International Research Journal of Engineering and Management Studies (IRJEMS)
Volume: 03 Issue: 04 | April -2019 ISSN: 1847-9790 || p-ISSN: 2395-0126

Comparison of fushun, dagong oil shale retorts with OSRGS retort.

DANYAL RIZVI, ATIF EQBAL,MOHAMMAD SHAHNAWAZ QAMAR.

STUDENTS, DEPARTMENT OF PETROLEUM ENGINEERING, UTTARANCHAL UNIVERSITY, DEHRADUN, UTTARAKHAND, INDIA.

Abstract - *Oil shale is the most alternative source of crude oil, its recovery depends upon the extent up to which pyrolysis of kerogen present in the block can occur. China constitutes of 720 billion tonnes of oil shale and majorly its recovery depends upon the Fushun oil shale retorting technology. The major drawback of this process is the dependency upon the size of the block particles recovered after grinding process. It does not operates with the fine particles recovered from the grinding process amounting up to 20-40% of the total oil. This is a review paper highlighting the problem associated with the Fushun oil shale retorting technique there solution with combining it with solid heat carrier technology (dagong oil shale retorting process) for the enhancement in recovery from the oil shale blocks. Further, a comparison is done between various retorting process and their respective efficiency is evaluated.*

Key Words: **pyrolysis, retorting, recovery, Fushun oil shale retorting, gas heat carrier, solid heat carrier, dagong oil shale retorting.**

1. INTRODUCTION

Oil shale resources is the second largest among all fossil fuels if converted into heat. Chinese oil shale resources are about 7.20 × 1011 t, i.e., 4.76 × 1010 t of oil in place shale oil. With the severe energy shortage, many countries focus on the developing oil and gas retorting techniques considering economical aspects including the United States and China. There are various industrialized oil shale retorting technologies of gas heat carrier, Chinese Fushun-type retort is one of them. There are many advantages in Fushun-type oil shale retorting (FsOSR) technology: (1) operates with low oil content oil shale; (2) uses recycled gas for the retorting process; and (3) it is easy to operate and maintain. Majorly used in China. Diagram of a conventional FsOSR process is illustrated in Figure 1. The coarse oil shale particles bigger than 10 mm in diameter are heated to 520 °C and reacted to produce an oil–gas mixture and ash in the retort. The mixture is subsequently fed to the water scrubbing and the flash separation to obtain retorting gas and shale oil.

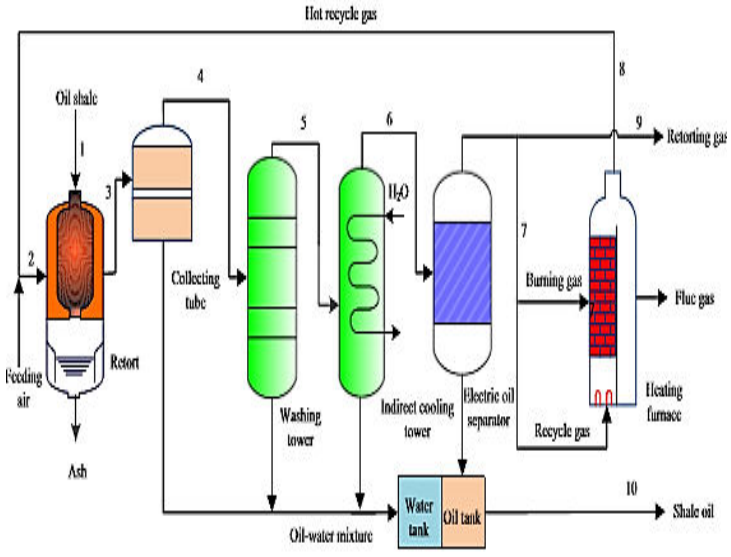

Figure 1 – FsOSR process

2. Solid heat carrier retorting technique

Chinese Dagong oil shale retorting (DGOSR) technology is a sort of solid heat carrier retorting technique, which operates on the model of retorting the oil shale particles through the recycled ash content. its oil yield is up to 90% and has a good economic benefit. Its block diagram is presented in Figure 2.

The extremely fine oil shale particles which are less than (<10 mm) are fed to a heat exchanger. Afterwards the hot flue gas generated from the combustion of semi-coke. The hot oil shale particles are heated by the hot recycle ash to 500 °C and got into the Dagong retort to produce an oil–gas mixture and semi-coke preheats them to (120–150 ° C). In a burning furnace, the semi coke is burned with the preheated air. Ash division occurs in two parts . Most of the ash is used to maintain the heat balance of the retorting reaction in the Dagong retort. The remaining ash is squared after exchanging heat with air. An oil-scrubbing tower and a flash separator separate shale oil and retorting gas. The retorting gas is further used to generate electricity.

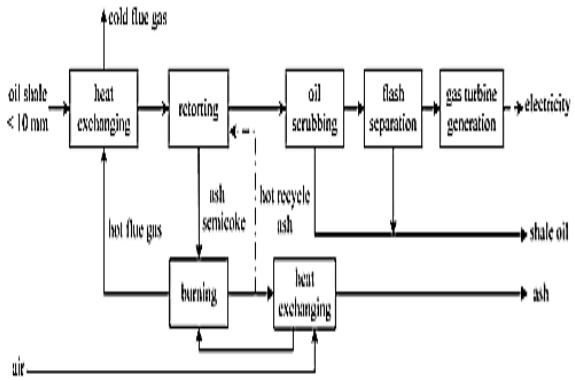

Figure 2 – Dagong oil shale retorting process.

2.1Retorting reaction and mechanism involved

Oil shale block consists of organic material, inorganic material and also comprises of some water. It is affected by many aspects and oil shale parameter is one of them. Further it can be divided into two major steps:

- Conversion of kerogen into pyrobitumen, shale oil, gas and char.
- Conversion of pyrobitumen into shale oil , gas and char

Reaction is as follows:

Kerogen → pyrobitumen + shale oil + gas + char.

Pyrobitumen → shale oil + gas +char

Conversion of kerogen into pyro bitumen is a first order reaction with reaction constant k1, which implies that pyrolysis depends upon the concentration of the reactants.

4.1Units involved in OSRGS process

GCR Unit. After being crushed and screened, the coarse oil shale particles are fed to the gas heat carrier retort, the Fushun-type retort. Under the conditions of 0.1 MPa and 525 °C, the granular oil shale particles are reacted to generate retorting gas, shale oil, and char. The Fushun-type retort consists of two stages: a retorting stage and a gasification stage. A continuously stirred tank reactor (RCSTR) model is considered for the retorting stage. A minimum Gibbs free energy reactor (RGibbs) model is used to model the gasification stage. In the gasification stage, the char is gasified by the drenched air into gasification gas at 0.1 MPa and 850 °C. The oil shale retorting reaction is an endothermic reaction. The gasification gas is used to supply heat for the retorting stage. The rest is provided by the hot recycle retorting gas. The recycle retorting gas is heated by the flue gas from the heating furnace. I. The oil–gas mixture out from the retorting stage enters the washing tower to eliminate ash and isolate a part of shale oil.

The authors can acknowledge any person/authorities in this section. This is not mandatory.

SCR Unit. The fine oil shale lesser than 10 mm arrives in a heat exchanger and is preheated by flue gas to 120 °C. The preheated oil shale is afterward heated by the regenerated hot ash to 500 °C and then fed into the Dagong retort. The outlet stream from the retort enters the multi-stage cyclone separators to discrete the oil–gas blend and semi-coke. The SSplit models model these processes. The parted semi-coke is brought into the furnace and seared by the preheated air at 0.1 MPa and 750 °C. Two models, the RGibbs and Ryield models model the semi-coke combustion process. The outlet stream from the furnace is parted in the gas–solid separator. The flue gas is used to heat up the feedstock. A part of ash is

re-fed for heating the retorting reaction in the SCR reactor. The residual part enters the heat exchanger to heat the air.

SOCR Unit. The oil–gas blends produced by the above two units enter the drench tower, the indirect freezing tower, and further electrostatic oil separator is used to separate shale oil. The RadFrac, HeatX, and Flash models, respectively model these three processes. The oil–water mixture streams of the washing tower and the indirect cooling tower enter the oil– water separator. The Sep model models the oil–water separation process. The shale oil product is recovered. Part of the separated water is back to the washing tower. The outlet stream from the indirect cooling tower is fed into the electrostatic oil separator to recover more shale oil.

EG Unit. Power gas, is a part of recycled gas, highly pressurized in nature is sent to the gas turbine to generate electricity. The Rstoic model models the combustion reactions.

The flue gas from the burning chamber develops into the gas turbine for power creation. The steam turbine is attached to recovery waste heat. In the imitation, the Compr models model the compressor, gas, and steam turbines.

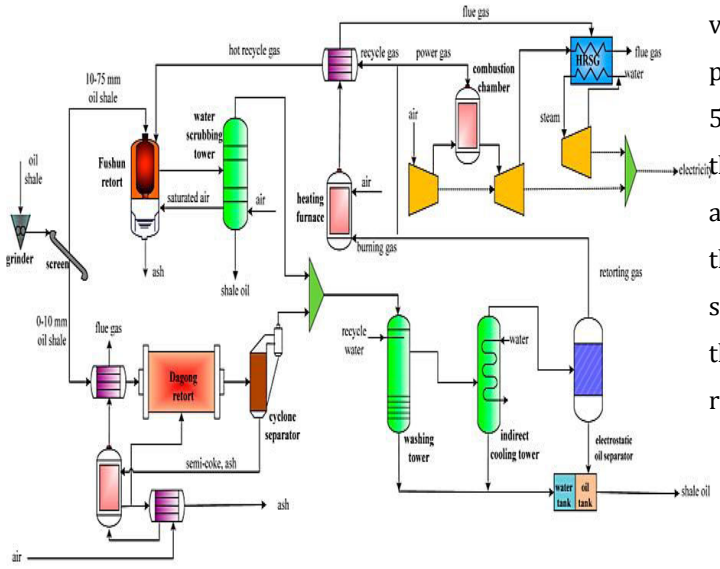

Figure-3: OSRGS process

5. Comparison between FsOSR, DGOSR and OSRGS process.

FsOSR process deals with retorting process of oil shale blocks in which only coarser particles, greater than 10 mm generated after grinding can be fed into the retort, the fine particles constitutes around 20-40% of the total oil whereas DGOSR process deals with only fine particles less than 10 mm in size and reaction occurs in the retorter with the help of recycled ash content, without inclusion of any recycled gas. Temperature plays an important role in retorting process. The retorting temperature of the Fushun-type and Dagong retorts has a huge effect on the retorting gas and shale oil generation of the two sorts of retorting technologies. According to the imitation results, the effect of the retorting temperature on the shale oil productivity is performed in this paper. As Figure 4 depicts, the oil productivity of the gas heat carrier retort quickly rises when the temperature rises from 425 to 525. It is since the rate of the retorting reaction increases fastly in this temperature zone. It is not a big change when the temperature is greater than 525 °C,as there is only a few lasting kerogens that can be retorted in this temperature zone. However, the effect of the retorting temperature on the solid heat carrier retort varies from that of gas heat carrier retort. The oil productivity rises as the temperature increases from 425 to 505 °C. However, it is reduced at the temperature greater than 510 °C. This drift is also steady with the result of He et al. This is because of quicker heat transmission efficiency of the solid heat carrier retort, resulting in the oil–gas blend subordinate cracking reaction. To generate more shale oil, the retorting temperature of the gas and solid heat carrier retorts are fixed to 525 and 505 °C in the study, respectively.

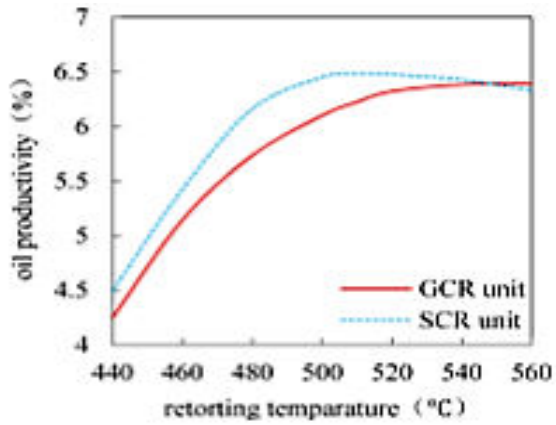

Figure-4 : oil productivity vs retorting temperature graph

OSGRS process generates more electricity than FsOSR and DGOSR processes. OSGRS process generates electricity around 22.65 MW while OSGRS process only generates 16.51 MW, which shows an increment of around 5.5 MW, according the simulation data available. This is possible due to the following reason.

1. It produces more shale oil as it operates on coarser as well as fine particles (10 mm).
2. It generates more retorting gas than any of the other two processes.
3. SCR unit produces gas with much heating value.

6. CONCLUSIONS

Fushun oil shale retort is a retort, which only works with coarser particles and contributes to maximum number of active retorts present in china; it shows a poor thermodynamic performance as it does not entertains fine particles left after the grinding process, which accounts for nearly 25-40% of the total oil in place. On its comparison with dagaong oil shale retort, which is a primary example of solid heat carrier retort, it has been found that it can operate with finer particles and works on recycled ash transmitted to retort for pyrolysis. Further there integration leads to the making of oil shale retorting process of gas and solid heat carrier retorts(OSRGS) ,its efficiency is much more than the other mentioned retorts as it operates both with fine as well as coarser particles collected after grinding. Electricity generation through OSGRS process is much higher than the Fushun oil shale retort. GCR and SCR units show a variation according to the retorting temperature and its effect occurs on oil productivity.

REFERENCE:

(1) International Energy Agency (IEA). World Energy Outlook 2014; IEA: Paris, France, 2014.

(2) He, D. M. Study Pyrolysis and Co-pyrolysis of Oil Shale and Coal; Dalin University of Technology Press: Dalin, China, 2006 (in Chinese).

(3) Qian, Jialin; Wang, Jianqiu (2006-11-07). *World oil shale retorting technologies* . Amman, Jordan: International Oil Shale Conference. .

(4) Yin, Liang (2006-11-07). "Current status of oil shale industry in Fushun, China". Amman, Jordan: International Oil Shale Conference. .

(5) Li, Shuyuan; Qian, Jialin (2010-10-18). *New development of Chinese oil shale activities* . 30th Oil Shale Symposium. Golden, Colorado: Colorado School of Mines.

(6) Bai, F. T., Guo, W., Lü, X. S., Liu, Y. M., Guo, M. G., Li, Q., Sun, Y. H. Kinetic study on the pyrolysis behavior of Huadian oil shale via non-isothermal thermogravimetric data. Fuel, 2015, 146, 111–118.

(7) Wang, Q., Sun, B. Z., Wu, X. H., Bai, J. R., Sun, J. Analysis of combustion reaction activation of oil shale semi-coke. Chemical Engineering (China), 2006, 34(11), 16–19 (in Chinese, with English abstract).