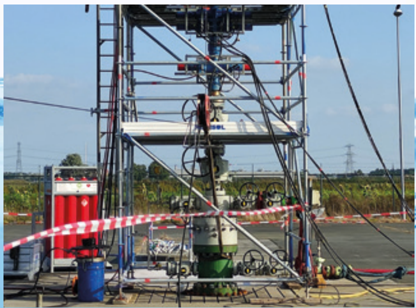
ISSUE 1/21 | September 2021

ECHO*News*

SOCON

- First surveys in hydrogen successfully carried out



- CavBase GasStorage 2.0
- German Mine Surveying Ordinance amended
- New SOCON homepage

Vorwort

Dr. Andreas Reitze
Managing Director of
SOCON Sonar Control Kavernenvermessung GmbH

Dear Readers,

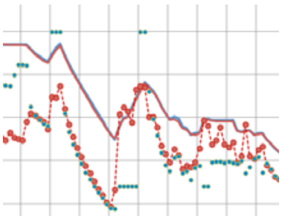
In corona year 2020, we had all our hopes pinned on 2021 and expected a quick return to normality. During this time, we also experienced how important personal meetings are, especially in a business environment. However, it was not until the second half of 2021 that we saw noticeable improvements in our private and professional lives.
We had to cancel all planned events in 2020, so we are therefore all the more pleased that we will be able to offer an in-person customer seminar again in November this year. At this seminar, we will focus on the current topic of cavern hydrogen storage. In addition to the basics of hydrogen and the presentation of various hydrogen projects in caverns, we will also report on the first hands-on experience with our tools in the medium of hydrogen. You will find the detailed event program on page 19 of this issue of ECHONews. We are very much looking forward to seeing you there.
Actually, we have been dealing with the topic of hydrogen for quite some time and carried out extensive preliminary investigations in recent years to be well prepared for the first practical deployment in a hydrogen-filled well or cavern. For example, in March this year, our pressure control equipment and tool technology were successfully tested and certified in the medium of hydrogen (see page 7). The first real-world deployment in a hydrogen-filled well took place in September 2021 and confirmed the basic operational capability of our survey tools in hydrogen. A brief report on the results of this first deployment can be found on page 10.

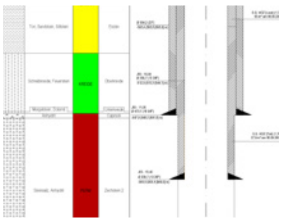
In addition to hydrogen, we also focused in particular on the further digitization and optimization of our processes and workflows. Moreover, our first survey trucks now equipped to communicate directly via the internet with our head office in Giesen are on the road.
Our development focus in the field of tool technology was again characterized on the one hand by developing solutions to customer-specific requirements and on the other by extensive basic developments in our new tool generation. Here we achieved interesting innovations and optimizations, which we will report on in our next issue.
Further topics in this issue concern the further development of our proven CavBase GasStorage software, specifically version 2.0, which features conceptual innovations and can also be fully used for thermodynamic calculations in hydrogen. In addition, we report on the impacts of the amended German Mine Surveying Ordinance on preparing maps for cavern storage facilities – the new ordinance includes a significant change with the introduction of upgraded borehole maps as part of the required mine maps.

I hope that there is something of interest for you in the current issue of our ECHONews and now wish you an interesting read.

All the best from

Contents





Survey technology / hydrogen

Physical properties of hydrogen and impact on safety and operation

Hydrogen has already been considered for many decades as an energy storage medium in a market characterized by renewable energies. In these years many studies have investigated how to store hydrogen in salt caverns. In recent years, the intensified focus on hydrogen handling has ramped up significantly.

For example, in 2018 Uniper initiated the generation and admixture of initially small amounts of hydrogen to natural gas networks in Falkenhagen, Germany. The continuation of this concept led to various projects and in-detail examination of the impact on the gas supply system as well as to updating the relevant technical regulations. In addition, more pilot projects, inter alia, on hydrogen storage in caverns have been implemented, some of which have already commissioned services from SOCON.

In these projects and in the intended long-term operation of hydrogen caverns, SOCON comes into contact with hydrogen in various areas:

- Tools and lubricators must withstand permanent use without compromising safety, and the same applies of course to the work safety of our staff.
- Surveys must continue to deliver reliable information on cavern contours, interface depths, humidity, gas composition etc.
- Our thermodynamic simulation programs must continue to enable reliable and economical storage planning for hydrogen.

So as not to leave anything to chance in preparation for real world applications, at SOCON we have compiled the essential substance properties of hydrogen, looked at how they can be compared with those of natural gas and nitrogen (gas leakage test), examined their impacts, and studied what adjustments may be needed in the above areas.

Some of the known properties of hydrogen may initially appear to be daunting or problematic, although there is a history of positive experience from town gas (also called coal gas) storage (in use until 1995 in Germany, this gas had a hydrogen content of about 55 %). On closer inspection, hydrogen has similar requirements to the natural gas with which we work routinely and safely. In the following, the relevant substance properties are described in more detail and related to our work.

Substance properties

The hydrogen atom is the first atom in the periodic table and therefore has the smallest mass and the smallest size of all the elements. However, hydrogen is usually present as molecule (H2) and as such is only about 1/3 smaller than, for example, methane (CH4) or nitrogen (N2) molecules[1]. Other relevant substance properties of hydrogen, nitrogen and high-calorific North Sea gas (or pure methane CH4 if so indicated) at 200 bar and 25 °C are listed in the table below.

Dynamic viscosity (η) is the decisive parameter in terms of possible leakage. As this is relatively low, it tends to lead to a higher leakage rate for hydrogen and therefore places higher demands on gas-tight compounds than natural gas or nitrogen. Hydrogen is therefore used as a leak detection medium in a mixture with nitrogen (forming gas), although mainly because of its very good detectability. On material surfaces, hydrogen may be present in atomic form. It can then diffuse into solids and lead to the well-known hydrogen embrittlement of some types of steel. This process, which occurs mainly in steels with increased strength but also in titanium, can be avoided, for example, by selecting suitable steel grades. Diffusion and thus the risk of hydrogen corrosion are very strongly dependent on pressure, so in the case of a mixture the partial pressure of the hydrogen is decisive. In the case of a relatively low addition of hydrogen to natural gas, the effect of hydrogen corrosion on the materials used is therefore much less pronounced. However, contrary to what has been discussed in some quarters, the diffusion does not lead to any significant "leakage" in dense materials such as steel or salt, since the material flows are far too small for this.

1 *Calculated molecular diameter, see section 2, subsection 2.1 in Molekülphysik und Quantenchemie, H. Haken, H.-C. Wolf, Springer, 2006*

	Natural gas	Nitrogen	Hydrogen
Dynamic viscosity, µPas	21,5 (CH_4)	23,1	9,40
Density, kg/m³	187,2	241,1	14,48
Volume-related calorific value, MJ/m³ NTP	42,89	-	12,74
Explosion limits, lower – upper, mol %	4,4 – 17,0 (CH_4)	-	4,0 - 77,0
Minimum ignition energy, J	230	-	17
Ignition temperature, °C	595	-	560
Thermal conductivity, mW/Km	60,0	37,1	193
Absolute isobaric heat capacity, kJ/K	666,5	279,6	213,2

Comparison of selected substance data for natural gas (North Sea gas), nitrogen and hydrogen at 25°C and 200 bar

Despite the very low density of hydrogen compared with natural gas (or nitrogen), the high mass-specific energy content of hydrogen means that around 30 % of the energy content of natural gas is stored in a hydrogen-filled cavern (at the same pressure and volume).
Under certain conditions (isenthalpic throttling, i.e. throttling without energy supply), throttling hydrogen produces an increase in temperature, which is described by a (partly) negative Joule-Thomson coefficient. This distinguishes it from most other gases. In the usual cases, however, this is overlaid by other influences and will therefore hardly be detectable in normal operations. Nevertheless, in the event of a leak, this effect may lead to a limited increase in temperature.

When hydrogen is burned (in an open flame or in a fuel cell), only water is produced as a reaction product. This also has an impact on the appearance of the open hydrogen flame. While, due to the carbon in methane molecules, natural gas combustion produces soot, which glows red-yellowish in a flame, a hydrogen flame is hardly visible, because it radiates its heat in a higher frequency range (UV range). Because of the low density, the flame tends to be rather narrow and high, so unlike natural gas or liquid fuels, hydrogen does not spread on the ground. If there is an air-methane mixture with more than 17 percent methane by volume, the mixture is supersaturated and cannot explode. In the case of hydrogen, this upper ignition limit is only reached at 77 vol %. This means that there is a much larger explosion range compared with methane. Moreover, the minimum ignition energy (for example a spark) of hydrogen is many times lower.
The heat transfer of hydrogen to a temperature probe or the cavern wall depends on a whole range of parameters or substance data. On the basis of a general calculation, however, it can be estimated that a somewhat reduced energy exchange would take place for hydrogen.

Hydrogen hydrate formation similar to natural gas hydrates can be considered irrelevant because it can only occur in pressure and temperature ranges that are far outside the usual storage operating conditions.

Impact on safety and operations

To ensure the safety of our work during operations in hydrogen, we performed a risk assessment that takes the abovementioned substance properties into account. To this end we looked at the following questions:

- Construction and materials of the tools, lubricators, tool sensitivity, safety aspects
- Possible effects during operation (leaks at the wellhead, lubricator, etc.)
    - How do risk probability and impacts change?
    - What risk reduction measures can be introduced (detection of leakage/flame, avoidance of hydrogen ignition)?

Furthermore, we examined the effects on storage operation and our related activities.

The CavBase GasStorage simulation program is already used by many operators in capacity planning for natural gas caverns and version 2.0 is also suitable for hydrogen storage. AGA 8 and GERG models are used to calculate the substance data. Both models allow variable adaptation to all technically relevant gas compositions and also take into account mixtures of natural gas and hydrogen as well as pure hydrogen. Our investigations to date show that hydrogen does not behave significantly differently from natural gas in the cavern, the borehole and in the surface pipeline network. Moreover, other processes play a more dominant role than the already mentioned negative Joule-Thompson coefficient. This means this coefficient only needs to be taken into account in the case of throttling when extracting gas (if the storage pressure is higher than the pipeline pressure). The simulation results created with CavBase GasStorage 2.0 also show slightly reduced temperature changes in the cavern, so that a marginally reduced thermal load on the rock salt can be assumed. Based on the maximum pressure permitted by the rock mechanics as well as the permissible pressure rates and service lives of caverns, operating storage caverns can therefore be continued under similar conditions. However, as a result of the low hydrogen density, there will be a significantly smaller difference between cavern and head pressure, so that head installations with a higher pressure level may be required on individual caverns.

The measured temperature in the borehole and in the cavern is an important piece of information for the thermodynamic simulation of the caverns as well as for gas tightness testing. In addition to the properties of the probe, the measurement accuracy achieved here depends very much on the heat transfer at the probe and on running speed. To estimate this influence, heat transfer was modelled and the influence of the tool on the gas temperature in the borehole was estimated on the basis of the absolute heat capacity of the gases. It turns out that in the case of nitrogen, compared with natural gas, the lower heat transfer rates and the stronger influence of the tool on the gas temperature need to be considered. Comparing hydrogen to natural gas, while there is a slightly lower heat transfer, the heat capacity is even lower. Concluding, in relation to the temperature logs for gas leak tests usually carried out in nitrogen, hardly any change is to be expected. On the other hand, in relation to temperature logging in natural gas, a significant reduction in running speed should be considered.

Dr. Olaf Kruck

Survey technology / hydrogen

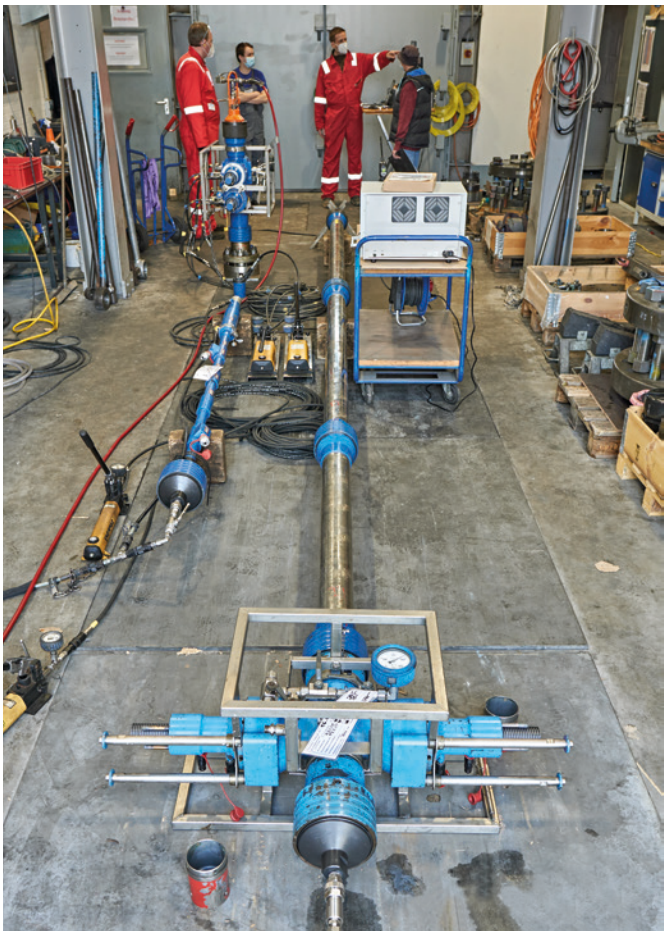
Testing of the pressure control equipment for use in hydrogen

For the safe execution of surveys in hydrogen, the pressure control equipment used must be technically suitable and approved. We have been using NOV (National Oilwell Varco) lubricators for 20 years, as they provide better H2S corrosion protection even though H2S does not occur in the cavern area.

To obtain official confirmation of the suitability of our pressure control equipment, we first contacted our supplier. They told us the pressure control equipment used was suitable for H2S and that use in hydrogen was unproblematic in terms of material resistance.

To obtain reliable proof of the suitability of the material and the sealing capacity of the elastomers used, at SOCON we decided to carry out a pressure test with hydrogen before putting them to first practical use and to have them certified by an authorizedbody. We found a competent partner for this test in the company Hartmann Valves, which has been manufacturing and selling hydrogen-resistant valves for the petrochemical industry for many years. The company was commissioned to prepare all the individual parts of a complete pressure control system based on the material certificates for their suitability for use in hydrogen. In addition to this theoretical test, pressure and functional tests of the pressure equipment as well as a BSF2 tool were carried out.

Extensive preparations were made in advance of the tests. Because testing with gas in a closed space poses an increased safety risk, prior to the gas test, the pressure control equipment was tested with liquid in our own pressure test container at 1.5 times the later gas pressure, in this case at 450 bar. For communication between the tool and the measuring apparatus, a pressure cap with a pressure bulkhead was built, through which the communication to the run-in tool could take place under pressure.



In spring 2021, the test setup was installed in a pressure testing hall at Hartmann Valves in Ehlershausen. The experimental setup consisted of 3 assemblies, each of which was closed with pressure caps and all connected to each other via a hose line.

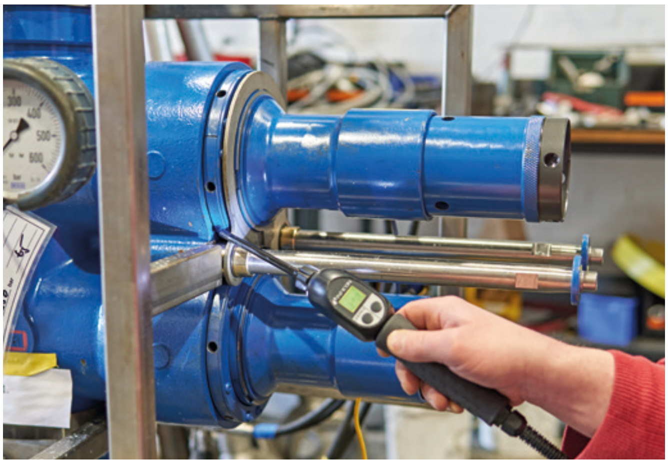
The first assembly consisted of a flange and a double preventer with a corresponding pressure cap, in which a test rod was mounted in lieu of the cable.
Hydraulic hoses and hydraulic hand pumps made it possible to close the preventer jaws around the test rod under test pressure and to carry out a measurement with closed BOP jaws by opening the ball valve of the upper pressure cap.
The second assembly consisted of a single cutting preventer and three lubricator pipe segments into which the survey tool was inserted. The system was closed by two pressure caps. Via the upper of the two pressure caps, the tool was connected to the measuring computer through a pressure bulkhead. The third assembly consisted of the grease injection unit, in which the flow pipes were dismantled. This made it possible to test the jacket tubes of the grease injection unit, which are not exposed to any pressure under normal conditions during survey work. A test rod was also used to test the sealing function of the two hydraulically operated cable seals (safety barrier in the event of failure of the grease injection).

The hydraulic cylinders for closing the sealing jaws were controlled by hand pumps, which were connected to the grease injection unit via hoses (illustrations on page 7).

After the installation of the three test sections and the connection of all lines, the entire system was initially loaded with compressed air at 25 bar for 15 minutes. The pressure was recorded both with a digital pressure gauge and with the probe. After the test was successfully completed at 25 bar, the system was loaded with 300 bar compressed air for another 15 minutes. Again, no leaks were detected.

After draining the compressed air from the system, the test setup was filled to a pressure of 20 bar with forming gas comprising 5% hydrogen and 95% nitrogen. After a holding time of 20 minutes, all connections were checked with a leak detector (Protec P3000 XL Sniffer Tester). During the measurement, the detector increased all measured values by a factor of 20 to simulate forming gas with 100% hydrogen content on the basis of the 5% hydrogen content of the gas being tested.

After successful verification of the connections, the sealing jaws of the double preventer closed around the test rod and the pressure in the space above the sealing jaws was released to the outside via a silencer. This was important for the test, as the measuring instrument used is extremely sensitive and releasing gas under pressure in the test room would have led to significant measurement errors.
Likewise, a measurement was carried out at the upper end of the grease injection unit directly behind the sealing jaws to confirm the tightness of the elastomer seals around the test rod. After pressure equalization, the jaws of the preventer were reopened hydraulically.



This test sequence described above was then repeated at 150 bar and 300 bar.

After the test was completed at 300 bar and the preventer jaws were back in the open state, the pressure was increased to 304 bar to test the system overnight at this pressure over a longer period of time, as this would be a realistic pressure during subsequent surveying.

The next morning, after 15 hours of holding time, the test procedure from the previous day was repeated. Here the measurement of the closed preventer jaws around the test rod, recorded an increased value of 200-300 ppm V. However, this value is still more than 100 times below the lower explosion limit of 4% for a hydrogen/air mixture. In addition, it is possible a during real survey run to inject sealant grease between the upper and lower seal jaws of the preventer to provide additional sealing.

The tool sensors did not register any increase in the measured values during the entire test period.
All measurement results of the sniffer test, with the exception described, were below the value of 50 ppmV as specified in ISO 15848 for housing seals.

The components tested at Hartmann Valves represent all the 4" pressure lubricator equipment items currently used at SOCON for gas surveys. All preventers, lubricator pipes and grease injectors used at SOCON are identical to the pressure control devices tested here. Therefore, based on the current state of knowledge, we assume that the entire 4" pressure equipment, as previously used for natural gas measurements, is also suitable for use in hydrogen.

Due to the large number of different cavern wellhead adapters that SOCON provides for the various caverns, the material suitability for the customer’s respective adaptor must be checked for suitability on the basis of the material certificate before use in a hydrogen atmosphere.

We at SOCON would like to take this opportunity to thank the entire team of Hartmann Valves for the friendly and competent cooperation. With this successful test, we have taken a significant step towards the safe handling of the new energy carrier hydrogen.

Axel
Heuer

Survey technology / hydrogen

First surveys in hydrogen as success

To date no survey has ever been carried out with direct contact to hydrogen in any of the world's existing hydrogen caverns (UK and USA). Typically, the only cavern survey work carried out was logging in brine-filled inner strings or sonar survey of caverns completely flooded with brine. Various projects and research activities on the storage of hydrogen are currently underway. Therefore, the surveys carried out in the context of the tests on the Zuidwending ZWA8A cavern belonging to N.V. Nederlandse Gasunie represent the first real-world use of borehole tools in a hydrogen-filled borehole.

For the first time sonar tools were run directly into a borehole filled with hydrogen in September 2021. Of course, extensive preliminary investigations had been carried out on the suitability of the materials used. The entire lubricator technology was tested at Hartmann Valves in Celle at the beginning of the year (see report on page 7).

The materials from which the sonar tools (SoMIT and BSF2) are made had been found to be suitable in advance.

In the survey carried out in hydrogen the primary interest was to prove that the SoMIT method can also be used safely and to the required accuracy in hydrogen-filled boreholes. However, further tests should also be carried out with a BSF2 tool to gain initial insights into the use of a sonar survey tool in hydrogen.

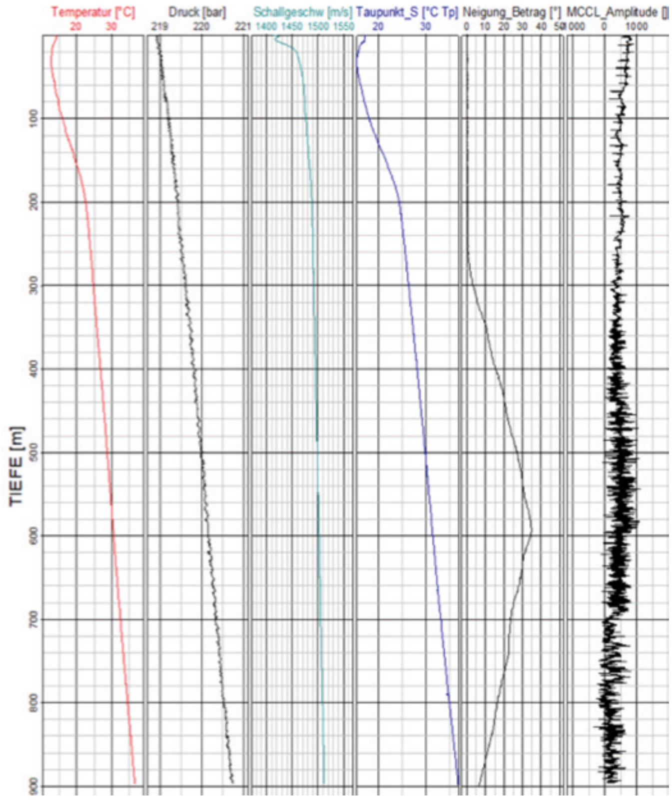
All SOCON employees involved in the operation received special instruction in advance on the subject of "Special features of working on hydrogen-filled caverns" to ensure their optimal preparation for the different conditions compared with surveying in natural gas-filled caverns (wider range of explosive mixtures, greater danger due to possible static charge due to hydrogen passing by, etc.).

The main results of the SoMIT test are:

- The method can also be used in hydrogen.
- The tool's full functionality in hydrogen is demonstrated.
- The coupling of the emitted sonar signal to the medium hydrogen is better than to nitrogen.
- The achievable ranges are longer and the attenuation of the emitted sonar signal is lower than in nitrogen.

The main results of the BSF2 test can be summarized as follows:

- The sonar tool is fully functional in hydrogen.
- The speed of sound (measured with the BSF2 speed of sound measuring module) is significantly higher than in nitrogen or natural gas.
- The dew point was measured, allowing moisture content to be extrapolated backwards.
- Compared with natural gas, different measurement frequencies could be utilized.
- For sonar surveys in hydrogen, extremely long ranges were achieved and the results, which had already been determined with the SoMIT tool, were confirmed.



After the measurements, both the tools used and test samples of the wireline cable were examined in detail. In the case of the survey cable, the focus of the investigations is, inter alia, on possible structural changes and the impacts on ductility. The tools were completely dismantled and all components examined for possible impacts or damage.

The results of these investigations were not yet available at the time of writing and will be presented at our customer seminar (see page 19).

In conclusion, with its survey tool technology SOCON is very well positioned to meet the challenges for MITs and sonar surveys in hydrogen-filled boreholes and caverns. The first results have shown that the chosen technology is the right one.

Frank Haßelkus

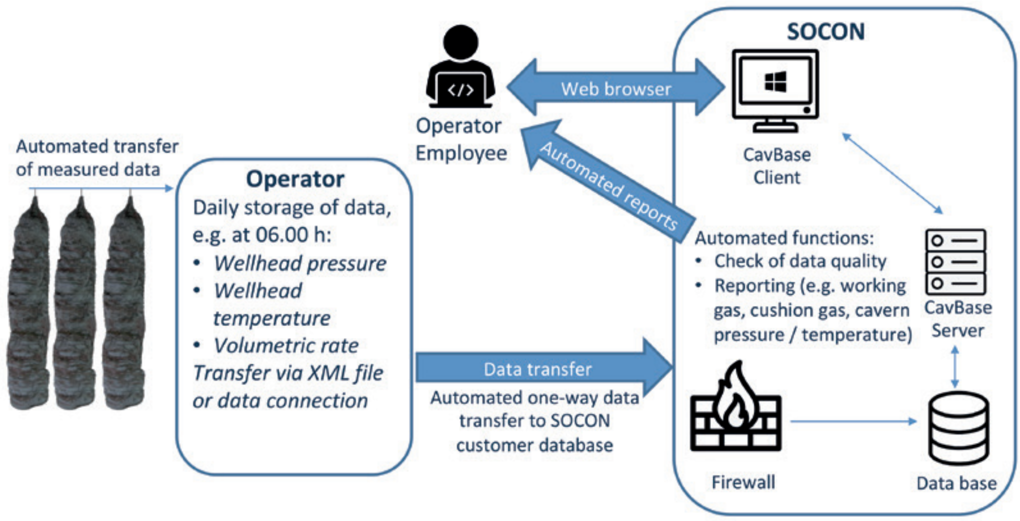
Cavern operation/gas storage optimization

CavBase GasStorage 2.0

The CavBase GasStorage cavern field software was developed in the mid-nineties and to this day has been under continuous further development on a modular basis. To take the rapid digitization (volume, speed, security requirements) of recent years into account, the software and its functionality are currently being updated to reflect the latest cutting-edge technology. CavBase GasStorage is installed locally at 20 gas storage facilities with a total of 181 gas caverns run by 13 storage operators. The support SOCON provides to the corresponding installations with respect to data control, troubleshooting and updates is either very time-consuming (business trips) or can only be guaranteed by remote dial-up (RDP connection with the operator's computer). However, in the interim RDP has proven to be increasingly problematic and time-consuming, as security measures have understandably increased significantly. SOCON has therefore designed a new concept of cavern storage support, which we present below. The new software version is currently being developed at SOCON under the title "CavBase GasStorage 2.0". This will be more powerful than the old version and have significantly more features. To avoid the above-mentioned shortcomings, the idea arose to digitally clone the storage systems to be maintained (digital twin). The digital clone or twin is setup and permanently maintained at SOCON. For data synchronization, the daily data from the gas cavern storage are transmitted via a secure data connection (e.g. VPN) to a server at SOCON. A newly developed software module automatically performs a plausibility check on the data, such as inadmissible jumps, completely unchanged values and limit value violations. The module compiles the results of this test in a report. The verified data is then added to the database and archived on SOCON's data backup system. Furthermore, the current storage data are analyzed and essential parameters (e.g. working gas, cushion gas, pressure and temperature in the cavern) are summarized in a report. Both reports are automatically sent to the operator or made available for download.

When using the program directly, the storage employee navigates and works on the CavBase server via a web browser, making customer software and expensive workstations redundant. Also, the CavBase server does not need to access the specially protected cavern-storage control system. Alternative access options, such as a local client or access to a client located at SOCON via RDP, can be developed as a bespoke customer solution.

The schematic structure is shown in the following figure. The usable features of the new version are based on the previous scope and will be expanded in the future.



Data transfer and customer access to the CavBase server located at SOCON via web interface

Previous features of the basic version of CavBase GasStorage (correspond to future basic module CavBase GasStorage 2.0):

- Thermodynamic calculations from caverns to manifolds and vice versa, including:
    - Gas flow
    - Automatic calculation of heat flow between salt body and gas cavern
    - History match of wellhead pressures and volume rates
    - Polytropic pressure, temperature and gas volume calculations
    - Pressure losses in the production string and in the piping system
    - Calculation of real gas factors for each time step (AGA8) depending on the gas composition
    - Automated history match (connection to the control system)
    - History match plus forecasts on an hourly basis

Optional modules for CavBase GasStorage or CavBase GasStorage 2.0:

- Continuous convergence calculation (based on maps)
- Hydrate module including calculation of inhibition quantities
- Cavern operation in pool mode with different pressure levels
- Hydrogen module (admixture of H_2 from 0 - 100%)
- CavBox module (gas filling, storage operation can also be simulated with partially filled cavern)
- Integration of surface facilities through to transport pipeline

Customizations and modules under development for CavBase GasStorage 2.0:

- New optimized user interface
- Improved information status by creating a digital twin
- Module for automated checking of daily or hourly data
- Backup system for storage database

Dr. Michael Krieter

Dr. Olaf Kruck

Mine surveying

Amendment of the German Mine Surveying Ordinance (MarkschBergV)

Upgrading of borehole plans for cavern and porous rock storage facilities

On 1 October 2019, the amendment to the German ordinance governing mine surveying and monitoring ground surface (German Mine Surveying Ordinance/MarkschBergV) came into force retroactively. Retroactive because the Federal Council adopted the amendment to MarkschBergV on 20 September 2019 and published it in the Federal Law Gazette on 20 November 2019. The announcement of the new version after final revision took place on 21.07.2020.

After more than three decades, there was now an update, new regulations and an addition to this ordinance, which is now applicable not only for "mine surveying and other surveying work in connection with activities and facilities in accordance with section 2 of the Federal Mining Act", but also for "surveys to record mining-related ground movements".

A major challenge of the amendment was to adequately take into account and evaluate the respective interests of the mining authorities and mining companies, and to establish a set of rules that corresponds to the state of the art. In addition to the impacts on the structure of the required mine surveying documentation, the amendment also covered other key issues (e.g. geodata, mapping guidance, measurement accuracies, follow-up deadlines, ...), which, however, cannot be looked at here.

For caverns and porous rock reservoirs, upgraded borehole plans have now been mandated as part of the mine map instead of the previously accepted borehole plans as part of the "Other documents". The table below shows the new structure of mapping cavern and porous rock storage facilities.

The preparation of borehole plans for inclusion in "Other documents" remains unchanged for:

- Underground exploration and underground production operations
- Surface exploration and surface production operations
- Storage mines

The main difference after the amendment is that the original borehole plan has been elevated to the status of "mine map". After being signed by a recognized mine surveyor, the mine map enjoys public trust and thus has greater credibility and legal certainty among authorities, companies and, in particular, the general public.

In line with section 63 (4) of the German Federal Mining Act (BBergG), a borehole plan as part of the "Other documents" would be exempted from inspection, whereas an upgraded borehole plan as part of the mine map would not. The amendment to MarkschBergV provides clarity here.

2. Other activities and installations

2.1 Underground storage
2.1.1 Cavern and porous rock storages

Mine map		Other documents	
Component	Content	Component	Content
Overview plan	Part 2 Number 2		
Operating site plan	Part 2 Number 10	Geological map	Part 2 Number 16
Upgraded borehole plan	Part 2 Number 14		
For cavern storages in addition			
Cavern plan	Part 2 Number 11	List of cavern surveys and volumes	Part 2 Number 17 Letter g
Benchmark map with height index	Part 2 Number 9		

Extract from the amended MarkschBergV (Annex 3, Part 1 Structure of the mine surveying documentation)

Recognized mine surveyors must ensure that their work is correct, comprehensible, accurate and complete. In the case of missing information, there are also exceptions, in which case reasons are to be indicated at a suitable place in the map. Last year SOCON's mine surveying department updated the contents of the archived mine surveying documentation to bring them in line with the new ordinance. New upgraded borehole plans were prepared and borehole plans were converted to borehole maps for 15 cavern storages and several mining operations with wells drilled from the surface.

In addition to the formal changes, the amendment also led to additions and changes in content, which had to be taken into account in the preparation of upgraded borehole plans to meet the new regulations (Annex 3, Part 2, Item 14 MarkschBergV) in addition to satisfying previously required content:

- Preparation of a list of completed surveys and borehole logs
- Addition of an overview of the reference point and the related survey points of the deviation surveys, indicating the relative or absolute measuring accuracies
- Addition of data on geological horizons of particular importance to safety
- Data on the loss and whereabouts of equipment and tools
- Representation of aquifers
- Representation of deviation sections in the borehole course
- In addition to the type of backfilling, the representation of the backfilling sections with indication of the backfilling material

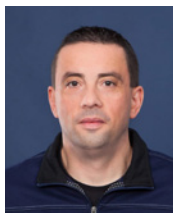
In the case of technically complex wells and boreholes that are significant in terms of safety, the authority may require that the upgraded borehole plan includes the following additional elements in the vertical section drawing:

- Installation depth of the completion
- Indication of the most important parameters of the filling material to prove its stability, indicating the reference standard
- Representation of the wellhead with data on the pressure level

The deadlines for the submission of the upgraded borehole plans are now 6 months for cavern storages after completion or significant changes in the wells. The filing deadline for porous rock storage facilities remains unchanged at 12 months. For "exploration and production operations with surface-drilled wells", on the other hand, this period has been increased to 24 months for hydrocarbon media.

As a matter of principle, current geodata must be used for the creation or updating of the mine surveying documentation. However, older maps may still be used. This also applies to upgraded borehole plans using the Gauss-Krüger (GK) coordinate reference system and the respective elevation systems. More recent projects are based on the UTM (Universal Transverse Mercator) coordinate system. The most recent elevation system in use is DHHN2016.

External documents, including geological data and results and evaluations of geophysical surveys or of other methods, may be included in the upgraded borehole plans. However, these must now be explicitly checked for plausibility and marked accordingly.

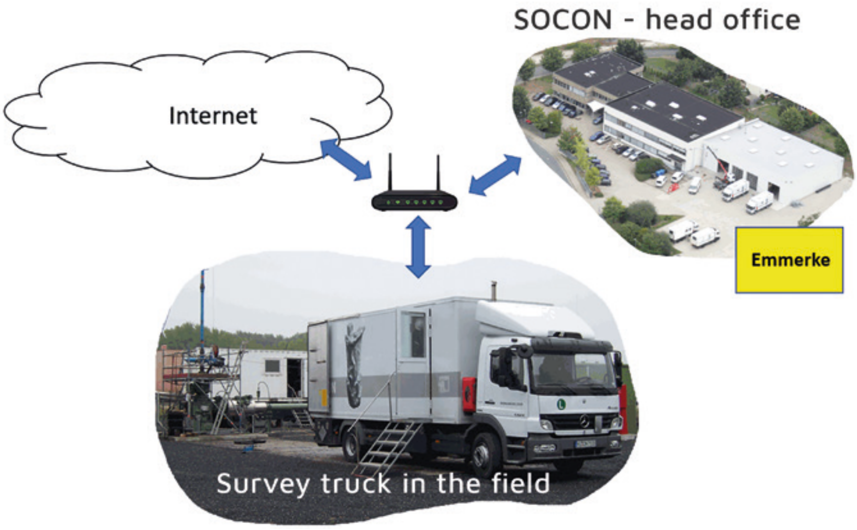

Peter Wurmbauer

In brief

SOCON survey trucks - IT hits the road

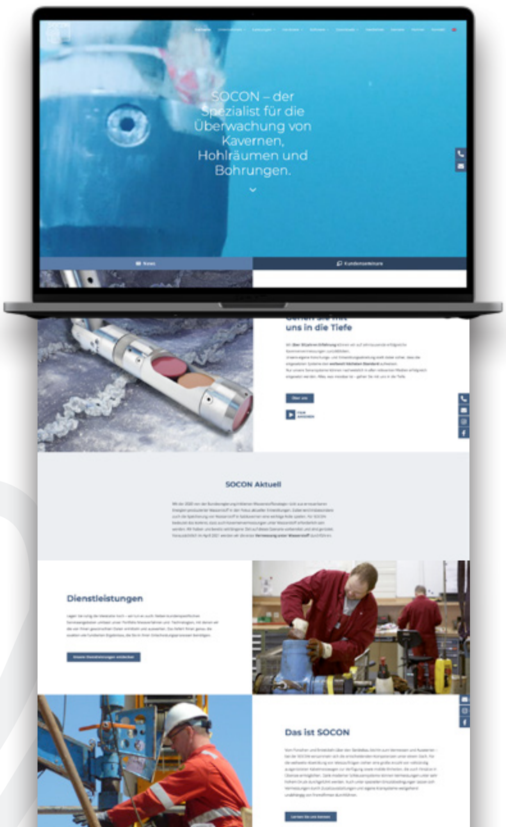
As part of the further digitization of our processes, mobile online computing is now also finding its way into the SOCON survey truck.
The mobile access point installed in the truck provides WiFi in and around the vehicle and a VPN allows secure communication with the SOCON head office in Emmerke.
This setup enables SOCON employees in the field to access all required data (e.g. test certificates) stored at the head office at short notice. If necessary, the head office can take "remote" control. Data can be sent to the head office for immediate clarification or – if desired – made available directly to the customer online. The two latest survey trucks in our fleet are already equipped with this technology. The retrofitting of the remaining SOCON survey trucks has begun.

Manfred Schiller / Andreas Lochte



New SOCON homepage

Our new homepage was recently launched online. In addition to a more contemporary look, you will also find a new short video about our company at www.socon.com. You can also see our presentations on Instagram and Facebook.
Check them out!



From Quality Management

There is news to report, because until the end of 2021 we will replace our previous management system for occupational safety, Safety Certificate Contractors (SCC**), with ISO 45001:2018, the management system for occupational health and safety protection.
ISO 45001 is the world's first uniform standard for occupational health and safety management and can be better integrated into existing ISO management systems (e.g. ISO 9001:2015). The structure of ISO 45001 is designed to create a holistic system with good implementation. Given our international orientation, this means we can better meet our requirements and obligations with ISO 45001.
We will continue to implement the SHE examinations for our operational managers (general SCC certificate).

Sabine Sousa-Stolte

New employees at SOCON

Our employees are our most important value. That is why we are particularly pleased to have welcomed seven new employees to our team in the last 2 years. The entire team at SOCON Sonar Control Kavernenvermessung GmbH warmly welcomes our new staff members and wishes everyone a successful future. We look forward to your active support in the company.

Oliver Busjahn

Maria Letourneux joined SOCON in February 2020. Ms. Letourneux studied electrical engineering and then worked as a network and telecommunications engineer in Colombia. In 2010, she decided to embark on a new adventure and traveled to Germany to pursue a master's degree in business administration and engineering (MBA&E) at the University of Applied Sciences (HTW) in Berlin. Her main responsibility in "Team 9" is to develop a completely new database structure and user interface for the CavOffice software package.

Birute Vaitkiene studied management and business administration at the Vytautas Magnus University in Kaunas and joined our admin team in the area of cavern survey work preparation. She provides our survey technicians with travelers, performance records and survey reports of the preliminary surveys. In addition, she takes care of archiving the surveys.

Eric Donner has been working in the area of interpretation at SOCON since October 2019. He studied geophysics at the TU Bergakademie Freiberg and then worked as a 3D modeler and borehole geophysicist in the Bavarian Molasse Basin. Since starting at SOCON, he has already successfully participated in numerous survey assignments.

Diana Glesmann has been with SOCON since August 2016 and successfully completed her training as an electronics technician for devices and systems in January 2020. Since January 2020, Ms. Glesmann has been working as a "new employee" in the field of tool manufacture and service.

Abdullmunam Bahar, or Musa for short, has been working for us as a survey technician since September 2019. Thanks to his previous experience in the oil and gas industry, he was able to successfully carry out numerous survey assignments at home and abroad for SOCON quickly and without much training.

Since spring 2021, Dr. Olaf Kruck has been a member of the Gas Storage Optimization & Services (GSOS) team. He took over the team leadership from Dr. Michael Krieter in the fall and brings a wealth of experience in thermodynamic simulation and optimization. His responsibilities include coordinating the ongoing development of CavBase GasStorage. He is also the contact person for all our work in the area of hydrogen storage.

Heiko Jahnel has been part of SOCON's R&D team since July 2021 and is responsible for microcontroller/Windows programming, electronics development and developing test devices for tool components. Mr Jahnel is a trained industrial electronics technician specializing in device technology and also studied electrical engineering and information technology.

SOCON EVENTS

Customer seminar on 25 November 2021 (IN GERMAN LANGUAGE ONLY!)

Hydrogen storage in caverns –
Basics, projects and first practical experience

Programm

09:30 Uhr	Welcome and introduction *Dr. Andreas Reitze, SOCON Sonar Control Kavernenvermessung GmbH*
09:45 Uhr	Physical properties of hydrogen *Dr. Olaf Kruck, SOCON Sonar Control Kavernenvermessung GmbH GmbH*
10:15 Uhr	Possibilities and potentials in geological formations – state of the art hydrogen storage at a glance Wasserstoffspeicherung im Überblick *Heike Bernhard, DEEP.KBB GmbH*
10:45 Uhr	The regulatory framework for the development of a hydrogen economy - with special consideration of storage in caverns *Dr. Stefan Tüngler, Dr. Ulrich Scholz, Freshfields Bruckhaus Deringer*
11:15–11:45 Uhr	**Coffee break**
11:45 Uhr	Material selection and alternative well design for planned new installation of potential hydrogen wells *Dr. Thomas Faber, UGS GmbH*
12:15 Uhr	Large volume storage of hydrogen - optimized wellhead design for cavern storage *Werner Hartmann, Hartmann Valves GmbH*
12:45-14:00 Uhr	**Lunch break**
14:00 Uhr	Presentation of the H2 project in Rüdersdorf *Hajo Seeba, EWE Gasspeicher GmbH*
14:30 Uhr	NetZero: The contribution of hydrogen to decarbonization in the UK *Andreas Acht, Atkins Energy Germany GmbH*
15:00 Uhr	Zuidwending A8 Hydrogen test *Patrick Roordink, N.V. Nederlandse Gasunie*
15:30 Uhr	First hands-on experience with the deployment of sonar tools in hydrogen *Frank Haßelkus, SOCON Sonar Control Kavernenvermessung GmbH*
16:00 Uhr	**Close of seminar / coffee and cake**

Seminar fee is **EUR 220,00** plus VAT

Venue: Roemer- und Pelizaeus-Museum, Am Steine 1-2, 31134 Hildesheim, Germany

Further information at **www.socon.com**

SOCON

Specialized in cavern, cavity and well monitoring

- Echometric cavity surveying with ultrasonic and laser systems in liquid and gaseous media
- Continuous interface, pressure and temperature measurement for tightness testing (SoMIT® method)
- Interface depth measurement with pulse-neutron-gamma and gamma-gamma modules
- Pressure, temperature and humidity measurements as well as sampling in liquids and gases
- Cavern well integrity surveying
- Mine surveying and measurements, updating mine maps and forecasting ground movement with KARISDAT®
- Scientific consulting & software (CavBase GasStorage) for optimizing underground gas storage
- Bespoke hardware and software development to customer requirements
- 3D visualization and animation
- Training and seminars

ECHO*News*

PUBLISHER

SOCON Sonar Control
Kavernenvermessung GmbH
Windmühlenstraße 41
31180 Giesen / Germany

Phone: +49 5121 99819 - 0
Fax.: +49 5121 99819 - 88

info@socon.com
www.socon.com

EDITORIAL TEAM

Dr. Andreas Reitze

LAYOUT & DESIGN

www.klocke-agentur.de

AUTHORS

Oliver Busjahn
Frank Haßelkus
Axel Heuer
Dr. Michael Krieter
Dr. Olaf Kruck
Andreas Lochte
Manfred Schiller
Sabine Sousa-Stolte
Peter Wurmbauer

CERTIFIED
ISO 9001
ISO 9001:2015
SCC**