2013 Year in Review

ACS GCI Industrial Roundtables

Pharmaceutical • Formulators' • Chemical Manufacturer's

HIGHLIGHTS

- 3rd Annual ACS GCI Roundtable Poster Reception provides a forum for companies to showcase more sustainable, industrially-relevant alternatives.
- The ACS GCI Pharmaceutical Roundtable continues to demonstrate influence and impact through collaborations and tool development.
- The ACS GCI Formulators' Roundtable works with key external stakeholders to enable more sustainable product design.
- The ACS GCI Chemical Manufacturer's Roundtable focuses on approaches to integrate sustainability into the chemical manufacturing industry.
- A new Roundtable, the ACS GCI Hydraulic Fracturing Roundtable, is in development.

THANK YOU

The ACS Green Chemistry Institute® would like to thank the 34 corporations that worked collaboratively and non-competitively throughout 2013 to catalyze the integration of sustainable and green chemistry and engineering in the global chemical enterprise.

Beginning in 2005 with just three companies on one Roundtable, there are now three Roundtables serving 34 members. The ACS GCI Industrial Roundtables are a proven concept, demonstrating that collaboration among peer companies can effectively provide value directly to the company, as well as to the collective industry, in designing more sustainable processes and products, a pursuit that is imperative for a sustainable business and environment.

ROUNDTABLE RECEPTION ANOTHER SUCCESS!

In its third year, the ACS GCI Roundtable Poster Reception once again created impressive networking opportunities focused on industrially relevant, greener alternatives.

In each of the past three years the event has been held, over 72% of attendees have indicated they learned about a greener technology of potential relevance to their organization.

100% of survey respondents indicated the reception met or exceeded the objective to expand attendees' network in order to foster the research, development, and marketing of industrially relevant, greener alternatives.

Sponsors for the event were the ILSI Health and Environmental Sciences Institute (HESI), and the Renewable Citrus Products Association (RCPA).

2013 ACS GCI ROUNDTABLE MEMBERS

Ajinomoto North America, Inc.
Amgen
Amway
Arizona Chemical Company LLC
AstraZeneca
Bissell Homecare
Boehringer Ingelheim Pharmaceuticals, Inc.
Bristol-Myers Squibb
Church & Dwight Co., Inc.
Codexis
Dixie Chemical Company, Inc.
Dr. Reddy's Laboratories Ltd.
DSM Pharmaceutical Products
E.I. du Pont de Nemours and Company
Eli Lilly and Company
F. Hoffmann-La Roche Ltd.
Florida Chemical Company, Inc.
GlaxoSmithKline
Johnson & Johnson
Johnson & Johnson Consumer Products
Merck & Co., Inc.
Novartis
Novozymes North America Inc.
Penn A Kem LLC
Pfizer Inc.
Rochester Midland Corporation
Rug Doctor LLC
Sanofi
S. C. Johnson & Son
Seventh Generation, Inc.
Sigma-Aldrich
Solvay USA Inc.
State Industrial Products
Virox Technologies Inc.
Zep Inc.

3rd Annual Roundtable Reception:

"Excellent venue for interacting with individuals from all phases of the chemical supply chain."

—Managing Director, ToxServices LLC

www.acs.org/gcipharmaroundtable
www.acs.org/gciformulators
www.acs.org/gci_chem_mfr
gciroundtables@acs.org

ACS Chemistry for Life®
American Chemical Society

ACS Green Chemistry Institute®

ACS GCI DEVELOPS ROUNDTABLE ON HYDRAULIC FRACTURING

Beginning in June 2013, ACS GCI met with prospective members to explore the creation of a Roundtable focused on improving the sustainability profile of hydraulic fracturing through green chemistry and engineering. The group met throughout the year to develop a business plan that represents the collective interests of the group.

Mission

To systematically integrate green chemistry and engineering principles into the chemical supply chain for hydraulic fracturing. This scientific collaboration will seek to enable informed decisions about those chemicals commonly employed in hydraulic fracturing and will work to promote the prioritized development of more sustainable chemical alternatives.

Member companies self-identify as meeting the definition of one of the following NAICS codes or a manufacturer of chemicals in direct supply to a company in one of the following NAICS codes:

- 211111: Crude Petroleum & Natural Gas Extraction
- 213112: Support activities for oil and gas separations

Global participation is encouraged.

The Hydraulic Fracturing Roundtable is open for membership as of June 2014.

THE ACS GCI CHEMICAL MANUFACTURER'S ROUNDTABLE FOCUSES ON APPROACHES TO INTEGRATE SUSTAINABILITY INTO THE CHEMICAL MANUFACTURING INDUSTRY

In 2013, the ACS GCI Chemical Manufacturer's Roundtable focused on defining opportunities for alternative separation technologies.

Exploiting differences in volatility has been the dominant means of separating desired and unwanted components in chemical processes for over a century.

- Separation by distillation accounts for over 30% of the energy used in the U.S. chemical manufacturing sector (National Research Council, 2005).[1]
- Reducing the energy required to manufacture products is a fundamental and common goal of the companies represented on the ACS GCI Chemical Manufacturer's Roundtable.
- The National Research Council (2005) identified "reducing the energy intensity of the CPI" as a "grand challenge for sustainability in the chemical industry".

The intent of this work is to:

- Foster implementation of alternative lower energy separations
- Provide guidance on alternative separation techniques in the modern chemical plant
- Define the need for academic research

The Roundtable also facilitated access to key organizations and researchers, such as:

- The US Department of Commerce to explore engagement with the Advanced Manufacturing and Innovation in Chemicals Management Program
- The ACS Sustainable Manufacturing Roundtable to understand potential synergy
- The National Science Foundation to assess funding opportunities
- Prof. Angelo Lucia, University of Rhode Island, to understand his work in energy efficient distillation

THE ACS GCI PHARMACEUTICAL ROUNDTABLE CONTINUES TO INFLUENCE AND IMPACT

- Process Mass Intensity (PMI) and material carbon footprint (calculated using the Roundtable PMI/Life Cycle Analysis (LCA) tool or similar) are proposed for use in the Voluntary Incentive Scheme for Green Pharmaceuticals in Sweden. Importantly, GlaxoSmithKline agreed to release essential LCA estimation numbers by publishing them on the Roundtable website.
- The Convergent Process Mass Intensity Tool was approved for public release.
- Prof. Janet Scott at the University of Bath was awarded $100,000 to study replacement of DMF, NMP, and DMAC with safer and greener alternatives. In particular, the work focused on

RECENT ROUNDTABLE PUBLICATIONS

Pharmaceutical Roundtable Study Demonstrates the Value of Continuous Manufacturing in the Design of Greener Processes, *Org. Process Res. Dev.,* 2013, 17 (12), pp 1472–1478.

Sustainable Practices in Medicinal Chemistry: Current State and Future Directions, *J. Med. Chem.*, 2013, 56 (15), pp 6007–6021.

Green Chemistry Articles of Interest to the Pharmaceutical Industry, *Org. Process Res. Dev.*, 2013, 17 (11), pp 1394–1405.

Go with the Flow, *Innovations in Pharmaceutical Technology*, 2013, 46, pp 52-55.

Green Chemistry Articles of Interest to the Pharmaceutical Industry, *Org. Process Res. Dev.*, 2013, 17 (4), pp 615–626

Expanding the Boundaries: Developing a Streamlined Tool for Eco-Footprinting of Pharmaceuticals, *Org. Process Res. Dev.*, 2013, 17 (2), pp 239–246.

Photo Credit: Christine Brennan-Schmidt

Matthew Gulick and Christie Harman of Renewable Citrus Products Association at the 3rd Annual ACS GCI Roundtable Poster Reception

[1] Angelini, P.; Armstrong, T.; Counce, R.; Griffith, W.; LKlasson, T.; Muralidharan, G.; Narula, C.; Sikka, V.; Closset, G.; Keller, G.; Watson, J. Materials for Separation Technologies: Energy and Emission Reduction Opportunities. DOE-EERE Report, Prepared by ORNL, 2005; pp 1– 103.

the following high interest reactions: Nucleophilic Aromatic Substitution (SNAr), ligandless Heck, Songashira, and POCl3 reactions.

- The Roundtable extended $10,000 to the grant provided to Prof. Neil Garg at UCLA to convert his successful research on greener methodologies for Suzuki couplings into an undergraduate lab experiment. His research (total of $60,000 for 15 months) funded by the Roundtable has produced 4 presentations, 2 posters, and 3 publications.
- In conjunction with Rutgers University, the Roundtable successfully organized the first Pharmaceutical Roundtable Research Symposium focused on catalysis. Speakers included Prof. Scott Miller (Yale University), Prof. Gary Molander (University of Pennsylvania), Dr. Greg Hughes (Merck & Co., Inc.), Prof. Paul Chirik (Princeton University), Prof. Dalibor Sames (Columbia University), and Prof. Michael Krische (University of Texas at Austin).
- The Roundtable published business cases demonstrating the value of continuous manufacturing in the design of greener processes (see presentation list on page 2).
- In-person meetings were held in Linz, Austria (hosted by DSM Pharmaceutical Products), Bethesda, MD (hosted by ACS GCI), and New Brunswick, New Jersey (hosted by Bristol-Myers Squibb). All of the meetings were also web-based to assure global participation.

THE ACS GCI FORMULATORS' ROUNDTABLE WORKS WITH KEY STAKEHOLDERS TO ENABLE MORE SUSTAINABLE PROCESS DESIGN

Through Roundtable discussions in 2013 with key stakeholders it became evident that additional fragrance materials could be added to the US EPA's Design for Environment (DfE) Safer Chemical Ingredient List (SCIL). The Roundtable commends the DfE for publishing the list which provides more information to formulators to develop more sustainable products that meet DfE certification. The Roundtable efforts to improve the SCIL were appreciated by US EPA Design for Environment Branch as a positive contribution to the list as well as to the ability of companies to design more sustainable formulations.

It was realized that not all of the eligible fragrance screens were considered for posting on the SCIL. In the past, if a formulation as a whole did not pass DfE screen, then individual ingredients within the formulation that had passed were not consistently posted to the list. This realization resulted in more ingredients being added to the Safer Chemical Ingredient List. In addition, a third party verifier changed their internal policy to submit all passing fragrance raw material screens to the DfE, regardless of whether the final formulation passes.

By engaging with guest speakers at bi-monthly meetings, the Formulators' Roundtable is able to effectively leverage industry positions on issues affecting the design of more sustainable formulated consumer products. Guest speakers in 2013 included:

- US EPA Design for Environment Branch to assure effective communication between industry and the agency to facilitate the design of more sustainable products.
- Third party profilers including ToxServices LLC and NSF International to explore opportunities to improve audit processes.
- Fragrance houses including Givaudan and Takasago to better understand challenges to designing greener fragrances and how the Roundtable could assist.

B. R. Reddy (Halliburton) networks with Klin Rodrigues (Akzo Nobel Surface Chemistry) at the 3rd Annual Roundtable Poster Reception.

Jim Pell (Amway) presenting his poster at the 3rd Annual Roundtable Poster Reception.

The 2013 Roundtable co-chairs: Phil Sliva (Amway), David Leahy (BMS), Juan Colberg (Pfizer), Samy Ponnusamy (Sigma-Aldrich), Paul Williams (Arizona Chemical). Not in attendance was Tom Burns (Novozymes). Photo credit: Christine Brennan-Schmidt