

Mechanical Engineering Seminar



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**Lecture Title: High-Pressure Thermo-Chemical Recuperation for Waste Heat Recovery in
Internal Combustion Engines**

Monday, April 18, 2016 at 11:30AM, Room 173 Light Engineering Building

Abstract

Internal combustion engines (ICEs) are a main power plant in transportation and are greatly responsible for fossil fuels consumption, as well as for environment pollution. The utilization of more energy-efficient ICEs together with low-carbon-intensity fuels is, therefore, of great importance. About one-third of fuel energy introduced to ICE is wasted with engine exhaust gases. One of the possible ways of engine's waste heat recovery is by using the energy of the exhaust gases to promote endothermic reactions of fuel reforming. This approach is called Thermo-Chemical Recuperation (TCR). Gaseous hydrogen-rich reforming products have, as a rule, higher heating value and can be burnt more efficiently by approaching the ideal constant-volume combustion of very lean fuel/air mixtures. In our study we focus on methanol because it is a truly low-carbon-intensity primary fuel, which can be reformed at relatively low temperature (~573K). Methanol can be produced from abundant and widely available sources, such as coal and natural gas, as well as from renewable sources, such as bio-mass.

We go beyond the previous studies in this field by applying direct injection of the reformat gas together with high-pressure steam-reforming process. Secondly, we aim at developing a reformer-ICE set as a part of a series hybrid propulsion system, thus alleviating the acute problems of the reformer's startup and transient behavior. The engine prototype operating in accordance with the described above principles and fed by the separately prepared methanol reforming products was successfully developed and tested in our Laboratory.

The obtained experimental results show a possibility of engine efficiency improvement up to 70% (higher improvement at lower loads) and dramatic reduction of pollutant emissions, when compared with gasoline. Harmful emissions of the gaseous pollutants CO and NOx are reduced by 96% and 85%, respectively. Emissions of ultrafine particles are decreased by more than 99%.

Biography

Dr. Tartakovsky joined The Technion – Israel Institute of Technology in 1992 and directs today the Technion Internal Combustion Engines Laboratory. Prior to joining the Technion in 1992, Dr. Tartakovsky worked eight years for the Research Center for Testing and Refining of Motor Vehicles in Moscow (USSR), where he led the Engine Research Laboratory. Leonid Tartakovsky received his D.Sc in Mechanical Engineering from the Central Automobile and Automotive Engines Research Institute (NAMI) in Moscow, with specialization in Heat Engines. His current research interests lie in developing energy conversion processes for sustainable propulsion systems. In particular, he is interested in waste heat recovery through thermo-chemical recuperation, alternative fuel effects on IC engine performance and combustion, nanoparticles formation and emissions control. Dr. Tartakovsky is a Chairman of SAE Technical Committee of the Small Engines Technology Conference and was elected SAE Fellow in 2015.

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