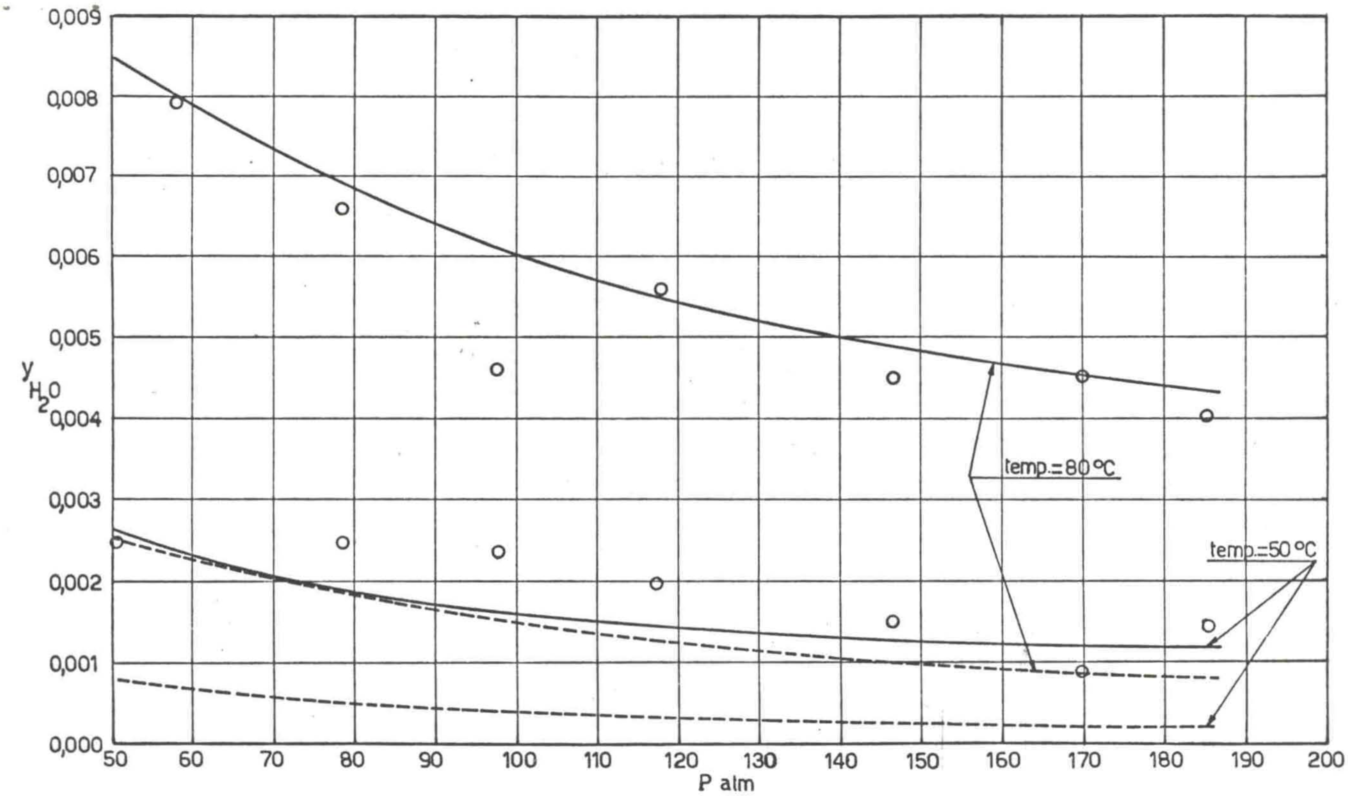

Fig. 5. Mole fraction of water in vapor phase as a function of pressure. Temperatures of 50° and 80°C. Ratio hydrogen-nitrogen 2.1 to 1.-65% by wt. of ammonia in liquid phase. ○ = experimental points; solid lines = calculated with Equation (9); dotted lines = calculated with Equation (8).

These equations can be applied to solve a boiling point or a dew point.

Data for boiling point solution: $T, P, N_{N_2}, N_{H_2}, x_{NH_3}$
Data for dew point solution: $T, P, N_{N_2}, N_{H_2}, y_{NH_3}, y_{H_2O}$

The first part of the solution is the same for both problems:

1. Choose a value of G.
2. Calculate y_{N_2} and y_{H_2} with Equations (c) and (d).
3. By use of T and P calculate $\overset{\circ}{f}_{NH_3,L,P}$ and $\overset{\circ}{f}_{H_2O,L,P}$ with Equation (16) or by use of the graphs of Figure 2 and 3 [Equations (f) and (g)].

The following refers to bubble point solution:

4. Calculate γ_{NH_3} and γ_{H_2O} with Equations (10) and (11) [Equations (h) and (i)].
5. Choose a value of y_{NH_3} and calculate y_{H_2O} with Equation (e).
6. Calculate $(f_{HN_3,v}/P \cdot y_{NH_3})$ with Equation (21).
7. Calculate y_{HN_3} with Equation (a) and check it with the value assumed at point 5 of this procedure. Return to point 5 if the two values are not sufficiently approximated.
8. Calculate $(f_{H_2O,v}/P \cdot y_{H_2O})$ with Equation (21).
9. Calculate y_{H_2O} with Equation (b) and check it with the value calculated at point 5 with Equation (e). Return to point 1 if the two values are not sufficiently approximated.

The following refers to dew point solution:

4. Calculate y_{NH_3} or y_{H_2O} with Equation (e).
5. Calculate $(f_{NH_3,v}/P \cdot y_{NH_3})$ and $(f_{H_2O,v}/P \cdot y_{H_2O})$ with Equation (21).
6. Choose a value of x_{NH_3} and calculate γ_{NH_3} with Equation (10) [Equation (h)].
7. Calculate y_{NH_3} with Equation (a) and check it with the known value or that calculated at point 4 with Equation (e). If the values are not sufficiently approximated, assume a new value of x_{NH_3} and return to point 6.
8. Calculate γ_{H_2O} with Equation (11) [Equation (i)].
9. Calculate y_{H_2O} with Equation (b) and check it with the known value or that calculated at point 4. If the values are not sufficiently approximated, assume a new value of G and return to point 1.

COMPARISON OF CALCULATED RESULTS WITH EXPERIMENTAL VALUES

To check the reliability of this calculation method for a nonideal solution, the results of a few experimental determinations have been compared with the corresponding calculated values.* The comparison is presented in Table 1 for fifteen points. Temperatures of 50° and 80°C. have been examined. The pressure range varies from 50 to 185 atm. For a definite mole fraction in the liquid phase and a constant ratio of nitrogen and hydrogen, mole fractions of ammonia and water in the vapor phase are given as experimental values, calculated from Equations (9) and (8).

In Figures 4 and 5 the same results of Table 1 are given. The solid line curves correspond to values calculated with Equation (9) and the broken line curves to values calculated with Equation (8). The experimental determinations have been repeated many times for each point. By comparing consecutive values of the same point, we see that ammonia experimental points are reproducible, but the laboratory was not in a position to give reproducible experimental points for water. In Figure 4 one notes a better agreement with experimental point of values calculated with Equation (9) than those calculated with

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* The apparatus used for the determination of vapor-liquid equilibria is of the type described by Rigas et al. (*20*) for natural gas.