IJE TRANSACTIONS B: Applications Vol. 31, No. 5, (May 2018) 856-862

International Journal of Engineering

Journal Homepage: www.ije.ir

Estimate the Performance of Catalytic Converter Using Turbulence Induce Devices

M. Bhandwal*, R. Kumar Tyagi, B. Singh Sikarwar

Departmnet of Mechanical Enginnering, Amity Univerity Uttar Pradesh, Noida

PAPER INFO

Paper history:
Received 05 January 2017
Received in revised form 25 Febraury 2018
Accepted 27 Febraury 2018

Keywords:
Air pollution
Catalytic converter
Gas emission
Turbulency
CFD
Simulation

ABSTRACT

In this manuscript, the experimental setup was designed and fabricated for optimizing the parameters of a catalytic converter of INDICA V2 exhaust system. Three turbulence intensify devices, namely Swirl Venturi, Swirl Blades and Swirl Contour, were close-fitted before the catalytic converter. The heating element is embedded in its body and thermocouples are used for knowing the performance at various temperature. The experiments were carried out with and without devices also with and without heating of catalytic converter. The emission was characterized by various engine speed. The results showed that catalytic converter effectiveness and efficiency increases when close-fitted the devices before the catalytic converter with heating. Among these devices, Swirl Blades was more effective and it reduces the CO and HC emission by 33.86%, and by 30.56% respectively. Flow Simulation of these devices was carried out using finite volume method. The obtained simulation shows that transport coefficient of catalytic converter enhances using these devices because of high turbulence intensity at the inlet of the catalytic converter. This research concluded that the heating of the catalytic converter and using the Swirl Blades device before it reduces the air pollution significantly of diesel engine motor vehicle.

doi: *10.5829/ije.2018.31.05b.23*

1. INTRODUCTION[1]

The World Health Organization announced in May 2015 that air of Delhi (the most polluted city in the world) India is nearly twice as toxic compared with Beijing [1]. Air pollution is the main source of harmful diseases and intensifies the epidemic of illnesses in the world [2]. Incomplete combustion of fuel is a substantial source of pollution from an automobile. It consists of emission with varied compositions of nitrogen oxides (NO_X), carbon monoxide (CO) and unburned hydrocarbons (HC) that pollute the atmosphere. Hence, vehicles produce significantly harmful pollutants that deplete the ozone layer at a high rate [3, 4]. They produce CO as a major pollutant along with NO_X. CO is poisonous, has no color, no odor, and has the high affinity for hemoglobin in blood [5, 6]. NO_X after combustion constitutes largely of nitric oxide (NO) and a small content of nitrogen dioxide (NO_2) [7]. NO causes dilatation of airspaces in lungs and NO_2 damages the bronchioles and alveolar ducts and HC produces ground-level ozone, which is a major component of smog [8-10]. As per literature [11-13], the acceptable range for an automobile exhaust is given in Table 1.

Diesel engine contaminates the air more as compared to a petrol engine. Diesel engine emits unacceptable smoke (seven times more) for a prolonged period of cold operation (0°C to 550°C) than warm conditions (550 ºC to 750 ºC) [14].

In literatures [15-27] various procedures were reported to reduce the pollutants as emission. They were classified as primary and secondary. In a primary, Biofuel blend with diesel reduces harmful emission [15, 16].

TABLE 1. Emission standards

S.N.	CO in vol.%	HC in ppm	NO in ppm	H_2 in vol.%	H_2O in vol.%	CO_2 in vol.%	O_2 in vol.%
BS III	0.5	350	900	0.17	10	10	0.5

*Corresponding Author Email: *mbhandwal@amity.edu* (M. Bhandwal)

Please cite this article as: M. Bhandwal, R. Kumar Tyagi, B. Singh Sikarwar, Estimate the Performance of Catalytic Converter Using Turbulence Induce Devices, International Journal of Engineering (IJE), IJE TRANSACTIONS B: Applications Vol. 31, No. 5, (May 2018) 856-862

Biodiesel-diesel and ethanol-biodiesel-diesel blends produce less carbon dioxide (main constituents of the greenhouse effect), CO, HC, and particulate matter [17, 18], but increases the NO level and had a minor effect on the transient performance [19]. The metal-based additive added with biodiesel shows the reduction in NO, CO, and HC [20]. Multistage fuel injection is another method to reduce the emission from automobiles. A small amount of fuel injection before main fuel injection reduces the emission such as two pilot injections prior to the main injection reduces HC, NO_X, and particulate matter [21, 22].

In the Secondary method, catalytic filters coated with cordierite monoliths with alumina-based suspensions containing Cu, Co or V and K were prepared to remove particulate matter and nitrogen oxides [23]. Treatments of exhaust gasses that uses the alkali solution reduce CO_2. The catalytic converter is an efficient device to reduce emission [24]. This device works on chemical reaction (Equations 1-3) and this device is mandatory for all vehicles registered in India for minimizing the pollutant in the air. In this device, Rhodium (Rh), Platinum (Pt), and Palladium (Pd) catalysts are used.

Reduction: $$2NOx \rightarrow XO_2 + N_2 \quad (1)$$

Oxidation: $$2CO + O_2 \rightarrow 2CO_2 \quad (2)$$

$$C_XH_{2X+2} + [(3x+1)/2]\, O_2 \rightarrow XCO_2 + (X+1)\, H_2O \quad (3)$$

The effectiveness of the catalytic converter depends on the various parameters such as the performance of catalytic converter increases when the exhaust has maximum contact area, and when it attains the required temperature. During the cold start phase, when the engine starts, 50% HC and 80% CO is emitted [25].

Different techniques are used to reduce the cold start emission such as assembling the converter close to the exhaust manifold, heating the catalytic converter and secondary hot air injection. Phase change material is used to reduce the cool-down rate of the engine that in turns reduces the cold start time [26]. Exhaust gas recirculation (EGR) control valve optimization for advancing the first firing cycle reduces 77% smoke emission [27].

Most of the literature focuses on the use of bio-fuel, EGR, and heating in cold start phase for reduction of emission. However, the literature that reduces the emission by increasing the turbulence intensity at the inlet of the catalytic converter device is not explicitly reported in the literature. Against this background, the aim of this research is to enhance the transport coefficients of chemical reaction in the catalytic converter. The turbulence intensifies devices used for increasing the turbulence intensity are namely as Swirl Venturi, Swirl Blades, and Swirl Contour. An experimental setup which consists of INDICA V2 diesel engine is designed and fabricated for carrying out the experiment at specific environment (25 °C, RH = 65% and pressure = 1atm) condition. The flow pattern of exhaust gases in these devices is simulated in using in-house FVM finite volume based CFD solver. The detail of this CFD solver is reported elsewhere [28]. The experimental and simulation results showed that turbulence device with heating enhances the performance of the catalytic converter.

2. EXPERIMENTAL SETUP

The experimental setup consists of a diesel engine which technical specification is given Table 2. The details of experimental setup are shown Figure 1. Figure 1(a) shows the line diagram of the setup. However, the photograph of the experimental setup is shown in Figure 1(b). The devices which are fitted for enhancing the turbulence intensity of exhaust at the inlet of the catalytic converter are shown in Figure 2.

TABLE 2. Engine specification

Type	BS3, 16 VALVES, DOHC
Engine capacity	1405cc
Max. power (PS@RPM)	48.9 PS @ 5000 RPM
Max. torque (NM @ RPM)	85 NM @ 2500 RPM
Fuel type	Diesel
Emission norms	BS3
Manufacturer	TATA Company India

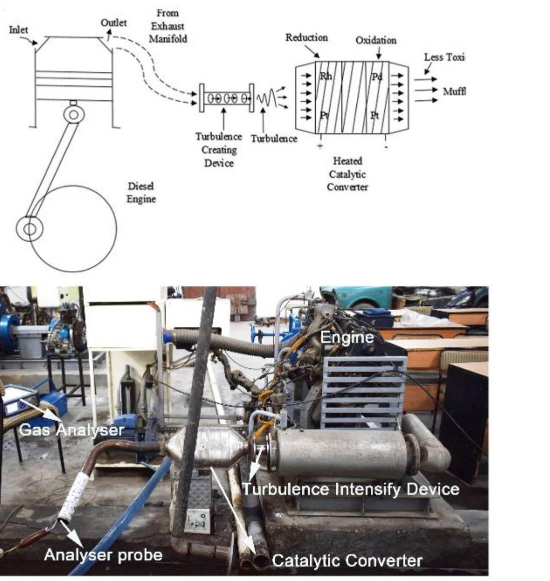


Figure 1. (a) Schematic diagram of experimental setup and (b) Photograph of the experimental setup used in present study

These devices are namely as Swirl Venturi, Swirl Blades, and Swirl Contour. The special arrangement is designed for fitting these devices before the catalytic converter. The devices were designed and fabricated in Amity University workshop. A gas analyzer (AVL DIGAS 444) was used for characterizing the exhaust. In this method, silicon coated probe was inserted into the exhaust pipe to display the contents of the emission gases digitally. Contact-type Digital Tachometer was used to measure the revolution per minute (RPM) of the engine.

The electrical heating coil was wound around the catalytic converter for heating it and K-thermocouples was used to measure the surface temperature of the catalytic surface at various locations.

The experiments were conducted in control condition to find out the toxicity level of the emitted gasses at different RPM and various condition with and without turbulence intensify devices. The details of the experimental conditions (for examples: experiment is performed at different RPM using various devices and heating/non heating of the catalytic converter) is shown in Figure 3.

3. SIMULATION METHOD

The turbulence intensify devices were used for enhancing the turbulence intensity of the exhaust at the inlet of the catalytic converter. These devices have a various configuration, Figure 2.

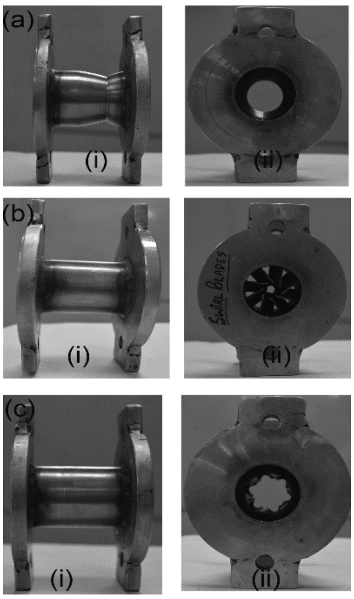


Figure 2. Photographs of devices used in enhancing the turbulence and turbulence intensity in the catalytic converter. (a) Swirl Venturi: (i) front view and (ii) side view. (b). Swirl Blades: (i) front view and (ii) side view. (c) Swirl Contour: (i) front view and (ii) side view

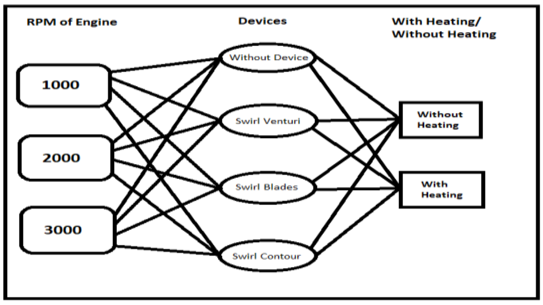


Figure 3. Relation among conditions for performing experiments

The CFD simulation of these devices was carried out for knowing the effectiveness of them. The computational domain with the meshing of these devices was shown in Figure 4. The unstructured mesh was formed on the domain. In-house CFD solver was used for simulation and details of this solver was reported by author elsewhere [29].

In the present work, Three-Dimensional k-ε turbulence (two-equation) model is used. The standard k-ε is a semi-empirical model based on model transport equations for the turbulence kinetic energy (k) and its dissipation rate (ε). The various conservation equations used in the standard k-ε model are given hereunder:

$$\frac{\partial u_i}{\partial x_i} = 0 \qquad (4)$$

$$\frac{\partial u_i}{\partial t} + \frac{\partial u_i u_j}{\partial x_j} = -\frac{\partial}{\partial x_i}\left(\frac{p}{\rho} + \frac{2}{3}k\right) + \frac{\partial}{\partial x_j}\left[\nu_t + \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right)\right] \qquad (5)$$

$$\frac{\partial k}{\partial t} + \frac{\partial k u_j}{\partial x_j} = \frac{\partial}{\partial x_j}\left(\frac{\nu_t}{\sigma_1}\frac{\partial k}{\partial x_j}\right) + \nu_t S - \varepsilon \qquad (6)$$

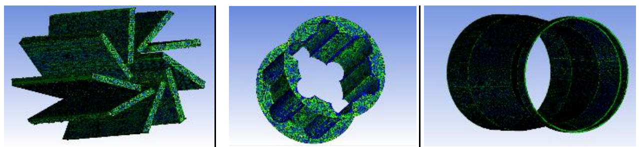
$$\frac{\partial \varepsilon}{\partial t} + \frac{\partial \varepsilon u_j}{\partial x_j} = \frac{\partial}{\partial x_j}\left(\frac{\nu_t}{\sigma_2}\frac{\partial \varepsilon}{\partial x_j}\right) + C_1 \frac{\varepsilon}{k}\nu_t S - C_2 \frac{\varepsilon^2}{k} \qquad (7)$$

$$\nu_t = C_\mu \frac{k^2}{\varepsilon} \qquad (8)$$

$$S = \left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i}\right)\frac{\partial u_i}{\partial x_j} \qquad (9)$$

where, $\sigma_1 = 1.0, \sigma_2 = 1.3, \sigma_3 = 1.0, C_\mu = 0.09, C_1 = 1.44, C_2 = 1.92$

The diffusion terms are discretized using a 2nd order central difference scheme.



(a) (b) (c)

Figure 4. Surface mesh on the computational domain o hypothesis device. (a) swirl blade, (b) swirl contour and (c) swir venturi

Convection terms are discretized using a second-order upwind scheme. For a higher-order scheme, cell face fluxes are calculated using an accurate estimation of left and right states at the cell face. The author proposed a multidimensional linear reconstruction approach. The face value of tetrahedron cells is determined by the simple formula

$$\phi_{f123} = \phi_c + \frac{1}{4}\left[\frac{1}{3}\left(\phi_{n1} + \phi_{n2} + \phi_{n3}\right) - \phi_{n4}\right] \qquad (10)$$

For determining nodal quantities, the weighted average of surrounding cell-centered properties is used.

$$\phi_n = \frac{\left(\sum_{i=1}^{N} \frac{\phi_{c,i}}{r_i}\right)}{\left(\sum_{i=1}^{N} \frac{1}{r_i}\right)} \qquad (11)$$

where,

$$r_i = \left[\left(x_{c,i} - x_n\right)^2 + \left(y_{c,i} - y_n\right)^2 + \left(z_{c,i} - z_n\right)^2\right]^{\frac{1}{2}} \qquad (12)$$

The discretized system of algebraic equation is solved by stabilized bi-conjugate gradient method (biCGStab) with a diagonal precondition. Grid independence test were carried out for mesh of all devices. The optimize grid are consider in this simulation.

The simulation was carried out by in-house CFD solver and the fluid flow simulation of three devices was captured and analyzed. The pressure contour, streamline and axial velocity contour is shown in Figure 5. Figure 5(a) shows the pressure contour, streamline and velocity contour for swirl blade. The pressure suddenly increases at the inlet of the blade and decreases monotonically towards flow direction, as shown in Figure 5(a, i).

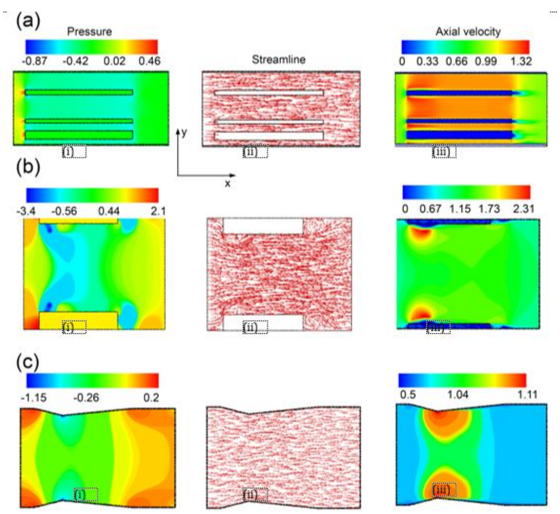


Figure 5. Pressure contour, streamline and axial velocity contour of three devices. The simulation was carried out using in-house CFD Solver. (a) swirl blade, (b) swirl contour and (c) swirl venture

Even the streamline deflects at inlet and outlet of blades, there was no vortex observed as shown in Figure 5(a, ii). Figure 5(a, iii) shows the axial velocity contour and high-velocity flow was observed as compared to other devices. Similarly, pressure contour, streamline and axial velocity contour were observed for other two devices. Figure 5(b) shows the results for swirl contour and Figure 5(c) shows the results for swirl venturi. The pressure drop is more in swirl contour; however, the pressure drops in less in swirl venturi. The basis of these simulation results it is concluded that the swirl blade is more effective as compared to other devices.

4. RESULTS AND DISCUSSION

The experimental studies were carried out under control condition and obtained data were stored for analyzing the parametric effects. The decrease in the emission of CO (Vol. %), HC (Hex. ppm) and NO (Vol. ppm) in the exhaust gases is observed using the device with heating. The error analysis has been carried out. The presented data under the 95% confidence level. The data were plotted for comparing the effectiveness of various device at the different speed. The observed data were discussed for the unheated and heated state of the catalytic converter in the following manner:

Carbon Monoxide (CO) Figure 6 shows the CO (Vol. %) in exhaust gases for two different states (with heating and without heating) of the catalytic converter along with the devices and without devices. Figure 6(a) shows results when catalytic converter was an environmental condition (No heating). However, Figure 6(b) shows the result when the catalytic converter was heated by an external source. In heating condition, the catalytic converter was heated from environmental condition to operating condition (550-750 °C) before starting the experiment. The Swirl Blades device gives good performance at high speed followed by Swirl Venturi as shown in Figure 6(a-b). The significant drop in exhaust emission was observed when catalytic converter was heated. High emission occurred when engine speeded-up.

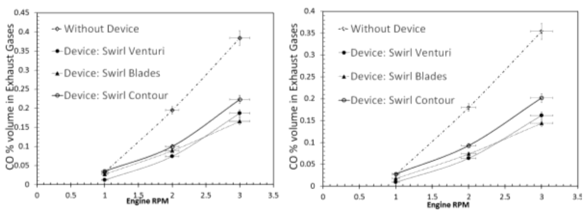


Figure 6. Comparison of CO emissions from the catalytic converter at various RPM Engine. (a)Without heating of the catalytic converter and (b) with the heating of the catalytic converter

Hydro Carbon(HC) Figure 7 shows the HC (Hex. ppm) in exhaust gases for two different states of the catalytic converter and with the devices and without devices. From the data obtained with the devices, the Swirl Blades device gives the best results followed by Swirl Venturi. Figure 7(a-b) shows the value of HC in exhaust gases at various speeds. As speed increases, the percentage of unburnt fuel increasing. Therefore, exhaust gases at high speed of engine contain more HC. The significant drop in the value of HC was observed by using a heated catalytic converter.

Carbon Dioxide (CO_2) Figure 8(a) shows the CO_2 (Vol. %) in exhaust gases when there was no heating of catalytic converter. However, Figure 8 (b) shows the CO_2 (Vol. %) in exhaust gases with heating. The percentage of CO_2 in exhaust gases increases as RPM increases. Figure 8(a-b) shows that high value of CO_2 in exhaust gases when heated. This result also shows that the Swirl contour device has a high value of CO_2 in exhaust gases as compared to other devices. However, the CO_2 value was found more in exhaust gases using devices as compared to without device. It means catalytic converter works effectively and efficiently when it was heated and devices were connected with the converter.

Oxygen (O_2) The volume percentage of O_2 in exhaust gases at various condition such as using hypothesis device along with heat and without heating at the various speed of engine was shown in Figure 9(a-b).

The following observations were noted: (i) percentage of O_2 decreases when there was heating of converter and using devices, (ii) percentage of O_2 decreases when uses swirl contour as compared to other devices and (iii) high volume of O_2 in exhaust observed at low RPM.

Nitrogen Oxide (NOx) Figure 10 shows that the NOx increases when converter was heated. However, NOx decreases as devices were connected. NOx goes down in exhaust gases as engine speed increases. At low speed, the Swirl contour device performed well, at moderate speed Swirl blades gave low emission and at high speeds, the Swirl venturi performed well. A significant increase in NO value was observed when catalytic converter was heated.

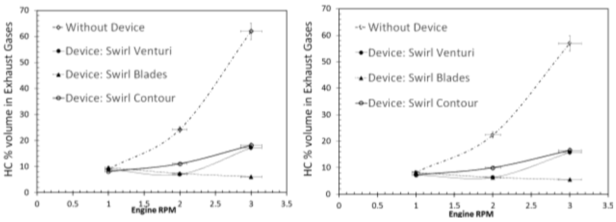


Figure 7. Comparison of HC emissions from the catalytic converter at various RPM Engine. (a)Without heating of the catalytic converter and (b) with the heating of the catalytic converter

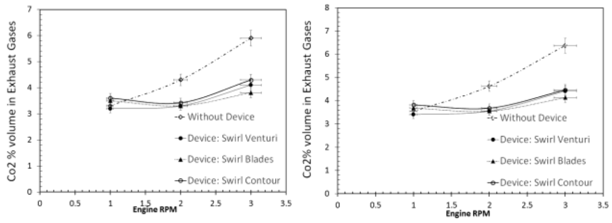


Figure 8. Comparison of CO_2 emissions from the catalytic converter at various RPM Engine. (a)Without heating of the catalytic converter and (b) with the heating of the catalytic converter

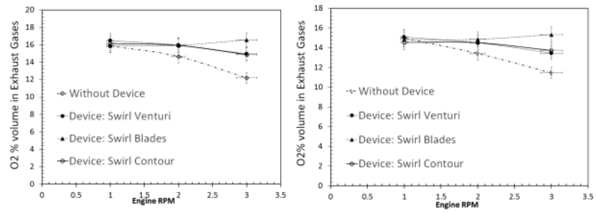


Figure 9. Comparison of O_2 emissions from the catalytic converter at various RPM Engine. (a)Without heating of the catalytic converter and (b) with the heating of the catalytic converter

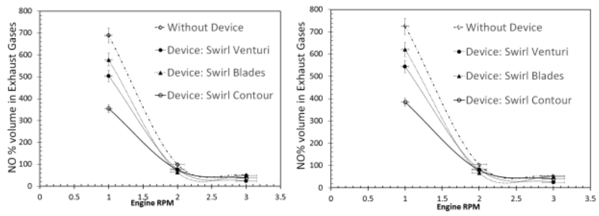


Figure 10. Comparison of NO emissions from the catalytic converter at various RPM Engine. (a)Without heating of the catalytic converter and (b) with the heating of the catalytic converter

5. SUMMARY AND CONCLUSIONS

An experimental study was carried out to optimize the performance of the catalytic converter. Turbulence intensify devices were used to create turbulence at the inlet of the catalytic converter for which transport coefficients (heat and mass transfer coefficients) increases. CFD Simulation was carried to know the effectiveness of the turbulence intensify device. In-house CFD solver was used for this simulation. The catalytic converter was heated to reduce the cold start time. Swirl blade device with heating of catalytic converter minimizes CO and HC level in exhaust gases at high speed. The averaged value displays the effectiveness of the Swirl blades along with heating of catalytic converter, which reduces the CO emission to 33.86% and HC emission to 30.56 %.

When we heat the catalytic converter, it increases the emission of CO_2 and NO and reduces O_2. An increase in the emission of CO_2 shows that more CO is getting oxidized which is desirable. As a result, the O_2 level decreases when heat the catalytic converter. The increase in the NO emission is because of more O_2 content while entering the first chamber of the catalytic converter that creates a problem in the reduction of NO into N_2 and O_2. Swirl Contour device gives the best results of 28.41% increase in the CO_2 level that is best and 20.5% increase in the NO level that is least, among all the turbulence intensify devices.

6. REFERENCES

1. Sperling, D. and Gordon, D., "Two billion cars: Transforming a culture", ***TR news***, No. 259, (2008).
2. McDermott, W., "Air pollution and public health", ***Scientific American***, Vol. 205, No. 4, (1961), 49-57.

٣. M., M.K., M., A. and Khalilarya S., "The effect of exhaust gas recirculation on performance and emissions of si engine fuelled with ethanol-gasoline blends", ***International Journal of Engineering, Transactions A: Basics***, Vol. 28, No. 1, (2015), 130-135.

٤. Tabejamaat, S., "Numerical study of reduction of nox emissionby high temperature air combustion technology", V ***International Journal of Engineering, Transactions B: Applications***, Vol.16, (2003), 255-255.

٥. Badr, O. and Probert, S., "Sources of atmospheric carbon monoxide", ***Applied Energy***, Vol. 49, No. 2, (1994), 145-195.

٦. Kampa, M. and Castanas, E., "Human health effects of air pollution", ***Environmental Pollution***, Vol. 151, No. 2, (2008), 362-367.

٧. Roy, S., Hegde, M. and Madras, G., "Catalysis for nox abatement", ***Applied Energy***, Vol. 86, No. 11, (2009), 2283-2297.

٨. Dimitriades, B., "Effects of hydrocarbon and nitrogen oxides on photochemical smog formation", ***Environmental Science & Technology***, Vol. 6, No. 3, (1972), 253-260.

٩. Meulenbelt, J., "Nitrogen and nitrogen oxides", ***Medicine***, Vol. 31, No. 10, (2003), 64.

١٠. Atkinson, R., Lloyd, A.C. and Winges, L., "An updated chemical mechanism for hydrocarbon/nox/so2 photooxidations suitable for inclusion in atmospheric simulation models", ***Atmospheric Environment (1967)***, Vol. 16, No. 6, (1982), 1341-1355.

١١. Tyagi, R. and Ranjan, R., "Effect of heating the catalytic converter on emission characteristic of gasoline automotive vehicles", ***International Journal of Ambient Energy***, Vol. 36, No. 5, (2015), 235-241.

١٢. Kisku, G., "Nature and type of pollution from automobiles and strategies for its control", ***Industrial Toxicology Research Centre, Environmental Monitoring Division, Lucknow***, (2013), 1-16.

١٣. Pundir, B., "Engine emissions: Pollutant formation and advances in control technology, Alpha Science International, Limited, (2007).

١٤. Weilenmann, M., Soltic, P., Saxer, C., Forss, A.-M. and Heeb, N., "Regulated and nonregulated diesel and gasoline cold start emissions at different temperatures", ***Atmospheric Environment***, Vol. 39, No. 13, (2005), 2433-2441.

١٥. Pelkmans, L., Lenaers, G., Bruyninx, J., Scheepers, K. and De Vlieger, I., "Impact of biofuel blends on the emissions of modern vehicles", ***Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering***, Vol. 225, No. 9, (2011), 1204-1220.

١٦. Giakoumis, E.G., "A statistical investigation of biodiesel effects on regulated exhaust emissions during transient cycles", ***Applied Energy***, Vol. 98, (2012), 273-291.

١٧. Mofijur, M., Rasul, M., Hyde, J., Azad, A., Mamat, R. and Bhuiya, M., "Role of biofuel and their binary (diesel–biodiesel) and ternary (ethanol–biodiesel–diesel) blends on internal combustion engines emission reduction", ***Renewable and Sustainable Energy Reviews***, Vol. 53, (2016), 265-278.

١٨. Hulwan, D.B. and Joshi, S.V., "Performance, emission and combustion characteristic of a multicylinder di diesel engine running on diesel–ethanol–biodiesel blends of high ethanol content", ***Applied Energy***, Vol. 88, No. 12, (2011), 5042-5055.

١٩. Rakopoulos, C., Dimaratos, A., Giakoumis, E. and Rakopoulos, D., "Study of turbocharged diesel engine operation, pollutant emissions and combustion noise radiation during starting with bio-diesel or n-butanol diesel fuel blends", ***Applied Energy***, Vol. 88, No. 11, (2011), 3905-3916.

٢٠. Kannan, G., Karvembu, R. and Anand, R., "Effect of metal based additive on performance emission and combustion characteristics of diesel engine fuelled with biodiesel", ***Applied Energy***, Vol. 88, No. 11, (2011), 3694-3703.

٢١. Ryu, K., "Effects of pilot injection timing on the combustion and emissions characteristics in a diesel engine using biodiesel–cng dual fuel", ***Applied Energy***, Vol. 111, (2013), 721-730.

٢٢. Suh, H.K., "Investigations of multiple injection strategies for the improvement of combustion and exhaust emissions characteristics in a low compression ratio (Cr) engine", ***Applied Energy***, Vol. 88, No. 12, (2011), 5013-5019.

٢٣. Schejbal, M., Štěpánek, J., Kočí, P., Marek, M. and Kubíček, M., "Sequence of monolithic converters doc–cdpf–nsrc for lean exhaust gas detoxification: A simulation study", ***Chemical Engineering and Processing: Process Intensification***, Vol. 49, No. 9, (2010), 943-952.

٢٤. Sharma, S., Goyal, P. and Tyagi, R., "Conversion efficiency of catalytic converter", ***International Journal of Ambient Energy***, Vol. 37, No. 5, (2016), 507-512.

٢٥. Shen, H., Shamim, T. and Sengupta, S., *An investigation of catalytic converter performances during cold starts*. 1999, SAE Technical Paper.

٢٦. Gumus, M. and Ugurlu, A., "Application of phase change materials to pre-heating of evaporator and pressure regulator of a gaseous sequential injection system", ***Applied Energy***, Vol. 88, No. 12, (2011), 4803-4810.

٢٧. Saravanan, S., "Effect of exhaust gas recirculation (egr) on performance and emissions of a constant speed di diesel engine fueled with pentanol/diesel blends", ***Fuel***, Vol. 160, (2015), 217-226.

٢٨. Sikarwar, B.S., Khandekar, S., Agrawal, S., Kumar, S. and Muralidhar, K., "Dropwise condensation studies on multiple scales", ***Heat Transfer Engineering***, Vol. 33, No. 4-5, (2012), 301-341.

٢٩. Sikarwar, B.S., Khandekar, S. and Muralidhar, K., "Simulation of flow and heat transfer in a liquid drop sliding underneath a hydrophobic surface", ***International Journal of Heat and Mass Transfer***, Vol. 57, No. 2, (٢٠١٣), ٧٨٦-٨١١.

Estimate the Performance of Catalytic Converter Using Turbulence Induce Devices

M. Bhandwal, R. Kumar Tyagi, B. Singh Sikarwar

Departmnet of Mechanical Enginnering, Amity Univerity Uttar Pradesh, Noida

P A P E R I N F O

Paper history:
Received 05 January 2017
Received in revised form 25 Febraury 2018
Accepted 27 Febraury 2018

Keywords:
Air pollution
Catalytic converter
Gas emission
Turbulency
CFD
Simulation

چکیده

در این مقاله برای بهینه سازی مبدل کاتالیستی سیستم اگزوز دستگاه آزمایشگاهی طراحی و ساخته شد. سه دستگاه نشان دهنده آشفتگی جریان به ترتیب سورل وانچوری، سورل پره ای و کنتوری که کاملا مناسب با سیستم بوده نصب گردید. المانت حرارتی و ترموکوپل در بدنه مبدل جا سازی شده که کارایی دمای سیستم را نشان دهد. آزمایش ها با المانت و بدون المانت حرارتی انجام گردید. مختصات نشر گازهای احتراق در اگزوز با سرعت متفاوت موتور تعین گردید. نتایج نشان میدهد که موثربودن و بازدهی فزاینده مبدل کاتالیستی در حالتی که مبدل حرارت دیده است کاملا مناسب بود. در میان سه نوع مبدل کاتلیستی نوع مبدل پره ای بسیار موثر عملکرد داشته که میزان نشر گاز کربن منواکید و گاز انتشار یافته هیدروکربوری به ترتیب به میزان ۳۳ و ۳۰ درصد کاهش یافته است. شبیه سازی جریان در این مبدل ها بروش آنالیز اجزاء محدود صورت گرفته است. نتایج شبیه سازی در توسعه و کارایی مبدل موثر بوده و با استفاده ازاین دستگاهها شدت آشفتگی جریان در هوای آلوده ورودی قابل ملاحظه بوده است. این تحقیق مبدل کاتالیستی حرارتی را بررسی می نماید. استفاده از مبدل کاتالیستی با پره سورل موجب کاهش قابل ملاحظه ای در الودگی موتور دیزلی می گردد.

***doi**: 10.5829/ije.2018.31.05b.23*