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MODIFICATION OF GAS BLOWER TO ENHANCE THE CAPACITY OF FUSHUN OIL SHALE RETORT

YONG GUANG HE*, YONG HUI ZHAO

Shale Oil Plant of Fushun Mining Group Co., Ltd.
Nan Hui Yuan Street, Fushun City, 113115,
Liao Ning Province, China

This paper describes the modification of gas blower made to enhance the capacity of Fushun oil shale plant. The rotor of the blower is reconstructed, its capacity and gas outlet pressure are increased, thus increasing the capacity of Fushun oil shale retort from 85 to 100 tonnes oil shale/day.

Introduction

Flow Scheme of Fushun Oil Shale Retorting

Shale Oil Plant of Fushun Mining Group Co., Ltd. is the only one oil shale retorting plant for producing shale oil in China now [1, 2]. The plant was put into operation in 1991, its design annual capacity is 3 million tonnes oil shale for producing 90,000 tonnes shale oil. The plant has sixty Fushun type retorts now.

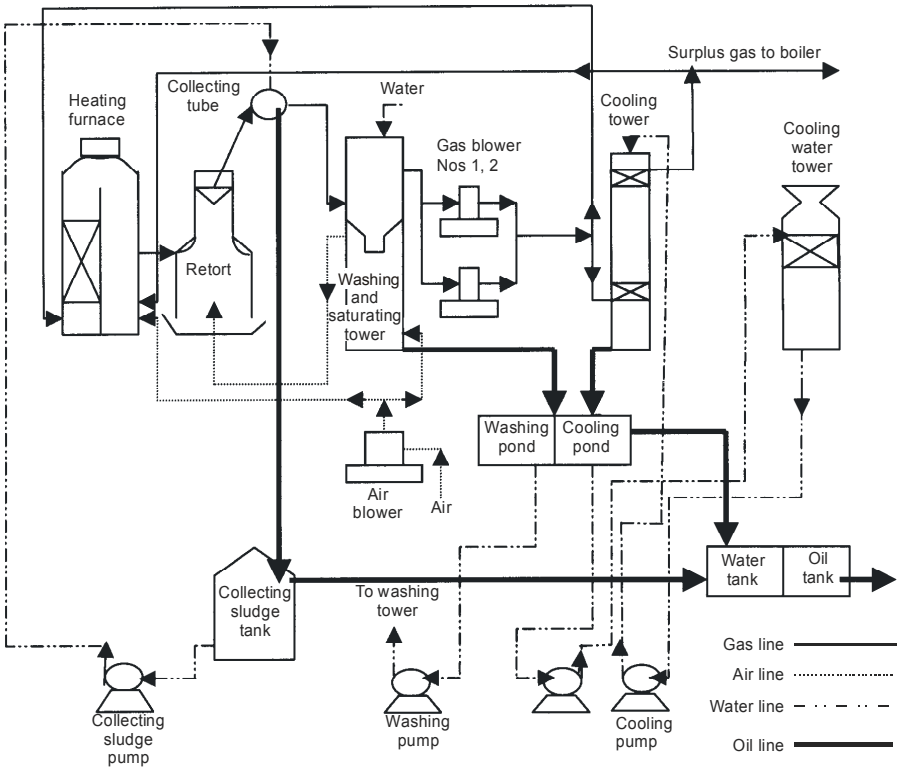
Fushun retort is of the vertical cylindrical type with the inner diameter of about 3 m and height of more than 10 m [3]. The retort has two sections: the upper one is the pyrolysis zone, the lower – gasification zone. Oil shale lumps 12–75 mm fed in from the top of the retort, are dried, preheated and pyrolyzed in the pyrolysis section. After pyrolysis, spent shale comes down into the gasification section, where it burns and gasifies with the air and steam (fed in from the bottom of the retort). The hot combustible gas formed goes upward and mixes with the heated recirculation gas in the mixing chamber in the middle part of the retort, the hot mixed gas comes upward to the pyrolysis zone and serves there as heating source for oil shale pyrolysis.

The spent shale burnt to ashes is discharged from the water seal at the retort bottom. The pyrolysis gas formed, mixed with gasification gas, comes out from the retort top (induced by gas blower), passes through the collecting tube and the washing tower. The sludge, oil, and water collected from the

* Corresponding author: e-mail *Jlqian@yahoo.com*

collecting tube arrive the sludge tank for settling and separation. The oil and water from the washing tower come through the saturation tower to washing pond for oil separation. The gas after the washing tower passes through the gas blower, a part of the gas is heated in a recuperator and recycled into the middle part of the Fushun retort for oil shale pyrolysis; the other part is transported to a cooling tower, where shale oil and water are gained and directed to a water-oil tank. The cooled gas from the top of the cooling tower is partly introduced to recuperator for burning as fuel, and partly fed into boiler as surplus fuel.

The flow scheme of the plant is shown in the Figure. One can see that the gas blower used for transferring the gas is located between the washing and cooling towers. Each set of 20 Fushun retorts shares one condensing and cooling system equipped with two recuperators (one at combustion, one at heating), two gas blowers (one at work, one standby) and two air blowers (one at work, one standby).



Flow scheme of Fushun oil shale retorting

Operation Problem

The Fushun retort is designed to have the daily capacity of 100 t oil shale. Normally the retort is operated under the pressure little smaller than the atmosphere at the top of the retort. Practically, the retort cannot be operated at the designed capacity because when operated with the daily capacity exceeding 85 t, too much retorting gas produced begins to escape from the oil shale feeder at the top of the retort. It indicates that the capacity of gas blower is too low to remove the retorting gas evolved, and the pressure at the top of the retort becomes positive.

Investigation of Gas Blower

Gas Blower Design Parameters

The gas blower of the centrifugal type 2008AB/1014 formerly used for low-calorific gas is produced by Shanghai Blower Factory.

Main technical parameters:

- Capacity 150,000 m^3/h, pressure rising 11.77 kPa (1200 mm H_2O), operating temperature 80 °C, medium relative density at 0 °C 1.25 kg/m^3.
- Design gas composition (vol. %): CO_2 20.84, CO 4.43, CH_4 6.77, C_nH_m 0.75, H_2 11.8, O_2 0.4, N_2 54.7.
- Design revolution: 1480 r/min, shaft power 576 kW and rotary inertia 545 kgm^2. 710 kW electric motor is produced by Dong Fang Electric Motor Factory.

Measuring Instruments Used for Investigation

Domestic-made AFD type pitot tube was used for measuring the pressure and flow quantity.

Japanese electric measuring instrument HIDHI-3266 was used for measuring motor power, current, voltage, frequency, and revolution.

Temperature, relative density, and composition of gas, atmospheric temperature, and retort pressure were measured by quality control department of the shale oil plant.

The processing capacity, air feed quantity, gas circulation quantity, and the gas pressure at the inlet and outlet of the gas blower were determined or calculated by the technical personnels of the shale oil plant.

Investigation was made varying oil shale throughput rate (60, 70, 80, 90 t/day), blower flow quantity and pressure.

Two investigation points were set up: one at the outlet, the other at the inlet of gas blower.

Investigation Results

The maximum average results characterizing gas blower operation did not reach the designed values (the Table).

Comparison of Measured and Designed Values

Items	Max average value measured	Design value	Measured/design, %
Flow quantity, m^3/h	131,500	150,000	87.6
Pressure rising, kPa	8.90	11.76	75.6
Power, kW	441	576	76.6

It also means that the actual operating data (flow quantity, pressure rising and power) correspond to the throughput rate of only 80 t oil shale/day for each retort.

It was found that in the actual case the gas contains 59 vol.% water vapor and has, therefore, low density – 0.78 kg/m^3 at the blower inlet, 0.84 kg/m^3 at the blower outlet. At designing the gas density was calculated on dry gas, at 0 °C 1.25 kg/m^3, at 80 °C – 0.934 kg/m^3. In comparison with the actual case, the designed gas density is about 20% higher, thus causing insufficient capacity of the blower.

It was considered to put also the standby blower into operation in parallel with the working one. Then the flow quantity would meet the requirements, but the pressure exerted would not.

Then it was considered to put the standby blower into operation in series with the working one. The pressure rising would be double, but the flow quantity would have no increase.

The next idea was to put the blower after the cooling tower, but then the pressure exerted still cannot meet the requirements.

Finally, it was considered to design and use a new rotor instead of the existing one in the gas blower without changing the blower case, motor and foundation.

Modification of Blower by Designing and Using a New Rotor

According to the investigations, the blower flow quantity should be 11.1%, and the pressure 7.35% higher to reach 10 t increase in oil shale throughput rate; thus the flow quantity should increase to 151,000 m^3/h and the pressure to 9.84 kPa (1,000 mm H_2O). The gas density at the blower inlet remains still 0.78 kg/m^3, its temperature 80 °C, and it contains 59% water vapor.

The new rotor was designed to have: diameter 2,160 mm instead of the previous 2,105 mm, and fifteen rotor blades with the angle 8° instead of twelve blades.

At operating the new rotor good results were obtained: the flow quantity increased to 15,370 m^3/h, (11% increase), the pressure increased to 11.1 kPa (17% increase), the retort was well operated at the daily throughput rate

100 tonnes for each retort. There was no gas leakage at its top; negative pressure was exerted at the collecting tube (– 85mm H_2O).

Conclusion

The modified gas blower with a new rotor having larger diameter and more blades enables to increase the oil shale daily throughput rate of each Fushun retort from 85 to 100 tonnes, thus increasing annual production of shale oil by about 10,000 tonnes, and creating significant economic profit for the shale oil plant.

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