

CHATTANOOGA PROCESS™

synthetic crude oil
changing the technology

January 2007

Comparison of Processes* for Producing Oil from Oil Shale

Subject / Feature	Chattanooga	Others
Reaction vessel	Fluid bed	Retort
Heat input method for product extraction	No combustion in the reactor. Heat is introduced through heated hydrogen.	Combustion of organics in air or oxygen atmosphere in the retort itself.
CO ₂ Production	No CO ₂ produced in the reactor. Some amounts produced in the fired heater.	Produces significant CO ₂ as a result of breakdown of Calcium Carbonate.
Gas byproducts	No CO ₂ , NO _x or SO _x produced in the reactor. Small amounts produced in the fired heater	CO ₂ , NO _x or SO _x produced as a result of combustion of organic material in the retort in a air or oxygen atmosphere
Shale Decomposition (Western US)	Spent shale remains intact as Calcium Carbonate	The Calcium Carbonate is broken down into Calcium Oxide and CO ₂
Land Reclamation	Spent shale suitable for immediate land reclamation. Requires minimal water for dust control.	Powder like product not practical for land reclamation. Requires significant water for dust control.
Operating Temperature	Below 1000° F	Above 1200° F
Product Yield	125-200% of Fischer Assay	80-90% of Fischer Assay
Reaction Efficiency	Demonstrated almost 100% conversion with minimal coke production	Production of coke and carbon in the retort

* excludes insitu processes

Differentiation:

	non-conventional petroleum		
	<u>Wet Oil Sands Process</u>	<u>Chatt Process</u>	<u>Shell In-situ</u>
<u>Conventional petroleum</u>			
return on energy consumed	~70 units produced: 1 unit consumed	~20:1	~3.5:1
process cost	\$5 - \$15/bbl	\$10 - \$20/bbl	\$30 - \$40/bbl
Issues	Peak supply, limited resource	Huge water consumption & waste water generation: 1bbl/1bbl Significant natural gas requirements	Industrial scale up 3 to 4 yrs per retort cycle Considering nuclear energy; 1.2Gwatt per plant
			\$45/bbl capital cost threshold produces 2x the carbon during cradle to grave lifecycle



References:
 Alberta Chamber of Resources, Oil Sands Technology Roadmap, Jan 30, 2004
 World Oil Magazine, Vol 226, No 8
 US News & World Report, April 24, 2006