BASIC PRINCIPLES OF RHEOLOGY AND ITS MEASUREMENT TECHNIQUES

October 12–13, 2010
Malmö – Sweden

Turning Torso, Malmö–Sweden

CALMIA
EDUCATION CENTER

BASIC PRINCIPLES OF RHEOLOGY AND ITS MEASUREMENT TECHNIQUES

Viscosity – Elasticity – Viscoelasticity

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This course is held for the 16th time.

Course outline

An introduction to rheology
A general presentation of the science of rheology and its application in different industrial branches. Concepts like liquids, solids, viscosity, elasticity, viscoelasticity and the Deborah number will be explained.

Basic rheological concepts
The most important concepts of rheology are defined: shear stress, shear rate, strain, viscosity, elasticity and extensional viscosity. Parameters influencing the magnitude of these concepts will also be introduced. The viscosity of some known liquids is given as well as the shear rate of different industrial processes.

Experimental rheological techniques
Fundamental and empirical rheological measurement techniques are presented and the corresponding application of the measurement results in material characterization is discussed. It is shown that empirical measurement results only can be used for comparative reasons where as fundamental results can be used for calculations of different material properties.

Empirical and fundamental rheological instruments are also discussed and displayed. Similarities and differences between controlled strain and controlled stress measurements will be explained.

Viscometry
The flow behaviour of different liquids is presented: Time Independent liquids, such as Newtonian, shear thinning, shear thickening and yield stress and Time Dependent liquids, such as thixotropic, rheopectic and antithixotropic. The flow behaviours are presented in different linear and logarithmic viscosity and flow diagrams.

Rheometry, that is the practical application of rheology, is discussed in relation to the different flow behaviours. For instance different measurement techniques must be applied to differentiate between shear thinning and thixotropic flow behaviour. Measurement data are fitted to different flow models such as the Power Law, Bingham, Herschel Bulkley and the Casson to simplify the presentation of rheological measurement data over a wide shear rate range.

Linear viscoelasticity, Part I and II
Linear viscoelasticity is defined both practically and theoretically. It is explained how linear viscoelastic measurements correspond to the degree of structure of a material. Viscoelastic concepts such as complex modulus, storage modulus, loss modulus, relaxation modulus, phase angle, dynamic viscosity, creep compliance and complex viscosity are defined and a mathematical approach to the relation between the different concepts is given. Concepts like stress and strain tensors are introduced.

Rheological measurements in simple shear mode and simple mechanical models like the spring and the dashpot are introduced to simplify the interpretation of rheological measurement data. Viscoelastic flow models such as the Maxwell and the Kelvin models are introduced. In viscoelasticity, these models are the link between theoretical and practical rheological flow and deformation behaviour. Linear viscoelastic measurement methods are presented, such as oscillation, relaxation and creep and the measurement methods are illustrated by several worked examples.

Rheometry: General rheological measuring methods and interpretation of rheological measurement results
A practical and useful guide is given, based on worked examples, to successful applied measurements in viscometry, frequency sweep, strain sweep, stress sweep, creep and relaxation. The corresponding measurement results are interpreted to relate rheological parameters to material properties.

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Advice is given on appropriate measuring geometries for different materials, like cone/plate, plate/plate and concentric cylinders. Rheological measuring techniques for studying material properties are defined such as consistency, storage stability, process viscosity, mouth feel, sagging, levelling, hardening, molecular weight and gel strength.

Course description

This course is a combined English version of the much appreciated courses 'Basic Rheology' and 'Advanced Rheology'. The courses have been held twice a year in Swedish since 1992 and over 600 hundred persons from the Nordic countries have attended.
The English version is in its 12th year and has until now attracted a few hundred persons from all over the world.

Rheology is the science of flow and deformation of materials. The viscosity of a material is related to its resistance to flow while the elasticity is related to its degree of structure. To determine the consistency of a material both its viscosity and elasticity parameters must be studied.

The rheological properties of a material are determined by the temperature, the pressure and the strain or the shear rate. Knowing the magnitude of these parameters in industrial processes the viscous and the elastic properties of a material can be studied in a laboratory environment by using fundamental rheological instruments such as rheometers.

The measurement results can be used to study different material properties such as consistency, storage stability, melting temperature, hardening temperature, shear stability and molecular weight. It can also be used to optimise product quality and to predict the impact of an industrial process on a specific product formulation.
The objective of this course is to give the participants a basic knowledge in both theoretical and applied rheology as well as in rheological instrumentation and the corresponding measurement techniques.

Course lecturer

Annika Sahlström, MSc
is a Senior Manager at Leaf Sweden AB.
After her graduation in chemical engineering at Lund Technical University she joined Bohlin Instruments AB in Lund, a company involved in developing and marketing rheological instrumentation. In this employment she gained vast experience of various applications and different rheological problems, and acquired a broad knowledge of rheological measuring techniques and the handling of instrumentation. She was involved in the training and teaching of personnel world wide.

Prior to her current employment she has worked at Tetra Pak AB where she was engaged in process design related to factory installation of processing and filling equipment and in packaging material development and analysis. During her employment at Nestlé R & D Center in Bjuv AB she was involved in project management of product and process development as well as engineering of new products.

Parallel with her employment, she has been engaged by Calmia AB since 1992 to lecture at courses in rheology at different levels.

Annika Sahlström was honoured in 1997 with 'The Rheology Award of the Year' by The Nordic Rheology Society for her skill in teaching rheology.

Course Fee and Payment

EUR 1480 **EUR 1410***

**** Discounted fee:*** *is valid for two or more enrolments from the same company, at the same time, for the same course. And for enrolments from Universities and Government Institutes.*

The course fee includes: Tuition, copies of all Power Point presentations, certificate and meals. Two lunches, beverages at breaks and course dinner the first day. VAT (Moms) will be added for applicants domicile in Sweden.
The registration will be confirmed with a course schedule and some practical information. We will send an **Invoice** to the amount of the Course Fee.
Accommodation is not included in the course fee.

Course Location and Hotel

The course is held at

Radisson BLU Hotel, Malmö – Sweden
October 12–13, 2010

To obtain the reduced price for accommodation, reservations must be made through Calmia.

Weekday nights
SEK 1575 (about **EUR 157**) for a single or double room per night incl. breakfast and VAT.

Nights between Saturday/Sunday/Monday
SEK 950 (about **EUR 95**) for a single or double room per night incl. breakfast and VAT.

Radisson BLU Hotel
Östergatan 10
211 25 Malmö, Sweden
Tel. +46-40-698 4000
www.radissonblu.com/hotel-malmo

Transport Information

Copenhagen Airport, Kastrup, is the nearest international airport. There are trains running several times each hour (20 min. journey) from Copenhagen Airport to Malmö Central Station. The course location is only 5–10 min. away from the station in Malmö. The airport bus from **Malmö Airport, Sturup**, stops outside the station in Malmö.

Course Time Table

Day 1: Registration 08:30–08:45

Day 2: The course ends 16:00–16:30

How to register

- **On-Line registration**
  www.calmia.se
- **Fax or Mail**
  A Registration Form can be printed from each PDF-file

Registration must be made before September 12, 2010

Substitutions are allowed at any time from the same company or institute.

Cancellation

Participants may cancel up to 15 working days prior to Course starting date for a refund.

No refunds will be made for those who do not attend the scheduled course and/or cancel less than 15 working days before the start date.

Questions

General questions contact:
Mrs G Tånge-Henderson
calmia@calmia.se
tel/fax: +46-46 211 00 20

Scientific questions contact:
Annika Sahlström
reokonsa@gmail.com

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Registration Form

Registration before September 12, 2010 ***Please print!***

The number of participants is limited.

I wish to attend the course:

BASIC PRINCIPLES OF RHEOLOGY AND ITS MEASUREMENTS TECHNIQUES
October 12–13, 2010
Malmö–Sweden

Reserve on my behalf a single room at the Radisson BLU Hotel in Malmö

From (date) _____ To (date) _____ Number of nights: _____

☐ Late arrival (after 18:00)

The hotel bill should be paid directly to Radisson BLU Hotel on the day of departure

Surname _____

Given Name _____

Job Title _____ ☐ Ms ☐ Mr

Company/Institute _____

Address _____

Country _____

Tel/fax _____ E-mail _____

Purchase Order number _____ (If required by your company)

Invoice address if different from the one above:

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