THERMAL BARRIER COATINGS APPLICATION IN DIESEL ENGINES

J.W. Fairbanks
Office of Transportation Technologies
Department of Energy
Washington, DC

Commercial use of thermal barrier coatings in diesel engines began in the mid 70's by Dr. Ingard Kvernes at the Central Institute for Industrial Research in Oslo, Norway. Dr. Kvernes attributed attack on diesel engine valves and piston crowns encountered in marine diesel engines in Norwegian ships as hot-corrosion attributed to a reduced quality of residual fuel. His solution was to coat these components to reduce metal temperature below the threshold of aggressive hot-corrosion and also provide protection.

Roy Kamo introduced thermal barrier coatings in his "Adiabatic Diesel Engine" in the late 70's. Kamo's concept was to eliminate the engine block water cooling system and reduce heat losses. Roy reported significant performance improvements in his thermally insulated engine at the SAE Congress in 1982.

Kamo's work stimulates major programs with insulated engines, particularly in Europe. Most of the major diesel engine manufacturers conducted some level of test with insulated combustion chamber components. They initially ran into increased fuel consumption. The German engine consortium had Prof. Woschni of the Technical Institute in Munich. Woschni conducted testing with pistons with air gaps to provide the insulation effects. Woschni indicated the hot walls of the insulated engine created a major increase in heat transfer he refers to as "convection vive." Woschni's work was a major factor in the abrupt curtailment of insulated diesel engine work in continental Europe. Ricardo in the UK suggested that combustion should be reoptimized for the hot-wall effects of the insulated combustion chamber and showed under a narrow range of conditions fuel economy could be improved.

The Department of Energy has supported thermal barrier coating development for diesel engine applications. In the Clean Diesel - 50 Percent Efficient (CD-50) engine for the year 2000, thermal barrier coatings will be used on piston crowns and possibly other components. The primary purpose of the thermal barrier coatings will be to reduce thermal fatigue as the engine peak cylinder pressure will nearly be doubled. As the coatings result in higher available energy in the exhaust gas, efficiency gains are achieved through use of this energy by turbochargers, turbocompounding or thermoelectric generators.