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ALTERNATIVE CATALYST FOR CATALYTIC CONVERTER OF AN AUTOMOBILE

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Abstract— Since last decade automotive exhaust emissions is damaging environment and thereby showing negative impact on health of human beings. It is a big challenge for a catalytic converter to archive tighter norms and standards of pollution control. Technologies developed so far includes improvement in engine design alternative fuels usage additives for fuel exhaust treatment fuel pre-treatment , EGR,PCV etc. Among of these one of the most affordable techniques is exhaust treatment by using catalytic converter. It is the best way for abating harmful pollutants like CO, HC, and NO etc. from automotive exhaust. The catalyst in the catalytic converter also plays an important role in reducing emissions. Also the use of non-noble metals like stainless steel as catalyst in the converter has significant results .This paper is dedicated to practical experience of latest technologies development in this view and overcoming of limitations of catalytic converter.
Keywords- l Catalytic converter, Cold start emissions, Fuel exhausts treatment

I. INTRODUCTION

CATALYTIC CONVERTER: A catalytic converter is an exhaust emission control device that converts toxic gases and pollutants in exhaust gas from an internal combustion engine into less-toxic pollutants by catalyzing a redox reaction (an oxidation and a reduction reaction). Catalytic converters are usually used with internal combustion engines fueled by either petrol (gasoline) or diesel—including lean- burn engines as well as kerosene heater sand stoves.

The first widespread introduction of catalytic converters was in the United States automobile market. To comply with the U.S. Environmental Protection Agency's stricter regulation of exhaust emissions, most gasoline-powered vehicles starting with the 1975 model year must be equipped with catalytic converters. These "two-way" converters combine oxygen with carbon monoxide (CO) and unburned hydrocarbons (HC) to produce carbon dioxide (CO2) and water (H2O). In 1981, two-way catalytic converters were rendered obsolete by "three-way" converters that also reduce oxides of nitrogen (NOx); however, two- way converters are still used for lean-burn engines. This is because three- way- converters require either rich or stoichiometric combustion to successfully reduce NOx.
Although catalytic converters are most commonly applied to exhaust systems in automobiles, they are also used on electrical generators, forklifts, mining equipment, trucks, buses, locomotives, and motorcycles. They are also used on some wood stoves to control emissions. This is usually in response government regulation, either through direct environmental regulation or through health and safety regulations.

HISTORY: The catalytic converter was invented by Eugene Houdry, a French mechanical engineer and expert in catalytic oil refining, who moved to the United States in 1930. When the results of early studies of smog in Los Angeles were published, Houdry became concerned about the role of smoke stack exhaust and automobile exhaust in air pollution and founded a company called Oxy-Catalyst. Houdry first developed catalytic converters for smoke stacks called "cats" for short and later developed catalytic converters for warehouse forklifts that used low grade, unleaded gasoline. In the mid-1950s, he began research to develop catalytic converters for gasoline engines used on cars. Widespread adoption of catalytic converters did not occur until more stringent emission control regulations forced the removal of the antiknock agent tetraethyl lead from most types of gasoline. Lead is a "catalyst poison" and would effectively disable a catalytic converter by forming a coating on the catalyst's surface.

Catalytic converters were further developed by a series of engineers including John J. Mooney, Carl D. Keith, Antonio Eleazar, and Phillip Messina at Engelhard Corporation, creating the first production catalytic converter in 1973. William C. Pfefferle developed a catalytic combustor for gas turbines in the early 1970s, allowing combustion without significant formation of nitrogen oxides and carbon monoxide

II. CONSTRUCTION

1. The catalyst support or substrate. For automotive catalytic converters, the core is usually a ceramic monolith that has a honeycomb structure (commonly square, not hexagonal). (Prior to the mid-1980s, the catalyst material was deposited on a packed bed of pellets, especially in early GM applications.) Metallic foil monoliths made of Kanthal (Fe CrAl) are used in applications where particularly high heat resistance is required. The substrate is structured to produce a large surface area. The cordierite ceramic substrate used in most catalytic converters was invented by Rodney Bagley, Irwin Lachman, and Ronald Lewis at Corning Glass, for which they were inducted into the National Inventors Hall of Fame in
2002.
2. The wash coat. A wash coat is a carrier for the catalytic materials and is used to disperse the materials over a large surface area. Aluminum oxide, titanium dioxide, silicon dioxide, or a mixture of silica and alumina can be used. The catalytic materials are suspended in the wash coat prior to applying to the core. Wash coat materials are selected to form a rough, irregular surface, which greatly increases the surface area compared to the smooth surface of the bare substrate. This in turn maximizes the catalytically active surface available to react with the engine exhaust. The coat must retain its surface area and prevent sintering of the catalytic metal particles even at high temperatures (1000 °C).
3. Ceria or ceria-zirconia. These oxides are mainly added as oxygen storage promoters.
4. The catalyst itself is most often a mix of precious metal. Platinum is the most active catalyst and is widely used, but is not suitable for all applications because of unwanted additional reactions and high cost. Palladium and rhodium are two other precious metals used. Rhodium is used as a reduction catalyst, palladium is used as an oxidation catalyst and platinum is used both for reduction and oxidation. Cerium, iron, manganese, and nickel are also used, although each has limitations
5. Nickel is not legal for use in the European Union because of its reaction with carbon monoxide into toxic nickel tetra carbonyl. Copper can be used everywhere except Japan.

PLACEMENT OF CATALYTIC CONVERTER: Catalytic converters require temperature of 800 degrees Fahrenheit (426 °C) to efficiently convert harmful exhaust gases into inert gases, such as carbon dioxide and water vapor. Therefore, the first catalytic converters were placed close to the engine to ensure fast heating. However, such placing caused several problems, such as vapor lock. It occurred several minutes after the engine is shut off, as the heat from the catalytic converter influences fuel in the fuel lines, which makes it first boil and then aerate. This condition of fuel results in non- start condition which lasts until the engine and fuel in the lines cool down. As an alternative, catalytic converters were moved to a third of the way back from the engine, and were then placed underneath the vehicle

TYPES: TWO WAY: A 2-way (or "oxidation", sometimes called an "oxi-cat") catalytic converter has two simultaneous tasks: This type of catalytic converter is widely used on diesel engines to reduce hydrocarbon and carbon monoxide emissions. They were also used on gasoline engines in

American- and Canadian-market automobiles until 1981. Because of their inability to control oxides of nitrogen, they were superseded by three-way converters.

THREE-WAY: Three-way catalytic converters (TWC) have the additional advantage of controlling the emission of nitric oxide (NO) and (both together abbreviated with NOx and not to be confused with), which are precursors to acid rain and smog. Since 1981, "three-way" (oxidation-reduction) catalytic converters have been used in vehicle emission control systems in the United States and Canada; many other countries have also adopted stringent vehicle emission regulations that in effect require three-way converters on gasoline-powered vehicles. The reduction and oxidation catalysts are typically contained in a common housing; however, in some instances, they may be housed separately. A three-way catalytic converter has three simultaneous tasks:

Reduction of nitrogen oxides to nitrogen (N_2)

$$2\,CO + 2\,NO \rightarrow 2\,CO_2 + N_2$$

$$\text{Hydrocarbon} + NO \rightarrow CO_2 + H_2O + N_2$$

$$2\,H_2 + 2\,NO \rightarrow 2\,H_2O + N_2$$

Oxidation of carbon monoxide to carbon dioxide

$$2\,CO + O_2 \rightarrow 2\,CO_2$$

Oxidation of unburnt hydrocarbons (HC) to carbon dioxide and water, in addition to the above NO reaction

$$\text{Hydrocarbon} + O_2 \rightarrow H_2O + CO_2$$

These three reactions occur most efficiently when the catalytic converter receives exhaust from an engine running slightly above the stoichiometric point. For gasoline combustion, this ratio is between 14.6 and 14.8 parts air to one part fuel, by weight. The ratio for auto gas (or liquefied petroleum gas LPG), natural gas, and ethanol fuels are slightly different for each, requiring modified fuel system settings when using those fuels. In general, engines fitted with 3-way catalytic converters are equipped with a computerized closed-loop feedback fuel injection system using one or more oxygen sensors, though early in the deployment of three-way converters, carburetors equipped with feedback mixture control were used.

$$2\,CO + O_2 \rightarrow 2\,CO_2 \quad :: \quad C_xH_{2x+2} + [(3x+1)/2]\,O_2 \rightarrow x\,CO_2 + (x+1)\,H_2O$$

These converters often operate at 90 percent efficiency, virtually eliminating diesel odor and helping reduce visible particulates (soot). These catalysts are not active for NOx reduction because any reductant present would react first with the high concentration of O_2 in diesel exhaust gas.

Reduction in NOx emissions from compression-ignition engines has previously been addressed by the addition of exhaust gas to incoming air charge, known as exhaust gas recirculation (EGR). In 2010, most light-duty diesel manufacturers in the U.S. added catalytic systems to their vehicles to meet new federal emissions requirements.

There are two techniques that have been developed for the catalytic reduction of NOx emissions under lean exhaust conditions: selective catalytic reduction (SCR) and the lean NOx trap or NOx adsorber. Instead of precious metal-containing NOx absorbers, most manufacturers selected base-metal SCR systems that use a reagent such as ammonia to reduce the NOx into nitrogen. Ammonia is supplied to the catalyst system by the injection of urea into the exhaust, which then undergoes thermal decomposition and hydrolysis into ammonia. One trademark product of urea solution, also referred to as Diesel Exhaust Fluid (DEF)

Diesel exhaust contains relatively high levels of particulate matter (soot), consisting largely of elemental carbon. Catalytic converters cannot clean up elemental carbon, though they do remove up to 90 percent of the soluble organic fraction, so particulates are cleaned up by a soot trap or diesel particulate filter (DPF). Historically, a DPF consists of a cordierite or silicon carbide substrate with a geometry that forces the exhaust flow through the substrate walls, leaving behind trapped soot

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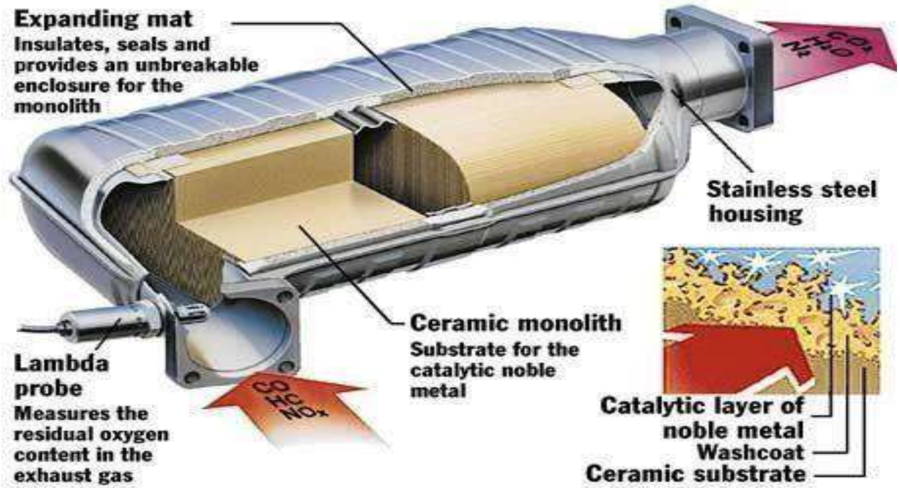
particles. Contemporary DPFs can be manufactured from a variety of rare metals that provide superior performance (at a greater expense).

As the amount of soot trapped on the DPF increases, so does the back pressure in the exhaust system. Periodic regenerations (high temperature excursions) are required to initiate combustion of the trapped soot and thereby reducing the exhaust back pressure. The amount of soot loaded on the DPF prior to regeneration may also be limited to prevent extreme exon terms from damaging the trap during regeneration. In the U.S., all on-road light, medium and heavy-duty vehicles powered by diesel and built after January 1, 2007, must meet diesel particulate emission limits, meaning that they effectively have to be equipped with a 2-way catalytic converter and a diesel

PARTS & FUNCTION: A catalytic converter is made up mainly of a muffler like chamber which contains porous, heat-resistant materials coated with either platinum or palladium. These materials are known as catalysts. A catalyst is an element which although causing a reaction to occur, does not change at all during the reaction. This is the idea behind a catalytic converter.



The carbon monoxide gas and hydrocarbons emitted from the engine will travel along the exhaust system until they reach their catalytic converter. There it comes into contact with the described catalyst. This forces a reaction between the carbon monoxide and hydrocarbons with the oxygen inside the converter creating products of carbon dioxide and water vapor. The reaction which occurs inside the converter is as follows:

The main compounds involved are carbon monoxide and hydrocarbons (compounds of hydrogen and carbon), as well as oxygen. When these three are combined with the provided catalyst, a reaction occurs as above. During the reaction the oxygen splits apart the carbon monoxide and the hydrocarbons and allows them to combine with its elements forming the aforementioned products. The catalytic converter first made an appearance in vehicles in 1975. The government of the United States of America had established a law controlling auto emissions. There was one minor detail that was outlined in the use of a catalytic converter, however. There must only be the use of lead-free gasoline. The reasoning behind this was that if a leaded gasoline was used the lead would cover the platinum and palladium pellets rendering them ineffective and thereby ceasing the reaction to exist. Phosphorus had much of the same effect on the pellets so the gasoline must contain minimal amounts of it as well.

A catalytic converter can be located in every new vehicle today, unless the vehicle runs on diesel fuel. In case you were interested in finding the catalytic converter nearest you, you may want to take a look under the nearest vehicle. It looks like the muffler only it is a little bit larger and more to the front of the exhaust system. Threats like these to our atmosphere spurred on the creation of anti-pollutant components in vehicles and the trend for a pollution free environment still continues. It will be a great struggle as inventors come up with new and bizarre ways to keep our atmosphere intact. Already, electric and solar powered test cars have taken to the highways to test their durability,

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effectiveness, and convenience. The catalytic converter was definitely the original spark that started the new "safe" auto craze, and was an ingenious invention

III. LITERATURE SURVEY

1 SK SHARMA, P.GOYAL, S.MAHESWARI, A.CHANDRA proposed that automobile pollution can be controlled using three way catalytic convertor. But it is expensive as platinum and palladium belong to same group and are more costly. But result obtained from it is good that controls the unburnt hydro carbons and carbon monoxide.

2. MOHAN T .TAYDE, DR CHETHANKUMAR M.SEDANI said that gold base catalyst is very low cost compared to noble metals. It reduces the effect of hydrocarbons, carbon dioxide, and nitrogen oxide. It also increases the thermal efficiency of the engine increases, but conversion is done at very low temperature as a result break power increases temperature increases and conversion efficiency decreases. So gold base catalyst is suitable at low level temperature.

3 TARIG SHAMIM AND SUBRATA SENGUPTA proposed that a numerical model is employed to predict the catalytic convertor performance during cold start. Initial catalyst temperature influences the emission conversion behavior only during first 65 seconds. If the converter is heated to 600K or above both HC and CO emissions decrease significantly.

4 CATALYTIC CONVERTER BASED ON NON-NOBLE MATERIAL

This paper reviewed the most common existing technologies available to reduce exhaust emission and catalytic exhaust after treatment. Methodologies to increase temperature of catalytic converter during cold starting were also discussed. Finally, current research going on to replace noble catalyst were discussed. This article concerns the problems associated with the Nobel metals based catalytic converter generally catalytic converter uses platinum group of metals like Pt, Pd and Rh. These noble metals are known to promote the oxidation processes. There are several types of problems associated with noble metal based catalytic converter.

5 SUSSANE RYBERG said that Ceria is certainly a challenging system and further studies are necessary. Pt/ceria catalysts exhibit high activity for CO oxidation at low temperature. Carbon-containing adsorbents on ceria are mainly released as C02. It takes very long time to saturate the ceria support with carbonates. The storage of carbon-containing adsorb ate show different behavior depending on if CO or C02 is supplied.

IV. MATERIALS

STAINLESS STEEL 316: Stain less steels are press base compounds containing at least 10.5% chromium. They have utilized for some modern building substance and purchaser applications for over 50 years. Currently there are being showcased various stain less steels initially perceived by the American iron and steel intuits (AlSI) as standard composites .likewise financially accessible are property recolor less steels with unique attributes. A stainless steel in the particular sense as though it were one material .quite is more than fifty stainless steel compounds there are grouping are utilized to recognize recolor less steels

Figure.1 316 STAINLESS STEEL METAL

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The somewhat higher value purpose of 316 is well justified, despite all the trouble in zones with high chloride presentation, particularly the drift and intensely salted roadways. Every application for stainless steel has its own novel requests, and needs a stainless steel that is up to the undertaking.316 evaluations is the second-most regular type of stainless steel. It has nearly indistinguishable physical and mechanical properties from 304 stainless steel, and contains a comparable material make-up. The key contrast is that 316 stainless steel consolidates around 2 to 3 percent molybdenum. The expansion builds consumption resistance, especially against chlorides and other mechanical solvents.

3l6 stainless-steel is normally utilized as a part of numerous modern applications including preparing chemicals, and additionally high-saline conditions, for example, beach front districts and open air territories where de-icing salts are normal. Because of its non-responsive qualities.

V .STAINLESS STEEL - GRADE 316 PROPERTIES

Sort 316 is an austenitic chromium nickel stainless steel containing molybdenum. This expansion builds general consumption resistance, enhances imperviousness to setting from chloride particle arrangements, and gives expanded quality at hoisted temperatures. Properties are like those of Type 304 with the exception of that this amalgam is to some degree more grounded at hoisted temperatures. Consumption resistance is enhanced, especially against sulphuric, hydrochloric, acidic, formic and tartaric acids, corrosive sulfates and basic chlorides. Sort 316L is an additional low carbon adaptation of Type 316 that limits hurtful carbide precipitation because of welding. Normal uses incorporate ventilation systems, heater parts, warm exchangers, stream motor parts, pharmaceutical and photographic gear, valve and pump trim, concoction hardware, digesters, tanks, evaporators, mash, paper and material preparing hardware, parts presented to marine airs and tubing. Sort 316L is utilized widely for components where its insusceptibility to carbide precipitation because of welding guarantees Optimum consumption resistance.

TABLE 1: MECHANICAL PROPERTIES OF STAINLESS STEEL OF 316 AND 304

Grade	Tensile Strength Ksi (Min)	Yield Strength 0.2% Ksi (Min)	Elongation %	Hardness (Brinell) Max	Hardness (Rockwel) Max
SS316	75	30	40	217	95
SSL02	70	25	40	217	95

TABLE 2: PHYSICAL AND THERMAL PROPERTIES OF STAINLESS STEEL OF 316 AND 304

Density(lbm /in 3)	Thermal Conductiy (BTU/hft.F)	Electrical Resistiviy (in*10^- 6)	Modulus of Elasticity (psi*10^6)	Coefficient of Thermal expansion (in/in)F x 10^-6)	Specific Heat (BTU/lblF)	Melting Range (F)
0.29 at 680F	100.8 at 68 2120F	29.1 at 680F	29	8.9 at 32-2120F	0.108 at 680F	2500 to 2550

VI. FABRICATION

FABRICATION OF THE SMOKE CHANNEL:
STAINLESS STEEL PROCESSES

The last operation after manufacture or warmth treatment is cleaning to expel surface sullying and reestablish erosion resistance of the uncovered surfaces. Degreasing to evacuate cutting oils, oil colored pencil markings, fingerprints, earth, grime and other natural deposits is the initial step.

DEGREASING:

Non-chlorinated mated solvents ought to be utilized as a part of request to abstain from leaving deposits of chloride particles in hole and different areas where they can start cleft assault, setting, as well as stress consumption later on when the gear is set in benefit

MACHINED COMPONENTS:

Subsequent to degreasing, machined segments are now and again "passivated" in 10% nitric corrosive. Nitric corrosive upgrades the characteristic oxide surface film.

UTILIZING THE MANUFACTURE MATERIALS:

Stainless steel 316. Stain less steel 304.

VII. FABRICATIONS

Subsequent to degreasing, metallic surface contaminants, for example, press implanted in manufacture shop framing and taking care of, welds splatter; warm tint, incorporations and other metallic particles must be evacuated keeping in mind the end goal to reestablish the intrinsic consumption resistance of the stainless steel surface. Nitric-HF pickling, (10% HN03, 2% HF at 4900C to 6000C (120 to 140F), is the most broadly utilized and compelling strategy evacuating metallic surface pollution. Pickling might be finished by submersion or locally utilizing a pickling glue.

ELECTRO POLISHING:

Electro cleaning is utilizing oxalic or phosphoric corrosive for the electrolyte; a copper bar or plate for the cathode can be similarly viable. Electro-cleaning might be done locally to expel warm tint close by of welds or over the entire surface. Both pickling and electro cleaning evacuate a layer a few iota’s profound from the surface. Evacuation of the surface layer has the further advantage of expelling surface layers that may have turned out to be to some degree ruined in chromium amid the last warmth treatment operation.

WELDING PROCESS OF SMOKE FILTER

The typical TIG welding procedure of smoke channel utilizing materials is ss3l6,ss102 ordinary Gas tungsten bend welding (GTAW), otherwise called tungsten dormant gas (TIG) welding, is a circular segment welding process that uses a non-consumable tungsten cathode to create the weld. The weld region is shielded from climatic tainting by an inactive protecting gas (argon or helium), and a filler metal is typically utilized , however a few welds, known as autogenously welds, don't require it. A steady current welding power supply produces electrical vitality, which is led over the circular segment through a section of profoundly ionized gas and metal vapors known as plasma.

Figure. 2 NORMAL TIG WELDING PROCESSOF SMOKE FILTER

DISCUSSION 1

GTAW is most regularly used to weld thin areas of stainless steel and non- ferrous metals, for example, aluminum magnesium, and copper composites. The procedure gives the administrator more noteworthy control over the weld than contending procedures, for example, protected metal circular segment welding and gas Meta curve welding, taking into account more grounded, higher quality welds. In any case, GTAW is nearly more intricate and hard to ace, and besides, it is fundamentally lower than most other welding methods. A related procedure plasma curve welding utilizes a somewhat extraordinary welding light to make a more engaged welding bend and therefore is regularly robotized

Figure. 3 THE FIGURE SHOWS THAT TIG WELDED COMPONENT (SS316, SS102)

DISCUSSION 2

Smoke sensor for diesel motors. The sensor is 11lanned to give methods for recognizing smoke levels that surpass certain pre-characterized limits. EGR levels were acclimated to fluctuate debilitate smoke levels at a settled Speed/stack test point. Smoke estimations were given by an accessible To 415s variable testing smoke meter.Motor dynamometer tests were done utilizing a substantial obligation diesel motor outfitted with a lab EGR framework. EGR levels were changed in accordance with shift debilitate smoke levels at a settled speed/stack test point

GLASS BEAD OR WALNUT SHELL BLASTING:

Glass dab or walnut shell impacting are exceptionally viable in evacuating metallic surface sullying without harming the surface. It is now and again important to turn to impacting with clean sand to reestablish intensely polluted surfaces, for example, tank bottoms, yet mind must be taken to be sure the sand is really perfect, is not reused and does not roughen the surface. Steel shot impacting ought not be utilized as it will pollute the stainless steel with an iron ore. Stainless steel wire brushing or light granulating with clean aluminum oxide grating circles or flapper wheels are useful. Granulating or cleaning with Pounding wheels or persistent belt sanders have a tendency to overheat the surface layers to the point where resistance can't be completely reestablished even with consequent

Figure.4. Fabrication Material of Smoke Filter

Figure.5 Housing of the Smoke Filter

Figure. 6 Jalley of the Smoke Filter

Figure 7. Jalley Part of the Smoke Filter

VIII. RESULTS AND DISCUSSIONS

RESULTS WERE TAKEN ON A 4 STROKE SINGLE CYLINDER DIESEL ENGINE.

Load (Kg)	HC (Without Filter) PPM	HC (With Filter) PPM
0	8	11
5	19	15
10	25	18
15	21	16

IV. CONCLUSIONS

CO emissions are reduced using this converter. All the remaining emission like (HC, NOx, and C02) was decreased to a greater extent but increasing at maximum load. As we use metallic filter as catalyst, it absorbs most of the CO content and releases more oxygen. As the converter is made of steel which has a property of absorbing heat and helps the converter to maintain a optimum temperature which can easily be started even in cold conditions

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