental conditions and the sampling and composition analysis steps required for testing mineral composition using the X-ray diffraction method, as well as the method and precision requirements for calculating shale brittleness index based on mineral composition.

This document is applicable to reservoir quality evaluation and sweet spot identification in shale gas production.

2 Normative references

The following documents are essential to the application of the standard. For dated references, only the edition cited applies. For undated references, their latest edition of the referenced document (including any amendments) applies.

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 5725-6, *Accuracy (trueness and precision) of measurement methods and results — Part 6: Use in practice of accuracy values*

ISO 14532, *Natural gas — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 14532 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

brittle mineral

mineral that exhibits virtually no plastic deformation prior to fracturing under external forces

Note 1 to entry: Brittle minerals are typically found in global shale gas reservoirs, include quartz, plagioclase, kalifeldspar, calcite, dolomite and pyrite (see References [2] to [9]) and can also include ankerite and siderite.

Note 2 to entry: Adapted from ISO 18684:2020, 3.4.

3.2**shale brittleness index**

index derived from a particular brittleness characterization principle and algorithm among various options, used for comparing the brittleness levels of different shales

3.3**shale mineral brittleness index**

shale brittleness index derived through calculation based on the mineral composition of the shale

4 Principles

Each crystal mineral features a specific X-ray diffraction pattern. The intensity of characteristic peaks is functionally proportional to the specific mineral content. The reference intensity of single mineral is tested by means of mixed comparison. Shale mineral brittleness index is calculated from brittle mineral content. The brittle mineral content is obtained from the X-ray diffraction pattern of shale powder sample and [Formula \(1\)](#).

$$X_i = \frac{I_i}{K_i} / \left[\sum_{i=1}^n \frac{I_i}{K_i} \right] \quad (1)$$

where

- X_i is the mass percentage content of mineral i , %;
- I_i is the integral intensity of the selected diffraction peak of mineral i , counts per second;
- K_i is the reference intensity of mineral i , dimensionless;
- i is a specific mineral in shale, such as quartz and calcite;
- n is the total number of mineral categories in shale.

The process for determining and calculating the shale mineral brittleness index is shown in [Figure 1](#).