Treatment of Produced Water Using Reed Beds

Nimr, Oman

Status | Project | Contact | Timeframe
Implemented | Water treatment | Shell | 2 year pilot study

The global economy is a tightly wound system, extremely interconnected and efficient, with increasing risks to organisations due to the rapid propagation of disruptive events. Ecosystem services – the goods and services humans receive from nature – underpin the global economy and provide tremendous value to people and organisations.

The potential of natural systems to boost resilience in the energy industry is significant. Green Infrastructure provides an essential element in a portfolio of solutions to increase business resilience to potential stressors. The combination of natural systems with so-called grey infrastructure can offer the most resilience and help reduce resource intensity in the context of the water, energy and food nexus.

The energy sector, like others, is becoming increasingly concerned about water use as water becomes scarcer. New approaches and advanced technologies are helping us to reduce the amount of water we need for certain operations. Shell has taken on a number of water management plans at the operational level to help monitor and reduce their water use in water-stressed areas. An example of this is in Oman where freshwater supply is scarce. Petroleum Development Oman (Shell share 34%) is using reed beds to treat water produced with oil. This approach would reduce or eliminate the power consumption and CO_2 emissions associated with the operation of equipment for deep well disposal. It saves on cost and has the potential to make water available for use by local communities.

The issue

Case background/context

By 2050 the world population is likely to reach 9 billion. Whilst many will rise out of poverty and live longer, healthier lives, the world's growing prosperity will also put stresses upon the world' energy, water and food. These resources are all closely intertwined; water is required for almost all forms of energy production, energy is required to treat and transport water and both water and energy are needed for food production. By 2030, according to the United Nations, the world's growing population and increased prosperity will push up global demand for water by 30%, energy by 40% and food by 50%.

The energy sector is becoming increasingly concerned about the global situation of increasing water demand and the subsequent scarcities. Energy and water are intrinsically linked. The energy industry needs water for flooding wells, refining crude, producing biofuels and, in the form of steam, driving

electricity turbines. Energy production requires a reliable water supply, so managing water resources even more effectively is firmly on the agenda for the world's energy companies.

The rising global population and the rapid industrialisation and commercial progress in developing economies are one of the many driving forces behind the surge in global demand for energy. Simultaneously, the purification, distribution and treatment of water and waste water require energy.

Energy production requires large and reliable amounts of water. Water is also increasing in the demand for other uses, but these other uses also have an increasing energy demand too. Considering the importance of energy and these multiple uses,, Shell is looking into new approaches and advanced technologies to help reduce the amount of water needed and used for its operations. As such Shell and other sector related organisations will have to improve water efficiency across the value chain, from well refinery and beyond.

The response

The main objective of the case

As global freshwater supplies come under increased pressure and demand for energy increases, the energy sector will continue to seek to understand and improve its water use. Considering the importance of energy and these multiple uses,, Shell is looking into new approaches and advanced technologies to help reduce the amount of water needed and used for its operations. As such Shell and other sector related organisations will have to improve water efficiency across the value chain, from well refinery and beyond. Shell has been addressing the role that water plays in oil and gas processes for many years and is committed to assessing and managing its water footprint and is exploring new working methods and developing and deploying water-efficient technologies throughout its up- and downstream facilities.

One aspect being worked on is the recycling of produced water that contains small amounts of salts and oil. Traditionally this water is disposed of by injection into deep or shallow disposal wells. However , several organizations are looking into the use of wetlands like reedbeds for water treatment. Reed beds have proven to be capable of efficiently, and cost effectively, handling the treatment of the produced water from the Nimr oilfields. This treatment has double benefits:

- The ability to reuse produced water. In parts of Oman, fresh water is extremely scarce, but more then five barrels of produced water are brought to surface for every barrel of oil and this water has to be disposed
- A reduction or elimination of the power consumption and CO_2 emissions associated with the operation of equipment for deep well disposal

In Oman, Petroleum Development Oman (PDO, Shell share 34%) created the world's biggest commercial reed-bed water-treatment plant; originally a 235 hectare facility that is treating water from the Nimr oilfield. The facility is now scaled up to 360 hectare treating 95,000 m3/d of produced water.

In 2008, PDO engaged German company Bauer Resources to design and build the water-treatment plant at the Nimr oilfield that uses reed beds to treat contaminated water. The reedbed facility is a four-tier gravity-based wetland design. Gravity pulls the water downhill, the reeds act as filters, removing oil from the water. The oil is eaten by microbes that naturally feed on hydrocarbons underground. Locally grown Phragmites Australis plants are used for the purification of produced water. The facility layout includes a pipeline, which enters the treatment plant system and leads to an oil/water separator. The water is then distributed into a wetland facility where it is channelled through the wetland terraces by gravity feed. Finally, evaporation ponds are used to recover the salt while the biomass is currently planned to be land filled. Alternative uses of the water and biomass that could offer a variety of social and environmental benefits are being explored. For ecample, biomass is also produced and can be used as an energy source. As with every effluent treatment plant, the subsoil are properly sealed using suitable sealants; synthetic materials were rejected in favour of a natural product. The surrounding desert areas were searched for suitable clay until an appropriate sealant mixture was found.

The results

Outcomes

Since its start-up late in 2010 the constructed wetland has been operating reliably. The system now treats about 95,000 m^3 of contaminated water every day; total dissolved solids ranges between 7,000 mg/l and 8,000 mg/l.The water treatment facility provides PDO with an approach that saves cost and energy for reinjection, and has the potential to make water available for use by local communities.

In 2011, Bauer Resources received the Global Water Award for Industrial Water Project of the Year for the innovative reed-bed water-treatment plant. PDO plans to yet again increase the wetland facility's water capacity, so that it can eventually treat more than 50% of the daily volume of water produced by the Nimr oilfield.

References

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