

## OIL SHALE DEVELOPMENT IN CHINA

J. QIAN\*, J. WANG, S. LI

Petroleum University  
P.O. Box 902, Beijing 100083, China

*In this paper history, current status and forecast of Chinese oil shale industry, as well as the characteristics of some typical Chinese oil shales are given.*

### Introduction

In China, oil shale deposits are widespread in many regions, the proved reserves amount to about 32 billion tons presenting a potential energy source. In recent years production of crude oil could not meet the requirements – in 2001, China had to import more than 70 million tons of crude oil and light liquid fuels. Besides, the higher world's crude oil price also stimulates the oil shale retorting industry.

### History

In nineteen twenties, in Fushun, Liaoning Province in China, shale oil industry was set up. The Fushun-type retort, combined with pyrolysis and gasification sections was developed.

In Fushun, oil shale lying upon the coal layer is a by-product of open pit mining of coal. The thickness of oil shale seam varies from 48 to 190 m. The reserves of Fushun oil shale amount to 2 billion tons. Oil shale belongs to Tertiary Period, the Fisher Assay oil yield accounts for about 7 %.

At the end of nineteen fifties, 266 retorts were in operation, each with the capacity of 100–200 tons oil shale per day. Shale oil was processed, including acid and alkaline wash and hydrogenation, to produce gasoline, kerosene, diesel oil, wax and lubricating oils. In 1959, total shale oil production reached 780,000 tons in Fushun Refineries Nos 1 and 2. In Huadian, Jilin Province, a kind of internal-external heating retort with smaller capacity was operated. In Maoming, Guandong Province, oil shale was open-pit mined, and shale oil plant was built in nineteen sixties [1, 2].

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\* Corresponding author: e-mail [Jlqian2001@yahoo.com](mailto:Jlqian2001@yahoo.com)

With the discovery of Daqing oil field in China in 1962, due to increasing production of cheap crude oil, shale oil production decreased – by nineteen eighties to 300,000 tons yearly [3]. At the beginning of nineties, shale oil production in Maoming and in Fushun Refineries Nos 1 and 2 were successively shut down.

However, under Fushun Bureau of Mines, a new shale oil plant equipped with sixty Fushun retorts (each with the capacity of 100 tons/day [4]) was established. It was financed by Chinese Government. In 1988, additional twenty retorts were built; thus, the total retort number increased to eighty. The annual production of shale oil increased to 80,000 tons by 2001. Due to the cheaper price of oil shale, the shale oil production made great benefit for Fushun Bureau of Mines.

Besides, in Huadian, Jilin Province, small capacities of oil shale for burning in fluidized bed to produce power have been mined underground; a small shale oil plant with two Fushun-type retorts has been operated.

### **Current Status**

In 2002, Fushun shale oil plant produced about 90,000 tons shale oil. In the case of Fushun-type retort, for producing 1 ton shale oil 33 tons oil shale are consumed (Fischer oil yield about 6 %). As the oil shale mining cost is no more than 10 yuan RMB per ton (as a by-product of coal mining), the oil shale feed cost for producing 1 ton shale oil accounts for about 330 yuan RMB.

Addition of the production cost (manpower, electricity, steam, maintenance, etc.), 750 yuan RMB per ton shale oil, gives about 1000 yuan RMB for the total cost. Shale oil is sold as fuel oil at the cost 1500 yuan RMB/ton, and so the plant gains the benefit for 1 ton shale oil about 500 yuan RMB, that makes 45 million yuan RMB per year. Due to the good situation, Fushun shale oil plant is now planning to double its production capacity, and is seeking for advanced and elaborated technology with larger retorts.

At present, besides the oil shale combustion plant, Huadian plans to build shale oil plant with the annual processing capacity of 1,500,000 tons oil shale (5,000 tons oil shale daily).

Harbin Gas and Chemical Company, in Heilongjiang Province, a company dealing with gasification of Yilan brown coal for producing town gas for Harbin City, is also now intended to utilize their coal mining by-product – oil shale for retorting to produce shale oil (1,000 tons oil shale daily).

Song Ya San Coal mining Company, Heilongjiang Province, is a large coal mining company with yearly production of 10 million tons coal, also plans to develop the oil shale business (1,000 tons oil shale daily).

Longkow Coal Mining Company, in Shandong Province, producing brown coal for more than twenty years already, also plans to mine its by-product – oil shale for producing shale oil (2,500 tons oil shale daily).

Above companies are seeking for advanced and elaborated retorting technologies.

**Table 1. Geology and Reserves**

	Oil shale				
	Fushun	Huadian	Longkow	Yilan	Songyasan
Province	Liaoning	Jilin	Shandong	Heilongjiang	
Age	Tertiary				
Burial condition	Coexists with coal, open pit mining	Oil shale, underground mining	Coexists with coal underground mining open pit mining		
Recoverable reserves, million tons	2,000	200	40	10	20

**Table 2. Properties of Oil Shale**

Indices	Oil shale			
	Fushun	Huadian	Longkow	Yilan
Fischer Assay, % (dry basis)				
Water	4.00	13.10	13.40	7.20
Shale oil	7.93	16.15	14.40	7.98
Char	84.80	64.30	66.70	80.39
Gas + losses	3.07	6.45	5.50	4.43
Proximate analysis, % (dry basis)				
Water	2.70	8.49	9.39	3.74
Ash	73.82	49.77	50.92	58.46
Volatile matter	20.13	37.37	39.00	23.32
Fixed carbon	3.35	4.37		14.48
Elemental analysis, % (dry basis)				
Oil shale kerogen composition:				
C	79.07	76.94	73.41	77.38
H	9.93	10.54	8.28	6.38
O	7.02	8.77	14.73	12.26
N	2.12	1.21	1.05	2.02
S	1.86	2.54	2.53	1.96
H/C mole ratio	1.51	1.64	1.35	0.99

## Forecast

Feasibility studies indicate that due to relatively low mining costs (as a by-product of coal mining) commercial production of Fushun and Yilan oil

shales is profitable, in spite of low Fischer Assay oil yield (only about 7.9 % – see Table 2).

As for Huadian and Longkow oil shales, in spite of much higher mining costs, their commercial production will also be profitable as their Fischer Assay oil yield is high.

Certainly, it is important to utilize advanced and elaborated retorting technologies at these shale oil plants.

## Conclusions

The world's increasing crude oil price and increasing need in the liquid fuel stimulate shale oil production in China. More oil shale retorting plants for producing shale oil will be built.

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