necessary to coordinate our activities and, to put it bluntly, to lobby for our cause. That will certainly benefit Poland.

An obvious proposal is to recognize the deposits in full, in respect of their adaptability for the construction of storage facilities. The Polish deposits, especially the diapirs, are difficult to handle due to their nature and parameters. However, previous works have indicated that such types of deposits are useful for the purposes under discussion (contrary to doubts expressed by some foreign experts).

The key problem is to manage and remove brine after cavern leaching. It is beyond doubt that the current consumption of ca. one thousand cubic metres per hour by the plants located in the area of Inowrocław definitely restricts the possibility of cavern storage facility development and operation. It is necessary to recognize other options, e.g. based on German experiences. Another option is to struggle against ecological hazard stereotypes, with reasonable analysis of safe brine disposal. It is also necessary to interconnect salt extraction with cavern development, or actually to stop pure extraction and continue it with designing of the cavern storage facilities at the same time.

In conclusion, we need to mention that the Polish salt industry has entered a new path, and it has a chance to play a wider role than that of the raw-material provider for the chemical industry. Our industry has a chance to become a lasting element of our national energy security system. Let's use that opportunity by joint and well-coordinated activities.

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The planning of a gas storage facility – basis for an investment decision

Key words: gas storage, planning, construction

Introduction. To ensure the supply with natural gas it is beneficial to operate gas storage facilities in the event of short-term as well as long-term fluctuations. Reasons for such fluctuations in supply could be on the one hand taking advantage of the spot market and on the other hand the influence of seasonal factors. For this reason there is a great interest in acquiring or creating cavities for the storage of gas. This paper gives an overview of the technical handling of the different tasks when an underground gas storage facility is planned to be built and gives information about their impact on the time schedule and on the associated cost estimate in case of a project realisation. The necessary tasks for the planning of a storage facility is based on boundary conditions given by the operator (e.g. regional, operational constraints). For the choice of a potential location the geological and rock mechanical issues are of importance. Other crucial points to look at are the planning of the drilling and solution mining, the solution mining itself, the well completion, the plant engineering and construction, and playing a decisive role, the authority engineering.

Reasons for the planning of a gas storage facility. Possible reasons for gas suppliers to invest into a gas storage plant might be the security of supply, the independence from external gas suppliers, the pricing of competing gas suppliers or favourable infrastructure boundary conditions. A crucial point for the planning procedure is the concept of the storage operation (peak shaving / seasonal storage) because this is important concerning the filling and withdrawal rates and therefore the layout of the gas plant equipment.

Planning step 1 – geology. In a first step possible locations have to be selected taking into consideration the size, depth and simplicity of the salt structure, the possibly existing pipeline network, the fresh water supply for the cavern leaching process and the disposal of the brine. This means that the first investigation of a preferred location is the geology which delivers first information concerning principle suitability of the location and gives also very important input parameters for further investigations for example for the rock mechanical layout, for the drilling procedure and for the leaching process. The geology gives knowledge about the external and internal structural settings and selects suitable lithologic intervals.

Planning step 2 – rock mechanics. With the geological information about the site in a rock mechanical layout the geometry (net volume of cavern) and the operating parameters (pressure range) have to be determined. These two parameter sets deliver the important variable of the possible working gas volume.

Planning step 3 – drilling. The planning of the drilling consists of the layout of the casing schemes (diameter, depth of last cemented casings etc.), the drilling facility specification (drill rig etc.), sampler services, coring programme, mud, sampling and cementations. In the planning stage it is crucial to think of the necessary drill equipment because especially nowadays the availability of rigs and casings might be difficult and therefore this item could have a great influence on the project time schedule.

Planning step 4 – leaching. Based on the geological information the leaching process is planned. Bearing in mind the different leaching methods and the possibility of leaching in one or several steps a leaching plan is prepared how to create the target volume. This concept will be verified and perhaps modified during the real leaching process based on a monitoring (physical and chemical analysis, sonar survey, blanket level measurement etc.). The aim of leaching concept is to create an optimal cavern shape within the rock mechanical limits in the shortest possible time and to have the lowest possible energy/water consumption.

P l a n n i n g s t e p 5 – l e a c h i n g p l a n t . In the layout of the leaching facility important parameters are: number of caverns, fresh water supply, brine disposal, operation type (manual/automatic), blanket type (gas/oil). An important point in the layout is the comparison of leaching rate and leaching time. That means the comparison of the costs for the leaching plant with the corresponding leaching time.

P l a n n i n g s t e p 6 – c o m p l e t i o n a n d g a s f i r s t f i l l . Next step after the cavern volume has been created is the so called completion of the borehole for the subsequent gas storage operations, as well as for the gas first fill and brine withdrawal. At first the leaching strings have to be removed and the underground completion equipment has to be installed (gas production string/gas wellhead). A gas tightness has to be carried out on the last cemented casing. Through an additional string the brine will be removed from the cavern by injecting gas through the annulus. If applicable a sub-surface safety valve will be installed into the gas production string.

P l a n n i n g s t e p 7 – s u r f a c e f a c i l i t i e s / g a s s t o r a g e p l a n t . The gas facilities are the connection of the pipeline network to the underground storage. Task is the adjustment of the gas pressure in the pipeline network to the storage conditions and vice versa. Crucial parameter for the layout of this complex facility is the planned operation mode. This item affects significantly the choice of the appropriate compressor. Like for the leaching plant also in this case the aim of the layout is a technical and economical optimization.

P l a n n i n g s t e p 8 – a u t h o r i t y e n g i n e e r i n g . To get the permission to create an underground storage you normally have to go through an approval procedure what differs from country to country. The background for the different steps on the way to the approval are e.g. health protection, protection of the surface, waste management, care of recultivation and other influences on the public (e.g. emissions).

I m p a c t o f d i f f e r e n t t a s k s o n t h e p r o j e c t t i m e s c h e d u l e . As an example Fig. 1 shows the time schedule for the construction of a new gas storage facility consisting of four caverns. Starting point is the end of the licensing procedure. The first step is the detail planning and building of the leaching facility. This will take approx. less than 2 years. It follows the time of the cavern construction. Exemplary the procedure is shown in more detail just for the first cavern. Here the different steps of the cavern construction can be seen, beginning with the drilling of the well, the completion for the leaching process, the leaching process itself and finally the emplacement of the gas completion. In this case two caverns are leached in parallel. So the whole cavern construction time takes approx. 4.5 years. Already during the leaching time of the first caverns the gas plant will be created so that immediately after finishing of the cavern volume the gas first fill can start. The construction time of the gas plant is approx. 1.5 years. Directly after the caverns are finished they are filled with gas and

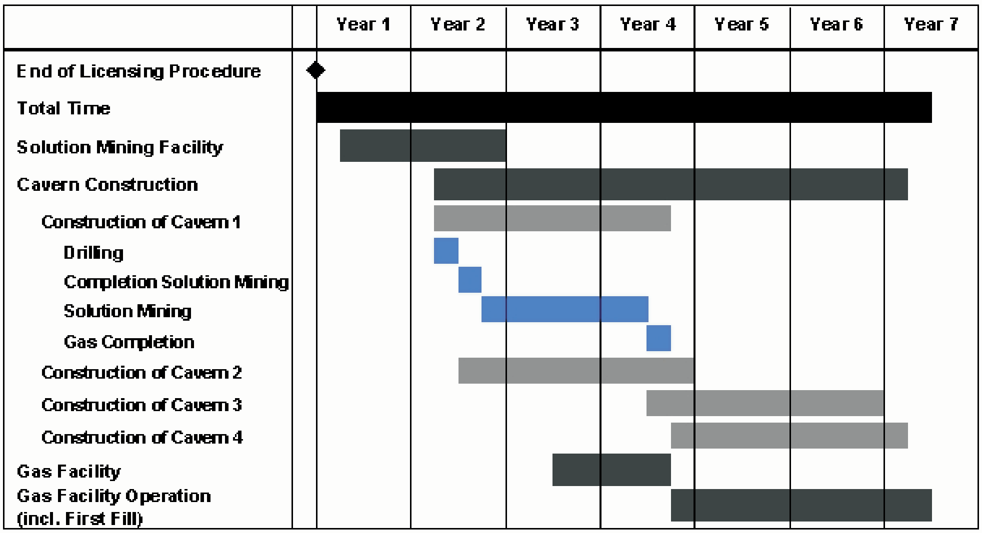

Fig. 1. Planning and Construction of a Storage Facility (4 caverns) – Time Schedule

Rys. 1. Harmonogram projektowania i budowy podziemnego magazynu (4 kawerny)

the brine in the caverns will be removed. So in this example the whole planning and construction time lasts approx. 6.5 years.

Impact of different tasks on the cost estimate. In Fig. 2 the proportion of the single tasks on the total amount when building a storage facility can be seen. Again in this example the plant consists of 4 cavities. The surface plants (for leaching and gas operation) are the main factors with approx. 15% for the leaching and approx 30% for the gas plant. Here it becomes apparent how important it is to optimize the surface facilities technically and commercially. The drilling and leaching procedures take approx. 10% of the total amount. The whole exploration of the site is just in the percentage range. A point which cannot be neglected is the so called cushion gas what is of no commercial use for the cavern owner, because it has to be in the cavern to guarantee the permissible minimum pressure in the cavern. At this example it can be seen how important it is perhaps to invest a little bit more into the planning procedure to get an optimized cavern layout and optimized permissible operation pressures

PLANOWANIE BUDOWY PODZIEMNEGO MAGAZYNU GAZU – PODSTAWA DO DECYZJI INWESTYCYJNEJ

Słowa kluczowe: podziemne magazyny gazu, planowanie, konstrukcja

W komunikacie przedstawiono przegląd technicznych działań związanych z planowaniem oraz budową podziemnych magazynów gazu, w tym harmonogram prac oraz rozkład kosztów inwestycji. Planowaną inwestycję podzielono na 8 kolejnych kroków. W pierwszym kroku dokonuje się wyboru lokalizacji struktury solnej,

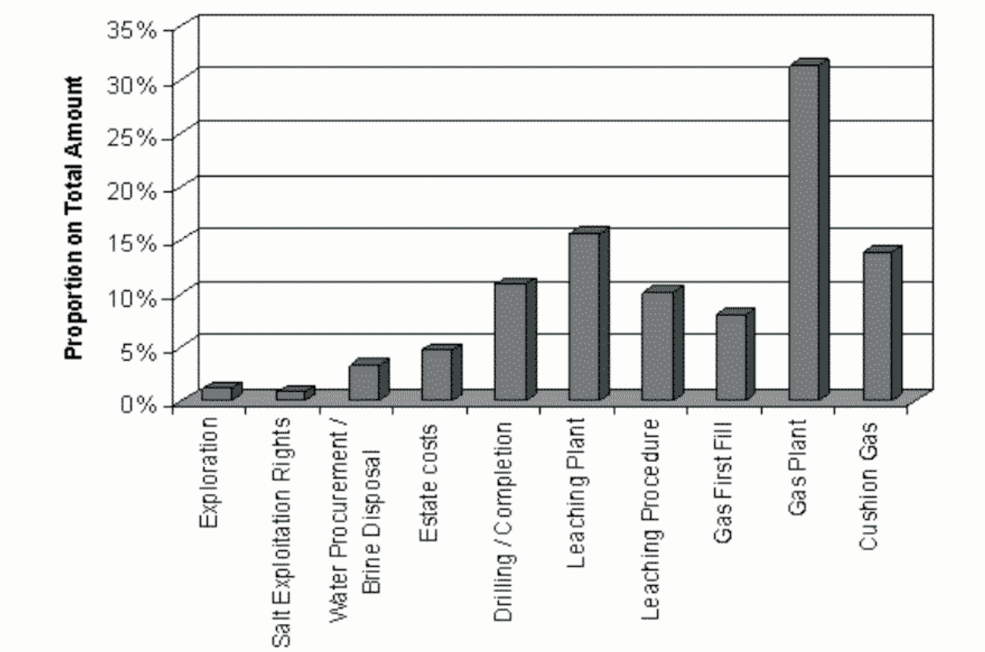

Fig. 2. Planning and Construction of a Storage Facility (4 caverns) – Apportioning of Costs

Rys. 2. Rozkład kosztów projektowania i budowy podziemnego magazynu (4 kawerny)

wykonuje się rozpoznanie budowy geologicznej, określa się możliwości istniejącej sieci rurociągów, a także określa się dostępność wody do ługowania komór oraz możliwość zrzutu lub zagospodarowania solanki. W drugim kroku na podstawie uzyskanych wcześniej geologicznych danych określa się objętość kawerny oraz parametry operacyjne (zakres ciśnień). W trzecim kroku planuje się wiercenia (średnice, głębokość), specyfikacje osprzętu wiertniczego, cementacje, rodzaj płuczki, sposób opróbowania itd. W kolejnym czwartym kroku w oparciu o dane geologiczne planuje się proces ługowania kawern. Celem tych prac jest stworzenie kawern o optymalnych kształtach, przy jak najkrótszym okresie budowy i najniższym zużyciu energii/wody. W piątym kroku określa się całą instalację: ilość kawern, dostawę świeżej wody, zrzut solanki, typ operacji (manualny/automatyczny), rodzaj blankietu (gaz/olej). Następny krok dotyczy prac związanych z ukończeniem budowy kawern aż do momentu pierwszego napełnienia gazem komory magazynowej. W kroku siódmym planuje się obiekty przemysłowe na powierzchni takie np. jak: sieć rurociągów itp. W ostatnim kroku planuje się procedury związane z uzyskaniem pozwolenia na stworzenie podziemnego magazynu gazu.

W komunikacie przedstawiono również harmonogram prac zwiazanych z budową podziemnych magazynów gazu. Przykładowo na rysunku 1 pokazano harmonogram budowy nowego obiektu składającego się z czterech kawern. Z kolei na rysunku 2 pokazano rozkład kosztów zwiazanych z budową podziemnego magazynu.

Na tym przykładzie widać jak bardzo ważne jest odpowiednie zaplanowanie inwestycji, gdzie przy stosunkowo niewielkich kosztach związanych z planowaniem można uzyskać najbardziej optymalne parametry pracy podziemnego magazynu.