

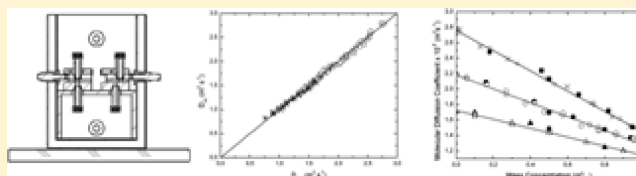
Determination of Molecular Diffusion Coefficient in *n*-Alkane Binary Mixtures: Empirical Correlations

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ABSTRACT: In this work we have measured the molecular diffusion coefficient of the *n*-alkane binary series nC_i - nC_6 , nC_i - nC_{10} , and nC_i - nC_{12} at 298 K and 1 atm and a mass fraction of 0.5 by using the so-called sliding symmetric tubes technique. The results show that the diffusion coefficient at this concentration is proportional to the inverse viscosity of the mixture. In addition, we have also measured the diffusion coefficient of the systems nC_{12} - nC_6 , nC_{12} - nC_7 , and nC_{12} - nC_8 as a function of concentration. From the data obtained, it is shown that the diffusion coefficient of the *n*-alkane binary mixtures at any concentration can be calculated from the molecular weight of the components and the dynamic viscosity of the corresponding mixture at 50% mass fraction.



I. INTRODUCTION

A concentration gradient within a mixture results in a mass transport of its components from the zones of a higher concentration to those of a lower concentration. This phenomenon, known as molecular diffusion, has generated great interest since its discovery in the nineteenth century when, first in gases and later on in liquids, it was studied with the aim of understanding the atom's behavior.

It was in 1855 when Fick¹ established the first quantitative relation for the molecular diffusion phenomenon, known nowadays as Fick's law. Since then, interest in this transport property has increased, discovering a great number of fields in which the molecular diffusion coefficient has a huge influence, such as medicine or physiology.²

As a consequence of this interest, there have appeared a great number of apparatus designed for the determination of the molecular diffusion coefficient. There are, for example, techniques that employ the principle of Taylor dispersion³ or other techniques such as open ended capillary (OEC)⁴ or thermal diffusion forced Rayleigh scattering (TDFRS)⁵ developed for the study of the molecular diffusion coefficient in liquid mixtures. The different techniques used for the determination of the molecular diffusion coefficient can be found elsewhere.^{2,6–9}

Some of these techniques, such as the OEC, have already been satisfactorily used in several studies earlier.^{4,10} With the aim of correcting some of the limitations of this technique, the sliding symmetric tubes (SST) technique has been developed. This new technique takes out perturbations that appeared in the OEC technique, especially in aspects such as evaporations or manipulation of the apparatus, reducing, at the same time, the liquid quantity needed to carry out a measurement. In this work a complete description of the SST technique will be done, including the improvements obtained compared with the OEC

technique, and the validation process used to validate this new technique.

On the other hand, nowadays, there exist several models developed for the estimation of the molecular diffusion coefficient.^{11,12} In order to check the validity of these models, it is necessary to compare the theoretical values obtained with the experimental ones. On some occasions, the procedure that checks these models requires a huge number of experimental values, which, at the same time, requires a great experimental effort. In this work, a new correlation, which is capable of predicting the molecular diffusion coefficient in normal alkane binary mixtures, is presented. The use of this correlation may help in the development of new theories or could be useful in verifying the existing ones.

This article is organized as follows: In section II, the SST technique is presented, and a complete description of the experimental installation and its analytical resolution is done. In this section, the process used to validate the technique is also included. In section III, the results obtained in the measurement of the molecular diffusion coefficient in several normal alkane mixtures are presented, to continue with the discussion and the development of new correlations for the prediction of the molecular diffusion coefficient (D_{12}) in normal alkane mixtures. In section IV, the conclusions obtained are based on the study carried out in this work.

II. SST TECHNIQUE

A. SST Technique Description. The SST technique consists of several sets of two identical vertical tubes. Each set has two positions: "faced tubes" (Figure 1a), in which the

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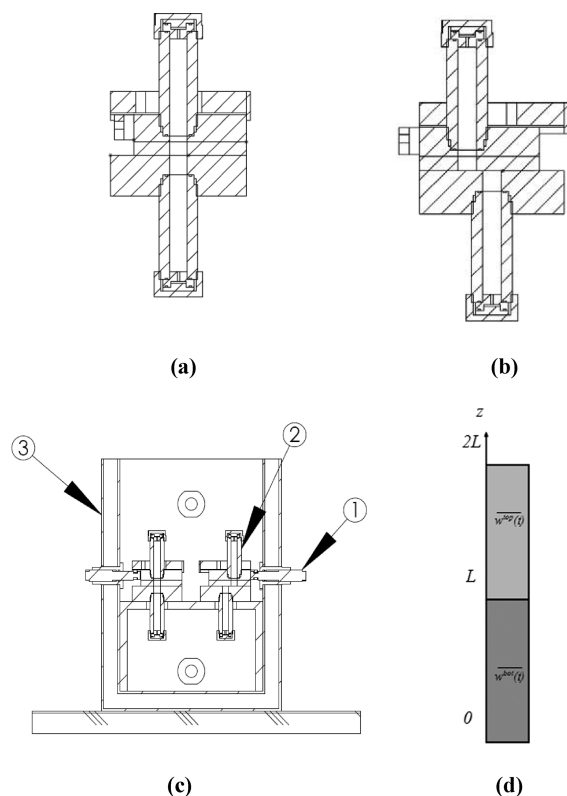


Figure 1. (a) Scheme of the sets of the SST technique on “faced tubes” configuration. (b) Scheme of the sets of the SST technique on “separated tubes” configuration. (c) Scheme of the SST sets (2) inside the water bath (3) in both their configurations: “faced tubes” position (left) and “separated tubes” position (right) and the screws (1) used to make the tubes slide. (d) Scheme of SST technique. $\overline{w^{top}(t)}$ and $\overline{w^{bot}(t)}$ are the mass fractions of component i in the top and bottom recipient, respectively.

78 mass transfer between both tubes is permitted, and “separated
79 tubes” (Figure 1b). In this position, the content of the tubes is
80 isolated. At the beginning of an experiment, the studied mixture
81 with a slight difference of mass fraction of its components is
82 introduced in each of the tubes. The mixture with a higher mass
83 fraction of the denser component is introduced in the bottom
84 tube, and the upper tube is filled with the mixture with a less
85 concentration of the denser component so that the convective
86 instability is avoided.

87 The SST technique introduces some improvements
88 compared with the OEC technique on which it is based. For
89 example, since the mixture is contained inside closed tubes,
90 evaporations are eliminated, which gives the advantage of using
91 this technique with volatile mixtures without reducing its
92 efficiency. Another fact that has been improved has been the
93 mixture quantity needed to carry out an essay. The OEC
94 technique requires a huge quantity of mixture (400 cm³
95 approximately). This quantity is highly reduced in the SST
96 technique, as it only needs around 100 cm³ of mixture in each
97 experiment. One more improvement has been done related to
98 the setup handling. In the OEC technique, whenever it is
99 needed to analyze the experiment evolution, it is necessary to
100 manipulate the setup. This fact affects the results of the
101 experiment, which are highly influenced by the experimenter’s
102 expertise. However, in the SST technique, thanks to its design,
103 all of these influences have been eliminated.

B. Analytical Solution. Assuming Fick’s second law in one
dimension (z : vertical direction), the following can be written:

$$\frac{\partial w}{\partial t} = D_{12} \frac{\partial^2 w}{\partial z^2} \quad (1)$$

where D_{12} is the molecular diffusion coefficient, which is
considered constant for small mass fraction (w) changes. The
formulation can be implemented as can be seen in Figure 1d
considering the following boundary conditions:

$$w(z, 0) = \begin{cases} w^{\text{bot}} & 0 \leq z < L \\ w^{\text{top}} & L < z \leq 2L \end{cases} \quad (2)$$

$$\frac{\partial w(z, t)}{\partial t} = 0 \text{ at } z = 0, 2L \text{ and } t > 0 \quad (3)$$

where w^{bot} and w^{top} are the mass fractions of the bottom and
upper tube, respectively, and L is the tube length. Solving
eqs 1–3, we have

$$w(z, t) = \frac{w^{\text{top}} + w^{\text{bot}}}{2} - \frac{2(w^{\text{top}} - w^{\text{bot}})}{\pi} \sum_{n=0}^{\infty} \frac{(-1)^n e^{\phi} \cos\left(\frac{2n+1}{2}\pi\frac{z}{L}\right)}{2n+1} \quad (4)$$

where $\phi = -((2n+1)/2)^2(\pi/L)^2 D_{12} t$. Therefore, at the
middle point between both the tubes, we have

$$w(L, t) = \frac{w^{\text{top}} + w^{\text{bot}}}{2} \quad (5)$$

The change of mass fraction in each tube in function of time
can be obtained using the following equations:

$$\begin{aligned} \overline{w^{\text{top}}(t)} &= \frac{1}{L} \int_L^{2L} w(z, t) dz \\ &= \frac{w^{\text{top}} + w^{\text{bot}}}{2} + \frac{4(w^{\text{top}} - w^{\text{bot}})}{\pi^2} \sum_{n=0}^{\infty} \frac{e^{\phi}}{(2n+1)^2} \end{aligned} \quad (6)$$

$$\begin{aligned} \overline{w^{\text{bot}}(t)} &= \frac{1}{L} \int_0^L w(z, t) dz \\ &= \frac{w^{\text{top}} + w^{\text{bot}}}{2} - \frac{4(w^{\text{top}} - w^{\text{bot}})}{\pi^2} \sum_{n=0}^{\infty} \frac{e^{\phi}}{(2n+1)^2} \end{aligned} \quad (7)$$

where $\overline{w^{\text{top}}}$ and $\overline{w^{\text{bot}}}$ are the mean mass fractions in the upper
and bottom tube, respectively. The solution of the inverse
problem posed by eqs 6 and 7 to obtain the molecular diffusion
coefficient (D_{12}) is solved by the least-squares method using
Matlab software. Solving expressions 6 and 7 when $n = 0$, an
initial guess of the molecular diffusion coefficient D_{12} is
obtained. This initial value is then used for obtaining the D_{12}
coefficient iterating the eqs 10 times and using terms on the
summation up to $n = 1000$. The more experimental points
used, the more accurate the estimated value of the molecular

diffusion coefficient. Typically up to 11 points are used in each experiment. This tactic allows the use of experimental points from the very beginning of the experiment, which does not happen in other similar techniques that require some initial experimental time before beginning the analysis of experimental data.^{3,8}

C. Equipment and Procedure. We have used the SST equipment designed and constructed in Mondragon Goi Eskola Politeknikoa and described elsewhere.^{13–15} The two tubes with which each set of the device is provided have the same dimensions (length of 60 ± 0.01 mm and diameter of 9 ± 0.01 mm). The experimental procedure starts with the preparation of two mixtures of 50 cm³ with a mass fraction difference (± 4 –6 wt %) so that the mean concentration of both mixtures corresponds with the one of the mixture to be studied. The tubes of several sets (typically 10) in their “separated tubes” position are filled with the mixtures, next introducing the sets in the water bath (Figure 1d) so that the mixture obtains the working temperature ($T = 298$ K). The temperature of the water in this bath is controlled by a thermostatic bath, which has a temperature control of 0.1 K. In order to make sure that the studied mixture is in the working temperature, the sets in their “separated tubes” configuration are introduced in the bath no less than 48 h before the beginning of the experiment.

Once the mixture has reached the working temperature, all the sets in the bath are changed to their “faced tubes” configuration, starting the diffusion process in this manner. With the aim of making this transition, the bath has some external screws (Figure 1c) that make sliding of the tubes possible in a controlled way.

In determined time intervals, the position of the sets is changed one by one using the screws back to the “separated tubes position.” The time intervals in which the set’s positions are changed are between 6, 12, or 24 h, depending on the speed at which sensitive concentration changes occur in the tubes. After stopping the mass transfer process between the tubes, the sets are extracted from the bath, and the concentration in each of them is analyzed. This allows obtaining the concentration change in the tubes in function of time.

The SST technique was validated^{13,14} using five binary mixtures: the three binary mixtures composed of pairwise combinations of tetrahydronaphtalene, normal dodecane, and isobutylbenzene at 298 K and 50 wt % of each component used in a benchmark test¹⁶ to compare various experimental techniques and the binary mixtures: water–ethanol at 298 K and 60.88 wt % water and toluene–n hexane at 298 K and 51.67 wt % toluene, which have been widely studied in the literature.^{17–20} The experimental test was repeated at least twice. The reproducibility of the experimental results of the SST technique is within 3% of deviation. In general, the differences with published data are, on an average, below 3%.

The determination of the mass fraction of a mixture is essential to determine molecular diffusion coefficients. In binary mixtures, the mass fraction is related to one physical property of the mixture (the density in this experimental study). An Anton Paar DMA 5000 vibrating quartz U-tube densimeter having an accuracy of $\pm 5 \times 10^{-6}$ g/cm³ is used to determine the density of the mixture. Since we are working with small mass fraction differences, it can be supposed that

$$\rho = aw_i \quad (8)$$

where ρ is the density of the mixture, w_i is the mass fraction of component i in the binary mixture, and a is a constant

Table 1. Values of Viscosity (μ) and Molecular Diffusion Coefficient (D_{12}) for the nC_6 - nC_6 , nC_{10} - nC_6 , and nC_{12} - nC_6 Series at 50 wt % and 298 K^a

system	μ mPa s	D_{12} 10^{-9} m ² s ⁻¹	$(\overline{D_{12}})_{cc}$ 10^{-9} m ² s ⁻¹	δ (%)
set 1: nC_7 - nC_6				
nC_{10} - nC_6	0.4704	2.53	2.51	0.8
nC_{11} - nC_6	0.5312	2.27	2.22	2.1
nC_{12} - nC_6	0.5581	2.09	2.11	-1.2
nC_{13} - nC_6	0.6103	1.96	1.93	1.4
nC_{14} - nC_6	0.6556	1.76	1.80	-2.3
nC_{15} - nC_6	0.6938	1.62	1.68	-3.7
nC_{16} - nC_6	0.7446	1.54	1.58	-2.6
nC_{17} - nC_6	0.7737	1.46	1.52	-4.1
nC_{18} - nC_6	0.8265	1.39	1.43	-2.9
set 1: nC_7 - nC_{10}				
nC_5 - nC_{10}	0.3993	3.03	2.96	2.3
nC_6 - nC_{10}	0.4704	2.54	2.51	1.2
nC_7 - nC_{10}	0.5633	2.09	2.09	-0.0
nC_{14} - nC_{10}	1.2929	0.913	0.915	-0.2
nC_{15} - nC_{10}	1.3972	0.819	0.845	-3.1
nC_{16} - nC_{10}	1.5150	0.756	0.779	-3.0
nC_{17} - nC_{10}	1.6337	0.702	0.722	-2.8
nC_{18} - nC_{10}	1.7780	0.656	0.664	-1.2
set 1: nC_7 - nC_{12}				
nC_5 - nC_{12}	0.4551	2.57	2.59	-0.9
nC_6 - nC_{12}	0.5581	2.09	2.11	-1.2
nC_7 - nC_{12}	0.6823	1.70	1.73	-1.7
nC_8 - nC_{12}	0.8071	1.49	1.46	1.9
nC_9 - nC_{12}	0.9452	1.24	1.25	-0.8
nC_{16} - nC_{12}	2.0335	0.589	0.580	1.5
nC_{17} - nC_{12}	2.2323	0.547	0.529	3.2
nC_{18} - nC_{12}	2.3945	0.503	0.493	2.0

^a $(\overline{D_{12}})_{cc}$ is the diffusion coefficient calculated from eq 9, and δ is the relative deviation between D_{12} and D_{cc} .

Table 2. Diffusion Coefficient (D_{12}) in the nC_{12} - nC_6 , nC_{12} - nC_7 , and nC_{12} - nC_8 Systems for Different Mass Fractions of nC_{12} (w_1) at 298 K^a

mixture	w_1	D_{12} 10^{-9} m ² s ⁻¹	$(D_{12})_{cc}$ 10^{-9} m ² s ⁻¹	δ (%)
nC_{12} - nC_6	0.18	2.48	2.55	-3.0
	0.46	2.24	2.17	3.1
	0.50	2.13	2.11	0.7
	0.66	1.93	1.88	2.2
	0.82	1.72	1.67	2.9
nC_{12} - nC_7	0.95	1.51	1.49	1.0
	0.16	2.09	2.04	2.6
	0.42	1.84	1.80	2.2
	0.50	1.70	1.73	-1.7
	0.63	1.64	1.61	1.6
nC_{12} - nC_8	0.80	1.48	1.46	1.2
	0.94	1.37	1.33	2.9
	0.10	1.70	1.69	0.6
	0.40	1.56	1.52	2.5
	0.50	1.49	1.46	2.0
	0.80	1.25	1.28	-2.4

^a $(D_{12})_{cc}$ is the diffusion coefficient calculated from eq 19, and δ is the relative deviation between calculated and measured diffusion coefficient.

parameter. To determine the constant parameter, a , five mixtures of known concentration are prepared by weighing and then, the density of each mixture is measured. Thus, we

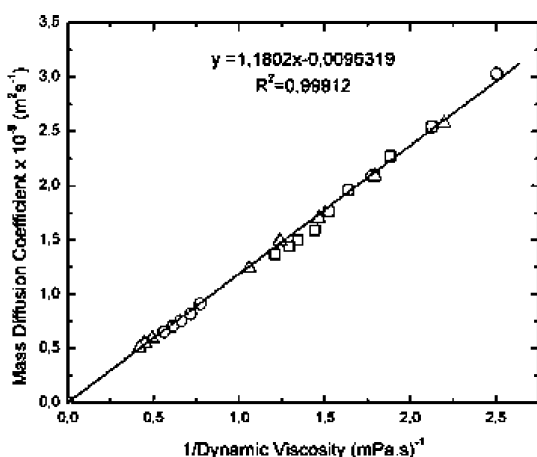


Figure 2. Diffusion coefficient as a function of the inverse of the dynamic viscosity for the systems nC_6-nC_i (\square), $nC_{10}-nC_i$ (\circ), and $nC_{12}-nC_i$ (Δ), at 50 wt % and 298 K.

191 determined the mass fraction with a deviation around wt % \pm
192 0.01.

193 The dynamic viscosity (μ) of the studied mixtures has been
194 measured with an Anton Paar AMVn falling ball Micro-
195 viscosimeter with reproducibility better than 0.1%. All the
196 measurements were done at 298 K.

III. RESULTS AND DISCUSSION

197 **A. Studied Mixtures.** All of the products used in this study
198 were purchased from Merck with a purity better than 99%. The
199 studied mixtures have been prepared by weight using a Gram
200 VXI-310 digital scale with a precision of 0.001 g. and intro-
201 ducing first the less volatile component and then the corres-
202 ponding amount of the second component; the mixture is
203 finally shaken to ensure homogeneity. After the preparation, the
204 density of the mixture was measured to confirm that the
205 composition deduced from the calibration curve coincides with
206 the prepared one. This was always the case.

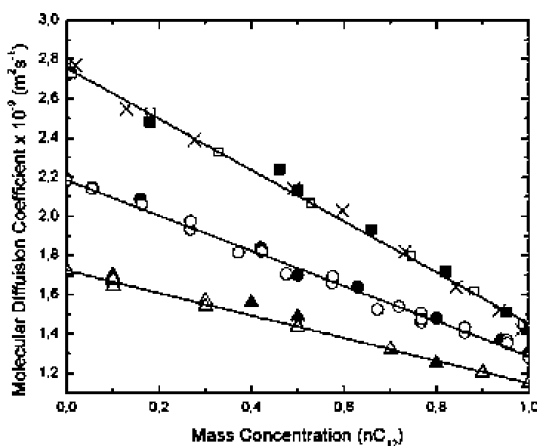


Figure 3. Diffusion coefficient as a function of the mass fraction of the denser component (nC_{12}) for the mixtures, $nC_{12}-nC_6$, $nC_{12}-nC_7$, and $nC_{12}-nC_8$ at 298 K. \blacksquare , $nC_{12}-nC_6$ this work; \square , $nC_{12}-nC_6$ ref 22; \times , $nC_{12}-nC_6$ ref 24; \bullet , $nC_{12}-nC_7$ this work; \circ , $nC_{12}-nC_7$ ref 23; \blacktriangle , $nC_{12}-nC_8$ this work; Δ , $nC_{12}-nC_8$ ref 21. The continuous lines represent a linear fit to the data.

In this study, 25 mixtures at 50 wt % have been prepared 207
corresponding to the n -alkane series 208

$$nC_6 - nC_i \text{ } i = 10, 11, 12, 13, 14, 15, 16, 17, 18$$

$$nC_{10} - nC_i \text{ } i = 5, 6, 7, 14, 15, 16, 17, 18$$

Table 3. Values of the Limiting Diffusion Coefficient (D_1^0 and D_2^0) Taken from Refs 3 and 23^a

system	D_1^0	D_2^0	D_1^0/D_2^0	M_1/M_2	$\delta(\%)$
$nC_{16}-nC_6$	2.21	0.85	2.60	2.62	0.7
$nC_{12}-nC_6$	2.74	1.42	1.93	1.97	2.5
$nC_{12}-nC_7$	2.19	1.30	1.69	1.70	0.6
$nC_{12}-nC_8$	1.71	1.15	1.49	1.49	0.0
$nC_{16}-nC_{12}$	0.67	0.49	1.36	1.33	-2.2
nC_7-nC_8	2.80 ^b	2.43 ^b	1.15	1.14	-1.7

^a M_1 and M_2 are the molecular masses of the components, and δ is the relative deviation between the ratios D_1^0/D_2^0 and M_1/M_2 . ^bInterpolated from ref 3.

$$nC_{12} - nC_i \text{ } i = 5, 6, 7, 8, 9, 16, 17, 18$$

The measured values at 298 K for dynamic viscosity (μ) and 209
mass diffusion coefficients for these mixtures are summarized in 210
Table 1. 211

In addition, this study has been completed measuring the 212
molecular diffusion coefficient of the systems $nC_{12}-nC_6$, $nC_{12}-$ 213
 nC_7 , and $nC_{12}-nC_8$ at 298 K at different concentrations. For 214
this end, the following mixtures were prepared: 215

$$nC_{12} - nC_6 \text{ } w_1 = 0.18, 0.46, 0.50, 0.66, 0.82, 0.95.$$

$$nC_{12} - nC_7 \text{ } w_1 = 0.16, 0.42, 0.50, 0.63, 0.80, 0.94.$$

$$nC_{12} - nC_8 \text{ } w_1 = 0.10, 0.40, 0.50, 0.80.$$

where w_1 is the mass fraction of dodecane. 216

In Table 2, the measured values of the diffusion coefficients 217
of these systems at the concentrations considered are shown. 218

These systems were chosen, as hydrocarbon mixtures are 219
quite regular in their properties. It was hoped that at least some 220
general and useful empirical relationship would be found. 221

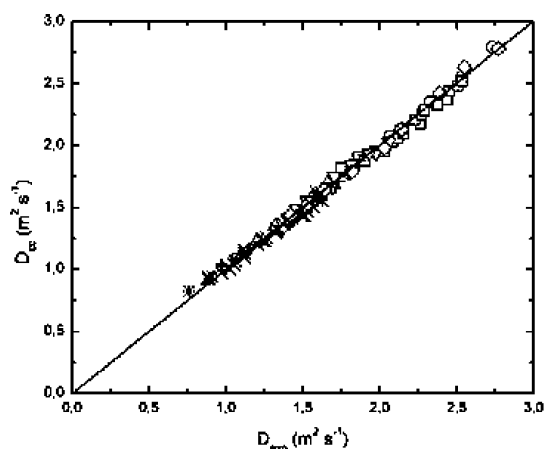


Figure 4. Experimental diffusion coefficient versus calculated from eq 19 diffusion coefficient. \times , $nC_{10}-nC_7$ ref 23; \circ , $nC_{12}-nC_6$ ref 22; \diamond , $nC_{12}-nC_6$ ref 24; ∇ , $nC_{12}-nC_7$ ref 23; Δ , $nC_{12}-nC_8$ ref 21; $+$, $nC_{14}-nC_7$ ref 23; \times , $nC_{14}-nC_8$ ref 23; $*$, $nC_{16}-nC_7$ ref 22.

222 **B. Correlation between Diffusion and Viscosity.** In
223 what follows, we shall analyze the relation between the diffusion
224 coefficient and the dynamic viscosity for mixtures at a mass
225 fraction equal to 50 wt % (equimass mixtures).

226 In Figure 2, the values of D_{12} as a function of the inverse of
227 dynamic viscosity for the equimass mixtures in Table 1 are
228 represented. As can be seen, the data fit well to a straight line,
229 which passes through the origin and, thus, the following linear
230 relation can be written:

$$\overline{D}_{12} = k \frac{1}{\bar{\mu}} \quad (9)$$

231 where \overline{D}_{12} and $\bar{\mu}$ are the diffusion coefficient and the dynamic
232 viscosity at $w_1 = 0.5$, respectively. The proportionality constant
233 k is $k = 1.18 \times 10^{-12}$ kg m/s².

234 In Table 1, the values of \overline{D}_{12} calculated using eq 9 for each
235 mixture are also shown and in the last column, the relative
236 deviations with the measured values are given. As can be seen,
237 these deviations are smaller than 3% in all the cases. Thus, we
238 can conclude that the product $\overline{D}_{12}\bar{\mu}$ for equimass mixtures is a
239 universal constant for *n*-alkane mixtures.

240 **D. Dependence of the Diffusion Coefficient with
241 Composition.** According to Darken equation for thermody-
242 namic ideal mixtures, the diffusion coefficient should be a linear
243 function of the molar fraction. However, as was suggested in an
244 earlier work by van Geet and Adamson,²¹ the diffusion coefficient
245 in *n*-alkane mixtures is linear with the mass fraction but not with
246 the mole fraction. To closely analyze the diffusion composition
247 dependence we have measured the diffusion coefficient as a
248 function of composition for the three systems: *n*C₁₂-*n*C₆, *n*C₁₂-
249 *n*C₇, and *n*C₁₂-*n*C₈. The results obtained appear in Table 2. In
250 Figure 3, these data as a function of the mass fraction of the
251 heavier component, w_1 , are plotted. As can be seen, the ordinary
252 diffusion coefficient is for each system a linear function of the
253 mass fraction and decreases with the concentration of the heavier
254 component. In this figure, the diffusion data in the literature for
255 the systems considered²¹⁻²⁴ are also shown. These data coincide
256 with our measurements within the experimental error.

257 Thus, the dependence of D_{12} with composition can be
258 written as follows:

$$D_{12} = w_2 D_1^0 + w_1 D_2^0 \quad (10)$$

259 where w_1 and w_2 are the mass fraction of heavier and lighter
260 components, respectively, and D_1^0 and D_2^0 are the limiting
261 diffusion coefficients defined by

$$D_1^0 = \lim_{w_1 \rightarrow 0} D_{12} \quad (11)$$

$$D_2^0 = \lim_{w_2 \rightarrow 0} D_{12} \quad (12)$$

262 In Table 3, the values of D_1^0 and D_2^0 for some selected mixtures
263 reported in the literature^{3,23} covering a large range of mass ratio for
264 liquid *n*-alkanes are given. As can be seen in this table, the ratio
265 D_1^0/D_2^0 is always close to the ratio of the molecular masses M_1/M_2
266 of the two alkanes involved. Thus, we have

$$\frac{D_1^0}{D_2^0} = \frac{M_1}{M_2} \quad (13)$$

Introducing eq 13 in eq 10, one obtains

$$D_{12} = D_1^0 \left(w_2 + \frac{M_2}{M_1} w_1 \right) \quad (14)$$

For $w_1 = w_2 = 0.5$, the corresponding diffusion coefficient \overline{D}_{12} will be

$$\overline{D}_{12} = \frac{D_1^0}{2} \left(\frac{M_1 + M_2}{M_1} \right) \quad (15)$$

and then, eq 14 in terms of \overline{D}_{12} can be written as

$$D_{12} = 2 \overline{D}_{12} \left(\frac{M_1 w_2 + M_2 w_1}{M_1 + M_2} \right) \quad (16)$$

In particular, the infinite dilution values D_1^0 and D_2^0 will be

$$D_1^0 = 2 \overline{D}_{12} \frac{M_1}{M_1 + M_2} \quad (17)$$

$$D_2^0 = 2 \overline{D}_{12} \frac{M_2}{M_1 + M_2} \quad (18)$$

Finally, using eq 9, the diffusion coefficient can be written as

$$D_{12} = \frac{2k}{\bar{\mu}} \left(\frac{M_1 w_2 + M_2 w_1}{M_1 + M_2} \right) \quad (19)$$

where $k = 1.18 \times 10^{-12}$ kg m/s².

Equation 16 allows determining D_{12} from \overline{D}_{12} measurements,
which, in turn, can be calculated using eq 9 from viscosity
measurements.

To confirm the validity of this correlation, we have
determined the values of D_{12} from eq 19 for the mixtures
given in Table 2. As shown in the last column of this table, the
relative deviations between these values and the experimental
ones are inferior to the experimental error.

As an additional test of eq 19, we have taken the
experimental D_{12} values as a function of concentration reported
in the literature²¹⁻²⁴ for different *n*-alkane systems. In Figure 4,
the values of D_{12} calculated using eq 19 are plotted against the
corresponding experimental ones. As seen here, all data lie on a
straight line through the origin with slope unity.

From what has been just mentioned, we can conclude that
the diffusion coefficient of *n*-alkane mixtures at any concentra-
tion can be calculated from the data of dynamic viscosity for
equimass mixtures.

IV. CONCLUSIONS

In this work, the diffusion coefficient of several *n*-alkane
mixtures at 50 wt % has been measured by using the SST
technique. From the results obtained, it is shown that the
product of the diffusion coefficient and the dynamic viscosity
for these mixtures is a universal constant independent of the
alkane involved.

In addition, the diffusion coefficient of the systems *n*C₁₂-*n*C₆,
*n*C₁₂-*n*C₇, and *n*C₁₂-*n*C₈ in the whole concentration range has
also been measured. We have obtained for each system a linear
correlation between the diffusion coefficient and the mass
fraction. This correlation allows determining the diffusion
coefficient at any concentration from the molecular weight of
the components of a mixture and the dynamic viscosity of the
mixture at 50 wt %.

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308 Notes

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