

CURRENT STATUS OF OIL SHALE INDUSTRY IN FUSHUN, CHINA

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ABSTRACT

This paper briefly introduces the test results for Jordan Lajjun oil shale in Fushun retorts in China with various main economic and technical data, thus coming to the conclusion that it is possible for Fushun retorts to process Jordan oil shale. This paper also describes in detail the four stages creation, developing, declining, and re-developing stages---of oil shale industry in China and the current status and characteristics of Fushun retorting process.

Oil shale retorting plants and its commercial operation have begun in Fushun mining areas since 1930s of last century; maximum annual shale oil yields reached 800,000 tons in 1959; rich experiences have been accumulated , the Fushun retorting process adopted has become matured with stable operation day by day . In recent years, with the rapid economic development of China , utilization of oil shale resources has been paid much more attention by relevant experts , scholars , enterprises and governmental institutions. With constantly expanding production scale, shale ash cement factory and shale ash sintered brick factory have been built subsequently in recent years in Fushun Mining area, industrial chains for comprehensive utilization of oil shale has been formed, good economic and social benefits have been obtained, causing great driving effect , thus Fushun becomes the pioneer of comprehensive utilization of oil shale in China. Huadian City in Jilin Province, Maoming City in Guangdong Province and Longkou city in Shandong Province etc. have subsequently carried out cooperation with us regarding development and utilization of oil shale.

I. TEST RESULTS FOR JORDAN SHALE IN CHINA

Industrialized single retort test for Jordan Lajjun oil shale in Fushun retort was done successfully in Fushun, China at the middle of 1980s, satisfactory results were obtained , proving that it is possible for Fushun retort to process Jordan oil shale .

The purpose of the test was to investigate the industrialization of Jordan Lajuun oil shale; Fushun retorting test for 1111.6 -ton oil shale supplied by Jordan was done in Oct. 1986 for ten days , the operation was smooth and large amount of data was obtained , which can be used as design basis for building Fushun type industrialized retort in Jordan .

Test results indicate as shown in Table 1:

1. Processing Jordan oil shale with high sulphur content and high carbonates content by Fushun retort should adopt suitable operation method and operation parameters, which make running stably and retorting completely ; pressure drop is reduced to below 2500Pa , oil recovery can reach 83.6% based on Fisher Assay.

2. The total thermal energy required for retorting Jordan oil shale is 1,053,000 KJ/t shale, which is 209,000~251,000 KJ/t shale less than Fushun shale.

3. The organic carbon utilization rate of Jordan oil shale char can reach 69.2%, but decomposition of carbonates will absorb heat of 205,000 KJ/t shale, the calorific value of char can't meet the heat required for retorting, so large amount of hot recycling gas needs replenishing when processing Jordan shale in Fushun retort, recycling gas heating load accounting for 63% of total heating load . The thermal energy of hot recycling gas is supplied by the combustion of part of exit retorting gas in recuperator.

4. The reactivity of Jordan shale char is high, time of complete combustion of char is shorter than that of Fushun shale.

5. Heat efficiency of retorting for Jordan shale can reach 70.8%, gas yield reaches 329Nm³/t shale,; heat required for retorting can met by oil shale itself when processing Jordan shale in Fushun retort .

6. Jordan oil shale doesn't agglomerate, which can fully avoid retort agglomeration while processing in Fushun retort.

7. The ash color of Jordan shale is gray and the ash has some strength which doesn't affect normal discharging, though breaking exists in less extent, due to mechanical friction during discharging residue.

Table1 Main Economic & Technical Data

Technical Data	Unit	Numerical Value
Utilization rate of Jordan oil shale	%	87.6
Oil recovery rate(including light oil)on Fisher assay	%	83.6
Oil recovery rate (excluding light oil)on Fisher Assay	%	72.73
Oil shale consumption for production of 1 ton oil	Ton /ton oil	12
Gas yield	Nm ³ /ton shale	329
Calorific value of gas	KJ/Nm ³	4907
Organic carbon utilization rate of char	%	69.2
Decomposition rate of carbonates in shale	%	78.1

According to evaluation by expert team organized by SINOPEC: their comments are as follows:

1. Processing Jordan Lajjun oil shale by Fushun retort is quite feasible and oil recovery rate (including light oil) can reach 83.6% on Fisher Assay, which has reached advanced level for internal combustion type industrialized retort both at home and abroad.

2. Heat for retorting can be met by itself and be surplus(according to existing procedure of Fushun retort), heat efficiency can reach 70.8% and is comparatively high .

3. The shale oil produced by processing Jordan oil shale in Fushun retort contains very little mechanical impurities which is below 0.06%(m/m) , being superior to shale oil produced by other processes .

4. The test results obtained can be used for designing and building Fushun type retort in Jordan.

5. The test results were obtained based on the condition that shale quantity is only 1111.6 tons and test period is only 10 days, the possibility of further improving efficiency still exists .

6. It is suggested that the condensation and recovery system shall be further improved when designing Fushun type retort for Jordan.

II. Development OF CHINA`S OIL SHALE INDUSTRY -FOUR STAGES.

1、 Stage I: The creation period beginning from 1930's, during which Fushun retort was developed as shown Table 2.

Table 2 Main Economic & Technical Data of Stage I

Items	Numerical Value
Oil production	Approx. 250000t/y
Construction Completed	200 retorts
Single retort running factor	72%
Shale use factor	60%~65%
Unit consumption of shale for oil production	35t shale /t oil
Shale ash	Filling coal mine

2、 Stage II : Developing period- In 1950's, the peak period of China's oil shale industry

(1) Expansion of Production Scale: totally 378 Fushun retorts have been recovered, and newly built in Fushun, Maoming and Huadian etc. Production capacity reached 900000t/y shale oil, accounted for 70%~80% of domestic oil demand.

(2) Technology Progress, Taking Fushun as an example(Table 3):

Table 3 Main Economic & Technical Data of Stage 2

Items	Numerical Value
Single retort running factor	>95%
Oil recovery rate	75%(including recovery of light oil)
Shale use factor	~80%
Unit consumption of shale for oil production	~25t/ t shale oil

Shale oil refining has been realized to produce light oil products meeting the oil specification; Researches on utilization of particulate shale and shale ash has

been carried out.

(3) Fundamentals of oil shale industry has been developed steadily, specialized research institute has been established, high level experts trained by colleges and universities can carry out engineering and design work of new retorting model and manufacturing of specialized equipments.

3、 Stage III :Declining of Oil Shale Industry .

Daqing oil field was discovered & developed in 1960's , its oil output increased dramatically, exceeding domestic market demand and was exported in great quantity, oil price in international market was in recession at that time, 3~10USD/barrel . Oil shale industry became stagnated, changing from output increasing into output decreasing.

Oil crisis occurred in 1973, although oil prices rose in international market, oil shale industry in China only produced shale oil with small quantity , due to market conditions and the weak domestic demand .

4、 Stage IV: Oil Shale Industry re-developing again in China at the beginning of the 21th Century:

(1) Domestic economy developed quickly and demand for oil increased significantly since 1990's of last century;

(2) Insufficient petroleum resources, China being changing from oil export country into petroleum net import country, import of crude oil has increased year after year;

(3) International oil price maintains high level continuously;

(4) Rich domestic oil shale resources;

Promoting the developing of our nation's oil shale industry again, the oil shale plant in Fushun Mining area has developed oil shale retorting technology and adopted strong environmental protection measures since it put into operation in 1991, it has significant leap compared with brilliant 1950's.

III. CURRENT STATUS FOR OIL SHALE RETORTING IN FUSHUN, CHINA

Fushun Mining Group Co. mainly produces coal, but the mining area is rich in oil shale resources, geological reserve for high grade oil shale is 3.5 billion tons, exploitable reserve is 920 million tons, there are two pits ---East Open Pit and

West Open Pit, it accounts for 160 million tons in West Open Pit and 760 million tons in East Open Pit.

Fushun Mining Group Co. began commercial retorting of oil shale in 1991, being the only state-owned enterprise processing & utilizing oil shale. It has retorting equipments of 7 units up to now, with 20 retorts in each unit, total 140 sets of Fushun retort. Annual oil shale processing capacity is designed to be 7 million tons and annual shale oil yields to be 210,000 tons. It has processed over 34 million tons of oil shale and produced more than 1 million tons of shale oil in nearly 20 years since its shale oil plant was established .

The retort is vertical cylindrical type, its upper part and lower part are retorting section and gasification section respectively. Heat required for oil shale retorting is supplied by both the hot circulating retort gas and gasification of shalechar. During retorting, besides shale oil, surplus retort gas is obtained. It means that by using Fushun retorting technology, the heat content of oil shale can be adequately utilized. The recovery system adopts water cooling method and technical process is simple.

We consistently carry out technological transfer and innovation for this process in recent years and have made the process itself more perfect, the technical level is greatly improved , production of shale oil is subsequently expanded and yields of shale oil is gradually increased(Fig 1).As fuel oil product, supply of shale oil can't meet the demand in China's domestic market. Better economic benefits have been achieved, the yields of shale oil was nearly 190,000 tons and revenue was over 400 million RMB in the year 2005.

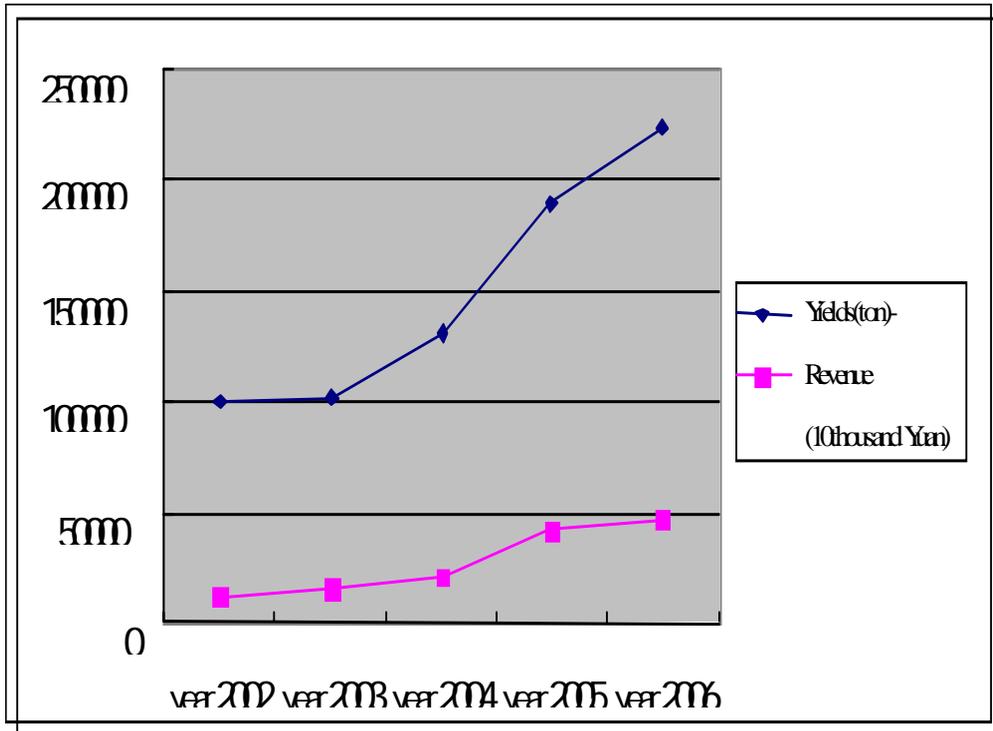


Fig 1 Trend Sketch of Shale Oil Yields and Revenue in Recent Years

Matured operation experience regarding Fushun retort has been accumulated for more than 70 years long term commercial production, it has the advantages of rapid heat transmission and high heat efficiency for internal heating retort, besides, with the following characteristics:

1. Capable of treating low-grade oil shale

Fushun retort can treat Fushun low-grade oil shale with oil content of 6% or lower as 4%-5% with fixed carbon content about 4%. and it can supply heat for retorting by itself; it is difficult for most other type retorts to achieve.

2. Capable of utilizing fixed carbon

Fushun retort can carry out retorting and gasification operation in the same retort simultaneously, which can supply adequate retorting heat for retorting section. The availability rate for fixed carbon contained in shale char in gasification section can reach 65%, the required heat for retorting can be

replenished by its self-generated gas

3. High Product Yields

The oil recovery rate for several domestic shales can reach 75%-85% (based on Fisher Assay) after retorting by Fushun retort, large amount of gas can be generated, surplus 200Nm³/ton shale can be used as fuel

4. Simple structure and convenient maintenance

Fushun retort is simple in structure, inside the vertical cylindrical shell, there are only arch abutment and mixing chamber, so maintenance is easy; The main driving equipments for the system are simple and have long life and less faults.

5. Wide size processing range for shale particles

Fushun retort can process shale of wide size range from 8mm-35mm to 35mm-75mm, which can also process 8mm-75mm shale with wide size range, while other type retorting can't do. But shale particles under 8mm still can't be utilized.

6. Easy and long-term operation

Fushun technical process is simple, easy to operate; the continuous production cycle is 355 days/year.

The advantage of Fushun, China is that it is rich in coal and oil shale resources and has matured and reasonable retorting technology. China's governmental department established China Oil Shale Society in Fushun in Nov. 2005 to further promote the development of Chinese oil shale industry in order to meet China's demand for petroleum and accelerate development and utilization of oil shale, as unconventional energy resources. Fushun Mining Group Co. has gradually transformed from a company with simple commodity production-coal to a research-development-production-multi products-industrial enterprise, which is expanding investment on Fushun retorting process and consistently improves existing technology, and develops new process at the same time .

• PLANNING FOR DEVELOPMENT AND UTILIZATION OF FUSHUN OIL SHALE

In order to better utilize oil shale resources in Fushun mining area , the oil shale retorting planning of Fushun Mining Group Co. is to continue expanding the shale oil production by Fushun retorting in 2006; Secondly, it will introduce ATP processor to treat small size oil shale which Fushun retort can't process ; A big oil

plant whose annual shale oil yields is designed to be 400,000 tons will be established , which makes shale oil yields of Fushun Mining Group Co. reaching more than 700,000 tons annually(Fig 2) .

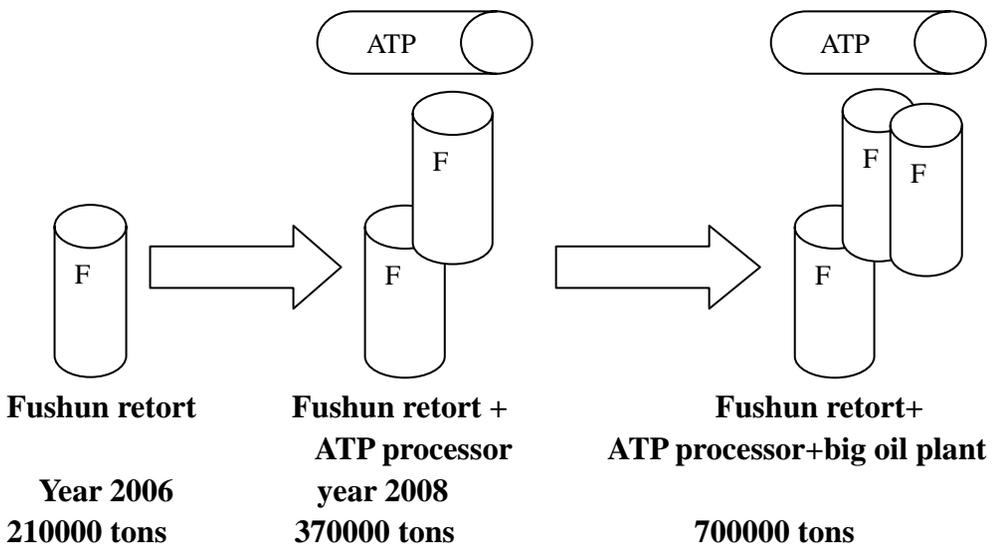


Fig 2 Shale Retorting Planning of Fushun Mining Group Co.

V. RESULTS AND DISCUSSION

1. The test proves that it is possible for Fushun retort to process Jordan Lajjun oil shale. Furthermore, all the economic and technological data can achieve or even exceed the designed capability of the units.
2. In the 20th century, Chinese oil shale industry experienced the stages of creation, developing, declining and re-developing. From the beginning of the 21st century, oil shale industry re-developed again, especially in the Fushun mining areas, which have been recognized as the demonstration base for comprehensive utilization of oil shale in China.

3. Fushun mining areas are rich in oil shale deposit. Industrial production of shale oil was re- initialed in 1991. With the continuous technological improvement and innovation, the retorting process and technology have become increasingly matured, which generates great economic benefits.

VI. CONCLUSION

Fushun is famous as “ coal capital “, West Open Pit with radius of over 10 kilometers is being No.1 pit in Asia , national leaders of several generations have come to Fushun for inspection and instruction . Fushun was also the cradle of Qing dynasty, Yong mausoleum in Xinbin county is called No.1 mausoleum in northeast China and listed as world culture heritage, Hetuala city shows characteristic culture of Man-Qing nationality again , we look forward to meeting you in Fushun !

NOMENCLATURE

t	weight
mm	length
Pa	pressure
Nm^3/t	volume of unit weight
KJ/Nm^3	heat value of unit volume



Fig3 Fushun Mining Group Co.

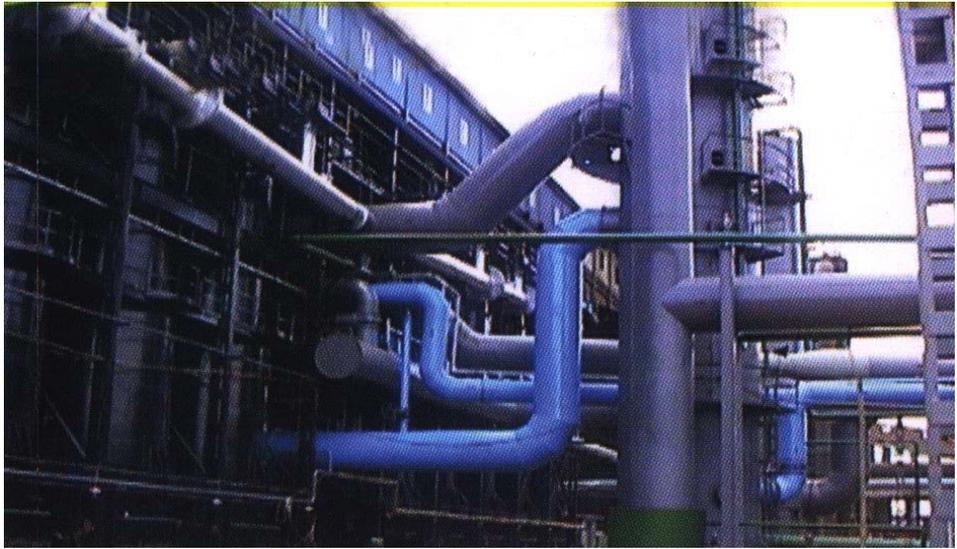


Fig4 Fushun Retorts



Fig5 Production Plant Area



Fig6 Production & Controlling System



Fig7 Night Scene of Oil Plant Area