Mine water: a sustainable energy resource?

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Summary

One of the challenges in decarbonisation of the heating sector in the UK is the lack of available options for renewable sources. This presentation will explore one potential option which could provide a significant contribution to the domestic heating requirement: obtaining heat from flooded, abandoned mine workings.

Abstract

Decarbonisation of the heating sector is one of the major challenges in the drive to meet legally binding climate change targets and to reduce the UK's vulnerability to global environmental or geo-political events. Currently only 5.6% of the UK heat requirement comes from renewable sources, BEIS [1], which is less than half of the 2020 target of 12%. The main challenge in reaching the target is the limited availability of renewable heat source options.

One of the potential options is geothermal energy; traditionally this has been assumed to mean deep, high enthalpy sources for electricity generation. However, low enthalpy, direct use sources are being increasingly recognised, Ghoreishi Madiseh et al. [2], in particular those which are shallower and more accessible from the surface. A study commissioned by the Scottish Government into the geothermal energy potential in Scotland, found that 1/3rd of Scotland's heat requirement could be obtained from shallow sources, specifically abandoned mine workings, Gillespie et al. [3].

Obtaining heat from abandoned mine workings is comparable to a ground source heat system, where the high heat capacity of groundwater is utilised in combination with heat pumps to provide heating or hot water. Historical mining has created reservoirs with enhanced permeability and, when they become flooded, with a large rock-water interface for heat transfer to produce a sizeable potential heat source, Banks et al. [4].

The enhanced permeability and resource availability are not the sole reasons mine workings are attractive as potential energy sources. Abandoned mines are generally located near urban areas and this close proximity enhances the efficiency of the resource. Over 60% of Scotland's population live in the central lowlands which is also where the main collieries were situated.

This is not a new concept, existing mine water heat systems have been in use since at least the 1980s, Jessop [5] with schemes operating in Scotland from 2000, Banks et al. [6]. Research into these systems has primarily focussed on the sustainability of the resource, in particular on deep total extraction (longwall) mines. This presentation will detail current research being undertaken into the resource potential of shallow (pillar and stall) mine workings where columns (pillars) of coal maintain stability.

Utilising abandoned mine workings as a renewable energy source will result in changes to the underground flow, pressure and heat regime. These changes could exacerbate pillar deterioration, reducing their capacity to support the overlying strata and ultimately lead to pillar failure.

Results of coupled thermal-mechanical-hydraulic modelling into the effect of heat extraction on the pillars will be presented. The modelling code OpenGeoSys has been used to understand the controls on the geomechanical properties of coal pillars, in particular how different material types can impact the underground stress distribution. One of the aims of the research is to determine whether the overlying geology influences the risk of surface subsidence from mine water heat schemes. The intention is to create a hazard map which could form an important part of the risk assessment process into the viability of this type of renewable energy scheme, in turn reducing some of the developmental barriers.

References

[1] Department for Business Energy & Industrial Strategy, "Digest of UK energy statistics 2017," *Dig. UK Energy Stat.*, no. July, p. 260, 2017.

[2] S. A. Ghoreishi Madiseh, F. Hassani, and F. Abbasy, "Numerical and experimental study of geothermal heat extraction from backfilled mine stopes," *Appl. Therm. Eng.*, vol. 90, pp. 1119–1130, 2015.

[3] B. H. F. Gillespie M.R., Crane E.J., "Study into the Potential for Deep Geothermal Energy in Scotland. Volume 2 of 2," *Br. Geol. Surv.*, vol. 2, no. August, p. 125, 2013.

[4] D. Banks, H. Skarphagen, R. Wiltshire, and C. Jessop, "Mine water as a resource: space heating and cooling via use of heat pumps," *L. Contam. Reclam.*, vol. 11, no. 2, pp. 191–198, 2003.

[5] A. Jessop, "Geothermal Energy From Old Mines At Springhill , Nova Scotia , Canada," *Proceedings*, vol. 17, no. April 1993, pp. 463–468, 1995.

[6] D. Banks, A. Fraga Pumar, and I. A. Watson, "The operational performance of Scottish minewater-based ground source heat pump systems," *Q. J. Eng. Geol. Hydrogeol.*, vol. 42, no. 3, pp. 347–357, 2009.