Minutes of the 17th IATP Meeting

1. INTRODUCTION

The meeting was opened by the Chairman, Prof. Sir William Wakeham, who welcomed all present and thanked Prof G. Pottlacher for the excellent arrangements as the local organiser of the meeting. 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. Surface Light Scattering for the Simultaneous Determination of Viscosity and Surface Tension of Hydrocarbons at Temperatures up to 600 K
   Th.M. Koller, T. Klein, C. Giraudet, M.H. Rausch, A.P. Fröba (Germany).

2.2. Light Scattering from Density Fluctuations in Fluids under Equilibrium and non-Equilibrium Conditions for the Determination of Transport Properties
   C. Giraudet, Th.M. Koller, M.H. Rausch, A.P. Fröba (Germany).

2.3. Novel Torsional Crystal Viscometer for Liquids at High Pressures
   C. Junker (Germany), A. Laesecke (USA), K. Meier (Germany).

2.4. Invited Presentation: Modulation Calorimetry for High-Temperature Metallic Melts
   H. Fukuyama (Tohoku University, Japan)

2.5. Understanding Nanoparticles Dispersion in Liquids

2.6. Modelling the Enhancement of the Thermal Conductivity of a Fluid when Nanoparticles are Added
   G.J. Tertsinidou, M.J. Assael (Greece), W.A. Wakeham (UK).

2.7. Initiation of a New Program to Study the Viscosity of PEGs

2.8. The Thermal Conductivity and Viscosity of the Next Generation Refrigerant Mixtures

2.9. A Reference Correlation for the Viscosity of Compressed n-Tetradecane

2.10. Reference Correlations for the Thermal Conductivity of 13 Liquid Metals
    K.D. Antoniadis, M.J. Assael (Greece), M.L. Huber (UK), W.A. Wakeham (UK).

2.11. Extension of the Friction Theory to the Thermal Conductivity – A Progress Update
      S. Quiñones-Cisneros, K. Schmidt, Ulrich K. Deiters (Germany).
Each presentation engendered discussion and a few points of special interest are noted here:

a) Invited Presentation
H. Fukuyama gave an invited presentation on “Modulation Calorimetry for High-Temperature Metallic Melts”. In order to avoid contact of the melt, which is usually corrosive, with the cell they employed electromagnetic levitation. To eliminate convection (buoyancy, Marangoni and magnetic hydrodynamic convection), a DC magnetic field technique was employed to measure the thermal conductivity of the molten drop. The drop was heated on the one side by a modulated laser, and its temperature was recorded on its other side. Measurements of the heat capacity were performed over a wide temperature range. The thermal conductivity and emissivity were obtained by numerical analysis of the results.

b) Instruments:
- Th.M. Koller described the problems associated with the simultaneous measurement of viscosity and surface tension of hydrocarbons up to 600 K, by the SLS technique. These were mostly related to the measuring cell and the temperature stability of 1 mK. He also gave a brief discussion of the uncertainty analysis.
- Measurements of mass, thermal and mutual diffusivity in mixtures as a function of temperature by Light Scattering from density fluctuations in fluids, were discussed by C. Giraudet. Non-equilibrium fluctuations were going to be investigated employing shadowgraphy.
- C. Junker described a new torsional crystal viscometer to operate in the temperature range 200-450 K and up to 100 MPa, with an expected absolute uncertainty <1%. Only preliminary measurements with an uncertainty of about 3-4% were shown.
- E. May described a new vibrating-wire viscometer to measuring the viscosity, and a transient hot-wire instrument to measure the thermal conductivity, of 4th generation refrigerants in gas and liquid phases. He also showed measurements on many refrigerant mixtures.

c) New Measurements:
F.J.P. Caetano presented new measurements of the viscosity, density and surface tension of Poly(ethylene glycol) – PEG, at 0.1MPa.

d) Theoretical:
- W.A. Wakeham gave a talk on the enhancement of the thermal conductivity of a liquid when nanoparticles are added. He showed that if only measurements performed properly in well-established instruments are considered, the enhancement is not large. Furthermore the Hamilton-Crosser theory is adequate for evaluation of the apparent thermal conductivity of nanofluids for engineering applications, while the modification of the Shukla et al. model (group of A. Fröba) offers also a reasonable description for an additional convective heat transfer mechanism. A general discussion on nanoparticles dispersions in fluids was also given by C.A. Nieto de Castro.
- S. Quiñones-Cisneros described the advantages of application of friction theory in correlations of pure fluids and mixtures.

e) Reference values:
K. Antoniadis presented a survey of thermal-conductivity measurements of molten metals and consequently proposed reference values for many of them.

3. BUSINESS SESSION

3.1. PROJECTS CONCLUDED

1. 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. Fröba, U. Hammerschmidt, B. Rathke (Germany), J. Fernandez (Spain), R. Perkins (USA), K. Harris (Australia), M.J. Assael (Greece)
   Project stopped.
2. Reference Correlations for Thermal conductivity of Molten Metals

*M.J. Assael (Greece), W.A. Wakeham (U.K.), M.L. Huber (U.S.A.)*

Two papers have been published as a result of this project:


Project concluded for now.

3. Two new volumes on experimental thermodynamics series published under the auspices of IUPAC

- Editor in Chief, W.Wakeham
- a) Vol. X. Non-equilibrium Thermodynamics
  Eds. S. Kjelstrup, D. Bedeaux, J.V. Sengers (USA). This is published.
- b) Vol. XI. Industrial Applications
  Eds. W.A. Wakeham, V. Vesovic (UK), M. Huber (USA), E. May (Australia)
  This is currently postponed owing to the depressed state of the oil industry and a lack of industrial authors.

### 3.2. PROJECTS CONTINUED

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

4. Reference correlations for the viscosity and thermal conductivity of fluids over extended temperature and pressure ranges.

*M.J. Assael (Greece), M.L. Huber, R.A. Perkins (USA), J.M.N.A Fareleira (Portugal)*

Project continues. M.J. Assael reminded everyone that there is a new section under IATP site (http://transp.cheng.auth.gr/ -> IATP) where all reference correlations for transport properties published by IATP members are listed; as well as ongoing work, in order to avoid possible duplication. J.M.N.A. Fareleira informed the group that they were starting to develop a new correlation for the viscosity of n-tetradecane.

5. Reference correlations for the viscosity and thermal conductivity of D2O over extended temperature and pressure ranges.

*S.K.Mylona, M.J. Assael (Greece), M.L. Huber, R.A. Perkins, J.V. Sengers (USA), R. Hellmann (Germany)*

Project continues.

6. High-temperature high-pressure viscosity standards

*J. Fernandez (Spain), J.M.N.A. Fareleira, F. Caetano (Portugal), W. A. Wakeham, J.P.M. Trusler (UK), A.P. Froba, A. Leipertz, B. Rathke (Germany), K. Harris (Australia), A. Laesecke (USA), K. Schmidt (Canada), Chr. Boned (France)*

- a) J. Fernandez presented a progress report. Squalane, Krytox, and TOTM, DiPEIC9 and other possible liquids will be included in the IUPAC project report to be prepared by J. Fernandez, on “International standard for viscosity at temperatures up to 473 K, pressures below 200 MPa” (J. Fernandez, J.P.M.Trusler, R.M. Enick, M.J. Assael)
- c) J. Fernandez will prepare a short report on Squalane and TOTM, as reference fluids for viscosity measurements, to inform industry of this work. Possibly in The Chemical Engineer Project continues.
7. Diffusion nomenclature in the IUPAC Definitions of Symbols & Units
   V. Shevtsova (Belgium), M. Banish (USA) (leader), W.A. Wakeham (UK), C.A. Nieto de Castro (Portugal), K. Harris (Australia).
   Project continues but no new information was available from the leader

3.3. NEW COLLABORATIVE PROJECTS

8. “Commonly Asked Questions in Thermodynamics”
   Assael M.J., Wakeham W.A., Goodwin A.R.H., Will S., Stamatoudis M.,
   A new edition is being considered, and W.A. Wakeham will look for additional authors. He sought suggestions of authors particularly for a theme around biological applications of thermodynamics

9. Problems associated with the low-density application of the THW technique.
   S. Mylona, E. May (Australia), R. Perkins (USA), M.J Assael (Greece), W.A. Wakeham (UK)

10. Properties of \( n \)-alkanes (higher than \( n \)-dodecane)
    J.M.N.A Fareleira, F.J.P. Caetano (Portugal), M.J. Assael (Greece), M.L. Huber (USA), E. May (Australia), A. Fröba, K. Meier, S.E. Quiñones-Cisneros (Germany), J. Fernandez (Spain).

3.4. INVITED LECTURES

In order to investigate the possibility of new projects, the following lectures were invited for the next meeting:
- L. Fedele to present the state of art of PCM used in energy storage.
- V. Shevtsova to discuss unresolved issues on Soret effect
- H. Fukuyama to present problems on high-temperature properties
- C.A. Nieto de Castro to present and discuss issues on ionic liquids applications.

3.5. PROCEDURE FOR IATP ENDORSEMENT

Members were reminded that if they wish to have the endorsement of IATP for their work they should submit it to the Secretary in the first instance to arrange a rapid review. Referees agreed to participate in the review process in addition to the Executive Member are A. Fröba, J.M. Trusler, M.L. Huber and E. May.

4. MEMBERSHIP

Prof. M.J. Assael reminded everyone that all information about IATP activities, as well as the current list of members, can always be found at


It was also decided that members who had not attended for some time, and where there was evidence that they would not have a continuing connection, would be removed from the list.

The following new members were approved:
- Prof. Eric F. May (Australia)
- Dr Sofia Mylona (Australia)
- Dr Konstantinos Antoniadis (Greece)
- Dr Laura Fedele (Italy)
- Dr Sergio Bobbo (Italy)
5. FUTURE MEETINGS

5.2. 18th IATP Meeting, 2018
The 18th IATP Meeting will take place on Sunday June 24th (or Saturday June 23rd) in Boulder, Colorado USA, prior to the 20th Symposium of Thermophysical Properties. R.A. Perkins will be the local host. Details will be announced in due course.

5.3. 19th IATP Meeting, 2019
The 19th IATP Meeting will take place on Saturday August 31st in Erlangen, Germany, just prior to the Diffusion Fundamentals VIII Conference which takes place also in Erlangen between September 1 and 5 (https://www.aot-tp.tf.fau.de/diffusion-fundamentals-8). A. Fröba will be the local host.

6. LIST OF ATTENDEES

List of people that attended the meeting:

1) Prof. Sir William A. Wakeham (Chairman)
2) Prof. M.J. Assael (Secretary)
3) Dr Konstantinos Antoniadis (Greece)
4) Mr Francisco Bioucas (Portugal)
5) Dr Sergio Bobo (Italy)
6) Dr Fernando J.P. Caetano (Portugal)
7) Dr Philipp Crusius (UK)
8) Prof. Joao MNA Fareleira (Portugal)
9) Dr Laura Fedele (Italy)
10) Prof. Josefa Fernandez (Spain)
11) Dr Tara Fortin (USA)
12) Prof. Andreas P. Fröba (Germany)
13) Prof. Hiroyuki Fukuyama (Japan)
14) Mr Cédric Giraudet (Germany)
15) Mr Junwei Gui (P.R. China)
16) Dr Robert Heilmann (Germany)
17) Dr Sebastian Herrmann (Germany)
18) Mr Ubaya Higgoda
19) Dr Marcia H. Huber (USA)
20) Mr Kai Humberg (UK)
21) Mr Clemens Junker (Germany)
22) Mr Tobias Klein (Germany)
23) Mr Matthias Knoll (Germany)
24) Mr Thomas M. Koller (Germany)
25) Prof. Alfred Leipertz (Germany)
26) Prof. Maria José Lourenço (Portugal)
27) Prof. Eric F. May (Australia)
28) Prof. Karsten Meier (Germany)
29) Dr Xianyang Meng (P.R. China)
30) Dr Sofia Mylona (Australia)
31) Prof. Akira Nagashima (Japan)
32) Prof. Carlos A. Nieto de Castro (Portugal)
33) Dr Binh-Thanh Nguyen (UK)
34) Dr Juan Carlos Castro Palacio (UK)
35) Prof. Nadejda Popovska-Leipertz (Germany)
36) Ms Carla Queirós (Portugal)
37) Prof. Sergio E. Quiñones-Cisneros (Germany)
38) Prof. Fernando Santos
39) Dr Valentina Shevtsova (Belgium)
40) Ms Helena Teixeina Avelino (Portugal)
41) Prof. Velisa Vesovic (UK)
42) Prof. Libor Vozar (Slovakia)
43) Prof. Jiangtao Wu (P.R. China)