The Kappe Lecture Series

AMERICAN ACADEMY
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2016

The 2016 Kappe Lecturer

Sudhir Murthy, Ph.D., P.E., BCEE

Innovations Chief
DC Water
Washington, DC

Education

- B.E., Civil Engineering, RV College of Engineering, India, 1990
- M.S., Environmental Engineering, Virginia Tech, 1992
- Ph.D., Civil Engineering, Virginia Tech, 1998

Professional Associations

- American Academy of Environmental Engineers and Scientists
- International Water Association (IWA)
- Water Environment Federation (WEF)
- Professional Engineer, Virginia
- Class 1 Wastewater Treatment Plant Operator License, Virginia

Dr. Murthy is the Innovations Chief at DC Water. He leads the development and implementation of the Authority's innovation strategy. Sudhir creates, defines, and translates research and development into new or improved facilities, products, services or revenue concepts. Dr. Murthy led the concept development for several programs at the 391 mgd Blue Plains advanced treatment plant that has led to nearly $1 billion in engineered facilities.

He started his engineering career in consulting at Parsons and later at CH2M, where he was involved in engineering planning studies and process design of wastewater treatment plants, including new approaches for nutrient removal, membrane treatment, anaerobic digestion, and dewatering. In 2002, he was invited to conceive and then lead the research and development program at DC Water to address the needs of a large capital program. Rather than build an internal team of employees, he chose to develop a collaborative open innovation program. Innovation projects are developed through novel approaches of public-public partnership with other water utilities and through collaboration with private enterprise and universities. Most of these research projects are developed through joint research proposals funded through WERF, EPA or NSF with matching funds often provided by the partners. More than 80 MS and PhD students from universities in North America, Europe, Australia, and Africa, and their academic advisors, have been contributing to the planning effort with most of these students being 'insourced' to perform research at DC Water or other partner utilities in a multifunctional and interdisciplinary setting. This approach is now viewed as a model for collaborative engagement by universities and utilities. Similarly, Dr. Murthy is working with private enterprise in developing new approaches for 'co-innovation' between the water technology supply and demand sectors. These collaborative approaches address both the need for scholarship and the need for robust designs for evaluating new and complex technologies and the promotion of free enterprise associated with technology adoption.

In the past few years, DC Water has won four of six Research Grand Prizes from the American Academy of Environmental Engineers and Scientists, several research and technology awards through the National Association of Clean Water Agencies, and the Water Environment Research Foundation Award for Excellence in Innovation. Dr. Murthy has received several Water Environment Federation awards including the Ralph Fuhrman Medal for Academia-Practitioner Collaboration, the George Gascoigne Medal for Wastewater Treatment Operational Improvement, and the Camp Applied Research Award. He is an IWA and WEF Fellow. He serves on the board of directors of IWA.

Dr. Murthy continues to champion the development of internal innovation programs as a means for developing sustainable and resilient water utilities and is the founding co-chair of the joint WEF/WERF utility program called LIFT – Leaders Innovation Forum for Technology – with nearly 300 participating utilities. This program helps utilities with policies and approaches to drive innovation in the water sector.

Dr. Murthy has contributed to several WEF *Manuals of Practice*, organized conferences for IWA and WEF, and served on committees (he Chairs the IWA Nutrient Removal and Recovery Specialist Group) for several professional organizations. He has published nearly 100 peer reviewed papers, reports, and manuals, and has published over 300 articles. He has presented at numerous state, national, and international conferences.

Dr. Murthy's lectures will provide valuable examples of converting fundamental engineering and scientific principles into practical large-scale solutions. Students will benefit from understanding both research approaches and constraints for implementing new technologies converted into full scale facilities.

Abstracts of Lectures Offered

Maximizing Process Intensification and Resource Recovery- from Theory to Practice

In the past 100 years of water reclamation, improvement in treatment to meet new or more stringent permit requirements have used more resources, more land, more energy, and more chemicals. Rapid urbanization is pushing plants to seek out new approaches for better use of these resources as property values increase and there is little room to expand. In the United States, where plant capacity is determined by flow, water conservation is resulting in larger populations and therefore larger loads being served within the same flow. Often, the solids capacity for treatment is met before the liquid capacity. Re-tooling plants to provide adequate intensification has become an important goal. To achieve this intensification within existing infrastructure of concrete tanks built to last for 50-100 years provides additional challenges. Examples will be provided of new approaches for intensification that use or augment existing infrastructure in new ways. Understanding and addressing process limitations have been key in bringing about this intensification. Examples will be provided of opportunities for intensification of greater than 200% (while simultaneously reducing or maintaining the resources used) for nearly every major part of the wastewater treatment plant including preliminary/primary treatment, secondary treatment, nutrient removal, anaerobic digestion, and dewatering.

There is also a global interest in developing new approaches for resource recovery in wastewater. The Water Environment Federation has led the renaming of wastewater treatment plants (WWTP) to water resource recovery facilities (WRRF). The name change reflects a change in the mindset within the water sector, focusing on resource recovery as an essential element of treatment. DC Water has embarked on a journey of maximizing resource recovered from used water by maximizing carbon redirection, intensifying anaerobic digestion with thermal hydrolysis, developing value products, heat and electrical energy.

This presentation will describe the continuing research journey for developing an intensification and resource recovery program within existing infrastructure at a large regional facility in Washington, DC, with little room to expand while meeting new stringent nutrient permits and managing combined sewer flows. The long-term sustainability of built infrastructure is dependent on the intensification that these approaches represent.

New Approaches for Nitrogen Removal

Water resources recovery facilities have extensively used energy and carbon within aerobic treatment processes that are dependent on the addition of oxygen for the oxidation of polluting carbon and nitrogen. One hundred years after the development of the activated sludge process, energy efficient anaerobic treatment processes (treatment in the absence of oxygen) are gaining prominence outside of tropical regions. This opportunity is availed through the use of the anammox microorganism. The anammox bacteria uses different metabolic pathways than the traditional bacteria used for nitrogen removal in wastewater treatment. These organisms can remove nitrogen from wastewater under anaerobic conditions and in the absence of organic carbon and uses two-thirds less energy. Thus, nitrogen removal and energy autarky (achieving self sufficiency for energy requirements) can now be two concomitant objectives for water resources recovery facilities. Conventional biological nitrogen removal processes use energy intensive aeration, internal or external carbon for denitrification, and alkalinity chemicals. In comparison, short-cut nitrogen removal processes provide potential benefits for energy, carbon, and chemical savings. Shortcut nitrogen removal is a form of biological nitrogen removal that proceeds with partial and/or incomplete oxidation of ammonia, stopping at nitrite instead of nitrate, to 'shortcut' the conventional nitrification/denitrification process. Shortcut nitrogen removal includes the nitrite-shunt process, which relies on partial nitritification and heterotrophic denitritation, as well as fully autotrophic partial and incomplete nitrification and anaerobic ammonium oxidation, or the deammonification process.

Shortcut nitrogen removal has successfully been applied in sidestream treatment but not as successfully in mainstream processes. Warm sidestream filtrate/centrate from anaerobic digestion contains high ammonia concentrations and insufficient alkalinity for full nitrification and provides an environment for suppressing nitrite-oxidizing bacteria (NOB). There is now a greater interest in developing shortcut approaches for the more dilute and colder mainstream processes. NOB out-selection in mainstream is a major emphasis in recently studied laboratory, pilot, and some full-scale systems.

This presentation will discuss the state of knowledge of shortcut nitrogen removal for sidestream and mainstream nitrogen removal. In this evolving research domain, three main approaches for mainstream short-cut nitrogen removal are considered: (i) granular approach, (ii) attached growth approach, and (iii) suspended/hybrid approach. There are many common elements in these different approaches that are a foundation for full-scale implementation.

"A man's debt to his profession is to help those that follow."

STANLEY E. KAPPE, P.E., DEE, a successful environmental engineer, believed he owed a debt to the profession that rewarded him so well. During his life, he gave of himself to his university and to his profession through countless hours of volunteer activity. And, through this Lecture Series, he continues to share his good fortune with tomorrow's environmental engineers and scientists.

He graduated from Pennsylvania State University in 1930 with a bachelor's degree in sanitary engineering. He served with the Pennsylvania State Health Department and the U.S. Army Corps of Engineers before joining the Chicago Pump Company as its Eastern Regional Manager in 1935. In 1945, he founded Kappe Associates, Inc., a water supply and wastewater equipment company headquartered in Rockville, Maryland, and continued as its Chief Executive Officer until his death in 1986.

His peers recognized his contributions to the profession by numerous awards, including the AWWA Fuller Award, the WEF Arthur Sidney Bedell Award, the WPCAP Ted Moses and Ted Haseltine Awards, and the AAEES Gordon Maskew Fair Award. In 1985, Pennsylvania State University named him Outstanding Engineer Alumnus.

Stanley E. Kappe was an activist member and leader in several national and Chesapeake region professional societies. He served as the Executive Director of the American Academy of Environmental Engineers (now the American Academy of Environmental Engineers and Scientists) from 1971 to 1981.

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