LOw Carbon After Life: sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure enviromental risks

LOCAL

Research Fund for Coal & Steel

LoCAL Deliverable 2.1

INSTALLATION OF AN OXIDATION SUPPRESSION EQUIPMENT.

WP number	**WP2**
Partner responsible	**ALKANE Energy**

Alkane

Deliverable 2.1:

Installation of an oxidation suppression equipment

The task 2.1 deals with study of impact of ochre on the maintenance and performance of the heat pump. As part of this task, trials are conducted at two sites with varying iron content in the raw mine water. At Markham site, the oxygen is prevented from coming in contact with raw mine water and trials are conducted to verify the impact oxygen has on the ochre formation and prevention. At Caphouse where the mine water is already oxygenated, the trials are conducted to supress the ochre formation by using environmentally benign chemicals.

Markham

At this site the warm water is pumped from a depth of 170 m and passed through a shell and tube heat exchanger and the cooler water is returned back through the same shaft to a depth of 155 m. Care has been taken to prevent the mine water from coming in contact with the oxygen. The total iron content in the mine water is 3.21 mg/l with ferrous iron content being 0.86 mg/l. The water quality is fairly good and ochre clogging problems of heat exchanger or the pipelines is not anticipated.

As a part of ochre monitoring mechanism the following procedure is being observed:

Mine water flow rate is monitored on a daily basis and checked for any signs of reduction in flow rate due to clogging. The filters are checked for any signs of ochre every 2 weeks

Heat exchangers and the pipelines are checked by taking the heat exchangers out and examining the internal parts of the heat exchanger once in every 6 months

Photographs of the filters, pipelines and the heat exchangers are taken. The amount of particles collected in the filter is also weighed every time the filter is cleaned.

The filters, pipelines and heat exchangers were removed and checked for any ochre deposition after 2 years of intermittent operation and very little deposition was noticed. Therefore the Markham plant will not be doused with any ochre clogging chemical. The initial studies further establishes the fact that by preventing the mine water from coming in contact with the oxygen the ochre clogging can be minimised to a great extent.

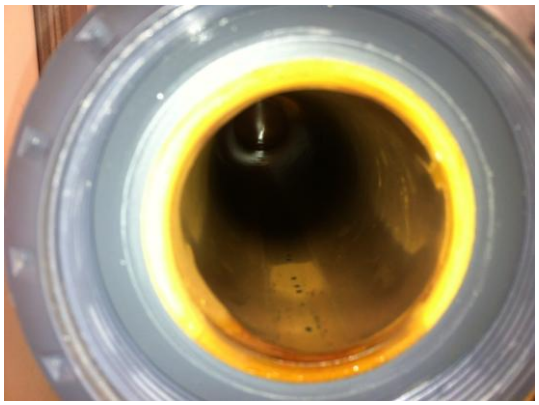

Figure 1: Pipeline after 2 years of run

Figure 2: Heatexchanger after 2 years of run

Figure 3 Filter after 2 years of run

As a part of our ochre monitoring process at Markham; we will continue to monitor for any reduction in the water flow rate on a daily basis, check the filters once every two weeks and the pipelines and heat exchangers once every six months. If any reduction in flow rate or any reduction in the performance of the system is noticed during the run the pipeline and heat exchangers will be taken out and checked.

Caphouse

Caphouse Colliery houses a mining museum and the underground galleries of the colliery are kept open for the public viewing. In order to keep the underground galleries dry and safe for the public the water is pumped from the underground workings at a rate of circa 30 l/s. The mine water has an iron content of circa 30 mg/l and is partially oxidised in the pumping shaft. The pumped water is rich in ochre due to this. The ochre rich water is passed through the settling tanks and reed beds to remove the ochre before discharging it into a stream.

Figure 4: google map image of the ochre treatment pond at Caphouse

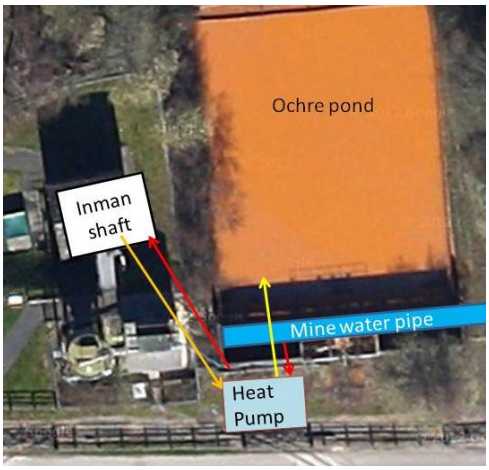

Figure 5: google map image of the pilot plant location at Caphouse

This site has been chosen as it is ideal to conduct trials and to test the performance of the heat pump running on an ochre rich water and also to test the effectiveness of the ochre suppression equipment. As a part of the testing process a pilot plant has been installed and the specifications are as follows

1. A Valliant heat pump of 10.5 kW thermal output.
2. A duplex filter with a mesh size of 80 to remove the particulates
3. A 300 litre buffer tank
4. Two prophylactic shell and tube heat exchangers (one will be used as a standby) are used to extract heat from the mine water
5. Two heat meters one on the mine water side and the other on the heat pump side to measure the instantaneous flow rate, instantaneous power, cumulative volume and cumulative energy generated
6. The system also has provision to connect a closed loop system as well**.** This part is linked with the Task 2.2

Small quantity of water is tapped from the main mine water pipe line and this water is passed through a mesh filter and then through to the heat exchanger and back to the lagoon.

Sodium dithionite (reducing agent) would be injected to sample line through a dousing pump.

The dissolved oxygen, ph and temperatures of the sample water are measured.

Figure 6: Heat pump and the Buffer tank

Figure 7: Shell and tube heat exchangers and the heat meter

Figure 8: The building (Inman shaft) to be heated by the heat pump

Figure9: mine water being tapped for the pilot plant from the main line

Figure 10 container housing the heat pump, heat exchanger and other accessories

Figure 11: Heat pump diplaying the brines temperatures

Figure 12: Heat pump power output

Figure 13: Mine water power input

Figure 14: A duplex filter to remove ochre and other suspended particles

Figure 15: The ochre dispersant dousing unit.

At Caphouse the installation of an open loop pilot plant was delayed by 3 months due to delayed delivery of the container and the heat exchangers to the site and also due to shortage of manpower over the holiday period. The plant is now running and the energy from the mine water is heating the Inman shaft. The plant was run for 2 months to acquire the base line data of ochre clogging. This data is necessary to compare the impact the chemical dousing will have on the performance of the clogging. Figure 16 shows the filter basket when clean and figure 17 shows the picture of the filter basket when clogged with ochre.

Figure 16 :Filter after cleaning

Figure 17 :Filter clogged with ochre