Emulsion Polymers Consulting and Education, LLC presents

*Scale-up and Commercial Production of Emulsion Polymers**

A 3.5 Day Interactive Workshop
March 7-10, 2016
Training To You
Phoenix, Arizona

Faculty
Donald C. Sundberg, PhD
Michael F. Cunningham, PhD

* Emulsion Polymers Consulting and Education (EPCEd) has a curriculum of 10 interactive workshops under the umbrella of the Science and Technology of Emulsion Polymers, or $STEP^n$. This workshop is $STEP^8$.

WORKSHOP OBJECTIVES: Provide industrial engineers and scientists with an ***intensive, interactive*** workshop on the production of synthetic latices in pilot and commercial scale reactors. Transition from laboratory scale operations to the pilot and commercial scales involves new considerations of mixing, feed streams, reactor operating mode (batch, semi-batch, continuous), heat transfer and finishing operations. Beginning with a review of the fundamental aspects of emulsion polymerization, the focus then turns to the details of process alternatives for producing co- and terpolymer latices at high solids content. The participants work through case studies in which they have to confront choices of monomer (neat or emulsion) feed streams, reactor temperature profiles, surfactant and initiator streams, and reducing residual monomers to acceptable levels. Reactor heat removal and mixing considerations become key features in reaching practical conditions for successful production in large reactors.

INTENDED AUDIENCE: This workshop is particularly directed towards those in industry who are responsible for moving latex polymerization processes from the lab to the commercial scale, including those responsible for process safety. Laboratory scientists will also benefit by learning to appreciate the special features of large scale reactors that help to define process possibilities and economics.

STRUCTURE OF THE WORKSHOP: This 3.5 day workshop will be conducted in a ***highly interactive manner*** with participants being engaged in discussions, demonstrations, problem solving and design studies.

WORKSHOP OUTLINE: See next page for a complete, daily schedule of topics. Faculty profiles follow on page 4.

REGISTRATION INFORMATION

The registration fee includes the full book of slides for the workshop, coffee breaks, and Tuesday evening dinner. It does not include lunches, lodging or travel. ***Early registration is recommended*** due to the workshop size limitation of 24 participants.

Registration Fee: $1850 USD
Registration Form – **Go To Page 5**

Contact for further information:
info@epced.com

Scale-up and Commercial Production of Emulsion Polymers

Day 1

AM

- Basics of creating and characterizing synthetic latices
  1. Particle nucleation and growth
  2. Control of particle size distribution
  3. Control of copolymer composition, MW, gel content
  4. Functional additives (esp. vinyl acids) and neutralization
  5. Colloidal stability
  6. Latex rheology, especially at high solids content
  7. Measurement of particle size, chemical composition, glass transitions, MFFT, acid distribution

PM

- Reaction process alternatives
  1. Batch reactors
     - *Ab initio* particle nucleation (I), growth (II) and final (III) periods
     - "Seeded" polymerizations
     - Copolymer composition drift, surfactant and initiator demands
     - Heat evolution profiles and heat transfer requirements
  2. Semi-batch reactors
     - Comonomer feed strategies (constant/variable rates, power feeds)
     - Effective monomer concentration in particles
     - Surfactant and initiator demands
     - Heat transfer requirements
  3. Continuous reactors
     - Residence time considerations
     - Number and size of reactors in series
  4. Temperature control characteristics of reactors
     - Jacketed reactors, cooling water limitations
     - Reflux operations, vapor velocity
     - Cooling capacity of monomer/emulsion feed streams

Day 2

AM

- Concepts and issues of scale up
  1. Comparisons of small and large reactors
     - Surface to volume ratio
     - Radial and vertical mixing
     - Potential for temperature and concentration gradients
  2. Dynamic similarity considerations of reactors
  3. Issues related to process type (batch, flooded, starve fed)
     - Reaction rate/time profiles, heat evolution
     - Free monomer content within reactor and vapor pressure
     - Phase distribution of functional monomers
     - Reactor entry point for monomer/emulsion feed stream

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- Fluid mixing characteristics and issues in large reactors
  1. Agitator types and purposes, tip speeds
  2. Fluid behavior near agitator blades
  3. Velocity distributions within the reactor
     - Effect on dispersing incoming monomers
     - Effect on energy transport to reactor walls
     - Computational fluid dynamics (CFD)
- Positioning feed stream entry points
- Agitator power requirements during reaction

Day 3

AM

- High solids latex production
  1. Optimization of polymer production capacity
  2. Latex viscosity and heat transfer
  3. Optimal particle size distribution
  4. Post-reaction neutralization of vinyl acid functional additives
     - Maximum concentration of base
     - Feed rate of base addition

Day 3

PM

- Residual monomer reduction – chemical and physical alternatives
- Avoiding secondary nucleation, particle aggregation and coagulum in scale-up
- Sensors for off/on-line measurements - latex surface tension and conductivity
- Scale-up criteria – what works best for different types of latices
- Identifying potential “show stoppers” or critical issues in a polymerization process
- Concepts in process ***scale-down***
    1. Designing lab and pilot scale experiments to investigate problems encountered in commercial scale operations
    2. Identifying potential large scale problems while still at the small scale

Day 4

AM

- ***Cap stone experience*** – interactive engagement in process design
    1. “Make it faster and cheaper, but don’t degrade the quality!”
    2. What changes are possible? What are their likely effects on latex properties?
    3. Homogeneous particles, structured particles
    4. Formulation change possibilities (monomers, initiators, surfactants, functional additives)
    5. Process change possibilities (temperature profiles, semi-batch variations)

Faculty Profiles

Professor Donald C. Sundberg has been working in the field of emulsion polymers for 48 years. He received a bachelor's degree in chemical engineering from Worcester Polytechnic Institute (Massachusetts) and his Ph.D. from the University of Delaware. He worked on latex based impact modifiers for ABS resins with the Monsanto Company, scaling processes to the 10,000 gallon reactor size. He has extensive research experience in emulsion polymerization and is widely recognized for his work on structured latex particles. This has resulted in nearly 100 peer reviewed publications and many conference papers. In addition he has conducted many workshops, most notably the one on latex particle morphology control, now in its 10th annual offering. He spent a sabbatical year at the Institute for Surface Chemistry in Stockholm and was Chair of the Gordon Research Conference on Polymer Colloids. He maintains active research interests in polymerization kinetics in solution, bulk and emulsion systems, interfacial science and polymer morphology control, diffusion in polymers, microencapsulation, coatings, and controlled release technology. He is an Emeritus Professor of Materials Science at the University of New Hampshire and is the founder of Emulsion Polymers Consulting and Education, LLC.

Professor Michael F. Cunningham has an extensive background in dispersed phase polymerizations, including suspension, emulsion, miniemulsion and dispersion polymerization. He received a bachelor's degree in chemical engineering from Queen's University (Kingston, Ontario) and his Ph.D. from the University of Waterloo. He spent six years working on dispersed phase polymerizations in the Xerox Corporate Research Group, acquiring experience in process scaleup and technology transfer to manufacturing. He has an active research program in polymer colloids and emulsion polymerization, particularly in the area of living radical polymerization, publishing over 100 papers and holding 26 U.S. patents. He is secretariat of the International Polymer Colloids Group, and holds an Ontario Research Chair in Green Chemistry and Engineering. He has consulted with several companies in the area of emulsion and suspension polymerization, and lectured for ten years at industrial short courses on emulsion polymerization in the USA and Switzerland.

Registration Form

Scale-up and Commercial Production of Emulsion Polymers
Training To You
2200 N Central Ave, Suite 400
Phoenix, Arizona 85004 USA
March 7-10, 2016

Name____
Address____
____
City/State_______________________________________
Postal Code______________________________________
Country____
Position or Title__________________________________
Organization______________________________________
Phone____
Fax____
E-mail____

Participant Category
☐ Standard price for industrial participant: $1850 (USD)
☐ Discounted price for additional participant(s) from the same company: $1750 (USD)
☐ Academic participant: $1650 (USD)

There is a non-refundable fee of $50 (USD). Cancellation of registration can be made up until February 7, 2016 with a full refund less the $50 processing fee.

Method of Payment:
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For a secure eCommerce transaction, *FAX* this completed form to EPCEd at 1-603-343-4015, *or* call 1-603-742-3370. ***This registration form may serve as an invoice for those who register.***