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Recent Updates in Designs of Catalytic Converters

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ABSTRACT: Protection of environment from every type of pollution is our moral principle. Building the technology in this regard towards a more advanced useful one is a bold step. Here in this work, we come out with recent updates on modified catalytic converter with an objective to reduce global warming. A catalytic converter is a device which is based on theme of using catalysts say, platinum & rhodium, to convert three harmful compounds in the exhaust of a vehicle into harmless compounds. These harmful compounds are carbon monoxide, a poison for any air-breathing animal, nitrogen oxides leading to acid rain and hydrocarbons which produce smog. The catalyst used helps to convert carbon monoxide into carbon dioxide, hydrocarbons into carbon dioxide & water and nitrogen oxides back into nitrogen and oxygen. As carbon dioxide is one of the most common greenhouse gases and contributes significantly to global warming, therefore one of leading solutions in this series is to modify the converter with palladium. It is to be made with palladium covered up with titanium alloy wall. Titanium is slow to react with water and air at room temperature because it forms a protective oxide around of 12 nm thick barrier film reaching a thickness of around 25 nm in four years that protects it from further reaction. It readily reacts with oxygen at around 1200 ºC in air, forming TiO_2 which is very useful in controlling CO_2. Nitrogen reacts much more slowly with titanium than oxygen. And also nitrogen has no adverse effects. In recent decades, carbon dioxide and water vapours are effectively photo-converted to methane using either pure or modified-TiO_2 and UV-Vis irradiation and this methane can be used as fuel. Therefore, using the currently happened breakthroughs in this technology, having huge applications in electrical generators, mining equipment, trucks and motorcycles etc. for a clean environment, can lead us in the class of countries with healthy technological foundations and motivate us to initiate a platform for more scientific innovations on converters. I am also presenting on how to control Nitrous Oxide and Hydrogen Sulfide and my focus is more in this 2nd part.

Keywords: Converter; technology; green house; titanium dioxide

INTRODUCTION

A catalytic converter (or cat-cons) is a device that uses a catalyst to convert three harmful compounds in car exhaust into harmless compounds. The three harmful compounds are:

- **a.** Carbon monoxide is a poison for any air-breathing animal.
- **b.** Nitrogen oxides lead to smog and acid rain, and
- **c.** Hydrocarbons produce smog.

Working: The cat sits between the engine and tailpipe and it changes the chemical composition of exhaust gases by rearrangement of the atoms.

- **a.** Molecules of polluting gases are pumped from the engine past the honeycomb catalyst, made from platinum, palladium, or rhodium.
- **b.** The catalyst splits up the molecules into their atoms.
- **c.** The atoms then recombine into molecules of relatively harmless substances such as carbon dioxide, nitrogen, and water, which blow out safely through the exhaust

Reactions that takes Place:

1. Removal of CO:

CO Oxidation: $2CO\,(g) + O_2(g) = CO_2(g)$

Water-gas shift (WGS) reaction:

$CO_2\,(g) + H_2O(g) = CO_2\,(g) + H_2(g)$

2. Removal of hydrocarbons

Hydrocarbon oxidation: example

$C_8H_{18}\,(g) + 6O_2\,(g) = 8CO_2\,(g) + 9\,H_2O\,(g)$

Steam reforming:

$C_nH_m\,(g) + nH_2O\,(g) = nCO\,(g) + (n+m/2)\,H_2\,(g)$

3. Removal of NO:

CO + NO redox reaction:

$2NO\,(g) + 2CO\,(g) = 2CO\,(g) + N_2\,(g)$

or with hydrogen:

$2NO\,(g) + 2H_2\,(g) = N_2\,(g) + 2H_2O\,(g)$

4. Special Case: Under *stoichiometric* or *slightly fuel-rich (reducing)* conditions, where there is insufficient oxygen present to oxidize the entire CO, conversion can also occur by one of the following routes:

- via the CO + NO redox reaction
- via the **water-gas shift reaction** , because H_2O is present in the exhaust gases as a product of combustion:

$CO + H_2O = CO_2 + H_2$ (all in gaseous state)

The water-gas shift reaction is catalyzed by Pt and/or Rh, with **ceria** acting as an excellent promoter.

$H_2\,(g) + ½\,O_2\,(g) = H_2O$

5. Special Case for Removal of NO: Laboratory experiments have shown that, under the conditions in the catalytic converter, the decomposition of NO to O_2 and N_2 over noble metal catalysts is too slow to be significant. When the A/F ratio is stoichiometric (or

below stoichiometry), NO can be removed by reduction with CO and/or hydrocarbons.

$2NO\ (g) + 2\ CO\ (g) = 2CO\ (g) + N_2\ (g)$
$2NO\ (g) + CO\ (g) = N_2O\ (g) + CO_2\ (g)$

INVENTION OF THE CATALYTIC CONVERTER

French chemical engineer Eugene Houdry (1892–1962) patented it, the very first catalytic converter in the United States, filing the invention on May 5, 1950. Here below is an *Artwork: Eugene Houdry's original catalytic converter from his 1950 patent.*

The improved converter by three-way catalytic converters, which could also tackle nitrogen oxides, was designed in the early 1970 by **Carl Keith** (1920–1988), **John Mooney**, and chemical engineers at Engelhard Corporation.

PROBLEMS ENCOUNTERED

1. One problem is that they only really work at high temperatures (over 300°C/600°F)
2. Another issue is carbon dioxide as we now know it's the major cause of global warming and climate change.
3. Another serious issue is, production of small amounts of nitrous oxide (N_2O) is there in the process, a greenhouse gas that's over 300 times more potent than carbon dioxide.
4. Sulfur present in fuel has two major undesirable effects. It can cause deactivation of the catalyst, and it also leads to generation of H_2S.

MY CONCEPT

To overcome above problems I have a concept of introducing Titanium and Niobium alloys and films Along with use of nickel film.

Controlling CO_2: From internet source, I found that Nanoscale titanium dioxide is used as a support material for catalyst applications. Major uses include in the automotive industry to remove harmful exhaust gas emissions and in power stations to remove Nitrous oxides.

Also, Years before Carbon dioxide and water vapor were effectively photo-converted to methane using either pure or modified-TiO 2 and UV-Vis irradiation. After one hour of UV-Vis irradiation 503 ppm of methane was formed and this methane can be used as fuel. This is the concept of modify cation.

Now, CO_2 can be controlled by titanium dioxide films. Converting carbon dioxide (CO_2) to hydrocarbons that can be used as fuels is beneficial from both environmental and economic points of view. In this study, nanoparticles are designed to enhance the photo-reduction of CO_2 on a titanium dioxide (TiO_2) catalyst. Carbon dioxide and water vapor were effectively photo-converted to methane using either pure or modified-TiO_2 and UV irradiation. The process of photo conversion in the gas phase was carried out in a tubular reactor equipped with a perforated TiO_2-coated support. CH_4 was found to be the major photo-reduction product. The highest methane production was observed after irradiation of CO_2+H_2O mixture over Au-TiO_2 photocatalyst. After one hour of UV-Vis irradiation 503 ppm of methane was formed.So I am basically working on how to make it possible to Irradiate with UV rays, the surface of converter so that this can be possible.

Another possibility to control CO_2 can be using Ti metal.The oxidation of titanium in carbon dioxide has been examined in the temperature range 675–800 °C, involving assessment of kinetics, and metallographic and micro hardness studies on oxidized substrates and scales. Overall linear kinetics were exhibited-in the temperature range 675–750 °C two consecutive linear stages were observed, whereas at 775 and 800 °C this linear/linear pattern was less well defined, tending to be replaced by simple linear kinetics. Another possibility can be using silica powder to adsorb the CO_2

Controlling N_2O: We can solve the temp. Problem by the use of Ti film .We know that the modern cat is insensitive to early temp. Ranges of engine like 200k or 300k is not sufficient.But by using Ti films,the fast dissociative adsorption will take place accompanied by N_2 evolution.This can bring out a vast change in today's cats as N_2O which is released by them will now be controllable even at cool temperatures.

So here Ti film gets oxidized by nitrous oxide.

Controlling H_2S: The interaction of hydrogen sulphide with films of nickel and tungsten has been studied over the temperature range - 80" to 100°C. Rapid dissociative adsorption, followed by desorption of hydrogen occurred on both metals.

Advantages: Using titanium can make us achieve working of cats up to high temperatures. Also it is effective in reducing nitrous oxide and controlling carbon dioxide which is clearly helpful.

CONCLUSIONS

Now in modern world advancements has led to more use of the three-way catalytic converter. So let's first see about it and then proposal for further advancements in it for a research purpose made by me.No experiment is performed by me on it, rather I have searched for more good techniques to be used here.So it's just an Idea to force our Scientists to conduct research on it. Here is a block diagram to show where to put up further advancements.

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