CORNET Research Project on Methane Oxidation Catalysts

In a German-Dutch CORNET (European Collective Research Networking) research project investigations were undertaken to minimise the emissions of gas engines. The German part of the project was carried out by the Exhaust Gas Emissions Centre at Karlsruhe Institute of Technology. The focus here was on experimental work and simulations on the catalytic oxidation of methane. With the help of synthesis, verification testing and the characterisation of catalytic converters (Pt-only, Pd-only, Pd-Pt, addition of promoters, optimised support materials) as well as by modelling the conversion behaviour, important new pathways for an optimised design of catalytic converters were created. The developed mechanism opens up opportunities for increasing activity and performance of the catalytic converters; the deactivating influence of water in the exhaust gas stream could be attributed to the formation of noxious surface species on Pd-based catalysts. The negative impact of very low amounts of sulphur in the exhaust gas could be explained and strategies for efficient reactivation were developed. In addition, the positioning of the catalytic converters upstream of the turbocharger was investigated and showed a great potential for future applications, particularly due to the high temperatures prevailing there. The knowledge gained during the laboratory tests was used to develop complimentary test-bed measurements on a gas engine. This Dutch part of the project was carried out at the University of Applied Science of Arnhem and Nijmegen (HAN). Supported by literature research, the engine-internal sources of emissions were revealed and optimisation strategies were demonstrated. Measurements and performance tests of the catalytic converters on a gas engine concluded the research work. Methane is a greenhouse gas. Its global warming potential is over 20 times more potent than CO_2. Methane oxidation catalysts suffer from constant deactivation. The long-term activity and reactivation of catalytic converters for total oxidation of methane are essential to achieve an ecological and efficient mode of operation of gas engines.

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Catalyst diluted with quartz (125 – 250µm sieve fraction) in a quartz glass reactor used for catalytic tests at the NSC setup. The catalyst bed is fixed by quartz glass wool.

Fatigue Strength in Hydrogen

If it is produced with electricity from renewable sources, hydrogen represents a potential alternative to fossil fuels as a climate-neutral energy carrier. Component design to ensure the required operational fatigue strength is based on the mechanical-technological characteristics of a material known from tensile tests as well as on specifications to describe its cycle behaviour, which includes the phase up to the formation of cracks (fatigue crack initiation) as well as the crack growth phase (da/DN curves), i.e. the entire service life of a component. Cyclic crack growth rates are therefore indispensable prerequisites for component design, which are to date, however, available in particular cases only. The FVV has now investigated in a publicly-funded (BMWI / AiF) research project into the questions to what extent the material behaviour of four different types of steel with different grain structures, that are customary in plant engineering and construction, is affected by simultaneous attack of hydrogen under cyclic loading: X2CrNi19-11, X4NiCrTi26-15, X3CrNiMo13-4 and X2CrNiMoN22-5. To quantify the mechanism of fatigue-crack propagation, experimental work was carried out under pressurised hydrogen and comparably under helium as inert gas. A special focus was placed on the impact of the load frequency on the fatigue strength in the hydrogen environment, so frequencies in the range of 0.01 and 10 Hz had been applied. In addition, cyclic crack growth tests were performed. The crack growth rate for the materials X2CrNi19-11, X3CrNiMo13-4 and X2CrNiMoN22-5 in hydrogen reached around ten times the value compared to that determined in helium. For the material X4NiCrTi26-15-2, which showed no significant impact of hydrogen under tensile and dynamic endurance and fatigue testing, a crack growth rate which is about a factor of two higher in hydrogen than in helium was found. Metallographic and fractographic investigations from selected specimen concluded the comprehensive research work.

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FVV – RESEARCH ASSOCIATION FOR COMBUSTION ENGINES E.V.

The FVV was founded in 1956 and has developed into a worldwide and unique network for engine and turbine research. It promotes pre-competitive joint research projects for this industry, bringing together industry experts and scientists to ensure continuous improvements in the efficiency and emissions of engines and turbines – to the benefit of our economy, our environment and our society as a whole. Furthermore, it provides support for junior researchers. Its members are small, medium-sized and large companies in the industry: automotive companies, engine and turbine manufacturers and their suppliers.

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