

The coefficient of variation obtained in using (7) and (8) does not exceed 7%.

NOTATION

B, dimensionless temperature coefficient; Rb, Rebinder number; \bar{t} , mean temperature of the material; t_d , temperature of drying agent; T_d , absolute temperature $T_d = t_d + 273^\circ\text{K}$; \bar{u} , mean (bulk) water content of material; u_0 , initial water content; u_f , final water content.

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CALCULATION OF HYDROCARBON-GAS SEPARATION IN A TURBULENT TUBE

Yu. M. Bazhenov, N. P. Ignin,
A. N. Chernov, and A. V. Kilinnik

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The separation of hydrocarbon gases in a turbulent tube is calculated by means of the material-balance method. The results are compared with experimental data.

At present, there are very many works on turbulent tubes used in the gas-retreatment industry. However, there are few data on the possibility of calculating the separation of hydrocarbon gases in such tubes [1-6].

The process of gas separation in a turbulent tube may be represented as follows: tangential introduction of gas through a tapering nozzle; condensation of heavy hydrocarbons at the exit from the nozzle; centrifugal separation of the resulting gas-liquid mixture to give an axial (cold) gas flow depleted in heavy hydrocarbons and an enriched (hot) gas flow at the wall.

For considerable velocities at the nozzle outlet (Mach number $0.9 < M < 1.5$) condensation is a nonequilibrium process [3]. However, if a series of assumptions is made (for example, assuming the nozzle to be sufficiently large), it is possible to proceed as for equilibrium separation of multicomponent systems using the material-balance method

$$\sum_{i=1}^n x_i' = \sum_{i=1}^n \frac{z_i}{1 + e(k_i - 1)} = 1,$$
$$\sum_{i=1}^n x_i^* = \sum_{i=1}^n \frac{k_i z_i}{1 + e(k_i - 1)} = 1.$$

The equilibrium constants k_i are determined by expressing them as a function of the convergence pressure according to the NGPA atlas. As the parameters for the calculation of the k_i , we take the measured static pressure at the outlet from the turbulent-tube nozzle and the corresponding calculated static temperature:

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TABLE 1. Results of a Calculation of the Hydrocarbon-Gas Separation in a Turbulent Tube

Component	$P_1 = 18.1 \text{ kg/cm}^2; T_1 = 303^\circ\text{K};$ $P_2 = 9.0 \text{ kg/cm}^2; T_{2st} = 269^\circ\text{K}$			$P_1 = 12.1 \text{ kg/cm}^2; T_1 = 280^\circ\text{K};$ $P_2 = 6.6 \text{ kg/cm}^2; T_{2st} = 252^\circ\text{K}$			$P_1 = 12.3 \text{ kg/cm}^2; T_1 = 298^\circ\text{K};$ $P_2 = 5.3 \text{ kg/cm}^2; T_{2st} = 263^\circ\text{K}$		
	composition of initial gas	composition of cold gas (calculation)	composition of cold gas (experiment)	composition of initial gas	composition of cold gas (calculation)	composition of cold gas (experiment)	composition of initial gas	composition of cold gas (calculation)	composition of cold gas (experiment)
CO ₂	0,015016	0,0151635	0,017984	0,012975	0,0131827	0,017118	0,014017	0,0142686	0,018987
N ₂ +C ₁	0,740506	0,7492916	0,735743	0,701704	0,7154197	0,721990	0,742111	0,7576361	0,749302
C ₂	0,156882	0,1579391	0,159516	0,174014	0,1758812	0,163678	0,154086	0,1560404	0,151832
C ₃	0,052406	0,0518543	0,058788	0,063883	0,0622133	0,056106	0,051098	0,0499372	0,050240
i-C ₄	0,005695	0,0054069	0,005112	0,010317	0,0091670	0,009188	0,006213	0,0055622	0,005993
n-C ₄	0,009796	0,0090399	0,007784	0,020396	0,0168578	0,016039	0,010482	0,0087198	0,009974
i-C ₅	0,003609	0,0028661	0,002496	0,006113	0,0035338	0,005246	0,004789	0,0028272	0,003987
n-C ₅	0,005385	0,0039415	0,003987	0,005986	0,0029262	0,005527	0,006202	0,0031002	0,004287
ΣC ₆	0,010705	0,0045051	0,008590	0,004612	0,0008261	0,004208	0,011002	0,0019141	0,005396

$$T_{2st} = T_1 - \frac{\frac{2k}{k-1} P_1 V_1 \left[1 - \left(\frac{P_2}{P_1} \right)^{\frac{k-1}{k}} \right] + W_1^2}{2g c_p A}$$

Assuming that all the condensate formed is concentrated in the hot flow, the result of the calculation gives the composition of the cold flow. Using the method outlined above, 60 calculations were carried out for various parameters of the initial gas flow. Comparison of the results with experiment showed that the relative deviation determined from the sum of the hydrocarbons C₃+B was 18.2% (some results on the calculation are given in Table 1). The discrepancy is explained by a partial evaporation of the condensate formed, leading to heating of the peripheral layer and subsequent turbulent mixing of the peripheral and axial layers.

NOTATION

x_i' , molar fractions of initial flow; e , fraction of liquid phase removed; k_i , equilibrium constants; z_i, x_i'' , molar fractions of liquid and gas phases formed, respectively; T_1 , total temperature of initial flow; P_1 , static pressure of initial flow; V_1 , specific volume of initial flow; W_1 , velocity of initial flow at nozzle inlet; g , acceleration due to gravity; c_p , isobaric specific heat; k , adiabatic constant.

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