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"Thermal transients in district heating systems: physics modeling for better identification and control"

Abstract. Velocity flow in the realistic setting (of a Russian or European city) is typically turbulent and incompressible but steady, i.e. it establishes fast (in seconds). However, changes in the heat, on either consumption or production sides, lead to slow transients which last for at least tens of minutes and often for hours. We classify relevant physical phenomena in a single pipe, e.g. thermal front, turbulent spread of the front, thermal waves following the front, and also discuss consequences of the phenomena for large networks of pipes connecting, consumers and producers of heat. We explain how to solve the direct problem [given consumer/producer temporal profile and steady flow distribution describe dynamics of the heat evolution in the system] and, then, motivate future research directions towards posing and solving of (1) inverse identification problem [given partial and uncertain measurements of flow and heat to reconstruct system-wide probabilistic profile of consumption/production] and (2) real time optimization/control problem for practical district heating system [given the observations find actions leading to feasible solutions striking a proper balance of cost and comfort]. This work is a part of Skoltech Energy Sysyems CREI collaboration with a group from Melentiev Energy systems institute (Irkutsk, SB RAS) lead by N.N. Novitsky.

Bio. Dr. Chertkov's areas of interest include statistical and mathematical physics applied to energy and communication networks, machine learning, control theory, information theory, computer science, fluid mechanics and optics. Dr. Chertkov received his Ph.D. in physics from the Weizmann Institute of Science in 1996, and his M.Sc. in physics from Novosibirsk State University in 1990. After his Ph.D., Dr. Chertkov spent three years at Princeton University as a R.H. Dicke Fellow in the Department of Physics. He joined Los Alamos National Lab in 1999, initially as a J.R. Oppenheimer Fellow in the Theoretical Division. He is now a technical staff member in the same division. Dr. Chertkov has published more than 150 papers in these research areas. He is an editor of the Journal of Statistical Mechanics (JSTAT), associate editor of IEEE Transactions on Control of Network Systems, member of the Editorial Board of Scientific Reports (Nature Group), a fellow of the American Physical Society (APS) and a senior member of IEEE. Dr. Chertkov is also an Adjunct Professor of the Energy Systems Center at Skoltech (Moscow).