Activated Carbon Short Courses

Activated Carbon Adsorption: Principles, Practices and Opportunities

Course Instructor -- Dr. Henry Nowicki Feb. 23-24, 2015

The course instructor, Dr. Henry Nowicki, has published widely on activated carbon (AC), has won nine government grants, has two patents and is a recognized authority in the field. A number of his methods are in active use by the activated carbon industry. Dr. Henry Nowicki provides chemical characterizations of influents, AC software programs, an AC Tester, ASTM carbon testing and R&D services, as well as other consulting services. The purpose of this two-day course is to provide the users and providers of AC services a broad base of knowledge about how AC works.

If your firm or customers have any potential air and/or water contamination problems then you need activated carbon knowledge. This course is designed for managers, engineers, chemists and technicians interested in activated carbon applications and a basic understanding of how activated carbon works.

1. Activated carbon: Sources, structure, properties (eg., surface area, porosity, pore-size distribution) and applications. Test methods - Gravimetric Adsorption Energy Distribution (GAED).
2. Adsorption isotherms in gas- and liquid- phase systems, and both single- and multi-component adsorbates; comparison of capacities in direct addition (pulverized carbons) and in column operation.
3. Fundamentals of adsorption; how and why activated carbon works; prediction of isotherms (and carbon performance) for many systems on a carbon, given a single calibrating isotherm; application to bulk and trace adsorption in vapor systems and from water solution; competitive adsorption in multicomponent systems. (You will need your calculator to determine adsorption in multicomponent systems.)
4. ASTM physical and activity lab tests and their relevance to individual applications.
5. Choosing between alternative carbons for specific applications; limitations of single-number specifications; laboratory and pilot carbon testing.
6. Elementary column design from experimental or calculated isotherm data, including kinetic effects; lead-lag column design to maximize carbon usage.
7. Thermal regeneration and life cycle for activated carbon adsorption process; chemical regeneration of used activated carbons.
8. Day-to-day problem-solving strategies for AC systems.
9. Discussion of a variety of applications; opportunities for discussion with the faculty; breaks and lunches will be in small groups to facilitate interaction with the course faculty. Please list your special interest on your registration form.
10. Software solutions for many problems; discussion of PACS software.
11. Role of modern analytical chemistry for influent/effluent and carbon adsorbate(s) chemical characterization and monitoring AC system performance.

Design, Operation, and Troubleshooting of Activated Carbon Liquid and Vapor Phase Systems

Course Instructor -- Wayne Schuliger, P.E. Feb. 25, 2015

The course instructor is Wayne Schuliger, P.E., Technical Director at PACS. He has been designing, starting-up and solving operational problems with liquid and vapor phase carbon adsorption systems worldwide for many years. His broad practical experiences with activated carbon (AC) process systems, his engineering background and his communication skills will help your career development in this subject. The purpose of this course is to provide attendees with knowledge to evaluate experimental data and to design activated carbon systems. Chemists, engineers, regulators and managers using or planning to use AC need this information. If AC is important to your firm, this course is for you.

Liquid Phase Systems

1. How to obtain and interpret isotherm and column data using several techniques. The discussion will include:
   A. Limits of various techniques, i.e. small laboratory columns, accelerated columns, field tests, and computer simulations
   B. Typical problems encountered
   C. Effect of experimental conditions
2. How to obtain and interpret isotherm and column data using several techniques. The discussion will include:
   A. Limits of various techniques, i.e. small laboratory columns, accelerated columns, field tests, and computer simulations
   B. Typical problems encountered
   C. Effect of experimental conditions
3. Design of fixed bed adsorbers. Discussion will include:
   A. Upflow versus downflow
   B. Types of underdrain systems
   C. Materials of construction
4. Process related items:
   A. Problems resulting from improper wetting of carbon
   B. Pressure drop and bed expansion
   C. Product recovery
   D. Carbon transport techniques and related design criteria
   E. Carbon fines
   F. Carbon bed density in backwashed and non-backwashed bed
5. Design of pulse (moving) bed adsorbers and systems, if there is interest expressed by attendees
6. Discussion of regeneration techniques with emphasis on thermal, if there is interest expressed by attendees.

Vapor Phase Systems

1. Design parameters for adsorbers, i.e. bed depth, gas velocity, etc
2. Effect of relative humidity of particle size, flow rate, bed packing and particle shape
3. Pressure drop as a function of particle size, flow rate, bed packing and particle shape
4. Regeneration of all types:
   A. Steam
   B. Hot gas
   C. Vacuum
   D. Pressure
   E. Swing
   F. Thermal
5. Working capacity versus equilibrium capacity in each of the above regeneration schemes
6. Temperature excursions in carbon beds.

Pressure Swing Adsorption and other Cyclic Adsorption Processes and Applications

Course Instructor -- Dr. James Ritter Feb. 28 and March 1, 2015

The course leader is Dr. James A. Ritter. Dr. Ritter is *Professor of Chemical Engineering* at the University of South Carolina, where he has resided for the past 14 years. He received his Ph.D. in 1989 from the University at Buffalo under the guidance of Professor Ralph T. Yang. Dr. Ritter is a renowned expert on the fundamentals and applications of adsorptive phenomena for gas separation and purification and energy storage. He has over 110 peer-reviewed articles published in these areas and has been studying and lecturing on cyclic adsorption process fundamentals and applications for the past 25 years.

Adsorption is classified as a unit operation in chemical engineering that exploits the ability of a solid surface to concentrate species selectively from a fluid phase onto its surface. Adsorption processes are ubiquitous throughout the chemical process industry and used extensively for gas and liquid purification and separation. While taking this two-day course, areas you will gain proficiency in are industrial adsorbent identification and characterization, adsorption equilibria, adsorption kinetics, adsorption column dynamics and adsorption process applications. The focus will be on gas phase adsorption and its applications, with an emphasis on the widely popular pressure swing adsorption process.

This two-day course is designed for the practicing chemical, mechanical, nuclear, civil or electrical engineer or industrial chemist interested in learning about the fundamentals and applications of cyclic adsorption process technology. Each registrant will receive detailed course notes (over 200 pages) and a simple pressure swing adsorption process simulator based on the MS Excel spreadsheet format. Each registrant should bring a laptop to class with MS Excel installed. This course emphasizes the practical considerations and keeps the math to a minimum.

Major course content includes

1. Industrial adsorbent identification and characterization
2. Adsorption equilibria
3. Adsorption kinetics
4. Adsorption column dynamics
5. Adsorption process principles
6. Adsorption process applications.

While taking this course

- You will develop an understanding of the basic principles of adsorption science and technology governing separation processes;
- You will gain an appreciation for the level of complexity of accounting for adsorption phenomena in various engineering systems and separation processes;
- You will be become familiar with different commercial separation processes based on adsorption technology, especially pressure swing adsorption;
- You will understand the difference between adsorptive separations designed for purification, bulk separation, and static enclosed space conditioning;
- You will become familiar with commercial adsorbents, such as activated carbons, zeolites, carbon molecular sieves, silica gels, activated aluminas, and ion exchange resins;
- You will learn about adsorptive process modes, such as fixed bed, simulated moving bed, moving bed, rotary monolithic bed, and static modes; and
- You will learn about adsorptive regeneration schemes, such as displacement purge, pressure swing adsorption (PSA), thermal swing adsorption (TSA) and steam regeneration schemes.

    * Special interest of participants
    * Review and discussion