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Several Typical Coal Pyrolysis Technologies

Көмірдің пиролизінің кейбір типті технологиялары

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Көмірдің пиролиздеу технологиялары мәселелерінің бірі — белгілі технологиялар негізінде жартылай орын басу жолдарымен көмірді өңдеу. Мақалада болашақта көмірдің пиролиздеу технологиясы үздіксіз өндіріс болуы шарт және технологиялық басшылықта қарапайым, сонымен қатар энерготиімді және экологиялық таза — «жасыл» болуы керек.

Существующая проблема технологии пиролиза угля — извлечение путем частичного замещения на основе некоторых типичных технологий. Были сделаны выводы о том, что технология пиролиза угля в будущем должно подходить для широкого диапазона частиц угольного сырья, быть способным для непрерывного производства и быть простым в технологическом управлении, а также энергосберегающим и экологически чистым — «зеленым».

Introductions

Petroleum resources are shortage in China. According to the International Energy Agency by 2010, China's oil imports will reach 390 million barrels per day, 55 percent of China's total demand, by 2020, is as high as 80 % of oil will rely on imports. On the other hand, China's and Kazakhstan's coal resources are very rich, but by pyrolysis technology can produce not only high calorific value of solid fuel, provides the high calorific value of carbocoal to plant, on the other hand also can produce high-value tar and thermal gas. Therefore, the coal pyrolysis technology in China is more and more attentive.

Since the 1960s, the United States, Germany, Canada, Australia, China and other countries have made lots of technologies research and development of different degree of the coal pyrolysis and gasification technologies in low temperature. The transformation reactors mainly included the fixed/moving bed, rotating furnace, fluidized bed and entrained-flow bed. For the above four typical coal pyrolysis reactors, summarized the current process technology of coal pyrolysis and put forward the next stage of the development trend of the technology of coal pyrolysis.

1. Several typical coal pyrolysis technologies

1.1. LR coal pyrolysis technology

LR (Lurgi-Ruhrgas) technology developed by Lurgi and Ruhrgas companies is the method of coal pyrolysis with hot carrier used by hot carbocoal. The process is shown in figure 1. The raw coals, which are smashed into 0–20mm, entered the hopper by the raiser, again through the coal feeder and ducts and entered the pyrolysis reactor. The carbocoal produced partly as fuel and partly as carrier recycling [1]. Gas and coal tar went into the separation system. This process in the former Yugoslavia in 1963, has built production equipment factory production capacity for 1600t/d [2]. This process exchanged heat with the part circular carbocoal and coal and gas used in coal drying pyrolysis, so the whole process with high efficiency. But due to a cinder particles were brought into the tar, tar content of solid particles as high as 40 percent to 50 per-

cent, to the processing and using the tar brings difficulties. Also, the use of coal tar for bonding caused by particles and condensation fault [3].

1.2. Toscoal technology

Toscoal technology, which developed based on U.S. oil shale distillation process Tosco-, is a low temperature coal pyrolysis technology with ceramic balls as the carrier [4]. Its process is shown in figure 2. The Non-bonding coal and Weak-bonding coal, which diameter less than 12.7mm, are added into the coal raiser and preheated to 260–320 °C by the hot flue gas [5]. The preheated coal go into the rotating drum and mix with high temperature ceramics ball ensuring the pyrolysis temperature in 427–510 °C. Gas and tar steam, which discharged to the top of the separator, enter the vapor-liquid separator for further separation. The heated ball and carbocoal separate through drum sieve in the separator, cinder fell on below the sieve and ceramics ball through the bucket send goal heater recycling. This process is completed in 1970s per 25 t/d pilot plant, but found in the test is due to the ball over 600 °C heat cycle, the problems existing in the abrasion resistant [6]. In addition, the bonding coal can paste in the ball in the pyrolysis, so only the Non-bonding coal and weak-bonding coal can be used for the process.

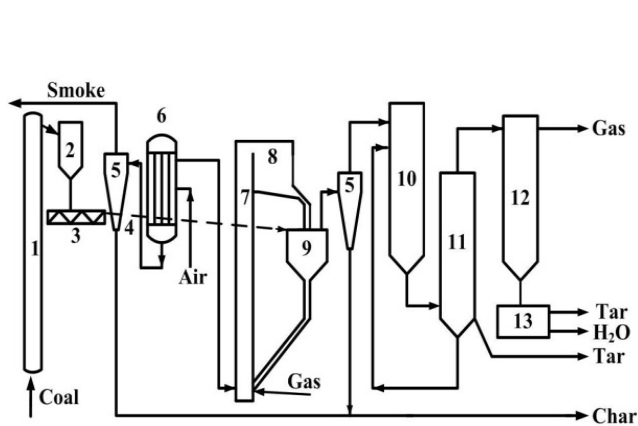


Fig. 1. Sketch of flowchart of LR technology: 1 — Coal raiser; 2 — Coal hopper; 3 — Screw feeder; 4 — Vessel; 5 — Cyclone; 6 — Air preheater; 7 — Char raiser; 8 — Char collector; 9 — Pyrolysis reactor; 10 — Tar collector; 11 — Dust catcher; 12 — Gas cooler; 13 — Oil-water separator

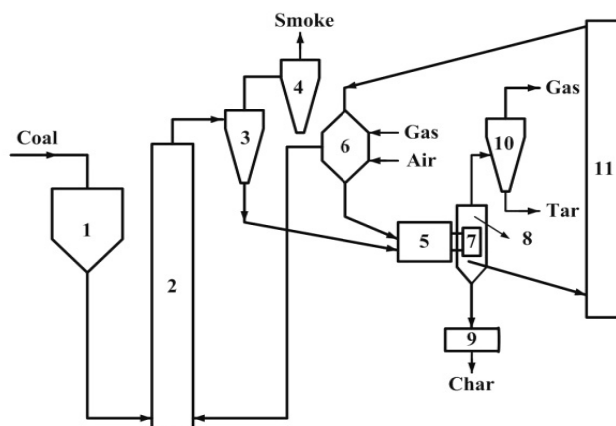


Fig. 2. Sketch of flowchart of Toscoal technology: 1 — Coal hopper; 2 — Coal raiser; 3 — Cyclone; 4 — Syringe; 5 — Pyrolysis Reactor; 6 — Heat carrier heater; 7 — Rotating drum; 8 — Gas-solid separator; 9 — Char cooler; 10 — Gas-liquid separator; 11 — Heat carrier raiser

1.3. DG pyrolysis technology

DG pyrolysis technology, which is put forward by Dalian university of technology of China, is a Poly-generation technology for lignite with solid heat carrier. Raw coals are the lignite for particle size of 0–6mm. The craft system mainly consists of raw coal processing system, distillation system, fluidization carbocoal upgrade system, tar and gas recovery system, as shown in figure 3. The lignite, whose diameter less than 6mm, is added into the coal raiser and mix with the hot flue gas about 550 °C. In the hot flue gas carrying crude coal under rapid-heating, outlet for 120 °C, moisture less than 5 %. Materials realize the gas-solid separation in the outlet of the raiser pipe. The flue gas from cyclone separator about 200°C is discharged into air directly through the induced draft fan after deducted. The dry coal enter the hopper and mix with the heat carbocoal powder about 800 °C in the mixer. After mixing, the materials whose temperature up to 550–650 °C complete pyrolysis in the pyrolysis reactor. The gaseous product from pyrolysis is first separated by cyclone separator; and cooled and washed with the water about 80 °C. The cooling gas and liquid mixture separated in the vapor-liquid separator, liquid materials achieve the oil-water separation in the cinder separator. Gas is collected as product after removing light tar and desulphurization [7].

The coal pyrolysis technology projected by Dalian technology university of China. The project started up in 1984, produced in 1990 and succeeds in gas production in 1992. Dalian technology university industrial test equipment of coal pyrolysis of coal processing capacity to do 3–6 t/h the author, coal consumption 0.2–0.33 t/h, every tons of coal production dry semi-coke 0.3–0.4 t, tar 0.02–0.03 t, gas 200 m³.

1.4. ETCH pyrolysis technology

The ex-Soviet Union former did some research and development works on the pulverized coal pyrolysis with solid heat carrier. The ETCH pyrolysis technology which is used for the comprehensive utilization on power coal had test equipment about 4 ~ 6 t/h and an industrial test device about 175t/h in Krasnoyarsk power plant [8]. ETCH-175 fast pyrolysis process flow diagram is shown in figure 4. Raw coal go to the pulverizer by the coal feeder, here provided the hot flue gas about 550 °C. The powdered coal are delivered in the cyclone, at the same time, are heated to 100–120 °C and the moisture less than 4. The dry coal entered the heater through the cyclone. In the heater, the coal mix with the heated powder chars and then paralyzes in the reactor. The volatile products are separated out in the pyrolysis reactor, and then are separated to tar, gas and condensed water. The char produced in the bottom of the pyrolysis reactor partly enter the raiser as heat carriers. The temperature upper the reactor about 500–700 °C. The surplus char produced in the system are discharged as power fuel after recovering heat.

The device tested a variety of lignite, moisture about 28–45 %, dry ash for 6–45 %. The char yield for 34–56 % used the dry coal, tar for 4~10 %, gas for 5–12 %, and water for 3~10 %.

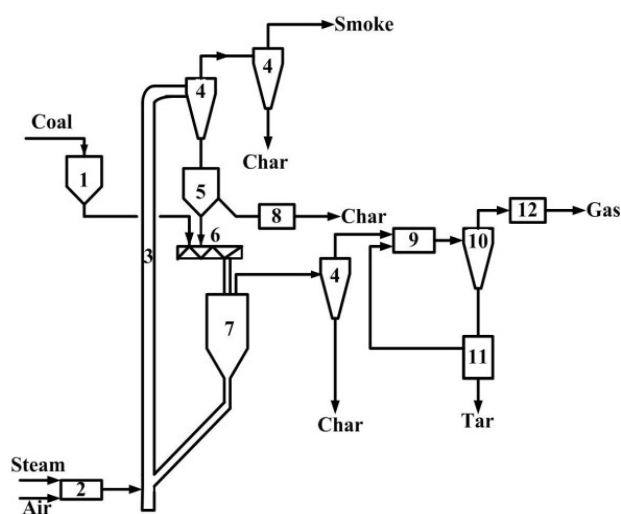


Fig. 3. Sketch of flowchart of DG technology: 1 — Coal hopper; 2 — Mixer; 3 — Char raiser; 4 — Cyclone; 5 — Char hopper; 6 — Screw feeder; 7 — Pyrolysis reactor; 8 — Char cooler; 9 — Syringe; 10 — Gas-liquid separator; 11 — Tar tank; 12 — Desulfuration

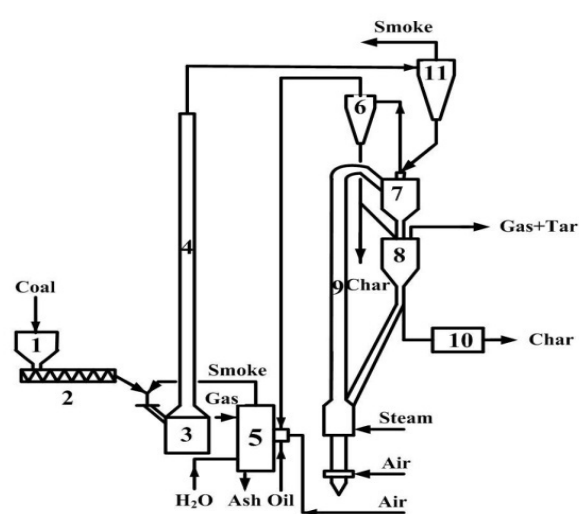


Fig. 4. Sketch of flowchart of ETCH technology: 1 — Coal hopper; 2 — Screw feeder; 3 — Pulverizer; 4 — Coal raiser; 5 — Combustion furnace; 6 — Char cyclone; 7 — Cyclone; 8 — Pyrolysis reactor; 9 — Char raiser; 10 — Char cooler; 11 — Coal cyclone

2. The evaluation for coal pyrolysis technologies

Fixed bed/moving bed of coal gasification or pyrolysis, which the coal use its own gravity in the reactor from moving, and complete gasification or pyrolysis, is a mature technology in industrialization degree, but its thermal efficiency is low, the environmental pressure is big, it is difficult to adapt to large-scale production, and due to the use of coal, grain to the increased cost of coal with grain, its technical economy gradually lowered.

Rotating furnace pyrolysis and gasification transmit heat faster, but there is serious phenomenon for dust deposition and blocking as continuous production process. The system is complex, energy consumption is high, and production capacity is limited, that there are many problems as continuous operation and is not fit for large scale producing.

Fluidized bed pyrolysis and gasification transmit heat rapidly and adapt for various kinds of coal, but the reaction bed is as shallow, that as disposing wide range of particle size distribution of coal, coal processing stage is uneven; causing the quality of thermal transition products is nonuniform.

Compare of the typical coal pyrolysis technologies

Technology	Reactors	Coal/particle size	Heat carriers	Products	Scale
LR	Moving bed	Lignite / 0–20mm	Solid Char	Char/Tar/Gas	1600 t/d Industrialization
Toscoal	Revolving furnace	Non/Weak-bonding coal / 0–12.7mm	Solid Ceramic Balls	Char/Tar/Gas	1000 t/d Industrialization
DG	Fluidized bed	Lignite / 0–6mm	Solid Char	Char/Tar/Gas	150 t/d Pilot scale test
ETCH	Entrained flow bed	Lignite / Powder coal	Gas Smoke	Char/Tar/Gas	175 t/d Pilot scale test

Entrained-flow bed has rapid reaction for pyrolysis and gasification and it has high tar yield. The system is simple, but only small size of coal fit it.

3. Development trend of the coal pyrolysis technologies

At present, the importance and necessity of extracting liquid fuels and chemicals from coal using mild pyrolysis has known over all countries in the world. Pyrolysis is another kind of coal conversion process which can produce liquid products substituting crude oil. This technology is simpler, lower cost and wider adaptability for coal than coal liquefaction technology, although the yield of liquid products is lower.

Unfortunately, these pyrolysis technologies at home and abroad are most on the stage of pilot test or industrial demonstration, yet still no commercial operation of coal pyrolysis technology. The existing pyrolysis technologies all have an insurmountable defect that the tars contained much heavy components because of lacking technical measures to control the heating rate and the secondary reactions for oil and gas. These heavy components not only reduce the grade and value of coal and oil, but also cause a series of problems in operation, for example, it's difficult to separate them from the system. So its further industrialization is hindered.

From the above mentioned information, we can make a conclusion that the coal pyrolysis technologies have been developing in the following trend:

- 1) Raw coal particle has wide ranging and a great variety of coal is fit to be processed by the new coal pyrolysis technologies;
- 2) Large scale coal pyrolysis technologies are simply geared to enable the continuous production process;
- 3) Coal pyrolysis technologies have been on the path of energy-saving and green trend.

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