POLYURETHANES
CONFERENCE 2002

October 13 – 16, 2002
Grand America Hotel
Salt Lake City, Utah

CONFERNECE PROCEEDINGS

Sponsored by the Alliance for the Polyurethanes Industry
Table of Contents

**TECHNICAL SESSION A — Construction**

Stabilization of Rigid Systems Containing Aromatic Polyester Polyol and Water ........................................... 3  
C. A. McAdams, S. Farmer, KoSa

Long Term Thermal Resistance of Pentane Blown Polyisocyanurate Laminate Boards ...................................... 19  
S. N. Singh, M. Ntiru, K. Dedecker, Huntsman Polyurethanes

Meeting the Future Requirements of Insulated Door and Pour In-Place Panel Manufacturers using Water and Enovate 3000 (HFC-245fa)/Water Blended Systems .............................................. 27  
J. Heraldo, B. Carlstrom, D. Tideswell, T. Thiem, Carpenter Co.

Flame Retardant Pentane Blown Polyisocyanurate Foams for Roofing .......................................................... 32  
E. F. Feske, W. R. Brown, Albemarle Corporation

Effective Use of Compatibilizers to Achieve Resin Stability with Hydrocarbon Blowing Agents ....................... 41  
J. T. Lyon, R. E. Riley, BASF Corporation

Novel Polyester Polyol to Enhance the Physical Properties of R245fa Foams ............................................... 49  
D. Shieh, Oxid L.P.

M. Devine, Foam Enterprises Research, Inc.

**TECHNICAL SESSION B — Automotive: Advances in Automotive Polyurethane Materials**

ClearRIM — New Polyurethane Coating System for Sealing Natural and Root Wood Trim for Automotive Applications ........................................................................................................... 57  
T. E. Cheryba, Hennecke Machinery

G. Willmeroth, Hennecke GmbH

Non Crushing Foam System for Automotive Seat .................................................................................................... 61  
H. H. Park, J. B. Park, H. Ueda, Kumho Mitsui Chemicals, Inc.

Baypreg®F Composite: A Winning Combination of Light Weight and High Stiffness ........................................ 70  
R. A. Cageao, Bayer Corporation

D. Wegener, Bayer AG Leverkusen

A Raw Materials System Concept for Wider Ranging Demands of Flexible Polyurethane Molded Foam ............................. 75  
K. Usaka, M. Isobe, H. Utsumi, K. Ohkubo, Mitsui Takeda Chemicals, Inc.

Cannon’s Approach for RIM PU Skin Production: Evaluation of a Recent Application .................................... 83  
C. Cairati, Cannon Afros

M. Taverna, Cannon Group

Newly Designed High Performance Raw Material System for Automotive Seat Cushion Foam .................... 89  
TECHNICAL SESSION C — Environment, Health and Safety
Laws and Regulations: What Every Polyurethane Manufacturer Needs to Know .................................................. 99
D. E. Miller, Miller Environmental & Safety Services

MDI, TDI and the Environment ................................................................................................................................. 106
R. E. Bailey, Bailey Associates
W. P. Robert, BASF Corporation

D. E. Miller, Miller Environmental & Safety Services

API Model Respiratory Protection Program ............................................................................................................ 113
C. Cleet, API

Emission of VOC's from Bonded Foam Carpet Underlayment ............................................................................. 118
B. Fogg, R. G. Sawitski, Huntsman Polyurethanes

PU Recovery Fit for End of Life Waste Regulations in the European Union?
A market, cost and technology overview ............................................................................................................... 123
F. E. Mark, DOW Europe

TECHNICAL SESSION D — Blowing Agents

Enovate™ TM 3000 Blowing Agent: A Versatile and Cost Effective Blowing Agent
Technology for Rigid Foam .................................................................................................................................... 135
D. Williams, Honeywell

Hydrochlorocarbons/Pentanes Coblown PIR Foams for Improved Fire Performance ........................................... 144
J. Wu, D. Dillon, R. Crooker, Atofina Chemicals, Inc.

Tailor Made HFC Foaming Agent Blends for PU System Application ................................................................. 151
L. Zipfel, SOLVAY Fluor und Derivate
P. Dournel, SOLVAY Research and Technology

Hydrocarbon Blown Polyisocyanurate Systems for Continuous Laminate Metal Faced Panels ........................... 157
M. J. Skowronski, The Dow Chemical Company
F. Pignagnoli, Dow Italia S.r.l.

Hydrocarbon-Blown Formulations for Appliances and Rigid Panels: Available Solutions for Specific Local Regulations ............................................................................................................................ 166
C. Cairati, D. Lucca, G. Gula, M. Taverna, Cannon USA

Polyurethane Raw Material Frothing Process and Acceptable Blowing Agents ................................................... 177
T. A. Rompala, Hennecke Machinery
M. Sulzbach, J. Wirth, Hennecke GmbH

TECHNICAL SESSION E — Automotive: Reduced V.O.C. Emissions for the Automotive Industry

Advance in Amine Emission Free Catalyst Systems for Automotive Seating — A Fundamental Study on Durability Performance by Humid Aging Load Loss Test (HALL) ........................................ 189
T. Masuda, H. Nakamura, Y. Tamano, H. Yoshimura, TOSOH Corporation
R. Van Maris, TOSOH EUROPE B.V.
K. M. Gay, TOSOH USA, Inc.

High-active Built-in Catalysts for Low-VOC-Applications Avoid the Odor of Amine Catalysts but Improve the HACS Values ....................................................................................................................... 199
S. Uwe Keimling, Nitroil Performance Chemicals
W. Klockeman, Performance Chemical International
M. Bader, INPUT Institute for Polyurethane Technology
Recent Advances in the Development of Catalytically Active Polyols for the Automotive Market.............206
J. M. Sonney, F. M. Casati, Dow Europe GmbH
R. D. Dawe, The Dow Chemical Company
K. N. Khameneh, Dow Automotive
T. Jones, J. Olari, P. Fielding, Renosol Corporation

TECHNICAL SESSION F — Combustibility
Polyurethane Products: Overview of US Model Building Code Fire Performance Requirements ..............217
L. Ross, J. Hagan, Intech Consulting
Fundamentals of Flame Retardation: The Burning Process and the Mode of Action of Flame Retardants.................................................................234
E. Bleuel, BASF Schwarzheide GmbH
P. Boehme, BASF Antwerp NV
U. Rotermund, M. Reichelt, BASF Schwarzheide GmbH
C. Seitz, Elastrogran GmbH
Fire Behavior of Polyurethane Foams.................................................................244
B. Bastin, Shell Chemicals
J. Lefebvre, UPRES EA
R. Paleja, Shell Chemicals
Polyurethane Products in Fires: Acute Toxicity of Smoke and Fire Gases ..........................................255
T. D. Landry, The Dow Chemical Company
D. Daems, Huntsman Polyurethanes
J. Pauluhn, Bayer AG
K. A. Reimann, BASF Corporation, BASF
Intumescent Barrier Coatings.............................................................................259
R. Dombrowski, TechTex Solutions, Inc.
Polyurethanes and Fire: Regulatory Trends in Europe and Standardisation.................................264
D. Daems, Huntsman Polyurethanes

TECHNICAL SESSION G — Coatings, Adhesives, Sealants, and Elastomers (CASE)
Effects of Inorganic Filler on Polyurethane Dispersion Formulations..................................................267
B. Erdem, D. Robinson, The Dow Chemical Company
Polyurethane Dispersion Based Pressure Sensitive Adhesives.............................................................275
P. Cranley, E. Cork, C. Esneault, A. Chavez, B. Erdem, Dow Chemical Co.
Mechanisms of Military Coatings Degradation: Color and Gloss Performance Evaluation ..............281
P. Patterson, W. Lum, J. Escarsega, Army Research Laboratory
Physical Properties of Aromatic Polyurea Elastomer Coatings After Exposure to Extreme Conditions.................................291
J. A. Johnston, S. Smith, Huntsman Polyurethanes
Polyurethane Elastoplastics for Load Bearing Applications.................................................................307
A. Sendijarevic, Troy Polymers, Inc.
C. O. Townley, BioPro, Inc.
Study of Polarity and Chain Extender Performance for Cast Elastomers .............................................316
The Evaluation of Novel Titanate Catalysts in Polyurethane Elastomers ..............................................322
B. F. Stengel, SYNETIX
TECHNICAL SESSION H — Testing

Regional Accelerated Aging Test ................................................................. 335
R. Yamasaki, J. T. McEvoy, Johnson Controls, Inc.

Resistance/Recovery of HR Foam Seating to Climatic Changes and Media Attack ........... 344
G. R. Blair, R. J. Bailey, I. Rai, Woodbridge Foam Corporation
M. Weierstall, The Woodbridge Group

Evaluation of Airflow Test Methods and Their Influence on Performance of Polyurethane Foams 352
R. V. Gummaraju, S. E. Wujcik, R. F. Pask, BASF Corporation

Using a Mass Loss Technique to Evaluate Furniture Flammability in Small Scale ........... 359
K. A. Reimann, R. F. Pask, BASF Corporation
A. F. Grand, Grand Fire Consulting
B. Fogg, Huntsman Polyurethanes
R. Skorpenske, Bayer Corporation

Polyiso Insulation: Leading the Way to Long Term Thermal Resistance (LTTR) Values .......... 370

TECHNICAL SESSION J — Furnishings

NovaFlex®-MultiFill: An Innovative Technology for Processing CO₂ Slabstock Foam with Fillers ................................................................. 377
I. Wilkes, J. D. Shoup, Bayer Corporation

Emanation Free Catalysis for the Production of Polyether Polyurethane Foam ............... 380
R. Hoffmann, H. Schoens, Degussa AG

Catalytically Active Polyols for VOC Emission Reduction in Flexible Slabstock Foams .......... 387
F. Aguirre, T. Woods, Dow Europe GmbH
L. Cooper, The Dow Chemical Company
H. De la Ruelle, Dow Benelux B.V.

D. J. Honkomp, G. Casagrande, The Dow Chemical Company

Tailor Made Silicone Surfactants for Viscoelastic Foams .................................... 409
O. Eyrisch, G. Burkhart, Degussa AG

Polyurethane Foam Compares Favorably to Latex Foam ...................................... 415
T. J. Green, T. M. Smiecinski, BASF Corporation

TECHNICAL SESSION K — Processing Innovations

Recent Advances in Low-Volume High-Quality Production of PUR Parts for Engineering Applications ................................................................. 423
A. McCourt, A. D. Nurse, R. Phelps, Loughborough University
L. E. J. Styger, Institute of Materials

Application Technology: The In-Line Blending of Pentane .................................. 428
J. Stout, Linden-Industries Inc./EMB
R. G. Begbie, Jr., ExxonMobile Chemical Company
C. J. Maher, Dow Chemical Company
W. Inhof, Siempelkamp Handling Systeme GmbH & Co.
Multi-Component Mixing Head for Automotive Seats Production: A Dedicated Solution
Opens New Manufacturing Opportunities
C. Cairati, Cannon Afros
M. Taverna, M. Castiglioni, Cannon Group
B. Pile, Cannon USA

An Innovative Approach to Flushing Applications
L. Kirby Kirkpatrick, Dynaloy, Inc.

High-Pressure Machines and High-Pressure Mixingheads for 2-6 Components and RIM-Star 8/8 for Multicolour Technology
J. P. Mead, Krauss Maffei Corporation
L. Schiemann, Krauss-Maffei

TECHNICAL SESSION L — Appliance
Tailor Made HFC-245fa Foam for Appliance Applications
J. King, P. Irwin, I. Latham, S. Moore, The Dow Chemical Company

Surfactants and Catalysts for HFC-245fa Appliance Foams

Novel Processing of LBBA Appliance Systems
J. Feighan, J. Deschaght, F. Magnani, Huntsman Polyurethanes

Can HFC245fa or Cyclopentane Blown Foams Match the Performance of HFC-Foams?
H. Seifert, A. Biedermann, C. Giesker, Elastogran GmbH

The Effect of the Blowing Agent and Shot-Weight Reduction on the Long-Term Dimensional Stability Performance of Rigid Polyurethane Systems for Appliance Insulation
E. Kucukpinar Niarchos, T. Gonul, F. Ozkadi, ARCELIK, A.S.

Innovative Technology for “New” Foam in Place Refrigerator Door Production
D. Hanne, Hennecke Machinery
B. Geiger, Hennecke GmbH

Brand-new Trend of the Cyclopentane-Blown Rigid Foam Systems for the Appliance Industry - Combined Systems of Excellent Insulation Performance with Fast Demoldability -

TECHNICAL SESSION M — Footwear
New Catalyst and Surfactant Additives Developed for Microcellular Polyurethane Foam Systems Used in Shoe Soling Applications
M. A. Dimitroff, Crompton Corporation

The Casting of Polyurethane (low pressure, self cleaning head) for Shoe Soles and Technical Parts using a Robot Guided Mixing Head with Small Shot Volume and Granulate Filler Dosing System
K. Freese, Klöckner DESMA Schuhmaschinen

Integrating High Performance PU-Materials in Sportshoe’s
K. Knoerr, V. Rouiller, adidas-Salomon AG

Factors determining the Slip Resistance of Polyurethane Soling Materials
T. Roels, Huntsman (Europe) BVBA
R. Camargo, Huntsman Polyurethanes
P. Goegebeur, Huntsman (Europe) BVBA
New Generation of VORALAST* Polyurethane Systems for Shoe Soles Applications ........................................ 543
J. Carnicer, Dow Italia S.r.l.
M. J. Barnes, The Dow Chemical Company

Additives for Improved Processing of Microcellular Polyurethane Shoe Sole Systems ........................................ 554
G. D. Andrew, J. D. Tobias, Air Products and Chemicals, Inc.

TECHNICAL SESSION N — Fundamentals

Effect of Average Particle Size and Distribution on the Performance of Copolymer Polyols ........................................ 567
A. Rath, W. Apichatachutapan, R. Gummaraju, R. Neff, D. Heyman, BASF Corporation

Synthesis of Low-monol Polyether Polyols by Using Highly Active Catalysts and Their
Applications to High-performance Polyurethanes ........................................ 583
I. Kim, J.-T. Ahn, Pusan National University
I. Park, S. Lee, SKC Company

New Hybrid Process for Purification and Separation of MDI Isomers ........................................ 594
M. Stepanski, Sulzer Chemtech Ltd.
P. Faessler, Sulzer Chemtech Pte. Ltd.

New Mannich Polyol for Next Generation Spray Technology ........................................ 601
R. D. Stewart, Huntsman Polyurethanes
R. L. Zimmerman, Huntsman Performance Chemicals

BASF’s Liquid Pure MDI: A New Innovative Storage Stable Liquid Pure 4,4’-MDI ........................................ 608
A. M. Rath, B. K. Searfoss, R. J. Tuinman, J. R. Broge, BASF Corporation

Study on Structure & Properties of Low Unsaturation Polyether Polyols Synthesized
by the Double Metal Cyanide Complex Catalysts ........................................ 618
S. Chen, L. Chen, Nanjing University of Technology

Use of Real-Time FTIR to Characterize Kinetics of Amine Catalysts and to Develop
New Grades for Various Polyurethane Applications, Including Low Emission Catalysts ........................................ 624
P. Chaffanjon, R. A. Grisby Jr., E. L. Rister Jr., R. L. Zimmerman, Huntsman Corporation

POSTER SESSION — Coatings, Adhesives, Sealants, and Elastomers (CASE)

ElastoLine: The Perfect Solution for Elastomer Processing ........................................ 639
T. A. Rompala, I. Wilkes, Hennecke Machinery

Morphology of Nanosilica Filled Segmented Polyurethanes ........................................ 640
Z. S. Petrović, Y. Cho, I. Javni, Pittsburg State University
S. N. Magonov, Digital Instruments

Polyurethane Elastoplastics for Load Bearing Applications ........................................ 641
A. Sendijarevic, Troy Polymers, Inc.
C. O. Townley, BioPro, Inc.

Reticulated PUR Foams as Reinforcing Three-Dimensional Fillers for PUR Elastomers ........................................ 642
F. Shutov, University of Minnesota
Y. Yuan, Tennessee Technological University

The Casting of Polyurethane (Low Pressure) for Shoe Soles and Technical Parts Using
a Robot Guided Mixing Head with Small Shot Volume and Granulate Filler Dosing System ........................................ 643
K. Freese, Klockner DESMA Schuhmaschinen GmbH
N. Streeter, Klockner Desma USA (KDE Sales & Service Inc)
POSTER SESSION — Flexible Foam/Automotive

Alternatives to Bromine or Halogenated FR's in Furniture and Automotive Foam
L. Bradford, M. Pinzoni, T. Halchak, Akzo Nobel

Effects of Mold Clamping on Flexible Molded Polyurethane Foam ILD
E. J. Reinstadtler, R. Riccitelli, Bayer Corporation

Fogging Performance with FR Flexible Foams (New Options)
M. Pinzoni, L. Bradford, Akzo Nobel

High-active Built-in Catalysts for Low-VOC-Applications Avoid the Odor of Amine Catalysts but Improve the HACS Values
K. Klockemann, Performance Chemical International Corporation
S. Uwe Keimling, Nitroil Performance Chemicals
M. Bader, INPUT Institute for Polyurethane Technology

Measurement of Physical Parameters in the Production of Slabstock Foams
B. H. W. Hofmann, Format Messtechnik GmbH
H.-D. Lutter, Elastogran GmbH

Urethane Foam which Outperforms Latex Foam for Cushioning Applications
T. Green, T. Smiecinski, BASF Corporation

POSTER SESSION — Fundamentals/Equipment

A Unified Spectroscopic Methodology for the Determination of Isocyanate and Hydroxyl Number in the Polyurethane Industry
P. Chabot, M. Kester, M. Trygstad, F. Baudais, ABB Bomeim Inc.

Analysis of Polyurethane Foam Processing and Aging
G. Kodippili, L. Sapochak, D. W. Hatchett, F. Benincasa, E. Sheld, K. Riccio, University of Nevada, Las Vegas

Application Technology — Pentane In-line Blending
J. Stout, Linden-Industries Inc./EMB
C. J. Maher, The Dow Chemical Company
R. G. Begbie, Jr., ExxonMobile Chemical Company
W. Inhoff, Siemenskamp Material Handling Systems

Comparison of Long-Term Thermal Performance of Polyurethane Foam Blown with Cyclopentane and HFC-365mfc
U. Jarfelt, C. Holmgren, S. Nilsson, S. Mangs, O. Ramnäs, Chalmers University of Technology

E-Stewardship: On Line, Real Time, All the Time
D. J. Nabuda, K. W. McCabe, Bayer Corporation

GBA Spray Foams
I. Wheeler, ATOFINA Chemicals, Inc.

High-pressure Machines and High-Pressure Mixingheads for 2-8 Components and RIM-Star 8/8 for Multicolour Technology
J. P. Mead, L. Schiemann, Krauss-Maffei Corporation

MDI and the Environment
R. Bailey, Bailey and Associates
W. Robert, BASF Corporation

Metering Equipment Technology: Hydraulically Controlled Orifices for 4 to 1 Ratio Change in 0.5 Seconds Providing Multiple Densities from a Single Mix Head
J. Stout, Linden-Industries Inc./EMB
C. Maher, Dow Chemical Company
R. Begbie, Jr., ExxonMobile Chemical Company
W. Inhoff, Siemenskamp
New High Performance Liquid Polyols .................................................................670
T. Obara, Hodogaya Chemical USA
K. Okabe, Hodogaya Chemical
R. Moore, Urethane Consultants International

New Hybrid Process for Purification and Separation of MDI Isomers ..................675
M. Stepanski, P. Faessler, Sulzer Chemtech Ltd.

Polyurethane Recycling Reactor for H&S Anlagentechnik GmbH .......................677
N. Streeter, H&S Anlagentechnik GmbH

Processing Equipment Technology: Patented Gas Infusion Equipment Design Continuously Monitors and Updates the Level of Gas Entrainment .................................678
J. Stout, T. Sherman, Linden-Industries Inc./EMB

Processing HFC-134a Systems for Various Applications ..................................679
I. Wheeler, ATOFINA Chemicals Inc.

Software Development: MicroProcessVu™ Computerized Data Acquisition Package 680
J. Stout, T. Sherman, Linden-Industries Inc./EMB

Study on Structure & Properties of the Low Unsaturation Polyether Polyols Synthesized by the Double Metal Cyanide Complex Catalysts ..............................681
S. Chen, L. Chen, Nanjing University of Technology

TDI and the Environment ..................................................................................687
R. Bailey, Bailey and Associates
W. Robert, BASF Corporation

Temperature and Mold Size Effects on Density Gradients and Mechanical Properties in a Polyurethane Foam System .........................................................688
B. O'Toole, D. Jackovich, M. Cameron Nelson, M. Mullin, R. Mohan,
University of Nevada, Las Vegas

The Use of Real-time FTIR Instrumentation to Characterize the Kinetics of Amine Catalysts and to Develop New Grades for Various Polyurethane Applications Including Low Emission Catalysts ........................................689
P. Chaffanjon, R. Grigsby, Jr., E. Rister, R. L. Zimmerman, Huntsman

POSTER SESSION — Rigid Foam

Brand-new Trend of the Cyclopentane-Blown Rigid Foam Systems for the Appliance Industry - Combined Systems of Excellent Insulation Performance with Fast Demoldability .................................................................693

Can HFC 245fa- or Cyclopentane-foam Meet the Performance of HCFC-Foams? ........701
H. Seifert, A. Biedermann, C. Giesker, Elastogran GmbH

Enovate™ 3000 Blowing Agent—A Performance Enhancing Additive for Polyurethane Foam in the Construction Industry ..................................................702
M. Bogdan, D. Williams, Honeywell

Long Term Thermal Resistance of Pentane Blown Polyisocyanurate Laminate Boardstock .................................................................703
S. N. Singh, M. K. Niriu, K. Dedecker, Huntsman Polyurethanes

New Spray Foam Systems Based on Solkane 365/227 ........................................704
J. M. Monso, J. Santamaria, J. Gimeno, Synthesia Española S.A.

Processing Study of Appliance Rigid Foams with Third Generation Blowing Agents .................................................................705
K. J. Elsken, S. L. Schilling, M. V. Han, W. A. Tingler, Bayer Corporation

Solkane® 365/227 Blends as a Substitute to HCFC-141b Application Skills .............706
L. Zipfel, K. Borner, SOLVAY Fluor und Derivate GmbH
P. Dournel, SOLVAY Research and Technology
Soybean Oil Based Polyisocyanurate Cast Resins
I. Javni, W. Zhang, Z. S. Petrovic, *Pittsburg State University*

Stabilizing Polyester Polyols for Rigid Foam Systems Co-Blown With Water
C. McAdams, KoSa

Author Index

Company Index