VERSITA

Chemical Papers
DOI: 10.2478/s11696-013-0469-7

REVIEW

Diesel soot combustion catalysts: review of active phases

Ana M. Hernández-Giménez, Dolores Lozano Castelló, Agustín Bueno-López*

Department of Inorganic Chemistry, University of Alicante, E-03080 Alicante, Spain

Received 27 March 2013; Revised 13 June 2013; Accepted 24 June 2013

The most relevant information about the different active phases that have been studied for the catalytic combustion of soot is reviewed and discussed in this article. Many catalysts have been reported to accelerate soot combustion, including formulations with noble metals, alkaline metals and alkaline earth metals, transition metals that can accomplish redox cycles (V, Mn, Co, Cu, Fe, etc.), and internal transition metals. Platinum catalysts are among those of most interest for practical applications, and an important feature of these catalysts is that sulphur-resistant platinum formulations have been prepared. Some metal oxide-based catalysts also appear to be promising candidates for soot combustion in practical applications, including ceria-based formulations and mixed oxides with perovskite and spinel structures. Some of these metal oxide catalysts produce highly reactive active oxygen species that promote efficient soot combustion. Thermal stability is an important requirement for a soot combustion catalyst, which precludes the practical utilisation of several potential catalysts such as most alkaline metal catalysts, molten salts, and metal chlorides. Some noble metal catalysts are also unstable due to the formation of volatile oxides (ruthenium, iridium, and osmium).

Keywords: diesel soot, DPF, DOC, soot combustion catalyst, Pt catalyst, ceria, perovskite

Introduction

Soot particles are emitted by diesel engines together with NO_x, CO, and unburned hydrocarbons (HC) in gas streams with high O_2, CO_2, and H_2O concentrations and temperatures typically below 500–550 ℃. Under these conditions, CO and HC oxidation can be easily accomplished with a Diesel Oxidation Catalyst (DOC), but both NO_x and soot require complex abatement strategies.

Diesel Particulate Filters (DPF) are used to remove soot particles from the exhaust stream (Neeft et al., 1996a; van Setten et al., 2001a; Maricq, 2007; Twigg, 2007). These filters usually consist of wall-flow monoliths, that is, honeycomb-like structures with 50 % of the channels plugged at the gas entry side and the remaining channels plugged at the exit. The gas stream enters into the filter through the open channels and is forced to pass through the porous walls where the soot particles get stuck. DPF filters must be regenerated by soot combustion in order to avoid pressure drop in the exhaust and several commercially available technologies have been designed for this purpose (Fino & Specchia, 2008).

The PSA system consists of using metal-fuel additives to obtain soot particles with catalytically active metals well-embedded in the structure. A DPF is used to collect the metal catalyst-containing soot particles and, once filter regeneration is required, extra fuel is injected and its exothermic combustion initiates the catalytic combustion of soot.

The Continuously Regenerating Trap (CRT) system (by Johnson Matthey) consists of a DPF filter located downstream of a Pt-containing DOC catalyst. CO and HC are oxidised in the DOC, which also oxidises NO to NO_2. NO_2 is much more active in its oxidising reactions than NO and O_2 and reacts rapidly with the soot and initiates its ignition.

Some other filter regeneration strategies are under investigation, such as modifications of the CRT

*Corresponding author, e-mail: agus@ua.es