DISPERSION OF POWDERS IN LIQUIDS AND STABILIZATION OF SUSPENSIONS

November 28–30, 2016
Malmö – Sweden

The Öresund bridge, Malmö–Copenhagen

CALMIA
EDUCATION CENTER

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This course is held for the 11th time and it has been updated continuously.

Course outline

General introduction
Industrial applications. Dispersion process. Fundamental knowledge required for successful dispersion of powders in a liquids: wetting of the powder into the liquid. Breaking of aggregates and agglomerates. Wet milling (comminution). Stabilization of the resulting dispersion. Prevention of sedimentation and formation of compact sediments.

Powder wetting and dispersion
Thermodynamic treatment of the contact angle and the Young's equation. Spreading pressure. Adhesion tension. Work of adhesion. Work of cohesion. Spreading coefficient. Contact angle hysteresis and its reasons.

Critical surface tension of wetting. Role of surfactants and powder dispersion
Zisman concept of the critical surface tension of wetting. Role of surfactants. Dispersion wetting. Agglomerates and wetting of the internal surface. The capillary pressure. Rate of penetration. Assessment of wettability: submersion test and sinking time, contact angle measurement for assessment of wetting. List of wetting agents.

Structure of the solid/liquid interface and electrostatic stabilization
Origin of charge on surfaces. Structure of the electrical double layer. Electrical double layer repulsion. Van der Waals attraction. Total energy of interaction. Energy distance curves. Coagulation of suspensions. Criteria for stabilization of dispersions.

Electrokinetic phenomena and the zeta potential
Electrokinetic effects: Electrophoresis, streaming potential. Surface (plane) of shear. Application of zeta potential. Calculation of zeta potential for large, intermediate and small particles. Measurement of electrophoretic mobility and zeta potential. Microelectrophoresis. Electrophoretic light scattering or laser velocimetry.

General classification of dispersing agents and adsorption of surfactants at the solid/ liquid interface
Dispersing agents and their classification: Ionic, Amphoteric, Nonionic, Polymeric, Polyelectrolytes. Examples of each class. Surfactant adsorption: Ionic surfactants on hydrophobic surfaces – Ionic surfactants on hydrophilic (polar) surfaces –Nonionic surfactants on hydrophobic and hydrophilic surfaces. Schematic picture of surfactant orientation on the solid surface and formation of hemi-micelles.

Adsorption of polymers at the solid/ liquid interface
Polymer adsorption and the various interactions involved. Conformation of polymer molecules on a solid substrate and effect of molecular structure. Description of polymer adsorption. Theories of polymer adsorption. Experimental methods for determination of adsorption parameters. Amount of polymer adsorbed and the adsorption isotherm. Fraction of segments in direct contact with the surface. Extension of the adsorbed polymer layer and its hydrodynamic thickness.

Stabilization of dispersions using polymeric surfactants and the theory of steric stabilization
Interaction between particles containing adsorbed polymer layers. Mixing interaction or osmotic repulsion. Entropic or elastic interaction. Total interaction energy and the energy distance curves. Influence of the adsorbed layer thickness. Criteria for effective steric stabilization. Flocculation of sterically stabilized dispersions.

Properties of concentrated suspensions
Classes of concentrated suspensions and their industrial applications. Distinction between dilute, concentrated and solid suspensions. States of suspension on standing and the role of the energy-distance curves. Colloidally stable suspensions with no sedimentation. Coarse suspensions and their separation. Unstable or coagulated suspensions. Weakly flocculated suspensions.

Characterisation of suspensions and assessment of their stability

Confocal scanning laser microscopy. Atomic force microscope. Light scattering techniques. Time-average and dynamic light scattering. Turbidity methods. Light diffraction technique. Photon correlation spectroscopy. Back scattering technique.

Methods of evaluation of suspensions without dilution – Rheological techniques

Rheological techniques applied: Steady state, shear stress – shear rate measurements – Constant stress (creep) measurements – Dynamic (oscillatory) measurements. The various rheological models are described and the relevant rheological parameters are derived. Application of each technique in assessment of the physical stability of suspensions without dilution is described.

Rheology of concentrated suspensions

Factors affecting rheology: Brownian diffusion, hydrodynamic interaction and interparticle forces. Rheology of very dilute hard-sphere suspensions (the Einstein equation). Rheology of moderately concentrated suspensions with hydrodynamic interaction. Rheology of concentrated suspensions: Hard-sphere systems – Electrostatically stabilized suspensions – Sterically stabilized suspensions – Flocculated systems.

Sedimentation of suspensions and prevention of formation of dilatant sediments

Sedimentation of suspensions: Very dilute, moderately concentrated and highly concentrated systems. Equations for calculation of sedimentation rate. Sedimentation in non-Newtonian systems and the role of thickerners. Prevention of settling: Balance of density of disperse phase and medium – Reduction of particle size – Use of thickeners (rheology modifiers) – Depletion flocculation – Use of liquid crystalline phases.

Course description

The dispersion of powders both hydrophobic (such as organic pigments, ceramics, agrochemicals, pharmaceuticals, etc.) and hydrophilic (such as oxides, clays etc.) into liquids both aqueous and non-aqueous represent a challenge to most industries.

It is essential to understand the process of dispersion at a fundamental level in order to be able to prepare dispersions that are suitable for applications and with a desirable shelf life.

Dry powders usually consist of aggregates and agglomerates which need to be dispersed in the liquid to produce "individual" units which may be further subdivided into smaller particles.

This requires understanding of various phenomena such as powder wetting, dispersion of aggregates and agglomerates and comminution of the primary particles into smaller units. Once a powder is dispersed into a liquid, it is essential to prevent aggregation of the particles (a process referred to as flocculation or coagulation) and their sedimentation.

Powder wetting, dispersion and subsequent stabilization require in most cases the use of a dispersing agent, usually a surfactant, a polymer or polyelectrolyte.

The objective of the present course is to address the above phenomena at a fundamental level.

In addition, the course should provide the chemist or chemical engineer with sufficient information for preparation of stable solid/liquid dispersions.

The course should be valuable for scientists and engineers involved in powder dispersions in the following industries: Dyestuffs, ceramics, paints, paper coatings, inks, agrochemicals, pharmaceuticals, cosmetics, detergents and food products.

Course lecturer

Prof. Tharwat Tadros

Tharwat F. Tadros obtained his Ph.D in 1962 at Alexandria University after which he was appointed to a lectureship in Physical Chemistry at that university. Between 1966 – 1969 he spent a sabbatical leave in the Netherlands to continue his research in colloid and interface science. Between 1969 - 1994 he worked at I.C.I. and ZENECA to lead a group of fundamental research in Colloid and Interface Science. He reached the highest scientific appointment of Senior Research Associate. In the mean time he was appointed visiting professor at Imperial College (London), Bristol and Reading Universities. In these 25 years he carried out research in various fields of surfactants, polymer adsorption and stability, emulsions, nanoemulsions, microemulsions, concentrated dispersions and rheology. He supervised many Ph.D students and postdoctoral research fellows. In 1992 he was elected President of the International Association of Colloid Scientists (IACIS).

Tharwat Tadros is the author, or a co-author, of around 290 published papers. He has edited nine books, and authored seven other books: "Surfactants in Agrochemicals" (1994), "Applied Surfactants" (2005), ''Colloids in Agrochemicals'' (2009), ''Colloids in Paints'' (2010), "Rheology of Dispersions" (2010) and ''Dispersions of Powders in Liquids'' (2012), ''Formulation of Disperse Systems'' (2014). He was editor of two series published by Wiley-VCH: "Colloid and Interface Science Series" (6 volumes set, published in 2006 - 2010) and "Topics in Colloid and Interface Science" (3 volumes, 2008 - 2013), as well as of the book "Self-Organized Surfactant Structures" (2011). In 2013 he edited the ''Encyclopaedia of Colloid and Interface Science'' that was published by Springer in Germany. He has been Editor-in-Chief for "Colloid and Surfaces A" and for "Advances in Colloid and Interface Science" (both published by Elsevier).

Since leaving ZENECA, Tharwat Tadros worked as a consultant for various industries and has taught several courses in his specialized fields. He is still co-supervising many Ph.D. students at various Universities. Due to his distinguished research he was awarded two medals by the Royal Society of Chemistry (UK).

Course Fee and Payment

EUR 1800 **EUR 1600***

*** 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. Three 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
November 28–30, 2016

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

Weekday nights
SEK 1395 (about **EUR 150**) for a single or double room per night incl. breakfast and VAT.

Nights between Saturday/Sunday/Monday
SEK 950 (about **EUR 103**) 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

Registration on Monday at 08:30–08:45

The course ends on Wednesday at 12:15

How to register

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

Registration must be made before October 28, 2016

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

Cancellation

No refunds will be made for those who do not attend the scheduled course and/or cancel after October 28, 2016.

Questions

For General questions please contact:
Mrs G Tånge-Henderson
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For Scientific questions please contact:
Prof. Tharwat Tadros
Tharwat@Tadros.fsnet.co.uk

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Registration Form

Registration before October 28, 2016

Please print!

The number of participants is limited.

I wish to attend the course:

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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

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