

1975 ENGINEERING FOUNDATION CONFERENCE

MIXING RESEARCH

Franklin Pierce College
Rindge, New Hampshire
August 17-22, 1975

PROGRAM

Sunday, August 17, 1975

2:00 p.m. - 9:00 p.m. REGISTRATION AND CHECK-IN
6:30 p.m. - 7:30 p.m. Dinner
8:00 p.m. - 10:30 p.m. Get Acquainted Social Period

Monday, August 18, 1975

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

WELCOME

Dr. Sanford S. Cole, Director
Engineering Foundation Conferences

PURPOSE AND GOALS OF THE CONFERENCE

W. Roy Penney, Conference Chairman
Monsanto Company, St. Louis, Missouri

SESSION I: MIXING IN MOTIONLESS MIXERS

Session Chairman: Professor R. J. Adler,
Case Western Reserve University, Cleveland, Ohio

"TURBULENT INLINE MIXING OF LIQUIDS"

Turbulent inline mixing was investigated in a straight tube, a tube with inserts, and a jet mixer. Dimensionless correlations are given.

Professor J. W. Hiby
Technical University of Aachen, West Germany

"MIXING OF MATERIALS OF WIDE VISCOSITY DIFFERENCES"

Experimental results are presented for use of a Static Mixer to mix small amounts of a low viscosity liquid with a viscous polymer melt.

R. L. Powell
Kenics Corporation, Danvers, Massachusetts

T. P. Bor
Kenics Europe, Brussels, Belgium

"PERFORMANCE OF A NEW MOTIONLESS MIXER"

Two older motionless mixers are compared with a new motionless mixer. Homogeneity, pressure drop, residence time distribution, and costs are compared. A short movie shows the flow processes in the mixers.

H. J. Kaluza
Bayer AG, Dormagen, West Germany

"RESIDENCE TIME DISTRIBUTIONS THROUGH MOTIONLESS MIXERS"

Studies were conducted for two types of mixers. Peclet number data and its implications will be presented.

Richard Barbini
Charles Ross & Son Company, Hauppauge, New York

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

SESSION II: DROPLET GENERATION IN MOTIONLESS MIXERS

Session Chairman: ^{Joe} J. B. Gray
duPont, Wilmington, Delaware

"DROP SIZE DISTRIBUTION GENERATED BY TURBULENT FLOW IN MOTIONLESS MIXERS"

Several organic liquids were dispersed in water using an LPD mixer. Dimensionless correlations were obtained and the results are compared with existing data for a STATIC MIXER.

Professor N. R. Schott
Lowell Technical Institute, Lowell, Massachusetts

Not Presented "DROP SIZE DISTRIBUTIONS FOR WATER-ORGANIC DISPERSIONS USING VARIOUS IN-LINE DEVICES"

A Koch mixer, a globe valve, and an orifice plate were used to create water in organic dispersions. Dimensionless correlations were obtained.

Bruce Weinstein
Koch Engineering Company, Wichita, Kansas

"DROPLET STUDIES IN TWO MOTIONLESS MIXERS"

The Ross LPD and LLPD were used to create dispersions of mineral oil-in-water dispersions. Drop size distributions were measured and dimensionless correlations were obtained.

Richard Barbini
Charles Ross & Son Company, Hauppauge, New York

Tuesday, August 19
9:00 - 12:00 noon

SESSION III: FUNDAMENTAL PHENOMENA OF AGITATED VESSELS

Session Chairman: Professor G.T. Tsao,
Purdue University, West Lafayette, Indiana

"FLOW PATTERN AND INSTABILITY PHENOMENA NEAR ROTATING BODIES AND AGITATORS IN VISCOELASTIC POLYMER SOLUTIONS"

Flow anomalies in agitated vessels are often related to rotational axisymmetric flow of viscoelastic fluids. Such secondary flow can lead to worsening of the mixing efficiency. Predictive methods will be discussed.

Professor J. Ulbrecht
University of Salford, Lancashire, England

also Elasticity & Torque - no difference
"ATTENUATION OF CONCENTRATION FLUCTUATIONS OF A PRODUCT STREAM BY A JET-AGITATED BUFFER LAYER"

Model experiments were performed in a jet-agitated, continuous-flow vessel. Mixing effectiveness was correlated vs. the Reynolds number and the Froude number.

Professor J.W. Hiby (Speaker) and H. Tsuge
Technical University of Aachen, West Germany

"THE HYDRODYNAMICS OF A RUSHTON TURBINE"

Pressure and velocity fields have been studied both with liquid mixing and with gas dispersion. Amongst the surprising findings are the extremely high shear rates which are important in non-coalescing systems.

Professor J.M. Smith (Speaker) and K. Van 'tRiet
Technical University of Delft, Holland

"INFLUENCE OF RHEOLOGY UPON THE RATE OF MIXING OF POLYMER SOLUTION IN STIRRED TANKS"

The influence of non-Newtonian properties on the mixing and circulation times was determined for a helical screw agitator operating in a draft tube.

Professor J. Ulbrecht
University of Salford, Lancashire, England

7:30 - 10:00 p.m.

SESSION IV: EFFECTS OF MIXING ON CHEMICAL REACTIONS

Session Chairman: W.C. Brasie, Dow Chemical
U.S.A., Midland, Michigan

"MIXING DIFFUSION AND CHEMICAL REACTION IN AN UN-PREMIXED REACTOR"

A single parameter-minimum age mixedness - species diffusion model has been developed to describe the effects of simultaneous diffusion and chemical reaction on the performance of a chemical reactor into which reactants are fed separately within feedstreams having residence time distributions. Predictions are compared with experiments.

Professor ^{BW} B. W. Ritchie (Speaker) and A. H. Tobgy
University of Exeter, England

"A NEW TEST FOR MICROMIXING EFFECTS"

Fast substitution of bromine in a aromatic nucleus has been used to measure micromixing in a turbine-agitated, baffled tank. A good correlation between product distribution and power input was obtained.

Professor ^{John} J. R. Bourne
Technical University, Zurich, Switzerland

"PREDICTING THE EFFECT OF MIXING ON CHEMICAL REACTIONS -A CURRENT STATE-OF-THE-ART"

The influence of the effects of mixing processes on chemical reactions in turbulent systems will be discussed, including systems with competing reactions. Emphasis is placed on systems with competing reactions.

Professor H. L. Toor
Carnegie-Mellon University, Pittsburgh, Penn.

Wednesday, August 20
9:00 - 12 noon

SESSION V: AXIAL MIXING AND ITS EFFECT ON THE DESIGN AND OPERATION OF PROCESSING EQUIPMENT

Session Chairman: Professor N. R. Schott,
Lowell Technological Institute, Lowell, Mass.

"FLOW AND RESIDENCE TIME CHARACTERISTICS OF A DOUBLE-SCREW PROCESSOR OR EXTRUDER"

A model is presented which predicts the operating characteristics and the residence time distribution for a Newtonian fluid. The model explains measured performance and is a valuable start toward development of models for non-Newtonian fluids.

Professor J. M. Smith and L. P. B. M. Janssen
Technical University of Delft, Holland

"AXIAL MIXING IN MASS TRANSFER EQUIPMENT"

This presentation will be a broad review of the importance of axial mixing, its effects on mass transfer performance, measurement techniques, the mechanisms by which it occurs, and ways to reduce it.

Professor M.H. Baird
McMaster University, Hamilton, Ontario, Canada

"RESIDENCE TIME DISTRIBUTION SCALEUP IN A CONTINUOUS MULTISTAGE MIXER COLUMN"

A technique for scaling up residence time is presented together with performance data for a cocurrent multistage mixer column and countercurrent packed column. Both examples demonstrate the general applicability of the technique.

Gyanendra Singh
Procter and Gamble Co., Cincinnati, Ohio

"GAS-LIQUID REACTION IN A STAGED CONTINUOUS REACTOR OF UNIQUE DESIGN"

Scaleup from pilot tests on a 6 inch diameter, 3 stage unit to a 4 feet diameter, 3 stage unit will be discussed.

M.S. Mery
The Bethlehem Corp., Bethlehem, Penn.

7:30 - 10:00 p.m.

SESSION VI: SOLID-LIQUID AND SOLID-SOLID OPERATIONS

Session Chairman: J.Y. Oldshue, *NY*
Mixing Equipment Co., Rochester, New York

Vineville

"THE ATTAINMENT OF HOMOGENEOUS SUSPENSION IN STIRRED TANKS"

Experiments were conducted to determine means to achieve homogeneous suspension in continuous-flow stirred tanks. New designs, including techniques of product removal, have proved successful for high sedimentation rates and low impeller tip speeds.

Bourne
Professor J.R. Bourne
Technical University, Zurich, Switzerland

"MIXING OF STARCH SLURRIES"

Experimental work was done with a marine propeller, a straight-blade turbine and pitched-blade turbine. Correlational attempts and several anomalous effects are discussed.

Professor G.T. Tsao (Speaker), L. Christiansen, and
A. Patel, Iowa State University, Ames, Iowa

☞ "SOLIDS-SOLIDS BLENDING AND THE INCORPORATION OF LIQUIDS
INTO DRY SOLIDS"

Results are presented for two independent, experimental
studies of the incorporation of liquids into powders for
preparing pharmaceutical granulations. Sampling programs,
analysis procedures and statistical evaluations are discussed.

T.A. Resing
Littleford Bros., Cincinnati, Ohio

Thursday, August 21
9:00 - 12:00 noon

SESSION VII: MIXING IN WASTE TREATMENT PROCESSES

Session Chairman: Jerry Shell, AWARE, *Industrial Waste Treatment*
Nashville, Tennessee

☞ "PROBLEMS IN OPERATION OF SURFACE AERATORS"
M.S. Berkeley

Small scale tests were conducted with several different
types of aerators. Dimensionless correlations were
obtained for sorption and power numbers. These correlations
were checked with data from a 14 feet diameter full-scale
aerator. These studies show that the large aerators are
often much less efficient than small surface aerators
and other kinds of oxygen transfer devices.

Marko Zlokarnik *Zur Abchen*
Bayer AG, Leverkusen, West Germany

"IMPORTANCE OF MIXING IN BIOLOGICAL WASTEWATER TREATMENT"

The effects of mass transfer, solids suspension and
residence time distribution will be discussed.

A.A. Kalinske
Camp, Dresser, and McKee, Boston, Mass.

MIXING OF BIOLOGICAL SUSPENSIONS WITH SUBSURFACE
MOTIONLESS MIXERS"

The oxygen transfer and solids suspension characteristics
of 5 different types were measured.

Jerry Shell
AWARE, Nashville, Tennessee

"MIXING OF BIOLOGICAL SYSTEMS WITH SUB-SURFACE IMPELLETS"

Aeration equipment included submerged radial turbines, surface
aerators with lower axial flow turbines and, in some cases
diffused air devices. Velocity profiles, solids suspension
profiles and dissolved oxygen gradients were measured.

Predictive models for calculating oxygen transfer were compared.

J. Y. Oldshue and G. L. Connelly
Mixing Equipment Co., Rochester, New York

7:30 - 10:00 p.m.

SESSION VIII: RESEARCH NEEDS AND OPEN FORUM

Session Chairman: J.G. Fenic, Chemineer,
Dayton, Ohio

All authors (lecturers) and session chairmen have been requested to prepare a short paper on research needs. They were requested to list five specific areas they consider most important. They will define clearly the state-of-the-art and indicate the probable research approach and scale of required research. Each will be given 5-10 minutes to present their material.

Any remaining time will be devoted to an open forum where anyone will be given 5-10 minutes to talk on any subject.

Friday, August 22

SESSION IX: POTPOURRI

9:00 - 12:00 noon

Session Chairman: W.G. Pfitzer,
Procter and Gamble, Cincinnati, Ohio

"AN EVALUATION OF FIRST COST AND POWER COST FOR FLOW CONTROLLED MIXING APPLICATIONS"

A method of determining the most economical mixer will be presented.

G. L. Connelly and J. Y. Oldshue
Mixing Equipment Co., Rochester, New York

"ENERGY CONSERVATION IN FLUID MIXING - THE PSYCHOLOGY AND PRACTICALITY OF MORE MIXING PER AMPERE"

Much previous work on common commercial operations has uncovered routes for getting specific fluid mixing results with minimum horsepower. Techniques to minimize mixing energy will be covered.

J. R. Connolly
Philadelphia Mixer Corp., King of Prussia, Penn.

"BLENDING OF MISCIBLE LIQUIDS HAVING WIDELY DIFFERENT VISCOSITIES"

The blending time as a function of viscosity difference was measured by carefully stratifying two layers of warm and cold liquids having different viscosities.

J.Y. Oldshue and G.L. Connelly
Mixing Equipment Co., Rochester, New York

"RECENT DEVELOPMENTS IN COMMERCIAL EXTRACTORS"

Industrial extractors are briefly reviewed, with emphasis on recent developments. Selection, economics, control, and operating practice in some large columns are discussed.

T.C. Lo

Hoffmann-La Roche, Nutley, New Jersey

"MIXING AND INTERFACIAL PHENOMENA IN MULTIPLE-PHASE FLUIDS"

Experimental measurements will be discussed.

Professor G.T. Tsao (Speaker), D.D. Lee, and
D.T. Hsu,
Iowa State University and Purdue University