NOX ABATEMENT IN DIESEL ENGINES

PATENTED TECHNOLOGY

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ABSTRACT

Nitrogen oxides (NOx) are the most important gaseous pollutants evolved by gasoline and diesel vehicles exhausts. Nowadays, an effective system able to reduce diesel vehicles emissions does not exist.

The Carbon materials and environmental group at the University of Alicante has designed a catalytic system to eliminate NOx from gaseous mixtures which simulate a real diesel exhaust, with a effectiveness near to 100%.

Partners from automotive, naval, power generation, catalysts and engine manufacturers are sought for final development and technical cooperation.

TECHNICAL DESCRIPTION

Atmosphere nitrogen oxides (NOx) emissions seriously contribute to the global environment contamination. It is well known that NOx are involved in pollution problems such as, for example, acid rain and urban smog. Additionally, some illnesses as bronchitis and pneumonia, as well as other alterations of immunologic system, are also related with the atmospheric NOx level. Furthermore, NOx participates in the formation of ground-level ozone in the presence of sunlight and, consequently, it is responsible in part for the greenhouse effect. Thus, the control of this pollutant has been a subject of great interest for more than one decade.

The efforts are mainly focused to control the NOx emissions from its respective sources. About one-half of the NOx man-made emissions are attributed to automobile engine emissions. Nowadays, all new gasoline-engine vehicles have a catalytic system (TWC: Three Way Catalyst) able to eliminate NOx emissions, besides those of unburned hydrocarbons and carbon monoxide. Unfortunately, these devices are not usable in diesel vehicles due, mainly, to the oxygen excess conditions present in diesel engines. Consequently, it is necessary to design a new catalytic system that allows to reduce NOx emissions specifically from diesel vehicles. Furthermore, according to future environmental legislation (European stage IV, for the year 2005), these NOx reductions will have similar to gasoline engines.

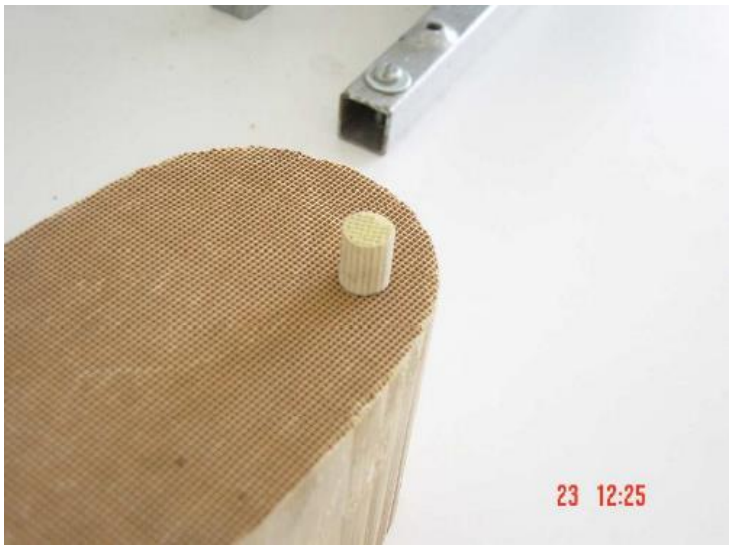
Different alternatives have been proposed to reduce NOx emissions from different diesel gaseous exhausts as, for example, direct decomposition, selective catalytic reduction (SCR) using NH3 or urea, reduction with H2 or CO, etc. However, these options are not applicable under real conditions of diesel vehicles (high reaction temperatures, dangerousness of the system, low selectivities, etc.). In the last few years, the use of different hydrocarbons as NOx reduction agents (HC-SCR technology) arise as a promising alternative, since allows to use reaction mixtures similar to those of diesel engine exhaust. Numerous catalytic systems have been tested to carry out this reaction but, at the moment, none of them assemble the necessary requirements to be used under real mobile conditions.

In the last five years, the Carbon materials and environmental group of the Department of Inorganic Chemistry at the University of Alicante, has dedicated great efforts studying the HC-SCR reaction using mainly platinum-based catalysts and, specially, those supported on zeolytic materials. The effect of numerous variables has been studied in detail, i.e., physical and chemical support properties, active phase content and dispersion, etc.

In general, the conversion levels reached, the thermal stabilities, as well as their behaviour during time-on-stream (even in presence of inhibitors), prove the applicability of these systems under real conditions.

In particular, a novel platinum-based catalytic system which incorporates a ceramic support (Pt-zeolite/cordierite) has also been designed and prepared in the CMEG laboratories, featuring an excellent behaviour for mobile sources pollutants depletion. Catalyst anchorage on the cordierite monolith surface has demonstrated to be strong, which is also a requisite for its use in the elimination of pollutants from mobile sources.

This system has demonstrated to present an excellent catalytic behaviour toward NOx elimination from a complex exhausts in terms of activity and stability. Recent studies using this type of catalysts have allowed to propose a reaction mechanism. The details of the reaction mechanism are of great importance in order to optimize the system properties to be used under real conditions.



ADVANTAGES AND INNOVATIVE ASPECTS

MAIN ADVANTAGES

• High activities: NOx conversion levels achieved by the novel catalyst surpass 90%, even under adverse reaction conditions and under the presence of inhibitors.

• Low reaction temperatures: the maximum NOx conversions are reached around 200ºC which allows not to have to use external heat sources during real applications.

• High stabilities and durabilities: the novel platinum-based catalyst exhibit a very stable behaviour under time-on-stream experiments, maintaining the NOx conversion levels during hundreds of hours.

• Honeycomb configuration: the anchorage of the catalyst on the cordierite monolith represents one of the main advantages from the point of view of the applicability of the novel system under real diesel exhausts.

INNOVATIVE ASPECTS

• Focused on Diesel engine exhausts.

• The use of a zeolitic material as platinum support has allowed to prepare a novel catalyst with an extraordinary catalytic behaviour toward NOx reduction under real diesel exhaust conditions.

• In contrast with other reaction mixtures alternatives, the use of hydrocarbons as a NOx reduction agent presents the advantage of using reaction mixtures similar to those of real diesel engine exhaust.

CURRENT STATE OF DEVELOPMENT

At the moment the research team has started the scaling up stage. The development is fully laboratory tested and now the scaling up level at a pilot plant has been reached.

MARKET APPLICATIONS

1. As diesel engines are used in many sectors, application areas would be:
    - Automotive sector, naval sector.
    - Energy, electricity and power generation.
    - All sectors involved with diesel engines and combustion.
2. Catalyst Manufacturers

COLLABORATION SOUGHT

- Technical Co-operation.
- License agreement.
- Financial resources.

Type of partner sought:
- Companies from automotive.
- Power generation.
- Naval.
- Catalysts sectors.
- Engine manufacturers.

Task to be performed:
The research group aims to finish the development of this catalyst and would like to test and develop it for the actual and commercial diesel systems. Partners could collaborate in providing their technology to be tested, in joint further development and also providing resources.

INTELLECTUAL PROPERTY RIGHTS

Patent: “Compósitos de carbón para la reducción de óxidos de nitrógeno, procedimiento para su preparación y aplicaciones”. [P9400104].

RESEARCH GROUP PROFILE

Carbon materials and environmental group – University of Alicante.

History:

The University of Alicante was created in 1979 and has rapidly established itself in Spain as a prestigious university, particularly in the teaching and research of science. The Carbon materials and environmental group involved in this research, belongs to the Department of Inorganic Chemistry in the Faculty of Sciences.

Personnel:

The group was established in 1983 when Prof. Ángel Linares-Solano joined the University of Alicante. Currently, it comprises three full professors (Prof. Concepción Salinas-Martinez de Lecea and Prof. Diego Cazorla-Amoros, the director of the group), five associate professors, eight PhD Research Fellows and thirteen PhD Students.

Research fields:

The main research fields of the group are: activated carbon preparation and characterisation, carbon fibre preparation, gas adsorption, gas-solid reactions, heterogeneous catalysis, pollution abatement, gas separation and gas storage.

Experience:

The experience of the group in research can be summarised as follows: since 1990, 183 research projects have been carried out with financial support from Spanish government, EC and private industries; 196 papers have been published in high quality scientific journals, 14 PhD Thesis have been completed and over 254 presentations have been made at International Conferences. Regarding the EC funding, our group has participated in 6 projects (5 ECSC, 1 BRITE), being the co-ordinator of three of them.

MARKET APPLICATION (4)

Pollution and Environmental Impact
Materials and Nanotechnology
Chemical Technology
Transport and Automotive