Bruce D. Adkins
2367 Tom Austin Highway, Greenbrier TN 37073
832-248-9972 **bdad57@earthlink.net**

ENGINEER/MODELER/MANAGER With 35 Years' Experience in Modeling, Process R&D, Catalyst R&D, Technical Management and Tech Service / Sales Support

Modeling: From CFD to Spreadsheets

- Many years of hands-on CFD experience using Ansys CFX (15 years) and CPFD Barracuda (4 years). As part of graduate coursework towards a Numerical Methods minor, I built my own CFD models using Fortran libraries IMSL & DGEAR.
- Equal emphasis on experimentation and model development. My credo is "model what you measure, measure what you model"
- Extremely well-versed in CFD modeling of gas-solid flows using EE (Eulerian-Eulerian), LE (Lagrangian-Eulerian), and MP-PIC
- Nine joint presentations / publications with CPFD Software dealing with modeling of gas-solid flows in Catalytic Fast Pyrolysis (CFP) using Barracuda. Model development sequence was catalyst flow, biomass flow, mixing, and heat transfer
- Other CFD areas of strength include gas-liquid flows (e.g. spraydryers), rotating equipment, and non-Newtonian rheology in static and rotating equipment (leading to a patented design for a rotary atomizer nozzle for non-Newtonian fluids, US 6,631,851). Also free surface modeling, turbulence modeling, and chemical reactions
- Extensive programming in Python and FORTRAN. Wrote dozens of User Routines for CFX and Python scripts for Barracuda
- Mastery of reaction kinetics, thermodynamics, and transport phenomena as applied in many types of models. Extensive experience in ODE kinetic modeling with ATHENA (FCC, CFP) and MATLAB (coal gasification).
- Carried out Unit Monitoring of commercial hydrotreaters and FCC units with KBC-Petrofine's HYDROP and CATOP models. Used both packages to help troubleshoot/optimize customer HPC and FCC units and support catalyst selection
- Used Argonne GREET.net model extensively to build custom pathways for internal GHG life cycle assessment
- Power user of Excel and JMP. Decades of programming experience in VB

Process R&D: Multiple Technologies and Industries

- Designed and developed several fixed-fluid-bed and circulating-fluid-bed lab units and catalytic fast pyrolysis equipment
- Led R&D efforts in numerous projects to develop, upscale or optimize technologies for catalyst manufacturing, based on atomization, spraydrying, extrusion, impregnation, drying, and calcination. Also led major efforts to develop/design reactors and processes for CFP, coal hydromethanation, and coal liquefaction
- Major roles in lab research, pilot-plant development, scale-up modeling and startup support for nine new plants: seven in catalyst manufacturing, one in CFP and one in coal hydromethanation
- Patented a unique atomizer for narrowing the particle size distribution of FCC catalysts. Ansys CFX was the primary design tool
- One of the founding members of the Rutgers CCMSE (Consortium on Catalyst Manufacturing Science and Engineering)

Catalyst R&D: Preparation, Formulation, Testing, Scale-up and Commercialization

- More than 30 years' experience in catalyst testing: fixed beds, fixed-fluid beds (E-bed, ACE, PRU) circulating riser units (DCR, KCR) and CSTRs (Robinson-Mahoney). Developed numerous test protocols and methods of analysis
- Co-developed (we believe) the world's first high-throughput industrialized CFP lab test, with more than 9,000 test runs
- 15 years in FCC catalyst development; 5 years in HPC catalyst development. 4 years in CFP catalyst development, including leading the group that developed, patented (multiple patents) and commercialized the world's first full-scale CFP catalysts
- Five patents and three pending applications in the area of biofuels catalytic fast pyrolysis (process and catalyst)
- Key roles in many catalyst commercialization projects, both as vendor and customer

Technical Management: Seven Different Groups, over 600 MY, all with Diverse Functions, Roles and Deliverables

- Six R&D / Process Development groups: two in biofuels catalyst & processes (200 MY), two in FCC and hydrotreating catalysts (300 MY in FCC, 40 MY in HTC) and one each in coal gasification (20 MY) and coal liquefaction (30 MY)
- Commercial/technical management in the refining catalyst business, as HPC Americas Technical Service Manager (40 MY).

Tech Service /Sales Support: Refining Catalyst (Hydrotreating and FCC) Technical Services

- Four year's experience supporting commercial sales and providing technical services to refining customers: 3 years as HTC Tech Services manager (overseeing 15 engineers) and 1 year as FCC Global VGO Specialist. Interacted frequently at refinery and corporate levels (R&D centers): ExxonMobil, Chevron, ConocoPhillips, Marathon Ashland, Flint Hills, Citgo
- Managed five iterations of Albemarle's highly successful 3-day training course for engineers new to hydrotreating
- Strong network of contacts in the refining industry

PROFESSIONAL HISTORY

Inaeris Technology (Formerly KiOR): 2010 to 2018

Manager of Process Research and Modeling **2014-May 2018**

Inaeris Technologies (formerly KiOR) was a startup firm commercializing an FCC-based CFP process ("BFCC") for producing transportation fuels from lignocellulosic biomass. As PRM Manager, I led a group of 4 extremely qualified professionals using computational and experimental methods to unlock and model critical hydrodynamics and kinetics for development and scale-up. Our tools include CPFD Barracuda (4 licenses), Athena, open source codes and JMP. Our models were being used to evaluate and scale-up new reactor designs right up to the point when the company was dissolved. Also, our collaboration with CPFD on general model development resulted in nine collaborative presentations and publications in major technology conferences and journals. Finally, I was also responsible for internal GHG life cycle assessments, using Argonne's GREET.net model

Research and Technology Manager for Catalyst and Process Development **2010-2014**

Managed a team of 35 to 45 researchers working on BFCC process development, catalyst development, and reactor design. We developed many one-of-a-kind methods and specialized equipment, and played a pivotal role in the design and evaluation of the world's first commercial BFCC unit at our plant in Columbus, MS. This plant was the first of its kind in the world, producing roughly a million gallons of drop-in gasoline and diesel from whole pine chips. My group also prepared and tested more than 2500 catalyst samples, interfaced with a dozen catalyst and component companies, identified several preferred families, guided 3 major catalyst vendors through scale-up and commercialization, and developed catalyst rejuvenation and wood washing technologies. This was all part of the process of commercializing the world's first full-scale BFCC catalysts. Five patents have been granted (US 9,649,624, US 9,561,501, US 9,522,392, US 9,518,229 and US 9,044,741) and three others are pending.

Great Point Energy: 2008-2009

Senior R&D Director **2008-2009**

I managed a group of 21 scientists, engineers and technicians in reactor design, process and catalyst development, feedstock evaluation, and model development for the Bluegas™ process for producing synthetic natural gas (SNG) from low-rank coal.

Albemarle Catalysts / Akzo-Nobel Catalysts: 1988-2008, 2009-2010

Global FCC VGO Specialist **2009-2010**

I had worldwide responsibility for technical introduction of new FCC VGO catalyst lines. I was the main interface with the FCC R&D groups in ExxonMobil, Chevron, ConocoPhillips, and Marathon Ashland. I became a proficient user of CATOP and in-house models, made four presentations at conferences and Albemarle Seminars, and co-authored three publications in trade journals. Also, I developed an innovative model (ODE form coded in ATHENA) to explain why high-alumina catalysts give much higher coke than low-alumina catalysts when tested in lab-scale fixed fluid bed reactors (ACE-type), whereas the difference is much smaller in commercial FCC units. The model is based on straightforward reactor equations and established coke formation kinetics, and provides a means to fit ACE-type data sets holistically (instead of individual yield-by-yield curve fits) and produce a simple set of rate constants for comparing catalysts.

HPC Technical Service Manager, Americas **2006-2008**

I managed 15 specialists providing technical service (TS) to the $200+MM/yr hydrotreating catalyst market in the Americas. I was one of three TS global managers responsible for Albemarle's HPC TS toolbox consisting of: models (HYDROP and in-house), technical bulletins, TS procedures, and training materials. I ran five iterations of one of the world's most successful HPC course and made ten presentations at Albemarle Seminars and external conferences. I was one of three Albemarle members of the Joint Operating Team for the UOP-Albemarle Hydroprocessing Alliance. I became quite proficient at HYDROP and contributed substantially to Albemarle's in-house model development. Personally handled technical accounts at Chevron (all refineries) and Citgo, where difficult issues had to be resolved through extensive personal attention.

FCC R&D PPD/PPRD Group Head **1993-2006**

I led a group of 20 scientists, engineers and technicians for 14 years. Our major role was to push manufacturing technology forward to reduce costs, improve existing products and enable new products. We developed manufacturing routes for new catalytic materials, carried out scale-up studies and process simulations, and assisted in designing and starting up new or expanded

plants including VESPA (high capacity zeolite plant in Houston), SPECLA (binding alumina plant in LA) and CORACIS (specialty zeolite plant in Houston). Our biggest success was CRUSADE: the Houston FCC plant was more than doubled in capacity at relatively low capital cost, allowing the closure of the old LA FCC plant, and increasing profits by more than $1 MM per month. The keys to CRUSADE were two entirely new manufacturing technologies called JADE and TOPAZ, both developed in PPRD. Within a few years, the plants in Amsterdam and Brazil were also revamped to the new routes. For TOPAZ and JADE, my group won two Albemarle Technology Development Awards.

In our other major roles, PPRD developed new catalysts (resid, octane, octane-barrel), additives (deSOX, deNOX, olefins), and supported the plants and marketing centers.

In my personal "pet project" I designed, scaled up and patented a nozzle (US 6,631,851) for rotary atomizer wheels using in-house pilot-plant equipment and CFD. The nozzle increased the fine grade capacity in our JV plant in Brazil, with a profit increase of $7 MM/year. The CFD part was especially challenging as it required rotating coordinates, two-phase flow with surface sharpening, non-Newtonian rheology, and highly turbulent inlet conditions. I also built CFD models of plant and pilot-plant spraydryers to tackle scale-up problems and minimize the CRUSADE investments. For these accomplishments I received an Albemarle Technology Development Award.

HPC R&D Group Head **1988-2003**

My small but very effective group developed new catalysts for e-bed bitumen hydrocracking, hydrocracker pretreat, FCC pretreat and distillate HDS markets. I constructed computational models quantifying the effects of impregnation and drying conditions on HDN and HDS activity of high metals NiMoP and CoMoP catalysts. I also developed extrusion and calcination lab procedures and scale-up models.

Kentucky Center for Applied Energy Research: 1981-1988

I worked full-time as a research engineer while attending two graduate-level classes per semester. I worked on direct coal liquefaction (mainly catalyst development and deactivation), coal liquids hydrotreating, slurry-phase Fischer-Tropsch catalyst development, and atmospheric fluid bed combustion. I led a joint project on advanced porous material characterization with the Center for Small-Angle Scattering Research at Oak Ridge National Lab. Somehow, I also squeezed in time to work on my thesis research, publish/present more than 30 papers and presentations, write a chapter on pore structure effects in coal hydroliquefaction catalysts (Vol. 3 of the Gulf Handbook of Heat and Mass Transfer) and last but not least, have two children

Education & Scholarly Awards

PhD Materials Engineering, University of Kentucky **1987**

- GPA 3.8/4.0
- Dual minors in Chemical Engineering and Numerical Analysis.
- Thesis: *A Unified Thermodynamic Model for Multilayer Adsorption and Capillary Condensation in Packings of Spherical Particles*

BS Materials Engineering, University of Kentucky **1981**

- GPA 3.7/4.0
- Worked full-time freshman and sophomore years; worked as a co-op student during the junior and senior years.
- Member of Tau Beta Pi and Alpha Sigma Mu honorary societies
- Outstanding Student in Materials Engineering Award, May 1981
- Kentucky Star Student award for 6th place ranking in ACT math test

Miscellaneous

- More than 30 publications in refereed journals, trade journals and conference proceedings, including one chapter in a major engineering handbook (*Gulf Handbook of Heat and Mass Transfer)*
- More than 20 presentations in conferences, symposia and seminars.
- 6 patents and 3 patent pending applications
- 3 Albemarle Technology Development awards
- Married with two children