Molal Boiling Point Constant for Butylacetylene

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Butylacetylene (1-hexyne) constitutes an excellent example of an aliphatic hydrocarbon readily prepared in pure form[1]. As a part of a research program concerning substituted acetylenes it was decided to determine the molal elevation of the boiling point for butylacetylene. The data have revealed that neither the triple linkage nor the labile hydrogen cause undesirable effects in the cases studied.

Six solutes were selected for the experiments. Each was of Eastman grade. The butylacetylene was prepared as previously described[1]. The McCoy apparatus was used with a Beckman thermometer. The essential data are given in Table I. For the sake of simplicity, the volume of each solution was considered to be the volume of the solvent. The density was taken as 0.7108. The constants (K_b) given are, therefore, close approximations only and are expressed as degrees per mole of solute in 1000 grams of solvent. The values were calculated from the expression

$$K_b = \frac{m(\triangle t)G}{1000\ g}, \text{ where}$$

K_b = B. p. constant
m = mol. wt. of solute used
G = wt. of solvent used
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Independent work in this laboratory[2] on the vapor pressures of acetylenes has shown that butylacetylene has a molal heat of vaporization of about 7586 calories at its normal boiling point, 71°. This value permits calculation of the boiling point constant by means of the equation

$$K_b = \frac{R(T_1)^2}{L_v n_1}, \text{ where}$$

R = gas constant
T_1 = b. p. of solvent in degrees Kelvin
L_v = molar heat of vaporization
n_1 = moles of solvent per kilogram

Substituting,

$$K_b = \frac{1.985(71+273)^2}{7586(1000/82)} = 2.54°$$

[1] Hennion, 1937. Proc. Indiana Acad. Sci., **47**: 116-121.
[2] Rich and Hennion, Unpublished work, this Laboratory.

The calculated value, 2.54°, is only in fair agreement with the experimental average, and no value as high as 2.54° was ever found.

TABLE I.—Molal Boiling Point Constant Data for Butylacetylene

Solute	Grams Solute	Grams Solvent	$\triangle t$	K_b
p-Dibromobenzene	0.2500	14.9	0.145	2.04
(M.W., 235.9)	0.4000	21.2	0.160	2.01
	0.5000	24.9	0.175	2.05
Diphenyl	0.3019	17.4	0.260	2.31
(M.W., 154.1)	0.4038	11.7	0.540	2.42
	0.6438	18.1	0.520	2.26
Naphthalene	0.3002	13.1	0.390	2.19
(M.W., 128.1)	0.6002	18.5	0.550	2.17
	0.2008	12.8	0.370	2.22
m-Dinitrobenzene	0.3000	12.4	0.315	2.19
(M.W., 168)	0.4000	19.9	0.270	2.26
	0.5000	22.4	0.290	2.18
Benzophenone	0.3000	12.8	0.285	2.26
(M.W., 182.1)	0.4000	15.3	0.310	2.16
	0.5000	20.3	0.290	2.14
Stilbene	0.2006	11.4	0.230	2.36
(M.W., 180.1)	0.3012	22.0	0.180	2.38
	0.4000	12.4	0.410	2.30
Average value of K_b	.....	.....	.....	2.21

Summary

1. Butylacetylene is an aliphatic hydrocarbon readily prepared in pure form and entirely suitable for many molecular weight determinations by the boiling point method.

2. Experimental values for the molal boiling point constant for butylacetylene indicate a value of about 2.21° per mole of solute in 1000 grams of solvent.