

## Applying the Fundamentals

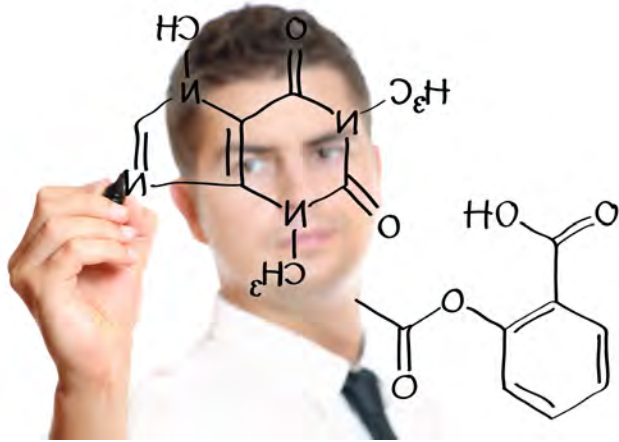
### PSRI and Breakthrough Technology



PSRI has over 200 cumulative years of experience in the design and optimization of various fluidized bed and circulating fluidized bed processes. These processes offer superior flowability and heat transfer, which are ideal for fast, exothermic reactions or catalyst that need frequent regeneration. However, capitalizing on these benefits requires a fundamental understanding of the underlying hydrodynamics. This is why PSRI has been involved in many new breakthrough technologies in the petrochemical, chemical, materials and mining industries for the last 45 years.

**PSRI** Particulate Solid Research, Inc.

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## Managing Your Breakthrough Technologies

Breakthrough technologies in the petrochemical, chemical, materials and mining industries depend on understanding the kinetic and mass transfer time-scales. For highly exothermic reactions or fast reactions, heat transfer is the key to success, but often it comes at the cost of reduced mass transfer or enhanced production of undesirables. Such challenges were evident with the development of the fluidized catalytic

cracking, oxychlorination, acrylonitrile and gas-phase polyethylene processes. In each case, fluidized beds or circulating fluidized beds provided unique and profitable solutions. These solutions come with other challenges such as managing solids mixing, gas back-mixing, particle size distribution, reliability, particle attrition and particle emissions, all of which have been managed for more than 30 years.

Today, these challenges remain the same, but the applications are different. New breakthrough technologies that can or are benefiting from fluidized unit operations are surfacing every day including technologies such as catalytic gasification and pyrolysis, polycrystalline silicon, olefin dehydrogenation, methane coupling, methanol to olefin, carbon capture, sulfur capture, and chemical looping. PSRI continues to provide the expertise needed to manage the hydrodynamics and scale-up of process technology in order to maximize productivity and reliability.

Our understanding of the relationship between particle properties and operating conditions with bubble hydrodynamics, mixing, gas and/or liquid distribution, entrainment, separations, segregation, erosion and particle attrition is second to none. We have been studying and applying these relationships for over 45 years with success for breakthrough technologies of the past and for the next breakthrough technologies yet to come. Chances are we have already seen your problem despite it being a new application.

If we have not seen your problem, we still have you covered. PSRI has the research talent and facilities to bridge the gap of what is unknown but required to move your potential process into commercialization. We have 110,000 sq. feet (10,000 sq. meters) of research space with 10,000 SCFM (17,000 NCMH) of blower/compressor capacity, 4160 VAC and 55 to 135 feet (17 to 41 meters) of height in our high bays that give us the tools to take what is unknown known and what is a concept into application. The biggest obstacle to commercializing breakthrough technology is having the tools to drive to success. PSRI has those tools, and we have that drive to get you there.



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## PSRI Process Development Experts



**Dr. S.B. Reddy Karri, Consulting Director:** Reddy has 28 years experience in particle technology and fluidization. He has worked on FCC technology, cokers, polyolefins, methanol to olefins, maleic anhydride, acrylonitrile, TiO<sub>2</sub>, polycrystalline silica, gasification, pyrolysis, sulfur capture, CO<sub>2</sub> capture, biomass and radioactive materials.



**Dr. Ted Knowlton, Fellow:** Ted has 46 years experience in particle technology. He has worked on FCC technology, cokers, polyolefin, MTO, maleic anhydride, acrylonitrile, TiO<sub>2</sub>, polycrystalline silica, gasification, pyrolysis, sulfur capture, CO<sub>2</sub> capture, and mining. He has developed well-known processes such as HYGAS, U-GAS, PEATGAS, RENUGAS, HYTORT, PFH and is the developer of the L-valve.



**Mr. John Findlay, Technical Consultant:** John has 34 years of experience in particle technology and fluidization. He has worked on FCC technology, cokers, polyolefin, TiO<sub>2</sub>, coal gasification, pyrolysis, sulfur capture, CO<sub>2</sub> capture, and biomass.



**Dr. Ray Cocco, President and CEO:** Ray has 27 years experience in reactor engineering, modeling, fluidization, and particle technology. He has worked on ceramic processing, oxydehydrogenation, pharmaceutical hydrogenation, catalytic oxidation, hydrogenation, hydrodesulfurization, composite materials, biomass, chemical looping, polyolefin, chlorination and oxychlorination.



**Dr. Stephen Sutcliffe:** Steve has 31 years of experience in the TiO<sub>2</sub> pigment and additives business with Huntsman, now Venator, where lead and developed global technology development programs and strategies. He is an expert with all the key unit operations associated with TiO<sub>2</sub> manufacture, feedstock preparations and waste handling technologies via the Chloride Process.



**Dr. Ben Freireich, Technical Director:** Ben has 8 years of experience in particle technology and has recently been listed as one of AIChE's 35 under 35. He has worked on a wide range of reactor engineering and solids processing problems including catalyst deactivation and attrition, bin design, fluidized beds, pneumatic conveying, mixing and blending, segregating systems, size reduction, etc.



**Dr. Manuk Colakyan, Technical Consultant:** Manuk has 30 years experience in reactor engineering and solids processing. Notably, he was instrumental in the R&D efforts for the commercialization of the Unipol process. He also has experience with multiphase flow systems, heat and mass transfer and super critical fluids.



**Dr. Ulrich Muschelknautz, Technical Consultant:** Ulrich has 27 years experience in particle technology with emphasis on cyclone design and optimization as applied to the energy and chemical sectors. Of late, he has been involved in the R&D efforts for the next generation of axial separators.

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