

## **Safety Concept for a LPG Underground Storage in Germany, Case Study for the Salt Caverns Storage Site at Gnetsch**

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### **Abstract**

In Germany plants for storing more than 50 t LPG are subject to very strong and detailed regulations regarding safety and fire protection. The storage of liquid propane in salt caverns must therefore be based on a comprehensive safety concept.

The major points of such a safety concept are:

- The stability of caverns is guaranteed by sufficiently designed pillars.
- The collapse and the burst strength of the final cemented casing and of the production string are designed for a period of operation exceeding 30 years including a sufficient safety factor.
- The operation pressure remains 5 bar below the maximum permissible pressure. The safety factor for defining the maximum permissible pressure amounts to 1.2.
- The design pressure of the cavern well head and the related valves are far higher than the maximum operational pressures.
- The annulus between final cemented casing and production string is filled with an inert liquid for corrosion protection allowing the monitoring of the tightness of the final cemented casing and the production string.
- A protection annulus filled with brine in combination with well head pressure monitoring serves as overflow protection measure for the LPG.
- If LPG is released from the well head in the case of an emergency its spreading is impeded by a special designed housing. Any gas release within this housing is detected by a gas concentration measurement device.
- The surface facilities are equipped with devices guaranteeing a high level of operational safety and protection in the case of emergency.
  - Pneumatically operated emergency shut-down valves in the LPG and brine lines which will be closed if limit values were exceeded
  - Permanent pressure monitoring of the product annulus, the protection annulus and the brine string at the well head. Exceeding of limit values will cause their shut-off.
  - Local pressure measurement devices at the annulus filled with inert liquid
  - Monitoring of the density of the brine and the LPG in the interconnecting lines with alarms and emergency-out if limit values were exceeded
  - Determination of differences in the amounts of LPG injected into the cavern and brine withdrawn from the cavern and vice versa for leak detection.

After the safety concept was applied successfully the following conclusions can be drawn:

- There are no threats towards the operational staff caused by the facility (explosion, emission of hazardous materials).

- There are no threats towards the population in surrounding living areas caused by the facility (emission of hazardous materials).
- The storage facilities themselves are not endangered by surrounding threats.
  - There are no threats towards the soil and/or the ground

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