Monitoring of mine water

Michael Drobniewski, Holger Witthaus

RAG Aktiengesellschaft, Servicebereich Technik- und Logistikdienste, Shamrockring 1, 44623 Herne

Abstract Observation of mine water level and chemical composition of water is one of the most important tasks today and in a long term view for German hard coal mining. The main aspect is the control and proof of avoiding any damage on public life and nature by former mining activities, as far it is possible by state of the art measures.
A wide range of monitoring measures is realized in a deposit of hardcoal, which was mined out for more than 2 centuries by underground mines in levels up to a depth of more than 1500 metres.

Key words Mine water monitoring, Post-mining water management, hard coal mining

Introduction

This paper gives an overview to the measures of monitoring in the area of active and closed mines. The requirements to the monitoring system are results of knowledge and experience ragarding geological parameters, influence of mining activities to the ground, aims of enviromental protection in the densely populated areas of mining in Germany, as well as state of the art in technological research.

Scope of monitoring:
The monitoring includes:

- Level of mine water in every local section
- Amount of mine water flow in former mining areas underground
- Pumping activities and quantity of emission to rivers
- Chemistry of mine water at the point of emission
- Chemistry of mine water in the underground
- Industrial loads in mine water
- Observation of deep ground water levels above carboniferious strata package
- Observation of deformation and subsidence of former mining areas
- Observation of seismic activity potentially caused by rising minewater level.

In addition measures are taken for proofing the long term composition of pumping activities. In an exemplary description a view on modern technology of shaft and pipeline monitoring is given.

Monitoring of mine water level

As an example the area of Ruhr district is shown in a map view. The whole area extents over app. 400 km² and currently 11 pump stations and districts of different mine water levels. The districts are combined in departments according to actual mine water levels (fig. 1).

***Figure 1**: Ruhr area with districts, pump stations and points of water level observation.*

In the mining area the mine water level is measured periodically by plumbing in shafts and plumbing pipelines in former shafts. Figure 1 includes the overview of located measurement points in the map view (RAG AG 2014).

The technique of plumbing is applied as mechanical plumbing using a sensor for signal of water level and a rope released by a wind for documenting the length – or stational probes installed below the minewater level and determination the water load above by measurement of pressure (fig. 2) and send that signal to a central observation headquarter (fig. 3).

Figure 2: *Example of stational probe for mine water level observation – recovered to surface.*

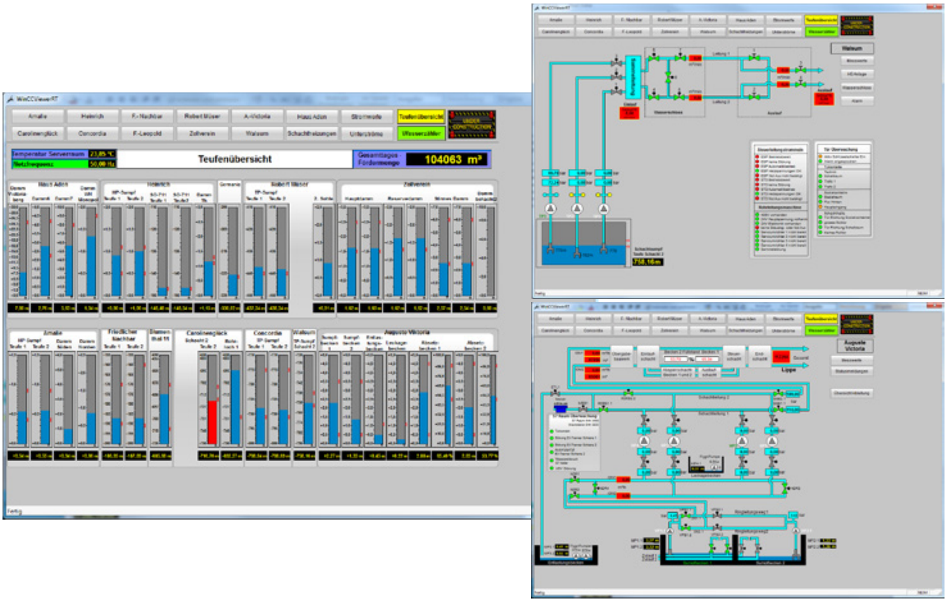


Figure 3: *Headquarter of observation – exemplary documentation of water level.*

The left side of fig. 3 shows an overview to all pump stations of observation. The red collumn shows a shaft that is not observed due to installation work. The right part shows a typical well station observation in the upper part, the lower part an underground pump station and structure.

Amount of mine water flow and pumping activities

The final documentation of a closed mine includes all located water inflow points and quantities. In addition pumping activities are reported and documented on a daily bases. By comparing the amounts of lifted water volume to prospected inflow to the water station the basic of risk management are documented.

Results of the forecasted mine water level in each district can be compared to actual measuring results and is analysed for interpreting the function of gateways in the underground and recallibrating of modelling in iterative processing and intense information transfer to experts.

Chemistry of mine water underground and at point of emmission

The evaluation of mine water is based on regulations by the mining administrative. Five categories of standard tests are presently used. Usually they are elements of a test every 6 months, additional examination was done every year or every 3 years (according to previous results of testing).

One aim of testing is proofing the influence on water quality of emission and following the legislatve restricted limits of water quality. Another aim is to proof the results of predicted concentrations based on numerical modelling. A permanent recalibration of the parameters of influence is possible and a continous improvement of modelling takes place. The modelling is described in another report at this conference (Ch. Klinger, DMT) with the background of additional monitoring of industrial loads.

Communication

In addition to specific demands of reporting and documentation an online platform gives information to the public at the RAG website (RAG 2017). This follows the aim of RAG strategy, to be a loyal and transparent partner for public, administration and industry in every way the company can do.

Fig. 4 gives an example as map view to the Ruhr area and a choice of information. The map shows an area of appr. 100 kilometers extension from East to West. The green markings show points of mine water level observation. The purple dots aligned to rows are points of measurement to document ground movement. The blue triangle marks are points of seismic sensoring. They are concentrated in the area of still active mining panels. By a click on a point of interest the user can get more information – including history of data development.

***Figure 4**: Online information at RAG platform (BID, basic map by ©google) (RAG 2017).*

Modern monitoring methods

Modern methods are used in several terms of observation eg. monitoring of the ground movement at surface. Euopean satellite program provides aeral photos and physical data which are analyzed for additional survey.

The latest expansion of the monitoring system is the conception and test run of underground probes especially developed for the environment in closed mines.

Standards of measuring in industry fail in this application, because there is no chance of maintenance or repair. Also the probes have to face the conditions of mine water contact for a long term. Figure 5 shows on the left side the principle construction and sensors of that probe.

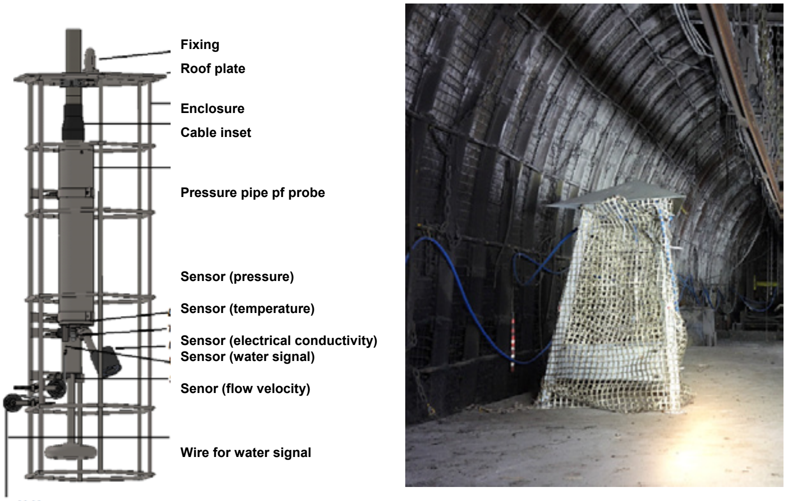
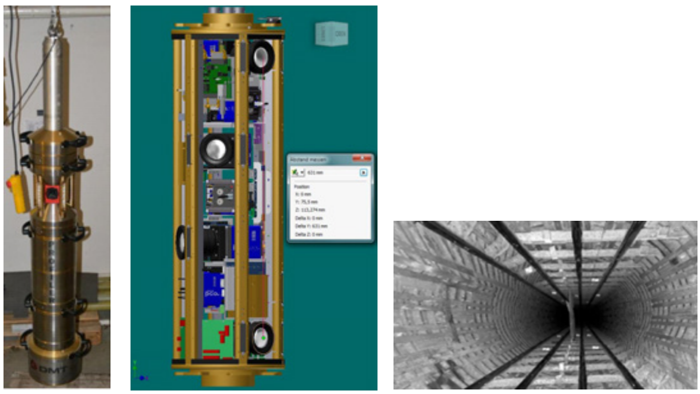


Figure 5*: Underground probe for long term observation in closed mines.*

On the right side an installed probe, using a specific development of safety construction is figured. The development is done in an ongoing research project with partners from Technical University of Bochum, DMT company and Sea&Sun Technology company (SST). The probe is based on deep sea observation by SST and has to be modified for underground specification.

Current research work is done in cooperation between RAG, DMT company and DLR company for stereophogrammetric oberservation of shafts and well-pipelines. The application gives three dimensional models of shaft structure by using a probe. High resultion of this modelling allows observation of deformation, incrustation or damage of the structure. Figure 6 shows a basic instrumentation developed by DMT for laser-scanning probes on the left (a.), the centre picture a model of development (b.) and on the right a graphic example of present documentation by laser scanning (c.) (annual report research RAG 2014).



a. b. c.

Figure 6*: Current model for shaft and well-pipe observation.*

Conclusions

RAG fulfils a wide range of monitoring measures. Observation is applied in every way of state of the art technology to prevent any risk from actual and former mining activities. Underground hard coal mining for more than 200 years in Germany includes risks of mine water rising, gas exhausting from abandoned areas, surface deformation and seismic events. Based on third party expertise RAG operates any requested monitoring system as a reliable partner for mining administration and public institutions. In addition RAG communicates any results to the public in an open and transparent way. This work will continue in a long term duration, even if the last hard coal mine in Germany will close in the year 2018. The future work concentrates on optimizing the mine water management by safe and economic concepts and technologies.

References

RAG AG (2014) Annual report research RAG 2014, not published, RAG Aktiengesellschaft, Herne

RAG AG (2014) Konzept zur langfristigen Optimierung der Grubenwasserhaltung der RAG Aktiengesellschaft für Nordrhein-Westfalen, Herne

www.rag-stiftung.de/en/perpetual-obligations/

RAG AG (2017) Bürgerinformationsdienst (BID) der RAG Aktiengesellschaft, Herne

http://www.bid.rag.de/bid/