



Processing Australian oil shale: The case for using Paraho retort technology

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Shale Oil Technology



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There are more than 60 oil shale processing technologies, but many of them are at little more than experimental stage. After determining which of the technologies were at a more advanced development stage, QER undertook a thorough review and investigation of many of the technologies that have proven performance. Primary amongst these proven technologies is the vertical shaft retort Paraho technology, developed in Colorado, USA, during the late 1970s/early 1980s.

QER, in association with the technology owners, recommissioned the Paraho pilot plant facility in Colorado during 2005 to test representative samples of Queensland oil shales utilising the Paraho process.

QER set key criteria to determine the suitability of the technology for further development. Broadly these criteria included:

- Environmental (emissions) performance
- Retort performance (throughput rate and yield)
- Process stability
- Process controllability
- Process predictability

On all counts, the trials were successful. The Paraho process proved to be robust, reliable, responsive and controllable. QER is using the data gathered from the Paraho pilot program to further preliminary engineering and design efforts on a Paraho-based processing facility in Queensland.



What is Oil Shale?

Oil shale is an organic-rich rock that yields oil when heated. The sediments, which over time and pressure form the oil shale rock along with a lot of organic matter, were deposited in swamps and lakes about 50 million years ago and have been folded over time into valley-like structures. Over millions of years, the organic matter in the sediments has been transformed into kerogen - the organic material that sometimes forms before oil in conventional oil reservoirs.

When oil shale is heated, the kerogen is vaporised and this vapour is cooled or distilled to produce liquid oil. Typical Queensland oil shale contains between 60-220 litres of oil per tonne of rock.

About Oil Shale

Modern oil shale mining is a typical cut and fill operation, similar to methods already used in most of the coal mines of central Queensland. Mining takes place in a single pit commencing with the relocation of topsoil and subsoils to stockpiles for post-mining landform rehabilitation.

The oil shale ore is mined using large shovels that load haul trucks and transport the rock to the processing plant to extract the oil. Following processing, the spent shale can be transported either back to the mine, where it is returned into the open cut, or to an out-of-pit site where it is piled and ultimately rehabilitated. Following compaction, the subsoils and topsoil are spread over the top of the reclaimed area, contoured and planted to return to native vegetation or some other agreed final land use form, such as a recreational facility.

QER has three guiding principles with regard to potential mining activities:

- Environmental responsibility – limit the environmental impacts during all stages of mining and processing to meet environmental standards and community expectations
- Health and safety – implement “zero harm” systems guided by the most modern management systems
- Efficiency – ensure the mining operation is efficient and operates as cost-effectively as is possible and feasible.

QER Testing Program

The success of the pilot plant testing program has provided QER with a very high level of confidence that the Paraho process provides a sound technological platform that can be further developed in measured and manageable scale-up stages to achieve commercial levels of shale oil production while meeting stringent environmental conditions.

Over a two-year period from 2005 to 2007, QER undertook a series of detailed testing programs at the pilot plant facility in Colorado, USA owned by its sister company Shale Tech International. The plant is located near the town of Rifle, on the western slopes of the Rockies, less than an hour's drive from the world-renowned ski resort of Aspen.

During QER's two-year testing period, 8,000 tonnes of oil shale from QER's Queensland deposits was prepared in Australia and shipped to Colorado, where the oil shale was processed over 5,140 operational hours allocated specifically for the collection of process and environmental data.

The main objectives of the pilot plant testing program were to:

- Establish safe, stable, controllable and environmentally compliant operations
- Determine and demonstrate the process predictability and repeatability
- Demonstrate the validity of commercial development case assumptions (yield and throughput rates)
- Generate process data, collect physical samples and conduct a comprehensive environmental sampling program
- Train QER Australian operations personnel.

The key results from the pilot plant testing program were:

- The Paraho process proved to be simple and safe to operate, and met all environmental standards of performance
- The Paraho process produced no dioxins detectable above normal environmental background levels
- The Paraho process proved to be efficient, reliable and forgiving of variations in feed properties
- Stable, controllable operations were achieved on all of the Australian shale types tested
- Yields and throughput rates, in excess of those assumed in the business case, were achieved.

Paraho Process

Australia's oil shale resources are vast and offer a promising, realistic solution to our current oil shortage, especially for transport fuel.



Distinguishing characteristics of the Paraho process are:

HIGH AVAILABILITY

Mechanical simplicity from the vertical, gravity-feed design translates into minimal downtimes and high availability.

HIGH OIL YIELDS

Operationally flexible allowing for steady retorting operations and consistent high oil yields.

ENERGY EFFICIENT

High thermal efficiency allows for better capture and reuse of generated process heat, resulting in overall lower operational costs.

SAFE TO OPERATE

The low pressure, thermally encapsulated process with few moving components is safe to operate.

ENVIRONMENTALLY SOUND

Thermal extraction process generates typical waste streams that are easily manageable with current emissions control technologies. It was for the above reasons that QER selected the Paraho process as the technology to be adopted in its development of a shale-to-liquids industry in Queensland.

History of the Paraho Process

The Paraho Development Corporation was formed in the USA in the early 1970s and oversaw the construction and testing after August 1973 of two operational retorts, a pilot-scale unit 4.5 feet (1.3 meters) in diameter and 60 feet (18 meters) high, and a semiworks unit 10.5 feet (3.1 meters) in diameter and 70 feet (21 meters) high. They were used to produce over 100,000 barrels of crude shale oil, some of which was used for refining and end-use experiments by the United States Department of Energy and the Department of Defense. Maximum throughput rates reached about 290 tons (263 tonnes) per day in the semiworks unit and both direct (combustion) and indirect (heating) modes.

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