

## Highlights from 37th international Activated Carbon Conference and Carbon Courses

By Henry Nowicki, PhD and Barbara Sherman

### Introduction

The 37th bi-annual International Activated Carbon Conference and Courses was provided in Orlando, Florida February 22-28, 2016. The conference oral-, poster- and abstract only presentations parts of the overall program were conducted on February 25-26.

### Technical Program Highlights

Two outstanding carbon experts received the International Activated Carbon Conference Hall of Fame award and presented plenary lectures. Professor Steve Lipka's plenary was titled "Porous Carbon and its Application in Energy Storage and Conversion." Dr. Lipka covered a wide variety of electrochemical devices that will improve batteries and capacitors.

Dr. Lipka also discussed a patented new way to manufacture activated carbons using aqueous temperature and pressure parameters. It avoids many environmental impacts caused by conventional activated carbon manufacture.

Jon Maurer was awarded the Hall of Fame for his vast experiences in manufacturing and global sales of activated carbon products. Jon Maurer covered historical thru present and provided projections for the future. Jon covered the impacts of the U.S. Dept of Commerce tariff on Chinese steam activated carbon imports. This tariff literally saved the U.S. activated carbon industry from bankruptcy historically. However, tariffs do not last forever. Jon pointed to the lack of test methods needed for current carbon applications. The present reliance upon the iodine number, a single isotherm point at high concentration does not provide information at low adsorbate concentration, where most carbon applications reside.

Dr. Henry Nowicki provided a proof-of-concept oral presentation that a high quality activated carbon could be made at lab scale from waste lignin, a by-product from cellulosic recovery processes and paper manufacture. Gravimetric Adsorption Energy Distribution or GAED revealed the pore structure of the lignin new activated carbon compared to four different commercial carbons of high quality. GAED provides a map of the adsorption spaces or pores. GAED provides a distribution of the adsorption energies and associated pore volumes for each adsorption energy. Lignin feedstock produced an activated carbon with a pore structure similar to coconut feedstock. In the U.S. coconut shell activated carbon is imported. Lignin based carbon is considered a "Green" technology because carbon dioxide emitted during its activated carbon manufacture was captured during recent time. On the other hand, coal family activated carbons members release carbon dioxide captured and stored eons of time in the past.

Professor Detlef Knappe from North Carolina State University presented an outstanding oral presentation titled " Polanyi-Dubinin-Manes model framework to predict adsorption isotherms of aqueous organic contaminants on Activated Carbon." His research group focuses on emerging environmental contaminants in water and air. Dr. Knappe eloquently laid out a forward path to determine activated carbon adsorbability of new and existing organic compounds in a fast and economical way. This would enable thousands of organics to be categorized on their carbon adsorption capacity. The method provides isotherms for nine orders of contaminant concentration, from trace- trace to saturation in water or air and three orders of capacity loadings.

Following this analytical path in the future would provide valuable protection of U.S. populations, knowing the carbon adsorbability of emerging organic contaminants would allow wastewater treatment facilities to have confidence they can remove the environmental contaminant. Following this path would provide a motive for needed carbon manufacturer improvements. Requiring successful carbon sales to be dependent on known performance for client applications, instead of using iodine number will have long lasting benefits for carbon users and their customers.

Dr. Knappe's path has long been available, but it has been underutilized. Dr. Michael Polanyi developed the basis of the heterogeneous physical adsorption model in the early 1900's. It uses the Boltzmann's equation to correlate adsorbate vapor- or aqueous concentrations to carbon's potential adsorption energies. The Polanyi-model has been enhanced by many times, but not fundamentally changed. Two major contributors to Polanyi enhancement were Dr. Dubinin and Dr. Manes as pointed out in Dr. Knappe's presentation. Dr. Dubinin found that Polanyi adsorption energy densities for different compounds characteristic curves could be divided by individual compound molar volumes to collapse many characteristic curve lines to a single correlation curve. Dr. Manes and his group advanced the Polanyi heterogeneous adsorption model by developing testing apparatus and protocols to deliver useful isotherm data quickly and economically. Dr. Manes upon retirement provided training courses on Polanyi Adsorption Concepts for some 15 years thru PACS and the American Chemical Society.

Michael Frati provided information on "Doing Business in Africa." Future carbon conferences will seek speakers to provide information on how to do business in different countries. Carbon is needed by all people. Mike Frati's talk on Africa was well received due to the detailed information provided about Africa.

Dr. Henry Nowicki presented the second talk in a series at IACC-37 on "Improving Carbon Users and Manufacturers." Neil Megonnell started the series at IACC-36 with a talk on "Returning the Carbon Industry to Speciality Chemical and Away from Commodity Chemical Status." Dr. Nowicki discussed need for more education and developing more prospects for carbon usage. Since most citizens do not understand carbon, why not educate them in their water bill they receive by U.S. postal, with an informational sheet about cost/benefits of carbon filtration from their local drinking water supplier. Modern relevant testing was covered lightly since Dr. Knappe and Jon Maurer covered it in detail. The carbon industry does not have a trade organization to coordinate their ideas and obtain the synergy gained through shared cooperation on agreed to areas of concern. U.S. carbon manufacturers are a disorganized group and mainly function as individual firms. Some degree of cooperation in certain areas would result in improvements. Dr. Nowicki questioned the current competitive behavior and lack of significant R&D and new products. His expressed opinion is that carbon is under-valued, when you consider difficulty of manufacture and the benefits it provides to its users. Market price increases for activated carbons could provide budget for more R&D. The carbon companies should consider pooling funds to do R&D that benefits the contributors. All carbons should be labeled catalytic because they cause premature volatile organic compound condensation in pores and premature solidification of precipitates out of water in pores well before they reach saturation in fine pores.

Barbara Sherman presented a talk on "Modern Marketing and Sales thru the Internet and Social Media." She provided information about a service that anyone could get their message out to some 36,000 individuals by name who have some interest in activated carbon services and products.

Mietek Jaroniec presented use of thermogravimetric analysis (TGA) to evaluate stages of carbon manufacture: raw feedstock, calcine heat treatment to increase carbon content product, and final steam activated product. He provided three TGA chromatograms to demonstrate the use of TGA for this activated carbon manufacturing application.

Charles Carr provided GAED advanced testing for a drinking water plant to help determine which ten carbon filters were best to change out with new carbon. GAED provided information on the remaining heterogeneous adsorption space using the Polanyi model. This information could not be obtained with only standard ASTM test methods.

Dr. Nowicki presented information on a software program to increase productivity. ASTM methods do not provide software programs to interpret and archive data. PACS has provided these needed programs as well as others.

JJ Smadi from Hydrosil International gave a powerful talk on use of zeolites and impregnated zeolites to solve a wide and deep variety of environmental problems. Hydrosil substituted zeolite for clay as the basis of capturing high concentrations of hydrocarbons to protect and extend the life of activated carbon. The zeolite substitution eliminated the swelling problem of clay.

#### **Next Carbon Conferences and Courses**

PACS International Activated Carbon Conferences are held at least two times per year, September in Pittsburgh PA and February in Orlando FL. An additional special conference is planned for June 2017 in Portland, OR on "Wood and Biochar Advances."

PACS is now accepting Call-for-Papers for oral-, poster-, and abstract only presentations September 15-16, 2016 in Pittsburgh PA for IACC-38. Carbon Conference Proceedings are available at Barb@pacslabs.com for IACC-37 completed recently in Orlando, Florida February 25-26, 2016.

#### **About the Authors**

Henry Nowicki, Ph.D./M.B.A. and Barbara Sherman, BA/MS organize the bi-annual carbon conferences with valuable inputs. They started and manage the 33 year old firm PACS - Activated Carbon Services Inc. with the mission of advancing the wise use of activated carbon. PACS can be reached by phone (724) 457-6576, email: Barb@pacslabs.com , website: www.pacslabs.com