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I. Lizarraga, C. Giraudet, Fabrizio Croccolo, M.M. Bou-Ali, Henri Bataller. Mass Diffusion and Thermal Diffusivity of the Decane-pentane Mixture Under High Pressure as a Ground-based Study for SCCO Project. *Microgravity Science and Technology*, 2016, 28 (5), pp.545-552. 10.1007/s12217-016-9506-9 . hal-01815883

HAL Id: hal-01815883

<https://hal.science/hal-01815883>

Submitted on 6 Feb 2020

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1 **Mass diffusion and thermal diffusivity of the decane-pentane**
2 **mixture under high pressure as a ground-based study for SCCO**
3 **project**

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10
11 **Abstract**

12 Thermodiffusion experiments on iso-massic binary mixture of decane and pentane in the
13 liquid phase have been performed between 25°C and 50°C and for pressures from 1MPa until
14 20MPa. By dynamic analysis of the light scattered by concentration non-equilibrium
15 fluctuations in the binary mixture we obtained the mass diffusion coefficients of the mixture
16 at each temperature and pressure. For the first time we were able to apply similar analysis to
17 thermal fluctuations thus getting a simultaneous measurement of the thermal diffusivity
18 coefficient. While mass diffusion coefficients decrease linearly with the pressure, thermal
19 diffusivity coefficients increase linearly. In principle the proposed method can be used also
20 for measuring the Soret coefficients at the same time. However, for the present mixture the
21 intensity of the optical signal is limited by the optical contrast factor. This affects our
22 capability of providing a reliable estimate of the Soret coefficient by means of dynamic
23 Shadowgraph. Therefore the mass diffusion coefficients measurements would need to be
24 combined with independent measurements of the thermodiffusion coefficients, e.g.
25 thermogravitational column, to provide Soret coefficients. The obtained values constitute the

26 on-ground reference measurements for one of the mixture studied in the frame of the project
27 SCCO-SJ10, which aims to measure the Soret coefficients of multicomponents mixtures
28 under reservoir conditions. Microgravity experiments will be performed on the Chinese
29 satellite SJ10 launched in April 2016.

30

31 **Keywords:** mass diffusion, thermal diffusivity, decane-pentane mixture, non-equilibrium

32 fluctuations, high pressure, SCCO, SJ10

33 1. Introduction

34 The precise modelling of the distribution of chemical species in oil and gas reservoirs remains
35 a topical issue for the oil industry, especially now that the reserves of fossil fuels are getting
36 more difficult to extract. It is known that not only gravitational segregation, but also
37 thermodiffusion due to geothermal gradients, are two physical phenomena determining the
38 vertical distribution of species in hydrocarbon reservoirs on Earth (Lira-Galeana et al. 1994,
39 Høier et al. 2001, Ghorayeb et al. 2003, Montel et al. 2007). Thermodiffusion, or Soret effect,
40 is a phenomenon that couples heat and mass fluxes (de Groot and Mazur 1984) and can also
41 lead to convective unstable conditions in particular cases (Galliero et al. 2009). The
42 contribution of thermodiffusion is difficult to quantify, mainly due to a lack of experimental
43 data as well as accurate modeling for multicomponent mixtures. Although noticeable
44 progresses have been made during the last twenty years, (Assael et al., 2014 and references
45 therein) especially on ternary mixtures both theoretically (Firoozabadi et al., 2000; Kempers,
46 2001; Galliero et al., 2003) and experimentally (Leahy-Dios et al., 2005; Larrañaga et al.,
47 2015; Gebhardt et al., 2015), more work is necessary. Micro-gravity experiments, to avoid
48 gravity-induced convection, are one possible way to provide further data on thermodiffusion
49 in multicomponent mixtures (Georis et al., 1998; Van Vaerenbergh et al., 2009; Touzet et al.,
50 2011; Bou-Ali et al., 2015). The Soret Coefficients in Crude Oil (SCCO) project aims at
51 producing values of Soret coefficients of mixture of petroleum interest and in reservoirs
52 conditions. In a first phase carried out in 2007 microgravity experiments were performed on
53 board the Russian satellite FOTON-M3. One binary, two ternaries and one quaternary
54 mixtures were studied (Van Vaerenbergh et al., 2009; Srinivasan et al., 2009; Touzet et al.,
55 2011). The measurements were compared with molecular dynamics simulations and with
56 theoretical calculations based on the Thermodynamics of Irreversible Processes. However, the
57 conclusions were incomplete because of difficulties encountered during post flight analysis at

58 the laboratories (Touzet et al., 2011). Now, on the occasion of the China Sea well
59 explorations, a second phase of the SCCO space experiment has been scheduled. The
60 thermodiffusion behaviour of the binary mixture decane-pentane, the ternary mixture decane-
61 heptane-pentane and the quaternary mixture decane-heptane-pentane-methane, at two
62 pressures and at 50°C, will be studied on-board the Shijian-10 (SJ-10) Chinese satellite during
63 2016 (Galliero et al., 2015). To assure the success of this new mission, both validating ground
64 measurements and numerical simulations have been planned. In this paper we present results
65 on the iso-massic binary mixture decane-pentane based on the measurement of non-
66 equilibrium (NE) fluctuations.

67 In general, from the analysis of the dynamics of concentration NE fluctuations by light-
68 scattering it is possible to measure the fluid transport properties coefficients, including the
69 mass diffusion and Soret coefficients, as demonstrated for binary mixtures (Croccolo et al.,
70 2012, 2014). The technique has been adapted to high pressure (Giraudet et al., 2014). In this
71 work we extend the technique to the analysis of thermal fluctuations thus including the
72 possibility of measuring the thermal diffusivity coefficient of the mixture. Conversely, due to
73 the limited amplitude of the optical signal obtained for this system, we were not able here to
74 measure the Soret coefficient.

75 The remainder of the paper is organized as follows: Section 2 reports the methodology, in
76 Section 3 we provide results and discussion, and in Section 4 conclusions are drawn.

77

78 **2. Methodology**

79

80 *Theoretical background*

81 In a homogeneous multicomponent mixture a temperature gradient induces heat transfer as
82 well as segregation of the components along the temperature gradient by means of the Soret

83 effect (de Groot and Mazur, 1984). The segregation induces then Fickian diffusion and the
 84 combination of the two phenomena results in a steady concentration gradient which is
 85 convection-free only in microgravity conditions or in particular cases on ground. A
 86 thermodiffusion experiment on ground is typically performed by applying a stabilizing
 87 thermal gradient to a multicomponent fluid mixture, thus obtaining a superposition of the
 88 mentioned phenomena. Even if there is no total mass flux in the steady state, thermal and
 89 concentration NE fluctuations are always present. NE fluctuations are strictly related to the
 90 transport properties of the fluid. That is why from NE fluctuations analysis one can determine
 91 in principle all transport coefficients, like viscosity, thermal diffusivity and solutal diffusion
 92 and thermodiffusion coefficients. A detailed description of the theory of NE fluctuations can
 93 be found in the book by Ortiz de Zárate and Sengers (Ortiz de Zárate and Sengers, 2006).
 94 Here we briefly recall the essential equations that will be used in the following.

95 In a binary mixture, the temporal correlation function of NE concentration fluctuations
 96 induced by the Soret effect is expected to be a single exponential decay for all wave vectors,
 97 with time constants $\tau_S(q)$ varying as a function of the wave vector q . For wave vectors much
 98 larger than a characteristic value q_s^* , the decay time is the solutal diffusive one:

99

$$100 \quad \tau_S(q) = 1/(Dq^2), \quad (\text{Eq. 1})$$

101

102 where D is the mass diffusion coefficient. NE thermal fluctuations are faster and overlap to
 103 the solutal ones. For wave vectors larger than a thermal characteristic wave vector q_T^* , the
 104 decay time is the thermal diffusive one:

105

$$106 \quad \tau_T(q) = 1/(\kappa q^2), \quad (\text{Eq. 2})$$

107

108 where κ is the thermal diffusivity coefficient.

109

110 *Experimental set-up*

111 Our thermodiffusion cell (Fig.1 of Giraudet et al., 2014) is specifically designed for applying
112 a vertical temperature gradient with excellent thermal homogeneity and stability to a
113 horizontal slab of a multicomponent fluid under high pressure while providing vertical optical
114 access to a central area of the cell. The cell core consists of a stainless steel annulus of
115 internal/external diameter 30/75mm with high pressure inlet and outlet at its opposite sides.
116 This part accommodates Teflon®-coated Viton® O-rings for sealing, and square sapphire
117 plates kept at a distance $L = 5\text{mm}$ by the annulus itself, thus defining the sample thickness. In
118 order to minimize the contact between the liquid sample and the conductive metal a Teflon
119 annulus (internal/external diameter 19.8/30mm) with two thin holes (diameter 1mm) for
120 inlet/outlet of the fluid has been inserted in the inner part of the stainless annulus zone.

121 The external sides of the sapphire windows are in thermal contact with two aluminium plates
122 with a central circular aperture ($d=13\text{mm}$), where two thermistors (Wavelength Electronics,
123 TCS651) are installed to monitor the sapphire temperatures. External to the aluminium plates,
124 two Peltier elements (Kryotherm, TB-109-1.4-1.5 CH) with central circular aperture
125 ($d=13\text{mm}$) provide/remove the heat necessary to maintain the set-point temperature as driven
126 by two temperature controllers (Wavelength Electronics, LFI-3751) maintaining the
127 temperature of the internal side of each Peltier device with a stability better than 1mK RMS
128 over 1 day. Finally, external to the Peltier elements, two aluminium plates are flushed with
129 water coming from a thermostatic bath (Huber, ministat 125) to remove the excess heat of the
130 Peltiers.

131 Experiments have been performed with the iso-massic binary mixture of decane (Sigma-
132 Aldrich, $\geq 99\%$) and pentane (Sigma-Aldrich, $\geq 99\%$). Components were used without further

133 purification. The mixture is prepared in a bottle by weighting on a balance (Sartorius,
134 TE313S, resolution 10^{-2} g/200g) first the decane and then the pentane. The bottle is carefully
135 closed by cover with Teflon sealing. Error in mass fraction is estimated less than ± 0.0001 .

136 The filling system consists of: a rotary vacuum pump able to evacuate most of the air from the
137 cell before filling operations down to a residual pressure of about 10Pa; a fluid vessel at
138 atmospheric pressure; a manual volumetric pump and a number of valves to facilitate the
139 procedure. Briefly, after a low vacuum is made inside the cell, the mixture to be studied is
140 transferred to the cell by acting on the volumetric pump. Visual check allows avoiding
141 bubbles during the injection procedure. After that, the cell is abundantly fluxed with the fluid
142 mixture. At the end of the procedure a valve is closed and the volumetric pump is operated to
143 modify the liquid pressure within the cell. A manometer (Keller, PAA-33X, pressure range:
144 $0.1 \div 100$ MPa, precision ± 0.04 MPa) is connected between the volumetric pump and the cell to
145 measure the pressure of the fluid mixture. A second identical manometer is connected to the
146 outlet of the cell. The manometer signals are transferred using an acquisition card (National
147 Instruments, NI 9215) interfaced to a computer.

148 We perform our experiments by imposing a difference of temperature ΔT on the horizontally
149 positioned thin cell, previously filled with the homogenous fluid mixture.

150 In order to investigate NE fluctuations, it is common to use a scattering in the near field
151 technique as the Shadowgraph (Wu et al. 1995), for which the physical optics treatment was
152 given by Trainoff and Cannell (2002) and Croccolo and Brogioli (2011). The shadowgraph
153 optical setup involves a low coherence light source (Super Lumen, SLD-MS-261-MP2-SM, λ
154 $= 675 \pm 13$ nm) that illuminates the bottom of the cell through a single-mode fiber. The
155 diverging beam exiting from the fiber end is collimated by an achromatic doublet lens ($f =$
156 150 mm, $\phi = 50.8$ mm) and then passes through a linear film polarizer. In combination with a
157 second linear polarizer after the cell the latter allows us to adapt the average light intensity.

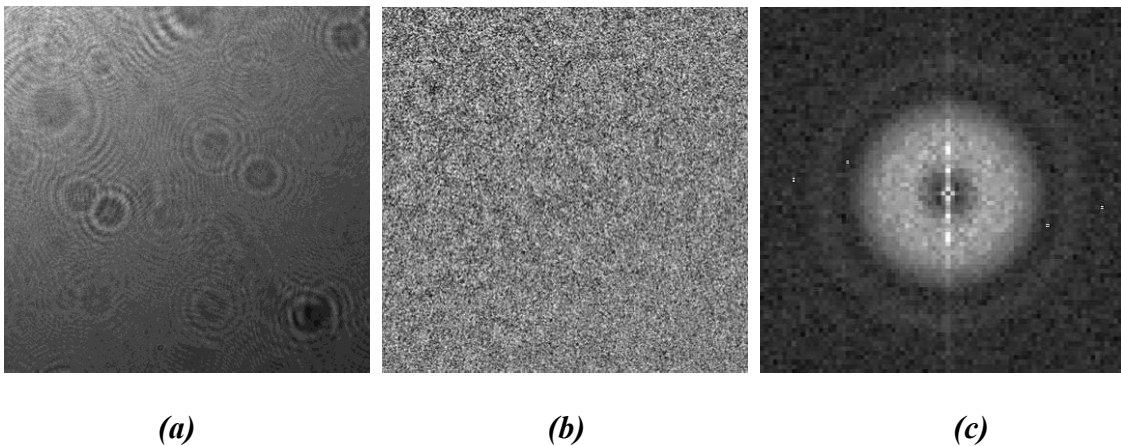
158 The detection plane is located at about $z = 95\text{mm}$ from the sample plane. As a sensor, we use
159 a charge coupled device (AVT, PIKE-F421B) with 2048×2048 square pixels each of size 7.4
160 $\times 7.4\mu\text{m}^2$ and a dynamic range of 14-bit. Images were cropped within a $768 \times 768\text{pix}^2$ in order
161 to reach the maximum acquisition frame rate of the camera of about 30Hz.

162

163 *Dynamic near-field imaging*

164 Images acquired by means of a near-field scattering setup consist of an intensity map $I(\vec{x}, t)$
165 generated by the interference on the CCD plane between the portion of the incident beam that
166 has passed undisturbed through the sample and the beams scattered by refractive index
167 fluctuations occurring within the sample (Trainoff and Cannell, 2002; Croccolo and Brogioli,
168 2011). Statistical analysis involving fast Fourier transforms provides accurate measurements
169 of the intensity $I_s(\vec{q}, t)$ of light scattered at each wave vector \vec{q} grabbed by the optical setup
170 and for all the times t of the acquisition sequence. Different setups show different responses to
171 the acquired signal as a function of the wave number q , which is described by the so-called
172 transfer function $T(q)$.

173



176 **Figure 1:** Results of a near field scattering experiment (shadowgraph layout) on the iso-
177 massic binary of decane and pentane stressed by a thermal gradient ($T_{mean} = 50^\circ\text{C}$, $P = 20$

178 $MPa, \Delta T = 30^\circ C$). (a) $768 \times 768 \text{ pix}^2$ near field image of the sample, $I(\vec{x}, t)$ (b) image
 179 difference, $\Delta I(\vec{x}, \Delta t) = I(\vec{x}, t + \Delta t) - I(\vec{x}, t)$, having a correlation time of $\Delta t = 0.35 \text{ s}$ and (c)
 180 2D Fast Fourier Transform squared $|I(\vec{q}, t + \Delta t) - I(\vec{q}, t)|^2$ of (b).

181

182 Details of the quantitative dynamic analysis can be found elsewhere (Croccolo et al., 2006a;
 183 Croccolo et al., 2006b; Croccolo et al., 2007; Cerchiari et al., 2012). Here we just recall that
 184 the quantity directly obtained from the experiments is the so-called structure function
 185 $C_m(q, \Delta t) = \langle |\Delta I_m(q, \Delta t)|^2 \rangle$, that is obtained by averaging (over all available times t in each
 186 image dataset and over the wave vector \vec{q} azimuthal angle) the individual spatial Fourier
 187 transforms of the shadowgraph image differences, like the one shown in the example of Fig.
 188 1. This experimental structure function is theoretically related to the temporal correlation
 189 function of NE composition fluctuations, also called intermediate scattering function (*ISF*),
 190 by:

191

$$192 \quad C_m(q, \Delta t) = 2\{S(q)T(q)[1 - ISF(q, \Delta t)] + B(q)\}, \quad (\text{Eq.3})$$

193

194 with $ISF(q, 0) = 1$. In Eq.3, $S(q)$ is the static power spectrum of the sample, $T(q)$ is the optical
 195 transfer function and $B(q)$ the background noise of the measurement. It is implicitly assumed
 196 in Eq.3 that the linear response of the CCD detector and any other electronic or
 197 electromagnetic proportionality parameters are aggregated inside $T(q)$ and/or $B(q)$.

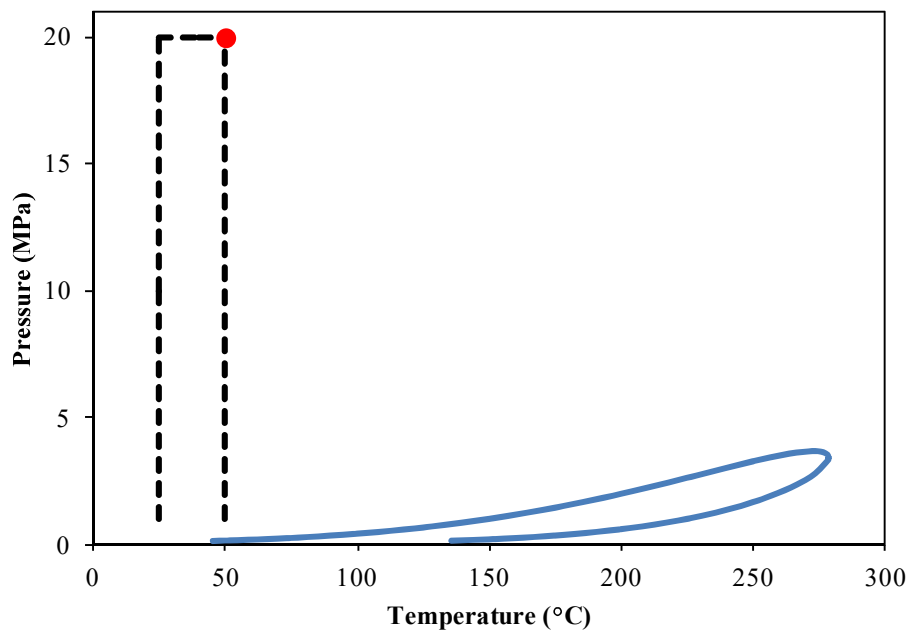
198

199 **3. Results and Discussion**

200

201 ***Thermodynamic conditions***

202 To determine the thermodynamic conditions of the study, we have calculated, with TOTAL
203 S.A. company BEST software, the biphasic envelop and critical coordinates of the iso-massic
204 binary mixture of decane and pentane. For a given pressure P and a given temperature T , the
205 software calculates the possible molar volumes v from the PPR78 equation of state (Peng and
206 Robinson, 1976). In Fig.2 we report the calculated biphasic envelop.
207



208
209 **Figure 2:** Phase diagram of the isomassic binary mixture decane-pentane: the continuous
210 line represents the biphasic envelop. The dashed lines represent the values of pressure and
211 temperature investigated for the reported thermodiffusion experiments. The red point
212 indicates the thermodynamic conditions of the thermodiffusion experiment shown in Fig. 1, 3
213 and 4 ($T_{mean} = 50^{\circ}\text{C}$, $P = 20 \text{ MPa}$).

214
215 In Fig.2 the dashed line represents the values of pressure and temperature investigated for
216 the present thermodiffusion experiments, the temperature of 50°C being imposed by the
217 microgravity experimental conditions of the SCCO project, and the temperature of 25°C
218 being selected as the experimental data references for mass diffusion coefficients only exist at

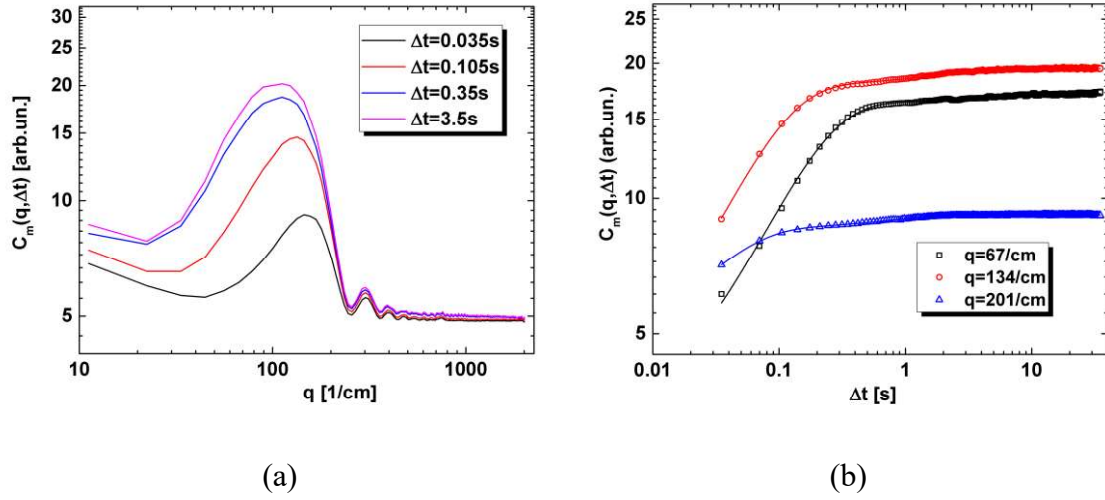
219 this temperature. Initially, a temperature difference of 20°C was applied to the system. To
220 increase the optical signal, which remains low as revealed by Fig.1b-c, we applied a
221 temperature difference of 30°C. In all the investigated conditions the mixture was in its liquid
222 state, even at low pressure and for temperature differences of $\Delta T = 20$ and 30°C. The red
223 point in Fig.2 indicates the thermodynamic conditions of the thermodiffusion experiment
224 shown in Fig.1, 3 and 4 ($T_{\text{mean}} = 50^\circ\text{C}$, $P = 20$ MPa).

225

226 ***Structure function***

227 At each investigated temperature T and pressure P , 10 different image acquisition runs have
228 been performed with a delay time $dt_{\text{min}} = 35\text{ms}$ between two consecutive images. Each set,
229 containing 2000 images, has then been processed on a dedicated PC by means of a custom-
230 made CUDA/C++ software (Cerchiari et al., 2012), in order to perform a fast parallel
231 processing of the images to obtain the structure functions $C_m(q, \Delta t)$, for all the wave numbers
232 and for all the correlation times accessible within the image datasets. In each experiment the
233 temperature gradient is applied via two distinct temperature controllers, so that a linear
234 temperature gradient sets up in some tens of seconds. The image acquisition is started about
235 five hours later, to be sure that the concentration gradient due to the Soret effect is fully
236 developed within the cell.

237 In Fig.3 we present the mean structure function $C_m(q, \Delta t)$ of the 10 runs a) as a function of the
238 wave number for different correlation times and b) as a function of the correlation time for
239 different wave numbers, for mean temperature $T_{\text{mean}} = 50^\circ\text{C}$, pressure $P = 20\text{MPa}$ and a
240 difference of temperature $\Delta T = 30^\circ\text{C}$. The oscillatory behavior shown in Fig.3a is due to the
241 optical transfer function $T(q)$ (see Eq.3). It is typical of shadowgraph experiments and it
242 corresponds to the ring pattern shown in Fig. 1c.



244

245

246 **Figure 3:** Experimental structure function $C_m(q, \Delta t)$ (a) as a function of the wave vector q for
 247 different correlation times Δt and (b) as a function of the correlation time Δt for different
 248 wave vectors q ($T_{\text{mean}} = 50^\circ\text{C}$, $P = 20\text{MPa}$, $\Delta T = 30^\circ\text{C}$).

249

250 Fig.3a shows that for wave numbers $q > 400\text{cm}^{-1}$, the signal is completely lost in the
 251 background noise. For intermediate wave numbers, Fig.3b shows that the time dependence of
 252 the structure function cannot be totally assumed mono-exponential, as it is visible for wave
 253 numbers $q = 134\text{cm}^{-1}$ and 201cm^{-1} . To account for the solutal relaxation mode plus the
 254 thermal relaxation mode, we therefore decided to perform a quantitative analysis of the
 255 experimental structure functions by modeling the *ISF* as a double exponential decay, namely:

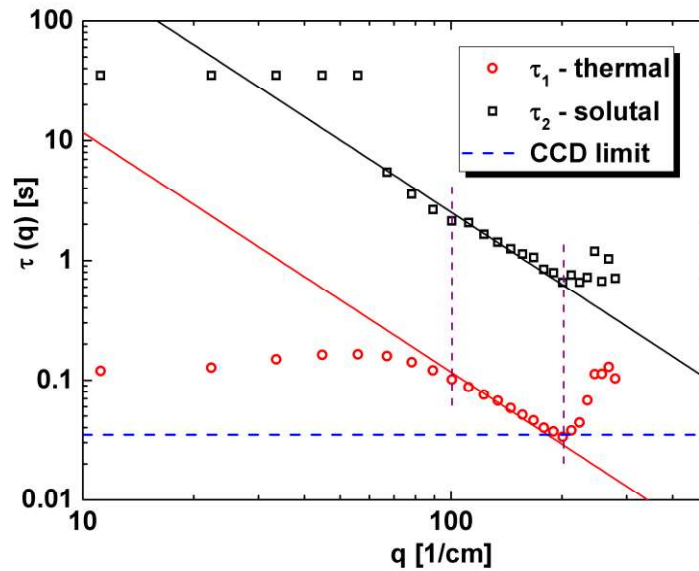
256

$$257 \quad ISF(q, \Delta t) = a \exp\left(-\frac{\Delta t}{\tau_1(q)}\right) + (1-a) \exp\left(-\frac{\Delta t}{\tau_2(q)}\right), \quad (\text{Eq. 4})$$

258

259 where τ_1 and τ_2 are two relaxation times. Hence, we performed fittings of the experimental
 260 $C_m(q, \Delta t)$ as a function of Δt (see Fig.3b) by substituting Eq.4 into Eq.3 and adopting as fitting

261 parameters: the product $S(q)T(q)$, the background $B(q)$, the relative amplitude a , and the two
 262 decay times, τ_1 and τ_2 . For the fitting procedure we used a Levenberg-Marquardt Non-Linear
 263 Least Square fitting algorithm.
 264



265
 266 **Figure 4:** Experimental decay times of NE fluctuations as obtained by fitting through Eqs.3
 267 and 4, as a function of the wave number q . \circ : fast mode, \square : slow mode ($T_{mean} = 50^\circ\text{C}$, $P =$
 268 20MPa , $\Delta T = 30^\circ\text{C}$). The black solid line represents the theoretical relaxation times $1/Dq^2$ of
 269 Eq.1 and the red solid line represents the theoretical relaxation times $1/\kappa q^2$ of Eq.2.

270
 271 In Fig.4 we show the two decay times obtained from modeling the *ISF* by Eq.4, as a function
 272 of the wave number. The horizontal dashed blue line corresponds to $dt_{\min} = 35\text{ms}$, which is
 273 the physical limit of our experimental recording equipment.

274 Intuitively, we assumed that the fastest mode was associated with a thermal mode and the
 275 slowest to a solutal mode.

276 In the range of wave numbers $100\text{ cm}^{-1} \leq q \leq 200\text{ cm}^{-1}$ (vertical dotted lines are plotted in Fig.4
 277 to guide the reader) the slowest mode was fitted with Eq.1 using D as free parameter and the

278 fastest was fitted with Eq.2 using κ as free parameter. The results of the adjustments are
 279 reported by continuous lines in Fig.4. For example, referring to the conditions of Fig.4 ($P =$
 280 20MPa , $T_{\text{mean}} = 50^\circ\text{C}$) the two values obtained by fitting are $D = (38\pm 4)\times 10^{-6}\text{cm}^2/\text{s}$ and $\kappa =$
 281 $(870\pm 40)\times 10^{-6}\text{cm}^2/\text{s}$. Uncertainties are the average of the deviations respect to the mean value
 282 of the 10 measurements.

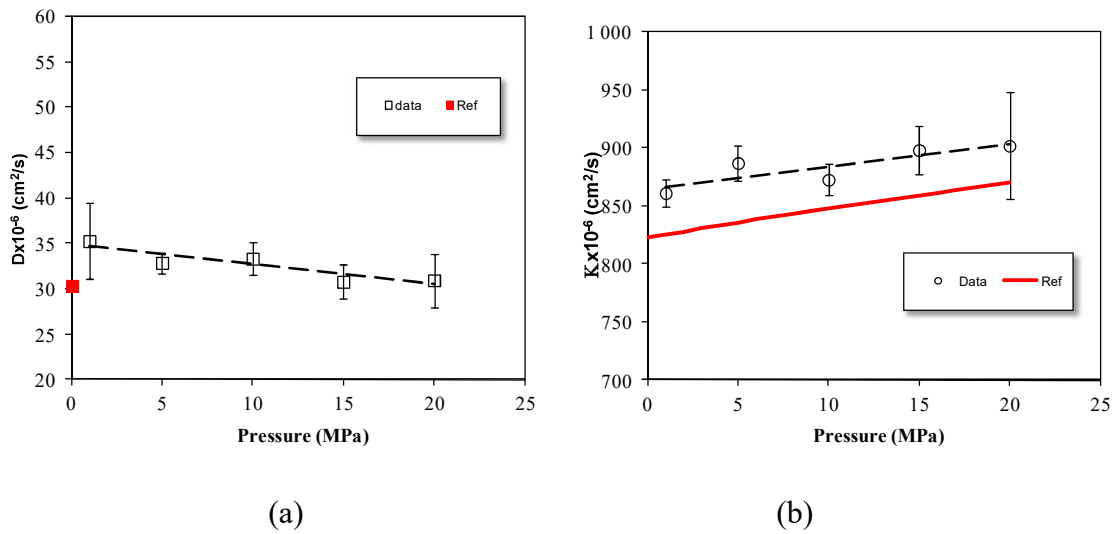
283

284 **Mass diffusion and thermal diffusivity coefficients**

285

286 In Fig.5 we report the values of mass diffusion and thermal diffusivity coefficients as a
 287 function of the pressure obtained for the iso-massic binary mixture of decane and pentane, at
 288 $T_{\text{mean}} = 25^\circ\text{C}$ and for a temperature difference $\Delta T = 20^\circ\text{C}$.

289



290

291

292 **Figure 5:** Mass diffusion D and thermal diffusivity κ coefficients as a function of the pressure
 293 at $T_{\text{mean}} = 25^\circ\text{C}$ and for a temperature difference of $\Delta T = 20^\circ\text{C}$.

294

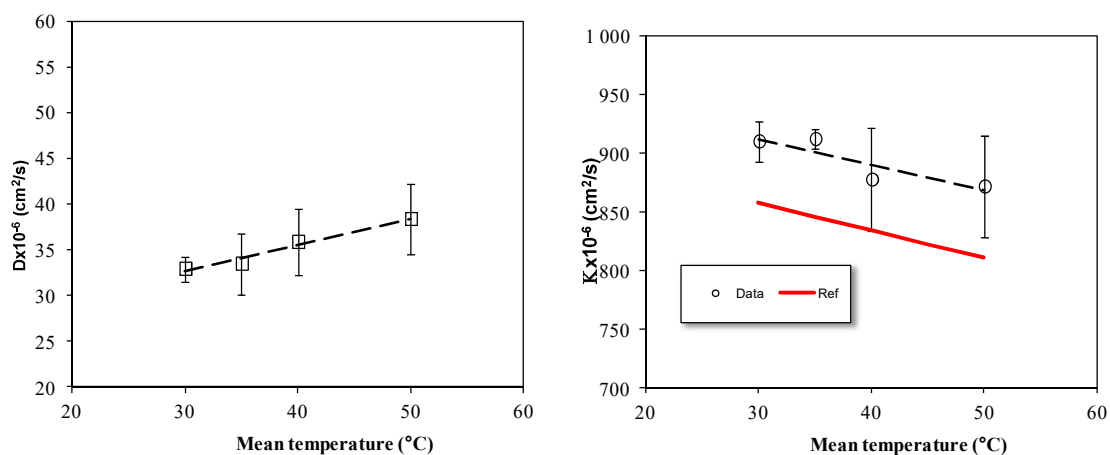
295 We found only one reference value of the mass diffusion coefficients at atmospheric pressure
 296 (Alonso De Mezquia et al., 2012) that we reported in Fig.5a as a red point. The thermal

297 diffusivity coefficients were compared with values found in NIST data base (NIST website)
 298 and reported by a red continuous line in Fig.5b. Our values slightly overestimate reference
 299 values. However, over the entire pressure range studied, the relative deviation of the thermal
 300 diffusivity coefficients values does not exceed 5%. These results validate our hypothesis for
 301 the interpretation of the modes of the measured intermediate scattering function, namely that
 302 the fastest mode is the thermal relaxation mode of NE fluctuations and the slowest a mass
 303 relaxation mode.

304 In Fig.5a we can notice a slight linear decrease in the mass diffusion coefficient with pressure
 305 that is consistent with an increase of the viscosity with pressure (mass diffusion coefficient
 306 being proportional to the inverse of the viscosity), as it has been shown in Alonso De Mezquia
 307 et al., 2012. Also in Fig.5b we can see a linear increase in the thermal diffusivity coefficients
 308 with pressure that is consistent with an increase of the density with pressure.

309 In Figure 6 we report the values of mass diffusion and thermal diffusivity coefficients as a
 310 function of the mean temperature obtained for the iso-massic binary mixture of decane and
 311 pentane, at $P = 20\text{MPa}$ and for a temperature difference $\Delta T = 30^\circ\text{C}$.

312



313

314

(a)

(b)

315 **Figure 6:** Mass diffusion D and thermal diffusivity κ coefficients as a function of the mean
 316 temperature at $P= 20\text{MPa}$ and for a temperature difference of $\Delta T = 30^\circ\text{C}$.

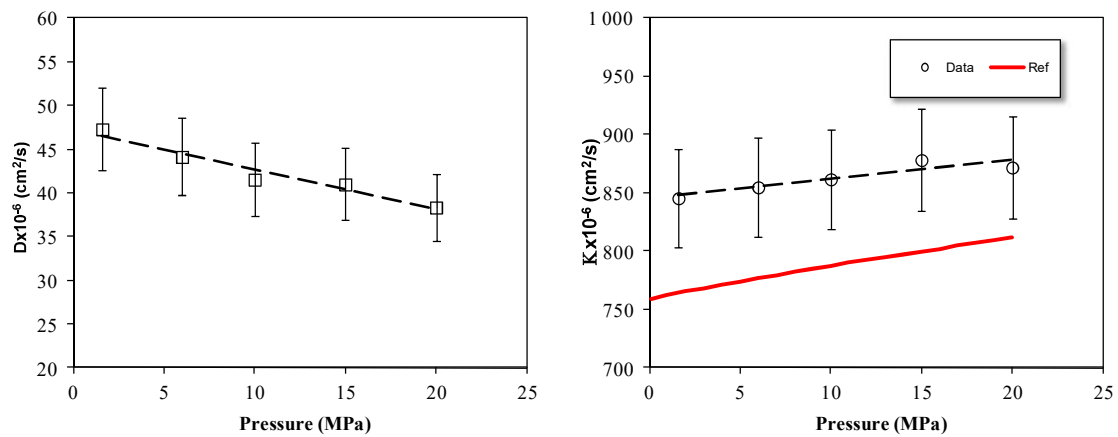
317

318 In Fig.6a we can see that the mass diffusion coefficient increases with the mean temperature,
 319 which is consistent with a decrease of the viscosity of the system with the mean temperature.

320 In Fig.6b we can see that the thermal diffusivity coefficient decreases with the mean
 321 temperature. Again an overestimate of the reference values is detected.

322 In Fig.7 we report the values of mass diffusion and thermal diffusivity coefficients as a
 323 function of the pressure obtained for the iso-massic binary mixture of decane and pentane, at
 324 $T_{\text{mean}} = 50^\circ\text{C}$ and for a temperature difference $\Delta T = 30^\circ\text{C}$. The same trends as for Fig.5 are
 325 observed.

326



327

328 **Figure 7:** Mass diffusion D and thermal diffusivity κ coefficients as a function of the pressure
 329 at $T_{\text{mean}} = 50^\circ\text{C}$ and for a temperature difference of $\Delta T = 30^\circ\text{C}$.

330

331 4. Conclusions

332

333 Thermodiffusion experiments on iso-massic binary mixture of decane and pentane, in the
334 liquid phase, have been performed between 25°C and 50°C and for pressures from 1MPa until
335 20MPa. By means of dynamic analysis of the light scattered by concentration NE fluctuations
336 of the binary mixture we obtained the values of the mass diffusion coefficient D at each
337 temperature and pressure. The shadowgraph set-up and its acquisition chain enabled us to
338 achieve a minimum delay time between two successive images of 35ms. We were thus able to
339 investigate for the first time temperature NE fluctuations, which let us model the ISF as the
340 sum of two decreasing exponentials. This procedure allowed obtaining simultaneously the
341 values of the thermal diffusivity coefficient κ . Mass diffusion coefficients D decrease with the
342 pressure while thermal diffusivity coefficients κ increase with the pressure. For the
343 investigated mixture, due to a limited intensity of the optical signal, it was not possible to
344 obtain a reliable measurement of the Soret coefficients S_T . Therefore the obtained values of
345 the mass diffusion coefficients D must be combined with thermodiffusion coefficients D_T
346 measurements obtained by an independent experiment, such as thermogravitational column.
347 The resulting values at 50°C can be directly compared to measurements made in microgravity
348 in the frame of the SCCO-SJ10 project.

349

350

351 **Acknowledgements**

352 This work has been supported by the European Space Agency through the SCCO project.
353 Support from the French space agency CNES is also acknowledged. We thank TOTAL S.A.
354 for allowing the use of the BEST software and Research Groups (No. IT1009-16) and
355 TERDISOMEZ (No. FIS2014-58950-C2-1-P) of MINECO.

356

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