

Gas supply systems — Underground gas storage —

Part 4: Functional recommendations for storage in rock caverns

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ICS 75.200

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- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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Partie 4: Recommandations fonctionnelles pour le
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Gasversorgungssysteme — Untertagespeicherung
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Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 234, Gas supply, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 1998, and conflicting national standards shall be withdrawn at the latest by August 1998.

It is Part 4 of a standard on underground gas storage which includes the five following parts:

- *Part 1: Functional recommendations for storage in aquifers;*
- *Part 2: Functional recommendations for storage in oil and gas fields;*
- *Part 3: Functional recommendations for storage in solution-mined salt cavities;*
- *Part 4: Functional recommendations for storage in rock caverns;*
- *Part 5: Functional recommendations for surface facilities.*

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Introduction

Use of mined cavern storage

Unlined mined caverns technology is widely used in the field of underground storage for:

- liquids (crude oil, distillates, etc.);
- liquefied petroleum gas (LPG).

R & D projects are currently underway to extend the field of application of this technology to underground storage for natural gas. The following areas are being investigated:

- compressed natural gas (CNG) in lined or unlined rock caverns;
- liquefied natural gas (LNG) in lined or unlined rock caverns.

Underground storage in mined caverns is an attractive alternative to underground storage in salt leached caverns, especially where the local geological setting does not contain salt or where the salt does not display suitable characteristics for solution mining.

The technology, provided it is correctly implemented, is applicable to the following geological conditions:

- hard igneous or metamorphic rocks such as granite, gneiss, andesites or shales;
- sedimentary rocks such as limestones, cemented sandstones, quartzites, chalk or shales;
- marls.

The main prerequisites for unlined cavern storage are the presence of a sufficient natural water head above the caverns to ensure the hydrodynamic containment of the product, and a rockmass quality sufficient to ensure the long-term stability of the excavation with, if needed, a structural reinforcement.

Underground storage in mined caverns is a safe way to create important reserves of LPG in the immediate vicinity of producing, importing or consuming centres such as:

- refineries, import or export terminals;
- petrochemical complexes for which LPG constitutes a feedstock;
- local storage for seasonal peak shaving connected with bottling plants and aimed at a local domestic market;
- regional feedstock for resale (distribution by truck, railway or boat).

This part of EN 1918 focuses on underground storage in unlined mined caverns for LPG. It does not cover refrigerated gas storage.

Technical description

The three key parameters governing the satisfactory operation of an underground storage facility in a mined cavern include:

- long-term stability;
- leaktightness and absence of environmental impact;

- absence of impact on product quality during storage time. The product stored is delivered after the storage period in a state compatible with the users' requirements (with or without implementation of surface treatment).

Very generally, a mined cavern storage facility comprises one or several galleries, excavated from an access shaft or ramp and sited deep enough to ensure the hydraulic containment of the product to be stored.

The access works are first used for the excavation of the caverns and may consist of:

- an inclined tunnel;
- one or several shafts with extraction equipment;
- a combination of one or several shafts and an inclined tunnel.

Before the storage facility is put into operation, the caverns are isolated from the access shaft and/or ramp by concrete plugs located near the cavern entrance. The shaft and/or ramp is then flooded with water.

The storage cavern(s) are made up of main galleries of variable section, according to rock type and depth. The gallery length depends upon the arrangement of galleries, often in parallel, and the required storage capacity.

Connection galleries, generally of smaller section, may link the main galleries together. They allow circulation of personnel, materials and equipment, and ventilation during the construction phase. They allow circulation of water and stored product, at the various levels of excavation, during the operation phase. Connection galleries contribute to the storage capacity.

The most commonly used excavation method in hard rock is drilling and blasting. Alternative methods include roadheaders or tunnelling machines. The choice of method is determined mainly by the rockmass properties and the size of the excavations but also by the cost and availability of equipment.

The underground storage space is connected to the surface by a series of lines accommodated in one or more operating shafts or in operating wells, drilled, cased and cemented. They include:

- inlet line(s);
- outlet line(s) fitted with submersible pump(s) for product delivery;
- seepage water line(s) and pump(s);
- instrumentation line(s);
- vent line(s).

When installed in a shaft, the operating pipes are anchored in a concrete sealing plug located immediately above the cavern crown. After pipe installation, the shaft is flooded with water for the operation phase.

In some cases, horizontal and/or vertical water curtains may be provided to enhance the permanent groundwater flow towards the storage caverns.