

1977 ENGINEERING FOUNDATION

MIXING CONFERENCE

Franklin Pierce College
Rindge, New Hampshire

August 21-26, 1977

PROGRAM

Sunday, August 21, 1977

3:00 p.m. - 9:00 p.m.

REGISTRATION AND CHECK-IN

7:00 p.m.

DINNER

INFORMAL GET ACQUAINTED SESSION

Monday, August 22, 1977

9:00 a.m. - 12:00 Noon

WELCOME

Sandford S. Cole, Director
Engineering Foundation Conferences

PURPOSE AND GOALS OF THE CONFERENCE

Robert J. Adler, Conference Chairman
Case Western Reserve University

SESSION 1: LASER MEASUREMENT OF MIXING

Session Chairman: Robert V. Edwards
Case Western Reserve University

"Principles, Phenomena, Applications, Potentials, and
Limitations"

An overview of laser light scattering, including the
basic phenomena, data processing, applications, and
limitations. A literature review will also be given.

Robert V. Edwards
Case Western Reserve University

"Correlation of Particle Velocities and Stereoscopic
Flow Visualization in a Stirred Tank"

Point velocity measurements of particle motions have
been made in a stirred tank by a cross beam correlation
technique using tracking and correlation of particle
shadow signals.

G. P. Tatler
University of South Carolina

Monday, August 22, 1977 continued

"An Experimental Investigation of the Mixing Region of a Turbulent Jet"

Velocity and concentration measurements in a turbulent jet are made by laser-doppler and laser light scattering techniques.

WPAFB
G. D. Catalano, J. B. Morton, and R. R. Humphris
University of Virginia

"Demonstration of Laser-Doppler Velocity Measurements"

Portable equipment will be used to demonstrate point velocity measurement by laser light scattering.

L. M. Fingerson
Thermosystems, Inc.

2:00 p.m. - 3:00 p.m.

INFORMAL SESSION

"Ball and Pebble Mill Operation"

A narrated film shows what happens inside of ball and pebble mills under varying conditions of operation.

J. M. Rahter
Paul O. Abbe, Inc.

7:30 p.m. - 10:00 p.m.

SESSION 2: DESIGN PROCEDURES FOR SELECTING TURBINE AGITATORS

Session Chairman: J. B. Gray
DuPont Company

A design procedure for selecting appropriate turbine agitators for applications in liquid blending, solid suspension, or gas dispersion has been developed. The procedure characterizes the size of the problem and its difficulty, interprets the desired results on a scale of 1 to 10, and results in specification of horsepower, speed, impeller type and size, and agitator drive size. The procedure is based on a series of papers published in Chemical Engineering in 1976 by Chemineer Agitators.

L. E. Gates, R. W. Hicks, and D. S. Dickey
Chemineer, Inc.

Tuesday, August 23, 1977

9:00 a.m. - 12:00 Noon

SESSION 3: STATIC MIXERS

Session Chairman: S. J. Chen
Kenics Corporation

Tuesday, August 23, 1977 continued

"Modeling Flow in a Static Mixer Unit"

A model based on non-orthogonal coordinates predicts pressure drop and mixing efficiency. Mixing efficiency is higher than in a single screw extruder, based on the criterion of weighted average total strain.

T. P. Tung and R. L. Laurence
University of Massachusetts

"Plug Flow Reactor Residence Time Behavior with Koch-Sulzer Static Mixing Elements"

The tracer response of the Koch-Sulzer mixer is close to that of an ideal plug flow reactor. There are 10 to 15 equivalent stirred tanks per meter.

M. Mutsakis
Koch Engineering Company

"Two Phase Flow in Kenics Mixers"

Pressure drop, holdup, and throughput characteristics of gas-liquid mixtures have been studied in Kenics mixers.

J. M. Smith
Technical University Delft
The Netherlands

"Drop Size Distribution Correlations for Ross LPD and and LLPD Motionless Mixers"

Organic solvent drop size is correlated with physical properties, ratio of solvent to water, geometry, and flow rate in Ross LPD and LLPD Motionless Mixers.

N. R. Schott and D. Yuu
University of Lowell

"Automatic pH Control Using Static Mixer Units"

Industrial pH control systems using static mixers to mix acid or caustic solutions into waste water streams will be discussed. Feedback and feedforward control loops with one and two stage mixer systems will be illustrated.

L. D. Beaudette
Kenics Corporation

"In-Line Flocculation"

An in-line flocculation process using a motionless mixer will be described. Detention time is less than one second. Favorable characteristics include low costs for capital, and especially energy and maintenance.

M. Fischer
Parkson Corporation

Tuesday, August 23, 1977 continued

"Koch-Sulzer Static Mixing Oxidation Power"

A superior way to oxidize sodium sulfite and other waste water streams having chemical oxidation demand is discussed with particular reference to research data, scale-up, and existing commercial applications.

M. Mutsakis
Koch Engineering Company

2:00 p.m. - 5:00 p.m.

AD HOC SESSIONS

7:30 p.m. - 10:00 p.m.

SESSION 4: CHEMICAL REACTION AND MIXING

Session Chairman: D. H. White
University of Arizona

"The Influence of Viscosity on Micromixing in a Stirred Tank Reactor"

Experiments have shown a large influence of stirrer speed and especially viscosity on the product distribution from two fast, series-parallel reactions. Theoretical interpretations are made based on unsteady state molecular diffusion and reaction within zones of size comparable to the Kolmogoroff microscale.

J. R. Bourne
Swiss Federal Institute of Technology

"Limiting and Asymptotic Forms of Residence Time Distributions"

The tail of a residence time distribution is often exponential, but it can decay slowly so that the variance is infinite. The effects of high internal circulation rates, laminar regions, and molecular diffusion are analyzed.

E. B. Nauman
Union Carbide Corporation

"Coalescence-Dispersion Modeling of Continuous Combustion"

Coalescence-dispersion modeling is applied to investigate the effect of mixing frequency on flame stability and pollutant production.

D. T. Pratt and J. L. Riley
University of Utah

"Flow Phenomena in Twin Screw Extruders"

A radioactive tracer technique has been used to measure flows and residence time distributions in a 47 mm twin screw extruder processing polypropylene granules

L.P.B.M. Janssen and J.M. Smith
Technical University Delft

Wednesday, August 24, 1977

9:00 a.m. - 12:00 Noon

SESSION 5: IMMISCIBLE LIQUID OPERATIONS

Session Chairmen: J. Oldshue
Mixing Equipment Company

L. L. Tavlarides
Illinois Institute of Technology

"Analysis of Liquid-Liquid Dispersions with Mass Transfer and Reaction"

A review of the literature from 1970 to the present is made. Drop sizes, breakage, coalescence, experimental methods, modeling methods, and applications are stressed.

L. L. Tavlarides
Illinois Institute of Technology

"Mass Transfer in Liquid-Liquid Extraction Systems"

Mixer-settler batch studies are used to design continuous liquid-liquid extraction systems.

J. Oldshue and M. Lakin
Mixing Equipment Company

"On the Transitional Probability of Droplets in Liquid-Liquid Dispersions"

G. Narsimhan, D. Ramkrishna, and J.P. Gupta
Purdue University

"Drop Formation and Polymerization Processes"

The paper includes an examination of various dispersion models, confirmation of these models with laboratory data, and practical experience in using the models for scale-up to commercial size batch polymerization reactors.

D. Leng
Dow Chemical Company

2:00 p.m. - 3:10 p.m.

SESSION 6: MIXING RESEARCH IN JAPAN

Session Chairmen: R. E. White
Villanova University

D. Ramkrishna
Purdue University

Wednesday, August 24, 1977 continued

"Recent Mixing and Agitation Research in Japan"

E. Oshima
Tokyo Institute of Technology

"Drop Size Distribution in a Mixing Vessel"

M. Nishikawa
Kyoto University

"Mean Flow and Turbulence Measurements for a Radially Discharging Impeller"

Y. Nagase
Hiroshima University

3:15 p.m. - 5:00 p.m.

SESSION 7: RESEARCH NEEDS AND OPPORTUNITIES IN MIXING
- PART 1

Session Chairman: *A. Gomezplata
University of Maryland

Short presentations of 5 to 15 minutes outlining research needs and opportunities as perceived by conference attendees. All speakers will be asked to prepare a one to three page written statement to be distributed by the National Science Foundation.

Conference attendees wishing to speak in this session should contact the Session Chairman prior to the Conference or on the first day of the Conference. Preference will be given to attendees with prepared written statements, authors of papers, and impromptu presentations, in that order.

7:30 p.m. - 10:00 p.m.

SESSION 8: LIQUID MOTION AND BLENDING

Session Chairman: T. R. Hanley
Tulane University

"Mixing Viscoelastic Liquids"

Influence of viscosity and viscoelasticity in agitated vessels, bubble induced mixing and solids suspension.

J. Ulbrecht
Chemical Engineering Department
University of Salford, England

"Shear vs. Circulation Flows in Agitated Vessels"

All impellers can be characterized according to the fraction of the input power which produces circulation, and the fraction which produces local shear and dissipation. Dimensionless criteria are developed and applied to blending, gas dispersion, solid suspension, and heat transfer.

Vincent W. Uhl
Environmental Protection Agency

Wednesday, August 24, 1977 continued

"Measurement and Interpretation of Circulation Time Distributions in Agitated Tanks"

J. C. Middleton
I.C.I. Corporate Laboratory
England

"A Design Procedure for Turbulent Jet Mixing in Tubes"

P. W. Coldrey
I.C.I. Corporate Laboratory
England

Thursday, August 25, 1977

9:00 a. m. - 11:00 a.m.

SESSION 9: SOLID LIQUID SYSTEMS

Session Chairman: R. W. Pike
Louisiana State University

"Effect of System Geometry on Flow Patterns and Fluid-Particle Mass Transfer in Agitated Vessels"

Flow patterns, suspension, and rate of dissolving of 2 mm sodium chloride crystals were studied in turbine agitated vessels. Power required to suspend the crystals varied by a factor of 30, but the mass transfer rate was nearly constant for all conditions which just suspended the crystals.

A. W. Nienow and D. Miles
University College London, England

"Continuous Twin Screw Mixing of Solids into Molten Polymers"

The incorporation of solid fillers such as titanium dioxide, talc, and fiberglass into plastics by a twin-screw machine is described.

D. B. Todd
Baker Perkins

"Production of Ultra High Solids Dispersions in a Colloid Mill"

A new process is described for producing ultra high solids dispersions in a small fraction of a second using a colloid mill. Products with up to 90%w solids loadings have been produced commercially.

G. Vickery
Basic Chemicals

Thursday, August 25, 1977 continued

"Mixing Solid Rocket Propellant"

Equipment, controls, and processing techniques for mixing solid rocket propellants are described. About 86-88%w solids are blended with an elastomeric binder to produce a 3,000-15,000 poise product.

M. T. Olliff
Thiokol Corporation

11:00 a.m. - 12:00 Noon

SESSION 10: LOW ENERGY MIXING

Session Chairman: R. V. Calabrese
Stevens Institute of Technology

"Energy Savings with Low Speed Mixers"

The current energy shortage motivates consideration of power savings in mixing. Low speed mixing can save considerable power.

M. D. Strong
Cleveland Mixer

"Fluid Mixer Drive Efficiencies - Practical Considerations"

Conserving energy in mixing, particularly in large, secondary treatment, wastewater plants, is of increasing interest. Practical considerations of overall reliability, operating noise, and mechanical efficiency of gear drives are discussed.

J. R. Connolly
Philadelphia Mixers

2:00 p.m. - 5:00 p.m.

AD HOC SESSIONS

7:30 p.m. - 10:00 p.m.

SESSION 11: GAS LIQUID SYSTEMS

Session Chairman: R. R. Furgason
University of Idaho

"Unconstrained Bubble Columns for Mixing Large Volumes"

Direct injection of air can mix deep pools of liquid. Quantitative measurements have been made, using conventional and laser-doppler methods.

J. M. Smith and L. H. J. Goosens
Technical University Delft
The Netherlands

Thursday, August 25, 1977 continued

"Gas Dispersion in Viscous and Viscoelastic Liquids"

Mechanism of gas dispersion, mass transfer rates, power consumption, and interpretations for viscous and viscoelastic liquids.

J. Ulbrecht
University of Salford, England

"Effect of Liquid Viscosity of a New, Conical, Self-Inducing, Gas Dispenser"

A conical, self-inducing, gas disperser has been studied in detail. Critical gas flow rate, bubble size, effects of rheology, applications, and comparisons with other types of self-inducing gas dispersers are discussed. A movie will be shown

C. Koen
Agitation Consultant
France

"Mass Transfer in Gas Liquid Systems"

Discrepancies caused by experimental methods are reviewed, and the main factors governing the rate of gas mass transfer are shown to be power per unit volume and superficial gas velocity. A useful correlation is presented.

K. Van't Riet
Gist Brocades nv, Delft
The Netherlands

Friday, August 26, 1977

9:00 a.m. - 12:00 Noon

SESSION 12: RESEARCH NEEDS AND OPPORTUNITIES IN MIXING
PART II

Session Chairmen: A. Benson and G. Martin
Shell Development Company

Short presentations of 5 to 15 minutes outlining research needs and opportunities as perceived by conference attendees. All speakers will be asked to prepare a one to three page written statement for a booklet to be distributed by the National Science Foundation.

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