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Gaasivarustussüsteemid. Maa-alune gaasisäilitus. Osa 4: Funktsionaalsed soovitused säilitamiseks kaljuõõnsustes

Gas supply systems - Underground gas storage - Part 4: Functional recommendations for storage in rock caverns

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 1918-4:2000 sisaldab Euroopa standardi EN 1918-4:1998 ingliskeelset teksti. Käesolev dokument on jõustatud 11.01.2000 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes. Standard on kättesaadav Eesti standardiorganisatsioonist.	This Estonian standard EVS-EN 1918-4:2000 consists of the English text of the European standard EN 1918-4:1998. This document is endorsed on 11.01.2000 with the notification being published in the official publication of the Estonian national standardisation organisation. The standard is available from Estonian standardisation organisation.

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ICS 75.200

Võtmesõnad: geoloogia, hooldus, kasutusnõuded, keskkonnakaitse, konstruktsioon, kontrollimine, ladustamine, looduslik gaas, määratlused, ohutus, tehnilised andmed, testimine

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Eesti Standardikeskusele kuulub standardite reprodutseerimis- ja levitamisõigus

EUROPEAN STANDARD
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English version

Gas supply systems

Underground gas storage

Part 4: Functional recommendations for storage in rock caverns

Systèmes d'alimentation en gaz – Stockage souterrain de gaz – Partie 4: Recommandations fonctionnelles pour le stockage en cavités minées

Gasversorgungssysteme – Untertagespeicherung von Gas – Teil 4: Funktionale Empfehlungen für die Speicherung in Felskavernen

This European Standard was approved by CEN on 1998-01-22.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
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of an identical text or by endorsement, at the latest by August 1998, and conflicting national standards shall be withdrawn at the latest by August 1998.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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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 under way 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.

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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.

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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.

A horizontal water curtain may consist of a gallery of small section, generally located above the storage caverns, from which boreholes are drilled.

A vertical water curtain consists of vertical or subvertical boreholes drilled from the surface, or from a purpose-designed gallery. The vertical water curtain is mainly used to avoid hydrogeological interference between two or more storage caverns, and allow independent operation of each one.

Figure 1 illustrates a mined rock cavern cross-section.

Working principle

The hydraulic containment principle for LPG storage in unlined underground caverns is that the product is contained by the groundwater pressure prevailing in the adjacent rockmass. The cavern is located at such a depth that the water naturally present in the surrounding rock flows everywhere towards the cavern preventing the stored product from migrating. The favourable effects of the threshold displacement pressure are considered as an additional safety term.

The product, lighter than and hardly miscible with water, is in this way hydraulically contained within the storage space.

The water which collects in the cavern during operation is removed by pumping, treated and disposed of or recycled.

Furthermore, depending on the required commercial product specifications, coalescers and/or dryers are implemented at the surface if necessary forthe product during withdrawal. Stripping units are implemented before disposal or recycling if necessary for the seepage water.

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1 Scope

This standard specifies procedures and practices which are safe and environmentally acceptable.

It covers the functional recommendations for design, construction, testing, commissioning, operation and maintenance of underground gas storage facilities in rock caverns up to and including the top flanges of the casings. It does not cover refrigerated gas storage.

The necessary surface facilities for an underground gas storage are described in EN 1918-5.

In this context "gas" is any gaseous fuel which is in a gaseous state at a temperature of 15 °C under a pressure of 1 bar.

This European Standard specifies common basic principles for gas supply systems. Users of this European Standard should be aware that more detailed national standards and/or codes of practice may exist in the CEN member countries.

This European Standard is intended to be applied in association with these national standards and/or codes of practice and does not replace them.

This standard is not intended to be applied retrospectively to existing facilities.

2 Definitions

For the purpose of this standard, the following definitions apply:

2.1 casing (for a rock cavern)
Pipe or set of pipes that can be screwed or welded together to form a string surrounding the tubing connecting the cavern to the surface.

2.2 cementing
Operation whereby a cement slurry is pumped and circulated down a well through the casing and then upwards into the annular space between the casing and the open or cased hole.

2.3 containment
Capability of a cavern to prevent migration of stored hydrocarbons.

2.4 drilling
All technical activities connected with the construction of a well.

2.5 exploration
All technical activities connected with the investigation of a geological site.

2.6 logging
Measurement of any physical parameter versus depth in a well.

2.7 maximum operating pressure (MOP) (for a rock cavern)
Maximum value of the pressure of any fluid contained in a cavern which can be accepted in normal operation and maintenance.

NOTE 1: It is defined at a reference point which is in general the roof of the cavern.

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