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1.Discuss in detail the different methods of storing natural gas

Natural gas is usually stored underground, in large storage reservoirs. There are three main types of underground storage: depleted gas reservoirs, aquifers and salt caverns. In addition to underground storage, however natural gas can be stored as liquefied natural gas (LNG), Pipeline capacity and gasholders.

**i. Depleted gas reservoir**

These are the most prominent and common form of underground storage of natural gas. They are the reservoir formations of natural gas fields that have produced all or part of their economically recoverable gas. The depleted reservoir formation should be readily capable of holding sufficient volumes of injected natural gas in the pore space between grains (via high porosity), of storing and delivering natural gas at sufficient economic rates (via high permeability) and be contained so that natural gas cannot migrate into other formations and be lost. In addition, the rock (both the reservoir and the seal) should be capable of withstanding the repeated cycle of an increase in pressure when natural gas is injected into the reservoir and in reverse the drop in pressure when natural gas is produced.

Using such a facility that meets the above criteria is economically attractive because it allows the re-use, with suitable modification, of the extraction and distribution infrastructure remaining from the productive life of the gas field which reduces the start-up costs. Depleted reservoirs are also attractive because their geological and physical characteristics have already been studied by geologists and petroleum engineers and are usually well known. Consequently, depleted reservoirs are generally the cheapest and easiest to develop, operate, and maintain of the three types of underground storage.

**ii. Aquifer reservoir**

Aquifers are underground, porous and permeable rock formations that act as natural water reservoirs. In some cases, they can be used for natural gas storage. Usually these facilities are operated on a single annual cycle as with depleted reservoirs. The geological and physical characteristics of aquifer formation are not known ahead of time and a significant investment has to go into investigating these and evaluating the aquifer’s suitability for natural gas storage.

If the aquifer is suitable, all of the associated infrastructure must be developed from scratch, increasing the development costs compared to depleted reservoirs. This includes installation of wells, extraction equipment, pipelines, dehydration facilities, and possibly compression equipment. Since the aquifer initially contains water there is little or no naturally occurring gas in the formation and of the gas injected some will be physically unrecoverable. As a result, aquifer storage typically requires significantly more cushion gas than depleted reservoirs; up to 80% of the total gas volume. Most aquifer storage facilities were developed when the price of natural gas was low, meaning this cushion gas was inexpensive to sacrifice. With rising gas prices aquifer storage becomes more expensive to develop.

**iii. Salt formation**

Underground salt formations are well suited to natural gas storage. Salt caverns allow very little of the injected natural gas to escape from storage unless specifically extracted. The walls of a salt cavern are strong and impervious to gas over the lifespan of the storage facility.

Once a salt feature is discovered and found to be suitable for the development of a gas storage facility a cavern is created within the salt feature. This is done by the process of solution mining. Fresh water is pumped down a borehole into the salt. Some of the salt is dissolved leaving a void and the water, now saline, is pumped back to the surface. The process continues until the cavern is the desired size. Once created, a salt cavern offers an underground natural gas storage vessel with very high deliverability. Cushion gas requirements are low, typically about 33 percent of total gas capacity.

Salt caverns are usually much smaller than depleted gas reservoir and aquifer storage facilities. A salt cavern facility may occupy only one one-hundredth of the area taken up by a depleted gas reservoir facility. Consequently, salt caverns cannot hold the large volumes of gas necessary to meet base load storage requirements. Deliverability from salt caverns is, however, much higher than for either aquifers or depleted reservoirs. This allows the gas stored in a salt cavern to be withdrawn and replenished more readily and quickly. This quick cycle-time is useful in emergency situations or during short periods of unexpected demand surges.

**Other types or methods are:**

**ix. LNG**

LNG facilities provide delivery capacity during peak periods when market demand exceeds pipeline deliverability. LNG storage tanks possess a number of advantages over underground storage. As a liquid at approximately −163 °C (−260 °F), it occupies about 600 times less space than gas stored underground, and it provides high deliverability at very short notice because LNG storage facilities are generally located close to market and can be trucked to some customers avoiding pipeline tolls. There is no requirement for cushion gas and it allows access to a global supply. LNG facilities are, however, more expensive to build and maintain than developing new underground storage facilities. It mainly contains butane gas.

**V. Pipeline capacity**

Gas can be temporarily stored in the pipeline system itself, through a process called line packing. This is done by packing more gas into the pipeline by an increase in the pressure. During periods of high demand, greater quantities of gas can be withdrawn from the pipeline in the market area, than is injected at the production area. The process of line packing is usually performed during off peak times to meet the next day’s peaking demands. This method, however, only provides a temporary short-term substitute for traditional underground storage.

**xi. Gasholders**

Gas can be stored above ground in a gasholder (or gasometer), largely for balancing, not long-term storage, and this has been done since Victorian times. These store gas at district pressure, meaning that they can provide extra gas very quickly at peak times. Gasholders are perhaps most used in the United Kingdom and Germany. There are two kinds of gasholder — column-guided, which are guided up by a large frame that is always visible, regardless of the position of the holder; and spiral-guided, which have no frame and are guided up by concentric runners in the previous lift.

2. Why is compressor stations necessary in oil and gas?

Compressor stations enable the natural gas itself to travel through the pipelines which is crucial to the natural gas transport system. They also allow the gas to be rerouted into storage areas during periods of low demand. In addition, compressor stations are often accompanied by PIG launchers and PIG receivers which are vital for the maintenance and efficiency of the pipeline. They even include many safety features allowing the pipeline and station to function safely.

3. Outline the key component parts of compressor station and what are their functions?

the gas compressor station consists of the following units:

1. a suction scrubber.
2. a gas manifold or a distribution header.
3. gas compressor “single or multiples stages” according to the required discharge pressure.
4. gas cooler fan.
5. discharge scrubber.
6. condensate gathering system.
7. corrosion inhibitor skid.
8. a dehydration unit.
9. metering station.
10. blow down flares.
11. Utilities:

**Gas Compressor Station components:**

**1.  suction scrubber**:

it is the first component of the gas compressor station, it is a 3-phase separator used to separate liquids and condensate from natural gas, the existence of any liquid in the natural gas stream will cause a compressor vibration.  
the liquids will be disposed to the burn bit to be burned, while the condensate will go to the condensate gathering header.

**2. gas manifold or a distribution header**.

after leaving the scrubber, natural gas will enter a manifold or a distribution header, it is used to distribute the gas to the compressor station trains” in large compressor station and if there is a big amount of gas is compressed”, before entering the compressing train it goes through a strainer to eliminate any liquid droplets.

**3. gas compressor**  
single or multiples stages according to the required pressure.  it is either driven by a gas turbine or an electric motor, single stage or multiple stages “2 or 3” according to the required discharge pressure.

centrifugal compressors are the most preferred in gas compressor station, and it is equipped with an [anti-surge system](https://www.arab-oil-naturalgas.com/surge-control-centrifugal-compressors/).

compressors are equipped with seal [oil](https://www.arab-oil-naturalgas.com/what-is-crude-oil/) system that seals the sour gas from the lubricating oil, which in turn lubricates the bearings, it is also equipped with vibration, speed and temperature sensors.

**4. cooler fan:**

after being compressed, the temperature of natural gas is greatly increased, sometimes reach to 170 – 180 ºC, this requires cooling the gas, it is done by air cooler fans, which draw air beneath, and cools the gas.

**5. discharge scrubber**:

after being compressed and cooled, vapors in natural gas will condense to liquids, these liquids can be separated and disposed in the discharge scrubber, as mentioned in suction scrubber; liquids will be disposed to the burn bit to be burned, while the condensate will go to the condensate gathering header, each compressing train is supplied with a suction and discharge scrubber.

**6. condensate gathering system**:

the condensates are gathered from all the scrubbers in the compressor station, there are many options to make use of this amount, but the most common one is to inject this condensate in the gas discharge pipeline, there is a special technology to do this, it is injected by a sparger to guarantee the homogeneous propagation in the pipeline.

**7. corrosion inhibitor skid**:

because of compression and cooling for the natural gas, water vapor will be converted to liquid water, it may react with [hydrogen sulfide](https://www.arab-oil-naturalgas.com/h2s-in-oil-industry/) to form sulfuric acid, this will lead to serious corrosion problems to the pipelines and equipment, so corrosion inhibitor is injected before the air cooler to prevent corrosion. this is done by special type injectors which receive the chemical from a chemical injection skid consists of a dosing pump and a [tank](https://www.arab-oil-naturalgas.com/crude-oil-storage-tanks/), injection pressure must be higher than the gas pipeline pressure, otherwise there will be no chemical injection.

**8. dehydration unit:**

each gas compressor station is equipped with a [gas dehydration unit](https://www.arab-oil-naturalgas.com/natural-gas-dehydration-p1/),  it is used to remove the water vapor from natural gas.

**9. metering station:**

it is used to measure the quantity of natural gas, gas volumes are expressed in Standard Cubic Foot and the Standard Cubic Meter.

**10. blow down flares:**

it is a kind of [flare](https://www.arab-oil-naturalgas.com/flare-types-and-components/) used to dispose the gas from the compressor station when shut down happens, Emergency Shut-Down [Valves](https://www.arab-oil-naturalgas.com/what-are-the-types-of-valves/) “ESDVs” that are equipped in each scrubber will do this.

**11. Utilities**:

such as: instrument air system and fire-fighting system.