Ira Wiley

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
OFFICE OF SYNTHETIC LIQUID FUELS 1141
LOUISIANA, MISSOURI

T-412

TOM Reel 44, Frames 1143 - 1146

W. H. Sternberg
Oct. 30, 1947

Linde Eismaschinen A. G.
Division of Liquefaction of gases

Höllriegelskreuth,
July 22, 1936.

To Ruhrbenzin A. G.
Oberhausen-Holten

ELIMINATION OF CARBON DIOXIDE BY LOW TEMPERATURE COOLING

Re: your letter, July 3, 1936.

We have subjected to more extended consideration the question of carbon dioxide removal by refrigeration, and are in position to submit to you preliminary figures for the cost of installation and operation. We base them in part on some tests performed a few years previously in Oberhausen. The main task to-day was an increase in the safety of operations of the process then developed.

Our installation costs are based on an hourly capacity of 42,000 m^3 of raw gas (52% H_2, 28% CO, 14% CO_2) asked for by your Dr. Karwat. Such an installation would contain three units, each of which to consist of four regenerators with the required valves and connections, as well as one expansion turbine for each. The raw gas is compressed in a steam driven turbocompressor to about 1.7 atm, and deposits the CO_2 it contains during the cooling in a regenerator, expands in a turbine with production of cold, and after being heated up in a second regenerator leaves with an excess pressure of 0.3 atm. The CO_2 content of the purified gas will be somewhat lower than in air. In addition to CO_2, the Sulfur compounds in the gas (H_2S, SO_2, COS, CS_2) are also deposited in the regenerator. No very definite statements can be made about the sulfur content of the purified gas, because, in the first place, very little is known about the kind of the sulfur compounds present in the converted water gas, and in the second place, the vapor tensions of those substances at low temperatures has not been measured. We may however count that a large proportion of the sulfur containing constituents of converted water gas will be removed by cooling to low temperatures.

Some simple condensation determinations of the raw gas may furnish data for conclusions.

When designing the process, we have taken particular care in eliminating all sources of danger produced by the use of air as a purging gas. Air, in which all the condensates deposited in the regenerator are re-vaporized, is kept in all parts of the apparatus at lower pressure than the gas. In this way any danger of air entering the gas pipe lines is safely overcome. The small amounts of gas which will mix with air during the purging of the regenerators are vented directly into the atmosphere. The order of operating the gas and air valves is so arranged, that no gas valve can be opened when the corresponding air valve is not fully closed.

Steam driven turbocompressors are used for the compression of gas and air. The Gutehoffnungs Hütte has submitted to us a quotation for these. We assume that the available raw gas is under an excess pressure of 1 atm. About 2340 HP will in that case be required for the compression of the gas to 2.7 atm. A live steam turbine with condensation (0.07 atm. back pressure) will require for this purpose about 8.8 to of steam (15 atm, 400°C). The compression of air from 1.0 to 1.3 atm. requires about 284 HP. We suggest a steam turbine with a back pressure of 3.5 atm. for the operation of the air blowers. This will require about 4.6 to steam (15 atm., 400°C). If the waste steam from this latter turbine has no specific use, it might be supplied to the low pressure stage of the gas compressor steam turbine. The expansion turbine, in which the cooled raw gas is expanded with the production of work is coupled with asynchronous generators. Their combined power supply to the power lines will amount to about 100 kw.

Not knowing your steam prices, we estimate the operating costs in terms of electric power obtained from the steam turbines. The gas and air compressors will jointly require 1940 kwh. The 100 kwh recovered in the expansion turbine can be deducted from this amount of power. We may further deduct the amount of power for the compression of the pure gas to 0.3 atm, assuming that the purified gas is actually to be used under that pressure. This amounts to about 320 kwh. The total energy consumption for the purification of 42,000 m^3 of gas per hour amounts therefore to 1,520 kwh, or to 36 kwh/1000 m^3 of raw gas. In our cost estimate we assume the price of 1 kwh to be 1.2 pfg, as quoted to us as being in line with the cost of steam at a gasoline synthesis plant.

The compressors require about 100 m^3/h of cooling water, and we have estimated its cost in accordance with the data submitted by you as 6 pfg. per m^3.

6 men are sufficient to operate the installation.
The cost of the installation will be about RM.1,100,000.

This price includes the delivery of the regenerators with their connections, as well as of the turbocompressors including the steam turbines and the costs of installation. The regenerators weigh about 150 te, the machinery about 80 - 100 to. The costs of the foundations, buildings, electric motors and arrangements are not included in the quotation. We consider 15% of the installation capital as sufficient for interest and depreciation in case of 8,000 hrs. operation/year, and have broken down in our quotation the hourly operating costs for the purification of 42,000 m^3 of raw gas as follows:

Power requirements: 1520 kwh, at 1.2 pfg. a kwh.	RM 18.30
Cooling water: 100 m^3, at 0.6 pfg/m^3	6.—
Gas compressors: labor, 6 men, at RM 1.—/hr.	6.—
interest and amortization, 15% on 1.1 mill. RM, 8000 hrs. operation	20.60
	RM 50.90

The operating costs for the purification of 1,000 m^3 of raw gas figure therefore to RM. 1.20; figured to 1,000 m^3 of purified gas they will amount to RM 1.42.

We wish to emphasize in conclusion, that with the present stage of industrial development of this process we are not yet in a position to guarantee the above figures. We have obtained them in good faith, and were conservative in our estimates, and have reasons to believe that they will be confirmed in practice.

Only a continuation of our earlier experiments can give us the necessary data, and we will shortly inform you about the setting up of such an experimental installation.