

Gas supply systems — Underground gas storage —

Part 1: Functional recommendations for storage in aquifers

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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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English version

Gas supply systems — Underground gas storage — Part 1: Functional recommendations for storage in aquifers

Système d'alimentation en gaz — Stockage
souterrain de gaz —
Partie 1: Recommandations fonctionnelles pour le
stockage en nappes aquifères

Gasversorgungssysteme — Untertagespeicherung
von Gas —
Teil 1: Funktionale Empfehlungen für die
Speicherung in Aquiferen

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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of an identical text or by endorsement, at the latest by August 1998, and conflicting national standards shall be withdrawn at the latest by August 1998.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 1 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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Contents

	Page
Foreword	2
Introduction	3
1 Scope	5
2 Definitions	5
3 General	7
3.1 Long-term containment of stored products	7
3.2 Environmental conservation	7
3.3 Safety	7
3.4 Monitoring	7
4 Design	7
4.1 Design principles	7
4.2 Geological concerns	7
4.3 Determination of the maximum operating pressure	8
4.4 Wells	9
4.5 Monitoring systems	10
4.6 Neighbouring subsurface activities	11
5 Construction	11
6 Testing and commissioning	12
7 Operation, monitoring and maintenance	12
7.1 Operating principles	12
7.2 Monitoring of the storage formation	12
7.3 Monitoring of upper aquifers	12
7.4 Monitoring of connected aquifers	13
7.5 Monitoring of wells	13
7.6 Maintenance of wells	13

Introduction

Use of aquifer storage

Unlike other energy sources, natural gas is distributed through a network of pipes and cannot be stored by consumers. Consequently, the distributor has the responsibility of adjusting supply to meet demand.

One of the principal means of adjusting supply to demand is through the use of underground storage facilities. Due to their substantial capacity, they can ensure:

- that peak consumption loads are met;
- seasonal adjustment, enabling gas to be supplied at a more or less constant rate throughout the year, whilst allowing for the significantly higher consumption in the winter than in the summer;
- the provision of security reserves intended to compensate for a potential interruption in supplies.

The performance of a storage facility is usually defined by two basic parameters:

- the working gas, which is the quantity of gas that may be withdrawn without jeopardizing the reconstitution of the stock required to meet the needs of the following gas withdrawal period;
- the peak flow rate, which is the maximum flow rate the storage facility can deliver under given operating conditions.

Technical description

Underground aquifer storage is the artificial creation of a natural gas deposit by displacing the water contained in the pores of a deep-laying aquifer with gas. The space forms a gas “bubble” which can be operated in alternate injection and withdrawal cycles. By their very nature, underground storage facilities in aquifers are closely related to oil and gas fields. Indeed, the exploration, installation and maintenance phases are based on oil and gas industry approved technology.

A suitable site for an underground aquifer storage facility has the following geological characteristics:

- a dome-shaped structure or structural trap with an adequate closure to ensure satisfactory containment of the gas-filled zone;
- a layer of soil or rock with a sufficient degree of porosity and permeability to form a reservoir of the desired capacity and productivity;
- a layer of gas-tight soil or rock deposits, known as caprock, which directly covers the storage formation and prevents any vertical gas migration.

Figure 1 shows a cross-section of a zone combining such characteristics.

The search for such structures is largely based on documentary studies of available data (regional geological surveys, oil exploration), on geophysical measurements (made essentially during seismic surveys) and on well drilling (core sampling, logging and well testing). At each stage, a critical examination of all the data gathered results either in abandoning the structure, recognizing it as suitable for storage or identifying further studies or tests that are required.

Geological surveys are not limited to gas filling but can be extended according to the results obtained when drilling new wells or developing the gas zone in the course of operation.

Underground gas storage facilities in aquifers (see Figure 1) consist of wells, which connect the aquifer and the surface, and surface installations.

Some wells are devoted to injection and withdrawal of gas; these are called operating wells. Monitoring wells monitor any extension of the gas zone and the quality of the water in the storage aquifer or watch over the upper aquifer.

The functions of surface installations are:

- gas transfer between the wells and the central station;
- gas treatment to meet the gas quality requirements of the network (dehydration, sweetening where necessary, possible odorization, filtering);
- gas compression or expansion to control the pressure difference between network pressure and storage pressure;
- metering of injected or withdrawn gas quantities.

Working principle

Gas injection

Gas is injected into the storage formation via the operating wells which provide communication between the zone used for storage and the surface. For the gas to displace the water contained in the pores of the reservoir rock, the injection pressure has to exceed the initial pressure in the aquifer. To avoid mechanical disturbance of overburden layers and gas penetration into the caprock, the pressure in the reservoir is not allowed to exceed a maximum value.

Because of the compressibility and viscosity of the water and the geometric extension of the aquifer horizon, there is a decrease in water movements and pressure changes with increasing distance from the gas injection area. Beyond a certain distance, these disturbances are scarcely noticeable.

Gas withdrawal — the concept of working gas

When gas needs to be withdrawn, the pressure at the operating wellhead is lowered to create a pressure drop from the formation into the well to commence production. As gas withdrawal progresses, the pressure in the gas phase drops below the aquifer pressure, the aquifer water starts to flow back and the gas water contact rises within the storage formation.

It is inevitable that, after a normal gas withdrawal operation, a large quantity of gas, known as cushion gas, will remain in the reservoir. A fraction of this gas remains trapped in the reservoir and the part which could be recovered is left to maintain sufficient pressure to ensure the desired flow rates and preclude well submergence. The cushion gas represents a volume equal to roughly half the total stored volume. The withdrawable gas volume is usually known as the working gas.