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РОЗДІЛ 2

ХІМІЧНІ, ФІЗИЧНІ ТА МАТЕМАТИЧНІ МЕТОДИ ДОСЛІДЖЕННЯ ПРОЦЕСІВ ТА АПАРАТІВ

ANALYSIS OF NATURAL GAS LOW-TEMPERATURE PROCESSING SCHEMES

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Nowadays, along with increased production of natural gas and petroleum great importance is attached to the comprehensive utilization of their resources. Use of ethane, propane, butane and heavier hydrocarbons, and hydrogen and helium in the other sub-sectors of the economy provide a quick return on investment for the construction of the complex installations for oil and gas production and gas processing plants. Associated gas is a mixture of methane series of hydrocarbons (methane, ethane, propane, C_{3+}), helium and other non-hydrocarbon compounds. The number and content of the hydrocarbon compounds in the mixture vary widely. The choice of method and technology for processing of raw materials depends on the pressure, temperature and gas composition, climate and soil conditions, areas of production and transportation of oil and gas, consumer demands for their quality, etc.

Until the mid-sixties at the basis of technological processes of target components extraction from the gas were absorption processes at normal and low temperatures.

These processes provided the depth of propane gas extraction up to 90 %. Increased demand for ethane, associated with an increase in prices of petroleum products, caused its production from natural gas and oil gas and led to the development of several new low-temperature technological schemes for deep extraction of propane and ethane from the gas. Soon began to apply the cold-using processes: low-temperature absorption (LTA) or low-temperature condensation (LTC) which is more effective on the degree of drying and cleaning of hydrocarbon gases.

Due to increasing consumption of ethane, propane and other hydrocarbons it is necessary to improve technologies for gas processing for a better extraction of its individual components.

Currently, LTA and LTC are the main technological processes for processing hydrocarbon gas. One of today's absorption of technological schemes is the scheme of the LTA with preliminary saturation of the absorbent.

In the United States at LTA facilities extraction of ethane from the oil and natural gas at the temperature of cold streams minus 40... minus 45 °C and a pressure of 7.6 MPa reaches 40...50 %, and hydrocarbons C_{3+} – 95...97 %.

At the Russian gas processing plants at the temperature minus 23... minus 30 °C and pressure of 3.6 MPa up to 95 % of C_{3+} hydrocarbons is extracted from oil gas. In LTA installations using lightweight absorbents (relative molecular mass 80-140) at the rate of approximately 1-1,5 liters per 1 m^3 of gas.

Technological schemes of LTC for raw gas processing can be divided by the stages of separation, kind of cold sources, type of the desired product. By the number of separation stages modern LTC schemes divided into one-, two- and three-staged. At each stage the liquid phase must be drawn. By type of cold source the LTC scheme can be with internal, external and combined (cold source are external and internal cooling cycles) cooling cycle. External cooling cycle does not depend on the technological scheme and has its own refrigerant. Depending on the type of refrigerant external cooling cycles can be divided into two groups: with one-component refrigerants and with multi-component (mixed) refrigerant – usually a mixture of light hydrocarbons.

In the process of petroleum gas refining, using the LTC at the extraction ratio of C_{3+} hydrocarbons of 95 % it is necessary to cool the processed gas to a temperature of minus 65 ... minus 100 °C. Such cooling gas temperature can be achieved when using an external refrigeration cycle (cascade propane-ethane cycle) or combined cooling cycle (propane cold and use of turbo-expander). During the processing of oil and natural gas in the gas processing plant for deep extraction of ethane, propane and heavier hydrocarbons most widely used five different technological schemes of LTC (Table 1).

Table 1

Type of the LTC scheme	Extraction rate, %		
	C_1+C_2	C_{3+}	C_{4+}
With propane and internal refrigeration cycles	40	90	97
With the turbo-expander	40-60	90	96
With a cascade refrigeration cycle	60-80	95	99
With the propane refrigeration cycle and turbo-expander	60-80	95	99
With a cascade of propane and ethane refrigeration cycle and turbo-expander	60-85	95	99

During the processing of petroleum gases technological schemes in which an external propane refrigeration cycle coupled with the internal one are primarily used. In the first stage of gas cooling to a temperature of minus 30 °C an external propane refrigeration cycle is used and on the second stage for lower temperatures achieving – throttling of liquid flow, obtained in the process, or expansion of partially stripped gas in turbo-expander. Depending on the desired product the technological scheme of LTC for hydrocarbons of C_{2+} or C_{3+} is applied.

Analysis of technical and economic performance of the LTA installation and the installation of the LTC with a turbo-expander shows that at the same output of propane and heavier hydrocarbons capital and operating costs when using the LTC installation with a turbo-expander are lower. Besides, the hardware execution of technological scheme of the LTA is bulky (the number of machines is almost 2 times greater).

Studies have shown that gas processing schemes of low-temperature absorption maintaining the same level of extraction of target components in a depleted natural gas requires an increase in consumption of the absorbent, more power, additional heat input, on what hardware and equipment are not calculated. The use of expander hub in the LTC schemes makes the whole process easily controlled, since the process parameters like self-correcting and maintained at the desired level, providing the required level of target components extraction. It is the great advantage of the LTC schemes with a turbo-expander hub. The use of mixed refrigerant allows getting the temperature for the evaporation of light components much lower than the evaporation isotherm of propane, and thereby achieving a better extraction rate of target components. And the parameters of refrigeration cycle are selected in such way that after compression in refrigeration machines and after cooling by reverse flow of dry gas refrigerant is fully condensed.

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STUDY OF NONLINEAR DIELECTRIC PROPERTIES OF P(VDF-TFE) COPOLYMER FILM

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To study the dielectric nonlinearity of P(VDF-TFE)copolymer films of 30 μm thickness we performed six series of experiments on unpolarized and polarized, unannealed

РОЗДІЛ 3 – ХОЛОДИЛЬНА ТЕХНІКА ТА ТЕХНОЛОГІЯ. ПРОЦЕСИ ТА АПАРАТИ ХАРЧОВИХ ТЕХНОЛОГІЙ

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