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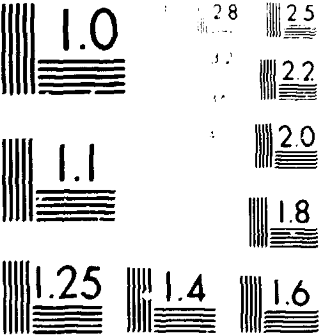
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SYNTHETIC AMMONIA PLANT OF 200 MT/D WITH ANTHRACITE AS RAW MATERIAL*

by

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ABSTRACT

This article describes the conditions for the development of 2oo MT/D synthetic ammonia plants with anthracite as raw material, for we have rich resources in anthracite of fine quality and low price.

This article also discusses two types of ammonia processes, confirming each advantages while pointing out respective deficiencies, and stresses what place they have occupied and what part they have played in nitrogen fertilizer industry in our country.

Finally it was pointed out that the technology with this type of synthetic ammonia plants is still being developed in China, the measures taken to improve the existing plants and the tentative plan contemplated on the process flow of new ones to be built, showing the prospect for the development of the said type of synthetic ammonia plants.

I. RAW MATERIALS

1. Anthracite:

There is a large reserve of anthracite in China. It is sold at a low price and is adaptable to make synthetic ammonia. So it is more economical to use this kind of cnthracite than to use coke, even though it may take a long distance of 1,000 KM or 2,000 KM of transportation. The following is the comparison of the economic effects of similarscale plants with anthracite and other raw materials (see Table 1).

The quality of most anthracite produced in China is suitable to make feed gas for synthetic ammonia with fixed bed gasification. The requirements on the quality of raw materials by ordinary fixed bed atmospheric gasifiers are as follows:

Fixed carbon (F.C) $\geqslant$ 75%

Thermal stability $\geqslant$ 60%

Moisture (air dried basis) $\leqslant$ 5%

Ash (dry basis) $\leqslant$ 15%

Volatile matter (flammable basis) $\leqslant$ 9%

Lump sizes 25 - 75 mm

Melting point of ash (T_2) > 1250°C

Mechanical strength (falling test) > 70%

Sulfur content $\leqslant$ 1.5%

Shanxi anthracite has a fine quality, when gasified, the methane content in the feed gas is below 1%. Its gasification parameters are all basically similar to those of coke. As for ordinary anthracite, its volatile matter content is higher than that of coke, which makes the methane content in the semi-water gas produce 0.5 - 0.8% higher than that of coke, the consumption figures 5-15% higher.

2. Other raw materials:

Chemical coke: It is made in tamped type coke ovens from local rich gas coal only and is used as a supplementary raw material for synthetic ammonia in places where it is difficult to get cnthracite but where there are abundant resources of gas coal. The quality of the coke made in tamped type coke or rich gas coal. The quality of the coke made in tamped type coke ovens from single coal is similar to that of metallurgical coke. However, the requirements on its ash content, sulfur content and methanical strength are allowed to be properly lowered in order to reduce the cost.

II, TECHNOLOGICAL PROCESSES

The processes used by the synthetic ammonia plants of 200 MT/D have been developed from the early conventional process. In those plants of 200 MT/D built up in the middle of 1960's the original conventional atmospheric CO-conversion was changed to pressure CO-conversion, the CO_2-removal by water absorption replaced by hot potassium-carbonate absorption, and the final purification by methanation was introduced for the purpose of reducing power consumption andmeeting the requirement of processing ammonia into urea. On the basis of such improvements, the persent two coexistent processes, the methanation process and the new copper liquor absorption process, have been formed. Nowadays, seldom are these two processes used in other countries. The reason so far they have been existing in our country and will continuously play a role consists in that they are founded upon raw materials of low price, bringing compensation in economy thereby.

Methanation process: (see Figure I) The schematic flow sheet shows that this process consists of desulfurization three times and decarbonation twice mainly to match the coals of various kinds. However, since the whole purification process is carried out under the same pressure, the power consumption is decreased, and the investment reduced to some extent accordingly. With the application of sulfer resistant catalysts, the process flow will be simplified, its superiority will fully display.

New copper liquor absorption process: (See Figure II) The difference between methanation process and this one consists in replacing methanation with copper liquor absorption in purifying synthetic gas Since the CO-absorption with copper-ammonium acetic liquor is more flexible, the operation of gas purification is comparatively a stable and reliable. It is fairly suitable to the process of manufacturing ammonia with anthracite. That so far it has not yet lost its value of existance is particularly because it has its own special feature with plants for co-producing methanol.

In comparison with conventional process, the electricity consumptions with the two processes mentioned above are obviously decreased (See Table II).

III. FUTURE IMPROVEMENTS

As for those newly built ones using methanation process, the following main steps are considered to be taken in order to further improve the process flow, and to reduce the energy consumption, making the process for ammonia maunfacturing with anthracite as raw material more competitive.

1. Sulfur- resistant catalysts will be used in high temperature and low temperature conversions. Original thrice desulfurization and twice decarbonation purification steps will be simplified to the process of twice desulfurization, once-decarbonation and high temperature and low temperature conversions in series. Through such a revision, the process flow will be so simplified that it can be expected to decrease the energy consumption by 0.65×10^6 kcal per T of NH_3.

2. Pressure swing absorption (PSA) will be adopted to recover the gases of hidrogen and nitrogen from the purge gas. 250 - 300 NM^3 of purge gas will be purged out to produce one T of ammonia in ammonia plants of 200 MT/D with anthracite as raw material, from which H_2 and N_2 equivalent to 50 - 60 kg of ammonia can be recovered with PSA method, thus energy consumption per T of ammonia can be lowered by 0.51×10^6 kcal at least.

3. Electric motors will be replaced partially by steam turbines. On the basis of steam balance, one desulfurizing pump and one decarbonating pump will

be driven by steam trubines. In this way, 0.21×10^6 kcal per T of NH_3 of energy can be further saved. The methanation process flow and the steam balance diagram of the whole plant will be shown in Figure 3 and Figure 4.

Table I. Comparison of Economic Effects in Ammonia Manufacturing with Different Raw Materials

Raw material	Gasification method	Energy consumption (kcal/T of NH_3)	Production cost (anthracite as 100)
Anthracite	Fixed bed atmospheric gasification	14.30×10^6	100
Coke	-"-	-"-	125
Heavy oil	Partial oxidation	12.46×10^6	110
Natural gas	Steam reforming	9.67×10^6	75

Table II. Main Economical Criteria of Ammonia Plants of 200 MT/D with Anthracite as Raw Material

(calculated on 1 ton of ammonia)

Main item	Conventional water absorption process	New copper liquor absorption process	Methanation process
water (M^3)	292 0.146×10^6	306 0.153×10^6	273 0.136×10^6
Electricity (kw)	1500 4.5×10^6	1159 3.48×10^6	1087 3.26×10^6
Steam (MT)	1.8 1.418×10^6	2.7 2.10×10^6	2.64 2.05×10^6
Anthracite (MT)	1.35 9.72×10^6	1.2 8.64×10^6	1.23 8.856×10^6
Total energy consumption(kcal /T of NH_3)	15.78×10^6	14.37×10^6	14.30×10^6
Unit investment %		100	99
Cost of synthetic ammonia %		100	101

Note: The energy consumption is calculated on the basis of the following:
Water ---- 500 kcal/M^3
Electricity ----3,000 kcal/KWH
Feed coal ------7,200 Kcal/kg

Figure 1. Schematic Flow Sheet of Methanation Process

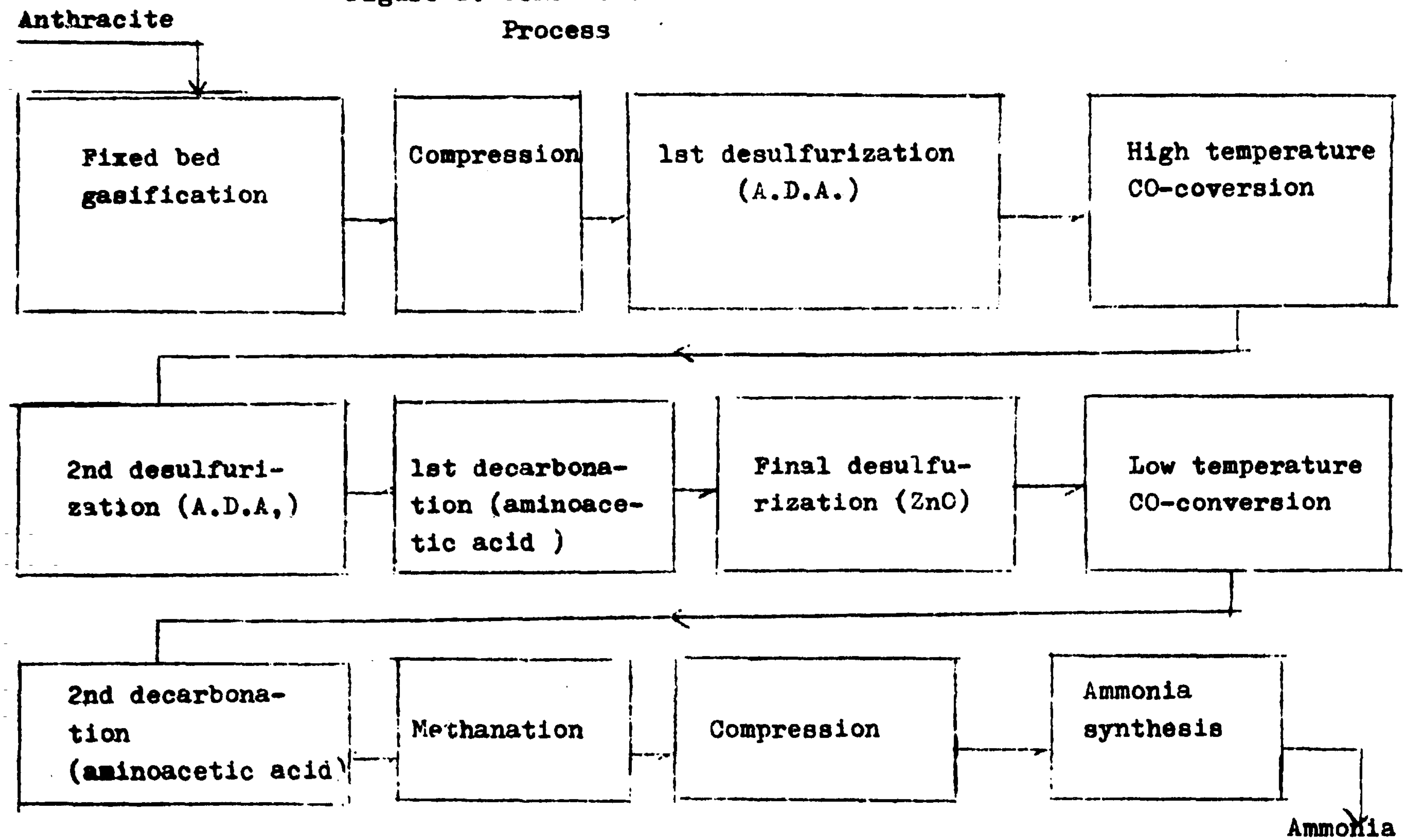


Figure 2. Schematic Flow Sheet of New Copper Liquor Absorption Process

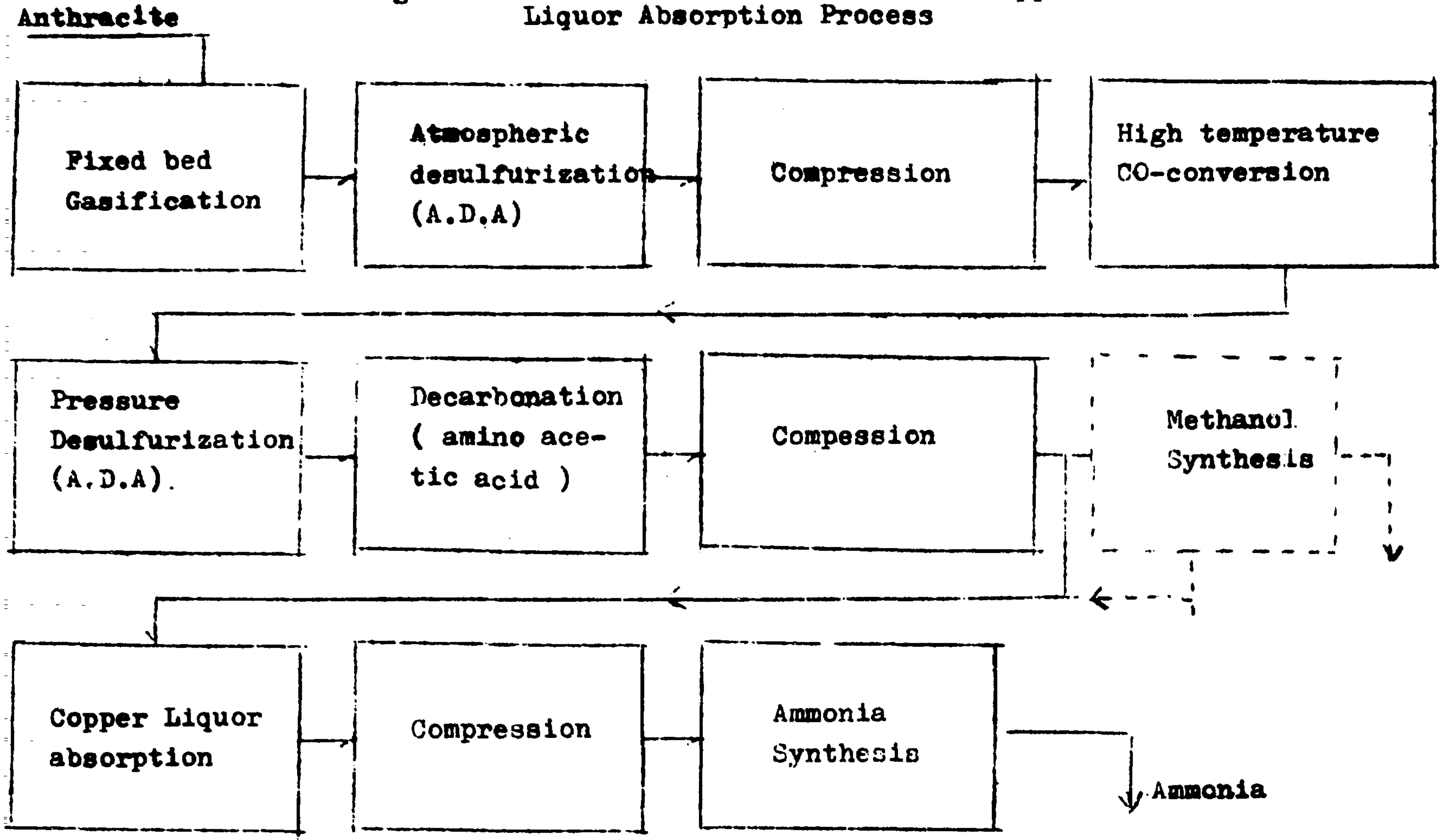
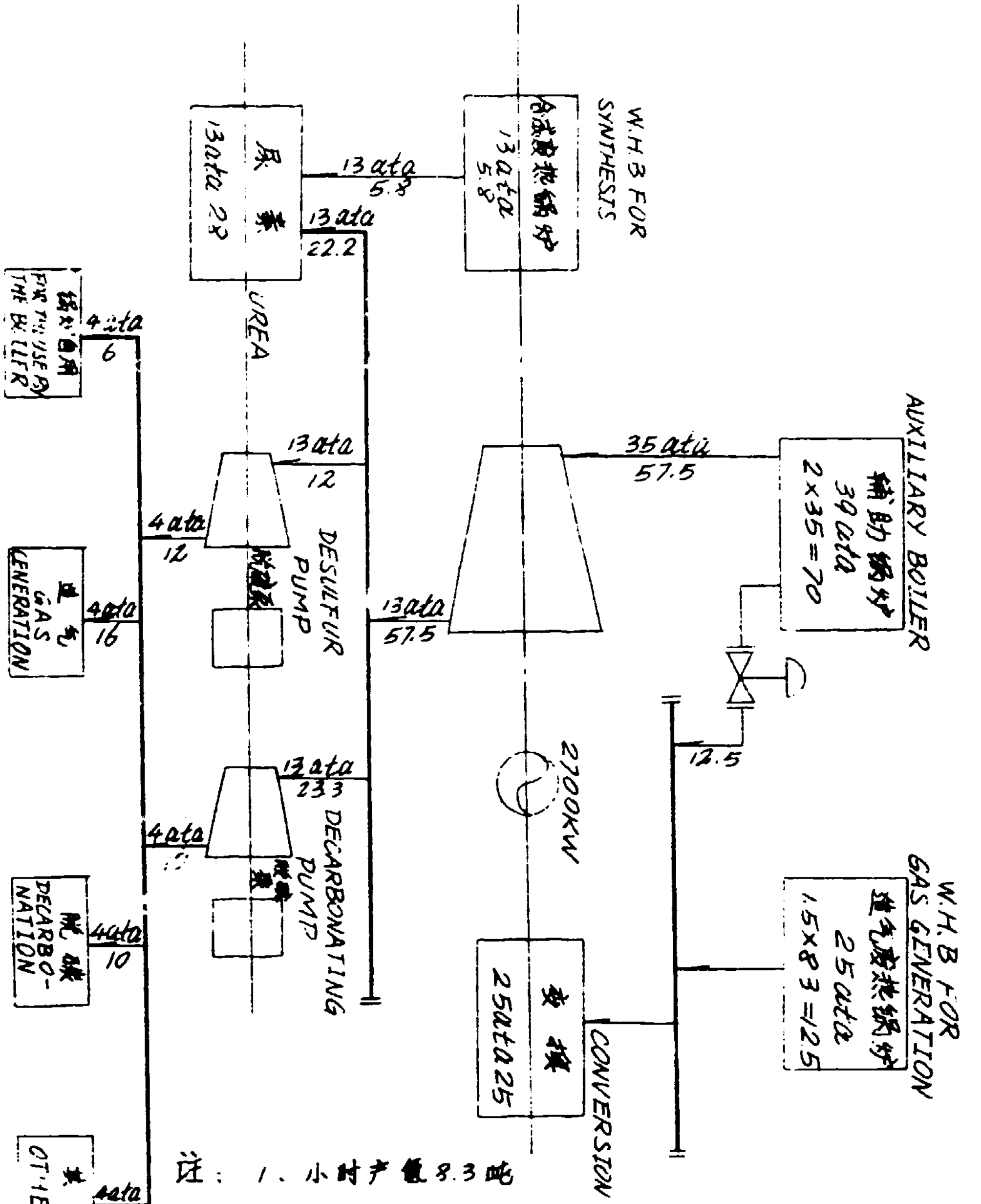


图3　日产200吨氨厂热能利用图

FIG 3 HEAT ENERGY UTILIZATION DIAGRAM OF AMMONIA UNIT (200T/D)



注：1、小时产氨8.3吨

2、脱硫脱碳透汇泵按照用蜗轮回收20%能量。

NOTES 1. AMMONIA OUTPUT IS 8.3 T/H

2. IT IS CONSIDERED TO RECOVER 20% OF THE ENERGY FOR DESULFUR PUMP AND DECARBONATING PUMP

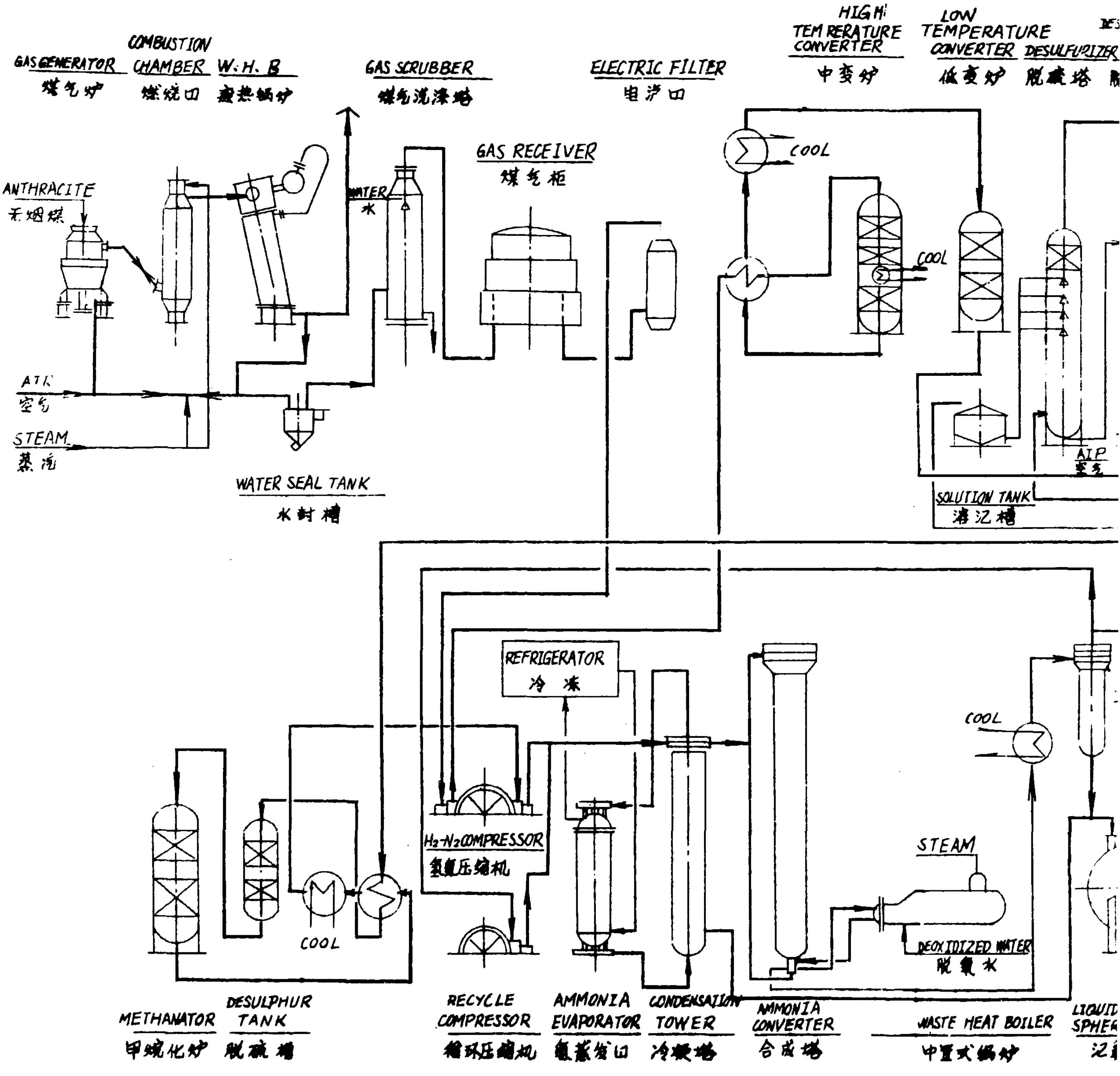


图4 以无烟煤为原料日产200吨氨厂概略流程图

FIG. 4 SCHEMATIC FLOW SHEET O AS RAW MATERIAL (

SECTION 1

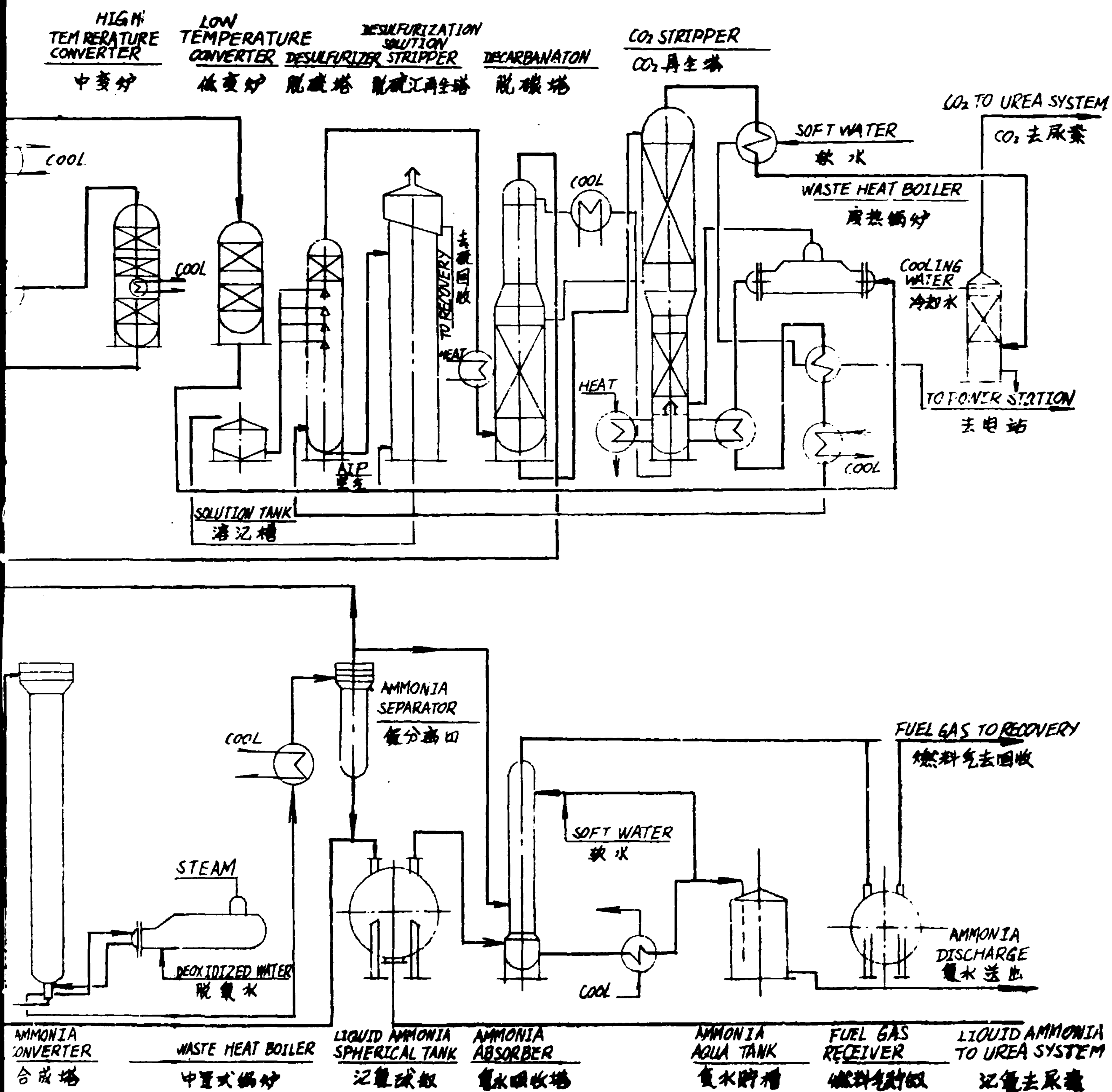


FIG. 4 SCHEMATIC FLOW SHEET OF AMMONIA PLANT WITH ANTHRACITE AS RAW MATERIAL (200 T/D)

SECTION 2