September 2nd, 2011, Thessaloniki, Greece

Minutes of the 11th IATP Meeting

1. INTRODUCTION

The meeting was opened by the Chairman, Prof. Sir W.A. Wakeham, who welcomed all present and thanked Prof. Marc Assael, Dr Konstantinos Antoniadis, Ms Sofia Mylona and Ms Agni Kalyva for the excellent arrangements as the local organisers of the meeting. The Chairman and the Members congratulated Prof. J.V. Sengers on his 80th birthday.

The meeting was divided into the usual scientific session and business session. The proceedings are recorded here in that order.

2. SCIENTIFIC SESSION

2.1 High-pressure characterization of dynamic viscosity and derived properties for five ionic liquids
J. Fernandez, F.M. Gaciño, M.J.P. Comuñas, X. Paredes (Spain)

2.2 On the nature of ionic liquid solvent mixtures from thermophysical properties research.
M.H. Rausch, A. Leipertz, A.P. Fröba (Germany)

2.3 Unusual transport property behaviour of certain ionic liquids
K.R. Harris, M. Kanakubo (Australia)

2.4 Characteristics of $C_n$mimNTf_2/n-Alcohol systems and efforts for the determination of thermophysical properties therein
V. Vale, B. Rathke, S. Will, W. Schroer (Germany)

2.5 Effect of water on the thermal conductivity of ionic liquids – a surprising result?
C A. Nieto de Castro, J. França (Portugal)

2.6 New formulation for the thermal conductivity of H_2O
J.V. Sengers, M.L. Huber, R.A. Perkins, D.G. Friend (USA), M.J. Assael, I.N. Metaxa (Greece), E. Vogel (Germany), R. Mareš (Czech Republic), K. Miyagawa (Japan)

2.7 Density and viscosity of molten antimony, bismuth, lead, nickel and silver
M.J. Assael, A. Kalyva, K.D. Antoniadis (Greece), W.A. Wakeham (UK), I. Egry (Germany), J.T. Wu (R.P. China), E. Kaschnitz (Austria), M. Banish (USA)

2.8 Modelling the viscosity of simple fluids based on a new interpretation of Enskog theory
R. Umla, N. Riesco, V. Vesovic (UK)

2.9 Lorentz force sigmometry: new ideas and open questions
A. Thess (Germany)

2.10 Aspects of fluid dynamic simulation of heavy oils
H. Hinojosa-Gómez, S.E. Quiñones-Cisneros (Mexico)

Each presentation engendered discussion and a few points of special interest are noted here:

a) In the case of ionic liquids:
- Prof. Fernandez presented new high-pressure density and viscosity measurements on five ionic liquids ($[C_1OC_2C_1Pyrr][NTf_2]$, $[C_4C_1Pyrr][NTf_2]$, $[C_2C_1im][C_2SO_4]$, $[C_4C_1C_1im][NTf_2]$, $[C_1OC_2C_1$ Pyrr] $[(C_2F_5)_3PF_3]$) and discussed the application of the density scaling to the experimental data.
- Dr Fröba discussed the application of Surface Light Scattering as well as Conventional Dynamic Light Scattering techniques to ionic liquids. Results for [EMIM][EtSO4] showed that up to a critical concentration, solutes are only present in the bulk of the mixture, while it seemed that

strong hydrogen bonds result in the formation of water clusters, causing distinct deviations from the expected behaviour of thermophysical properties.

- Unusual transport behaviour in ionic liquids was reported by Prof. Harris - he noticed weak transitions for the temperature dependence of the viscosities and molar conductivities of [EMIM][TCB] and [EMIM][CH_3SO_3], but not for the self-diffusion coefficients.
- Dr Rathke presented the phase behaviour characteristics of [$C_n$mim][NTf_2]/n-ethanol systems as basis for kinetic studies and emphasized the need for thermophysical properties. He also drew attention to the time-dependent phenomena he had observed in light scattering experiments over periods of days and to effects of hysteresis; that suggested slow structure formation in ionic liquids and mixtures.
- Finally Prof. Nieto de Castro demonstrated that the thermal conductivity of an ionic liquid is strongly influenced by the amount of water present, and this influence increases with temperature.

b) In the area of correlations:

- Prof. Sengers reported on the conclusion of the new reference formulation for the thermal conductivity of water, which following its adoption by IAPWS in the beginning of September, will be the new reference standard for the thermal conductivity of water.
- Ms Kalyva reported on the new reference correlations for the density and viscosity of molten antimony, bismuth, lead, nickel and silver.

c) Other presentations were:

- Mr Umla reported on the progress achieved in the modelling of the viscosity of simple fluids based on a new interpretation of Enskog theory. He demonstrated good correlative power for simple fluids and noble gases, over wide range of temperatures and pressures.
- Prof. Thess presented a very interesting application of Lorentz Force Sigmometry resulting in a very promising mobile contactless flowmeter for molten metals.
- Mr Hinojosa- Gómez presented aspects of fluid dynamic simulation of heavy oils in various interesting situations including the study of non-newtonian behaviour.

3. BUSINESS SESSION

3.1. PROJECTS CONCLUDED

The following projects were concluded:

1. New Formulation for the Thermal Conductivity of Water & Steam
   J.V. Sengers, M.L. Huber, R.A. Perkins, D.G. Friend (USA), M.J. Assael, I.N. Metaxa (Greece), E. Vogel (Germany), R. Mareš (Czech Republic), K. Miyagawa (Japan)
   The paper is concluded and following its adoption by IAPWS at the beginning of September, it will be submitted to *J. Chem. Phys. Ref. Data.*

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2. Reference Data for the Density and Viscosity of liquid Metals
   The work carried out under the proposal for funding submitted to IUPAC by the Secretary Prof. Assael has been concluded, as

   - Reference Data for the Density and Viscosity of Liquid Copper and Liquid Tin
     M.J. Assael, A.E. Kalyva, K.D. Antoniadis, M. Banish, I. Egry, P.N. Quested, J. Wu, E. Kaschnitz, W.A. Wakeham, J. Phys. Chem. Ref. Data **39**:033105:1-9 (2010).

   - Reference data for the density and viscosity of liquid antimony, bismuth, lead, nickel and silver
     M.J. Assael, A.E. Kalyva, K.D. Antoniadis, M. Banish, I. Egry, J. Wu, E. Kaschnitz, W.A. Wakeham, *High Temp. High Press.* (submitted)

   (The project continues for further molten metals for which sufficient data exist).

3.2. PROJECTS CONTINUED

The following projects were discussed and it was agreed to continue them:

1. Evaluation of the Viscosity Effect upon the Vibrating U-tube Densimeter
   J.P.M. Trusler (UK) - Coordinator, J. Fernandez, M.J.P. Comunas, L. Lugo (Spain), Caetano, J.M.N.A. Fareleira (Portugal), A. Goodwin (USA), K. Harris (Australia), B. Rathke (Germany), S. Quinones-Cisneros (Mexico)
   Work still continues and some recommended actions will be proposed in 2012.

2. Density and Viscosity of Liquid Metals (Si and Hg) and Eutectics (Pb+Sn, and Al+Si)
   M.J. Assael (Greece) - Coordinator, W.A. Wakeham (UK), J. Brillo, A Thess (Germany), J.T. Wu (R.P. China), E. Kaschnitz (Austria), M. Banish (USA)
   It is proposed to investigate the possibility of proposing reference correlations for above liquid metals and eutectics.

3. High Temperature - High Pressure Viscosity Standards
   J.P.M. Trusler - Coordinator, W.A. Wakeham (UK), J.M.N.A. Fareleira (Portugal), A.P. Froba, A. Leipertz, B. Rathke (Germany), K. Harris (Australia), A.R.H. Goodwin, A. Laesecke (USA), J. Fernandez (Spain), F. Caetano (Portugal), K. Schmidt (Canada), Chr. Boned (France).

   It was noted that US government proposed to launch a project for their own stimulated by IATP work and that of industry to date but not involving IATP. It was agreed that IATP project should continue and if industry funding could be secured by those companies not happy with USA approach, it could be accepted.

   In parallel with the project, a COST proposal will be submitted to the European Union. Dr A. Goodwin and Prof. J. Fernandez, will assist Dr K. Antoniadis to write the proposal. Probable title could be “Novel High Temperature High Pressure Viscosity Standard for the Petroleum Industry”. Countries involved will be Greece, UK, Portugal, Spain, Germany, France and associated countries Mexico, Japan, China and Australia.

4. Update of state-of-the-art developments in both experimental and theory that have occurred since publication of the following:
   - Experimental Thermodynamics III, Measurement of the Transport Properties of Fluids. Editors Eds. A. Nagashima, J.V. Sengers and W.A. Wakeham (1991)
   - Transport Properties of Fluids: Their Correlation, Prediction and Estimation. Editors J. Millat, J. H. Dymond and C. A. Nieto de Castro (1996)

   W.A. Wakeham - Coordinator, V. Vesovic (UK), A. Goodwin, M. Huber, J. Sengers (USA), M.J. Assael (Greece)
   Authors will be approached by the above editors.

   Probably there will be three volumes
   - Volume A. Aimed at a predominantly, but not exclusively, academic audience but certainly an audience of practitioners in research not of users of data. It will only describe what is new since the previous volumes and in theory will summarise the state of the art.
   - Volume B. This is for industrial users of transport property data. This will rely on the content of Volume A and therefore be written later.
   - Volume C. A third volume will be concerned with irreversible thermodynamics. and therefore extend the series of material.

   These volumes are envisaged to form part of the Experimental Thermodynamics Series published under the auspices of IUPAC.

   The above volumes will incorporate the previously proposes projects on reviews of modern viscosity and thermal conductivity techniques.

5. Round Robin Project on Ionic Liquids Viscosity, and Thermal Conductivity Measurements.
   J.M.N.A. Fareleira, C.A. Nieto de Castro (Portugal), A. Leipertz, A. Froeba, U. Hammerschmidt, B. Rathke (Germany), J. Fernandez (Spain), R. Perkins (USA), and K. Harris (Australia).
   It was decided that it was not wise to seek to establish a standard reference fluid and property values for a standard in view of the difficulties about handling these fluids and the effects of impurities. Instead work will continue aiming to examine the many effects of impurities and possible structures on transport properties in ionic liquids. Samples to be investigated are

[EMIM][$EtSO_4$], [EMIM][NTf_2], and [HMIM][NTf_2] and measurements in various laboratories on these fluids will be compared.

3.3. NEW PROJECT

The following new project was discussed and it was agreed to start

6. Reference correlation for the thermal conductivity of toluene
   M.J. Assael (Greece), M. Huber, R. Perkins (USA)
   This correlation will cover the vapor, liquid and critical region.

7. Mexican research perspectives in the rheology of heavy oils
   S.E. Quiñones-Cisneros (Mexico)
   Simulations involving thermophysical properties pending approval of funds; it is possible the project could involve other partners.

4. MEMBERSHIP

Dr Robert Hellmann and Dr Echard Bich (Germany) were approved as new Members of IATP.

5. FUTURE MEETINGS

The following dates and places of the IATP meetings were decided

5.1. 12th IATP Meeting, 2012

The 12th IATP Meeting will take place on June 23rd 2012, in Boulder, just prior to the 18th Symposium on Thermophysical Properties, which will also occur in the same place. Dr Rich Perkins will be the local organiser.

5.2. 13th IATP Meeting, 2013

The 13th IATP Meeting will take place in Bremen, Germany. Dr Bernd Rathke will be the local organiser.

6. LIST OF ATTENDEES

List of People that attended the meeting:

1) Prof. William A. Wakeham (UK), Chairman
2) Prof. Marc J. Assael (Greece), Secretary
3) Ms Ivi Armyra (Greece)
4) Dr Konstantinos Antoniadis (Greece)
5) Dr Eckard Bich (Germany)
6) Dr Jurgen Brillo (Germany)
7) Prof. Carlos Nieto de Castro (Portugal)
8) Prof. Josefa Fernandez (Spain)
9) Prof. Andreas Froeba (Germany)
10) Dr Daniela Gaal (USA)
11) Dr Peter Gaal (USA)
12) Dr. Antony Goodwin (USA)
13) Dr Ulf Hammerschmidt (Germany)
14) Prof. Kenneth Harris (Australia)
15) Dr. Robert Hellmann (Germany)
16) Mr Sebastian Herrmann (Germany)
17) Mr Humberto Hinojosa -Gómez
18) Dr Marcia Huber (USA)
19) Ms. Agni Kalyva (Greece)
20) Dr Arno Laesecke (USA)

21) Mr Benjamin Jäger (Germany)
22) Ms Sofia Mylona (Greece)
23) Prof. Yuji Nagasaka (Japan)
24) Prof. Akira Nagashima (Japan)
25) Prof. Carla M.B.P. Oliveira (Portugal)
26) Dr. Sergio Quinones-Cisneros (Mexico)
27) Prof. Jan V. Sengers (USA)
28) Prof. J.P. Martin Trusler (UK)
29) Dr. Bernd Rathke (Germany)
30) Mr Rudolf Umla (UK)
31) Prof. Andre Thess (Germany)
32) Prof. Velisa Vesovic (UK)
33) Prof Jiangtao Wu (R.P. China)