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Modelling study of flue gas flow pattern with pressure, amount and shape variation catalytic converter

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ABSTRACT

Purpose: The purpose of this study is to analyse the modelling of exhaust gas flow patterns with variations in pressure, number, and shape of filters on the catalytic converter.

Design/methodology/approach: The research method used is a simulation using ANSYS, which starts by creating a converter catalytic model with pressure variations: (0.5-1.5 atm), number of filters: (2-5), and the form of filter-cut/filter-not-cut.

Findings: The decrease in velocity is caused by non-uniform velocity in the exhaust gas flow that occurs when passing through a bend in the filter-cut that serves as a directional flow to create turbulence. Filter-cut type tends to have fluctuating pressure, turbulence flow pattern shape so that contact between filter and exhaust gas is more effective. Based on the analysis of flow patterns, the speed and pressure of the 5 filter-not-cut design at a pressure of 0.5 are the best, while at pressure (1-1.5 atm) the type 5 filter-cut is the best.

Research limitations/implications: This study is limited to filter-not-cut and filter-cut types with variations in the number of filters: 2, 3, 4, and 5, and the inlet pressure between 0.5-1 atm.

Practical implications: The practical implications of this study are to find a catalytic converter design that has advantages in the effectiveness of exhaust gas absorption.

Originality/value: The results show that the filter-not-cut and filter-cut types have the best effectiveness in the number of 5 filters. Filter-not-cut at the pressure of 0.5 atm and filter-cut at pressure (1-1.5 atm).

Keywords: Shape effect, Absorption effectiveness, ANSYS, Catalytic converter, Filter-not-cut, Filter-cut

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METHODOLOGY OF RESEARCH, ANALYSIS AND MODELLING

1. Introduction

Research on catalytic converters is currently developing and advancing very rapidly. Many changes have been achieved in the research that has been done. Broadly speaking, these studies are grouped into 5 major groups, namely: types of numerical model research, computational fluid dynamic models, catalytic converter design, experimental laboratories, and the development of catalytic materials [1]. In each research has found important things that support progress in the development of catalytic converters.

Competition to make vehicles that have low exhaust emissions at affordable costs encourage the automotive industry to compete to find qualified technology [2]. Testing is carried out with laboratory resources in the design of an increasingly complex exhaust gas system optimization. All is done to get a more perfect catalytic converter design so that it meets user expectations.

The catalytic converter is a device that converts harmful exhaust gases from the internal combustion engine into harmless gas [3]. Gases released from internal combustion include NO_X, CO, HC which does not burn. All of these pollutants are harmful to the environment and human health because they cause the greenhouse effect, acid rain, and global warming. By using the catalytic converter of dangerous gases it can be converted into: N_2, CO_2, H_2O.

To overcome complex problems, various methods are used to save costs in his research. Experimental research is not suitable because the research costs are very high. Many researchers have applied numerical methods to overcome this problem, among others: using comprehensive mathematical and numerical models to simulate the catalytic performance of converters to reduce engine exhaust emissions [4]. The developed model is used to investigate the dynamic response of catalytic converters in vehicles when emitting exhaust emissions.

This numerical analysis research continues to develop by carrying out new approaches by combining physical and numerical multi-resolution techniques to display the flow in the catalytic converter [5]. In this technique, a more optimal meshing technique is performed to display the flow of convergent and divergent regions.

Research using a more thorough and sophisticated numerical analysis has been carried out by [6]. In this study, a Computational Fluid Dynamics-3D analysis was performed using ANSYS. The set equation is solved using the FLUENT solver, which is then added to the surface reaction model. The characteristics of the flow across the catalytic parts of the converter are visualized together with the simulation of heterogamous reactions in the converter. The results of this study are compared with other studies and the results meet acceptable limits.

The use of catalysts by using precious metals has been widely introduced and researched. There are some disadvantages of this catalyst, including the price of catalytic converters tends to be high so that users are less interested. To overcome this, research is carried out by introducing non-precious metal-based catalyst types such as copper [7]. The results of this research show superior properties that have better endurance and more toxic resistance compared to precious metals. By using copper-based catalytic the HC value was reduced by 38% and CO by 33% at full load.

Research on catalysts using non-precious metals continues to develop as recent research was carried out by [8], in this study using catalysts of nano iron oxide particles. The results obtained indicate a significant increase in the concentration of carbon dioxide, oxygen, and exhaust gases after using an innovative catalytic converter coated with nano iron oxide particles.

When the flue gas pressure decreases along with the converter there will be an increase in temperature in the converter wall and a reduced soot weight [9]. Increasing the weight of soot contained by the inlet gas of the converter increases the length of the converter. Conversely, an increase in catalyst particle diameter does not affect soot weight and temperature but results in a decrease in pressure on the catalytic converter.

Research on catalytic converters with porous ceramic materials, where the lower the porosity of a material, the higher the inlet pressure and the more pressure loss [10]. The more catalytic converter will increase the exhaust back-pressure, this is caused by the reduced volumetric efficiency and higher fuel consumption [11]. The increase in the number of catalytic converters affects the vacuum

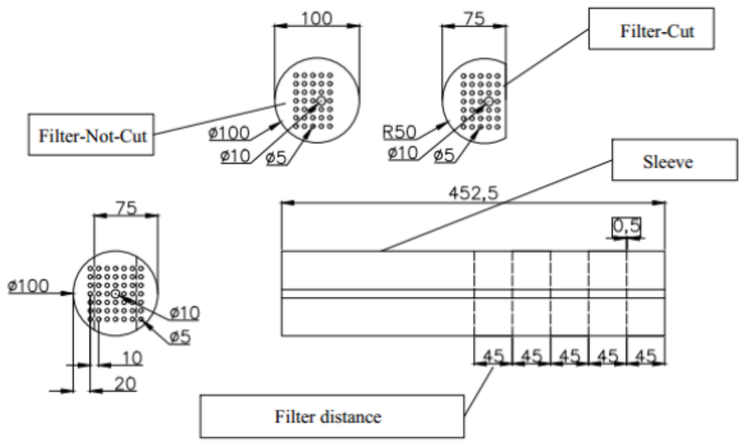

Fig. 1. Dimension of catalytic converter design (mm units)

formed along with the converter [12]. The catalytic converter pressure, amount, and shape directly influence its efficiency and durability. For this reason, it is necessary to conduct further studies on the modelling of exhaust gas flow patterns with variations in pressure, amount, and shape on the catalytic converter.

2. Materials and methods

This research method begins with the creation of a catalytic converter design which includes: a dimension of filter-not-cut and filter-cut image (Fig. 1). Then design the catalytic frame dimensions of the converter and the distance of the filter placement with variations in the number of filters: 2, 3, 4, and 5. In the next step do the simulation with CFD 14.5 software, student version with the following parameters:

- User mode: Viscous-laminar;
- Analysis mode: Steady-state;
- Fluid type: Water;
- Boundary condition: inlet, outlet, wall.

Filter-not-cut dimensions shown (Fig. 1) have a diameter: 100 mm, a diameter of the middle hole 10 mm, a diameter of the filter hole: 5 mm, and the total number of filter holes is 49. Filter-cut dimensions are shown (Fig. 1) with radius: 50 mm, a diameter of the middle hole: 10 mm, a diameter of the filter hole: 5 mm, and the total number of filter holes is 35. The distance between the filters is 45 mm with the total length of the sleeve: 452.5 mm.

3. Research procedures

These simulation steps follow the research flow chart as shown in Figure 2. The first step is to create a catalytic converter design with variations: filter-not-cut and filter-cut forms; variations in the number of filters, namely: two, three, four, and five; Inlet pressure variations of: 0.5, 1 and 1.5 atm. Next do the simulation with ANSYS software to find out the exhaust gas flow pattern and analyse the results.

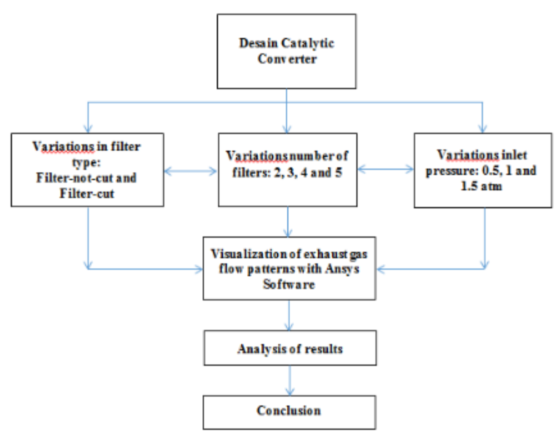

Fig. 2. Research flow chart

4. Results and discussion

Figures 3a and 3b, show the catalytic arrangement of the converter across 5 filter-not-cut and filter-cut types. For the arrangement of the filter-cut type, a portion of the cross-section is cut with the aim that the exhaust gas flow is faster and turbulent flow is formed as shown in the white ellipse of Figure 3b.

The turbulence that occurs in the converter catalytic channel will increase contact between the exhaust gas and catalytic converter so that the absorption of harmful gases occurs effectively. This exhaust gas flow process passes through filters 1, 2, 3, 4, and 5 (in sequence), then released into free air.

Table 1 show the exit velocity data on the catalytic converter, with an input pressure of 0.5 atm and an inlet speed of 1 m/s. The results of the percentage increase in filter-not-cut are: (215.60-323.70%) and filter-cut (220.10-325.40%). At a pressure of 0.5 atm, the influence of the number of filters is still dominant towards increasing and decreasing the exhaust gas flow velocity. The difference in percentage between filter-not-cut compared to filter-cut shows an increase in speed at filter-cut with a range of values (1.70-101.60%). The highest speed increase occurred in 4 filter-cut with a value of 101.60% as shown in Table 1 (gray vertical shading). The lowest speed increase occurred in 2 filter-cut with a value of 1.70% as shown in Table 1 (gray horizontal shading). In all not-cut filters, all variations produce a decrease in speed, this indicates a bottleneck in the exhaust gas flow.

Figure 4 show the results of the velocity distribution of the filter-not-cut and filter-cut with a speed of 1 m/s and a pressure of 0.5 atm. There are two regions are formed namely dark blue and light blue which indicate the speed of the exhaust gas. Where the dark blue area of the filter-not-cut is wider this indicates a lower exhaust gas velocity value. Conversely, the light blue filter-cut is more dominant than the dark blue colour, this indicates a higher exhaust gas speed. The exit speed values for each filter are 3.392 m/s (filter-not-cut) and 3.508 m/s (filter-cut) as shown in Table 1. The slowdown experienced by 4 filter-not-cut is 101.60 which indicates filter cutting can increase the exhaust gas speed. Simulation results show the speed of light blue is higher than the speed of dark blue. Because of the difference in velocity gradients that occur, the average speed is the sum of the high-speed region and the region of lower speed. So the areas that have a more dominant light blue colour have a higher speed value.

a) b)

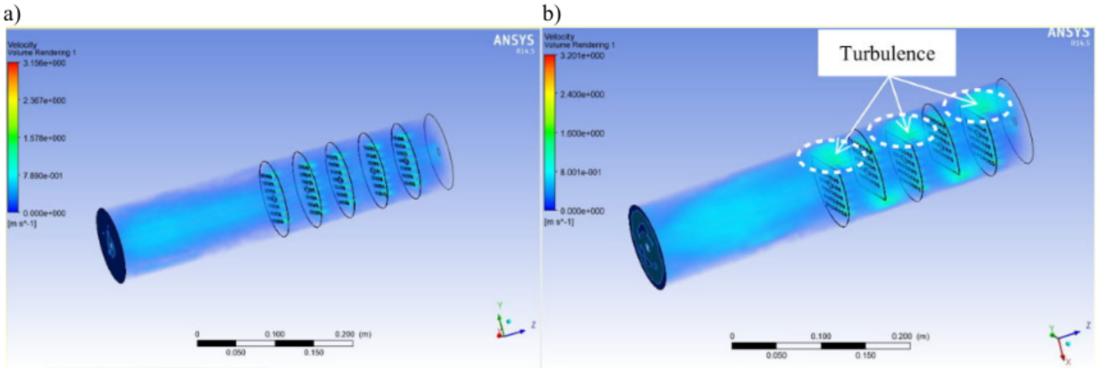

Fig. 3. The exhaust gas flow pattern passes through 5 filters at: a) Filter-not-cut type and b) Filter-cut type

Table 1.
Difference in percentage of exit speed at 0.5 atm inlet pressure

Number of filters	Inlet Speed, m/s	Filter-not-cut design speed, m/s	Filter-not-cut speed increase percentage, %	Filter-cut design exit speed, m/s	Percentage increase in filter-cut speed, %	Difference in percentage of speed, %
2	1	4.237	323.70	4.254	325.40	-1.70
3		3.781	278.10	3.810	281.00	-2.90
4		3.392	239.20	3.508	340.80	-101.60
5		3.156	215.60	3.201	220.10	-4.50

The speed distribution that occurs in filter-cut (Fig. 4b) is more varied when compared to filter-not-cut (Fig. 4a), this is indicated by the wider light blue colour. Variations in velocity distribution indicate the occurrence of friction between higher particles resulting in greater energy. This large energy triggers turbulence in the flow. Turbulence flow is very beneficial in the contact process between the catalytic converter and the exhaust gas so that the absorption of toxic gas is more effective.

Table 2 show the difference in the percentage of speed on the catalytic converter, with an inlet pressure of 1 atm and an inlet velocity of 1 m/s. The results of the percentage increase in filter-not-cut are: (219-334.60%) and filter-cut (219.90-300.40%). At 1 atm pressure, increasing the number of filters indicates a decrease in exhaust gas flow velocity. The highest speed increase in 2 filter-not-cut with filter-cut was 34.20%, shown in Table 2 (horizontal shading gray). The highest slowdown occurred at 17.60%, occurring in the number of 4 filter-not-cut shown in Table 2 (gray vertical shading). At 1 atm pressure increase with a number of 2 filters shows a filter-not-cut higher speed than the filter-cut, this is inversely proportional when the number of filters: 3, 4, and 5.

Based on the simulation results shown in Figures 5 and 6, changes in the exhaust gas flow velocity are caused by an increase in inlet pressure from 0.5-1 atm. Uniform-velocity of exhaust gas that flows affects the velocity value as shown in Figure 5a. This changes when there is an increase in the number of filters as shown in Figure 6a, where an increase in the number of filters causes a non-uniform velocity of flow which is indicated by the growth of a light blue colour that is not solid or spread (white ellipse marks).

The same thing happened to filter-cut Figures 5b and 6b, where the decrease in speed due to an increase in the number of filters resulted in a reduction in the number of areas that were light blue. This decrease in speed is caused by the non-uniform velocity of the exhaust gas flow that occurs when passing through a bend in the filter-cut that serves as a directional flow to create turbulence.

a) b)

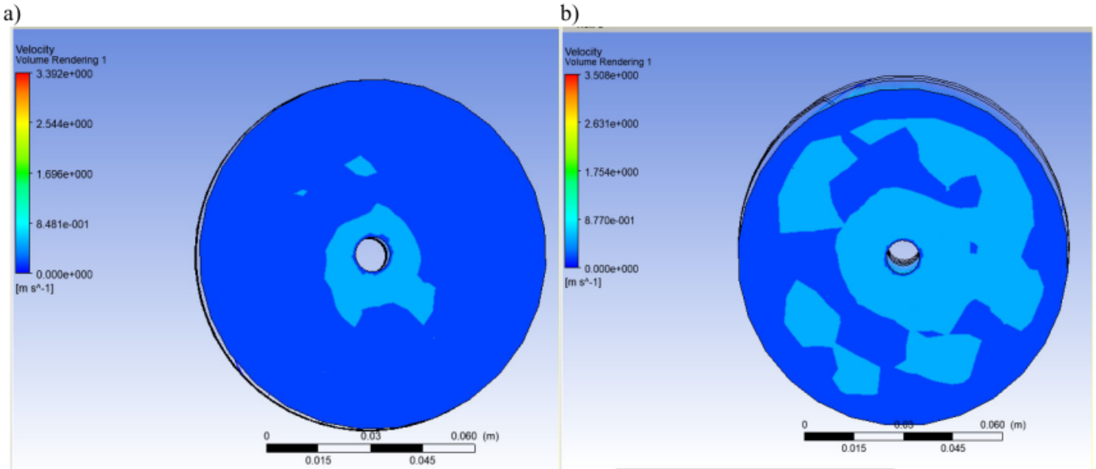

Fig. 4. Distribution of inlet velocity 1 m/s at a pressure of 0.5 atm: a) 4 filter-not-cut and b) 4 filter-cut

Table 2.
Difference in speed percentage at 1 atm inlet pressure

Number of filters	Inlet Speed, m/s	Filter-not-cut design speed, m/s	Filter-not-cut speed increase percentage, %	Filter-cut design exit speed, m/s	Percentage increase in filter-cut speed, %	Difference in percentage of speed, %
2	1	4.346	334.60	4.004	300.40	+34.20
3		3.765	276.50	3.817	281.70	-5.20
4		3.354	235.40	3.530	253.00	-17.60
5		3.190	219.00	3.199	219.90	-0.90

The non-uniform velocity area as shown in Figures 5b and 6a (white ellipse marks) is very effective to inhibit the rate of exhaust gas flow rate. This happens to the number of 2 filters where the filter-cut exit speed (4.004 m/s) is lower than the filter-not-cut (4.346 m/s). This phenomenon is reversed when the non-uniform velocity growing region of the filter-not-cut is shown in Figure 6a (white ellipse), where the speed of the filter-not-cut exit (3.354 m/s) is lower than that of the Filter-cut (3.530 m/s). Areas that have non-uniform velocity are very good at slowing down the exhaust gas flow, so the contact between the catalytic converter with the exhaust gas is more effective [12].

Table 3 show the exit velocity data on the catalytic converter, with a pressure of 1.5 atm and inlet velocity of 1 m/s. The results of the percentage increase in filter-not-cut are: (218.30-339.30%) and filter-cut (229.10-284.60%). The influence of the number of filter-not-cut is still dominant on the increase in the exhaust gas flow velocity and the opposite applies to the filter-cut. The highest speed increase occurred at 2 filter-not-cut of 110.20% shown in Table 3 (gray horizontal shading). While the slowdown occurred at 4 filter-not-cut of 17.90% shown in Table 3 (gray vertical shading). The decrease in speed at the not-cut filter is caused by increasing the number of filters on the

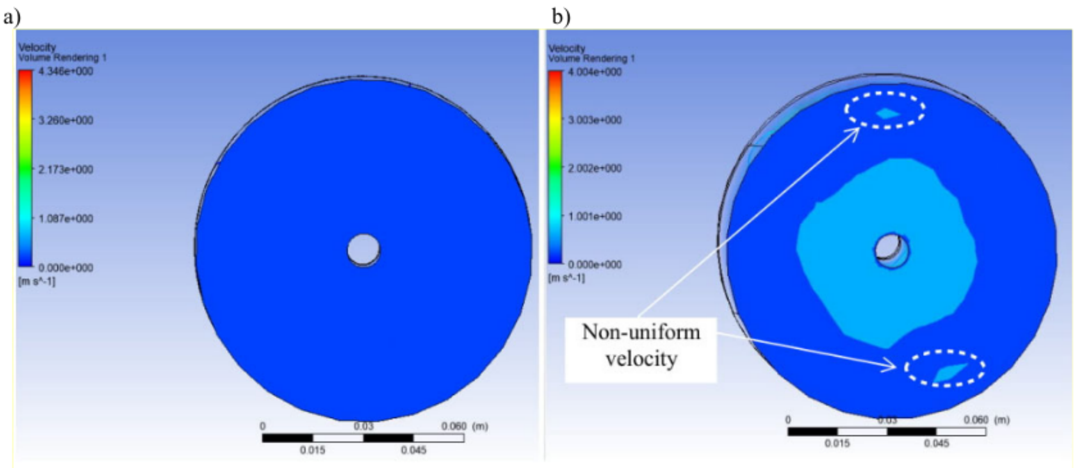

Fig. 5. Distribution of inlet velocity of 1 m/s at a pressure of 1 atm: a) 2 filter-not-cut and b) 2 filter-cut

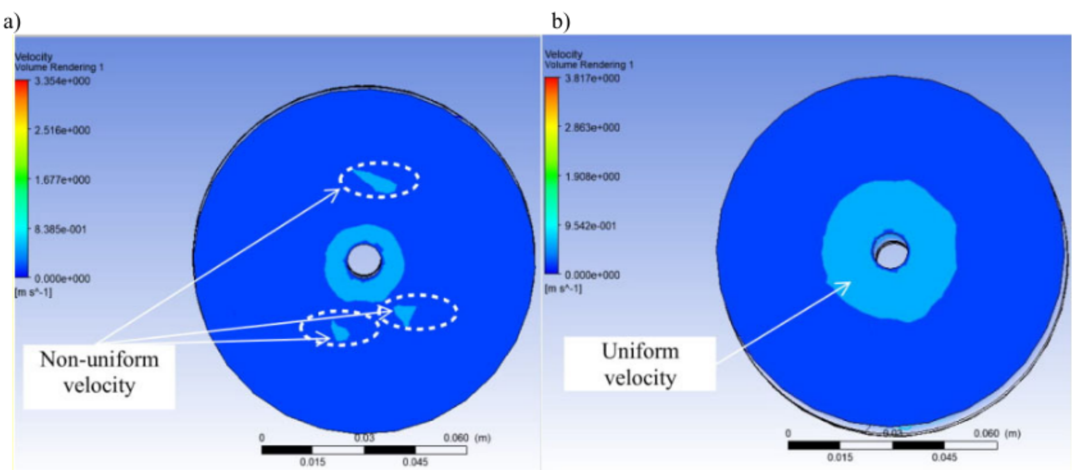

Fig. 6. Distribution of inlet velocity of 1 m/s at a pressure of 1 atm: a) 4 filter-not-cut and b) 4 filter-cut

catalytic converter. Unlike the case in the filter-cut where the number of filters: 3, 4, and 5 precisely the speed goes up with a fluctuating increase.

Figures 7a and 7b is a distribution of the catalytic converter speed with filter-not-cut and filter-cut at an inlet velocity of 1 m/s and a pressure of 1.5 atm. Differences in the wider non-uniform velocity area cause the filter-cut to have a lower speed than the filter-not-cut. Lower exhaust gas flow velocity will increase the contact efficiency with the catalytic converter.

A more solid pressure is shown in Figure 8a, where the pressure results are evenly distributed across the surface marked in red along with the catalytic converter. Different things happen to filter-cut which tends to flow turbulence due to the winding channel so that the pressure that occurs is very fluctuating. Gas flow through filter-cut causes turbulence flow along the catalytic, so the pressure becomes varied. The exhaust gas pressure directly behind the filter decreases due to the backflow of gas hitting the filter wall.

The catalytic converter has a dual function as a filter and also a directing blade at the exhaust gas flow so that the exhaust gas flow becomes non-uniform velocity. In filter-cut Figure 8b, the backflow of exhaust gases is reduced, caused by the influence of the flow through the gap in the filter-cut. This phenomenon is characterized by the appearance of a green colour that appears in front of the second filter-cut.

The difference between filter-not-cut and filter-cut is shown in Figures 9a and 9b, where the homogeneity of the different exhaust gases appears. This can be seen from the area of non-uniform velocity that is formed in the exhaust gas flow as shown in Figure 9. The non-uniform velocity area is marked in light blue in Figure 9b, wider than 4 filter-not-cut images in Figure 9a. This indicates that the exhaust gas velocity in the filter-not-cut is higher than the filter-cut. But this does not apply anymore at pressures above 1.5 atm where the influence of the stronger pressure determines the rate of exhaust gas that occurs.

Table 3.
Difference in percentage of velocity at 1.5 atm inlet pressure

Number of filters	Inlet Speed, m/s	Filter-not-cut design speed, m/s	Filter-not-cut speed increase percentage, %	Filter-cut design exit speed, m/s	Percentage increase in filter-cut speed, %	Difference in percentage of speed, %
2	1	4.393	339.30	3.291	229.10	+110.20
3		3.796	279.60	3.846	284.60	-5.00
4		3.390	239.00	3.569	256.90	-17.90
5		3.183	218.30	3.315	231.50	-13.20

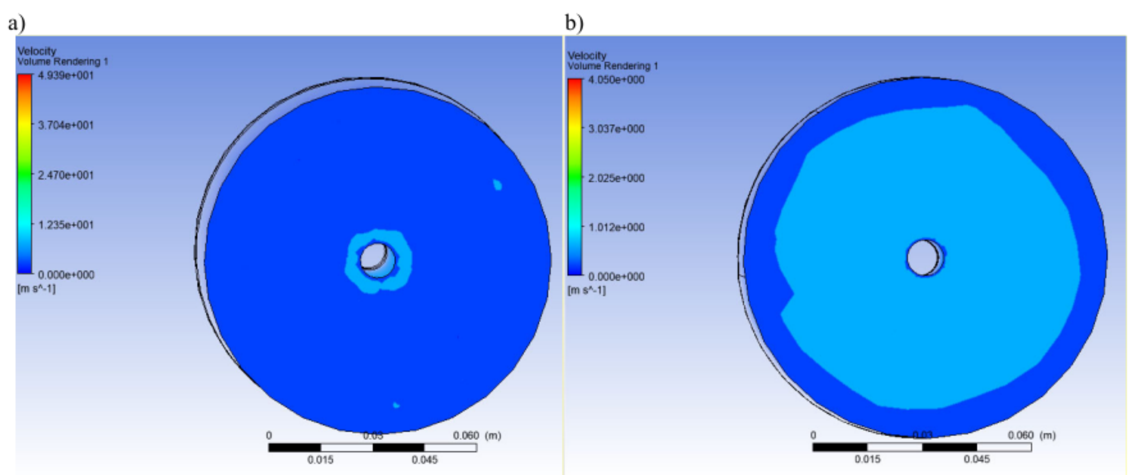

Fig. 7. Distribution of inlet velocity of 1 m/s at a pressure of 1.5 atm: a) 2 filter-not-cut and b) 2 filter-cut

The increasing number of filters causes back pressure on the first filter to increase and the highest pressure occurs in the area after passing the first filter. (Fig. 10). For not-cut filters, the pressure tends to be evenly distributed so the filters tend to be durable.

While the filter-cut tends to fluctuate pressure, due to turbulence, so the filter tends to damage quickly. But another advantage is the contact between the filter with the exhaust gas more effective.

Table 4 show the relationship between the number of filters with the exhaust gas intake pressure. The highest pressure difference occurs in the number of 3 filter-not-cut with a pressure percentage difference of 352.6%, as shown in table 4 (gray horizontal shading) and the lowest pressure difference occurs in the number 5 filter-cut with a pressure difference of 61%, shown in Table 4 (gray vertical shading).

Pressure distribution at 3 filter-not-cut tends to be stable as shown in Figure 11a, the highest pressure occurs after passing the 3rd filter with a pressure value of 2.86 Pa. Before passing the 3rd filter there is a slight decrease in pressure due to the back-pressure of the exhaust gas. For filter-cut, the pressure varies more as shown in Figure 11b. In filter-cut, the turbulence of flow occurs in each cavity between filters so that contact between the filter and the exhaust gas is more effective. Filter-cut has a lower pressure than the filter-not-cut pressure. This is caused by the area of the filter hole.

a) b)

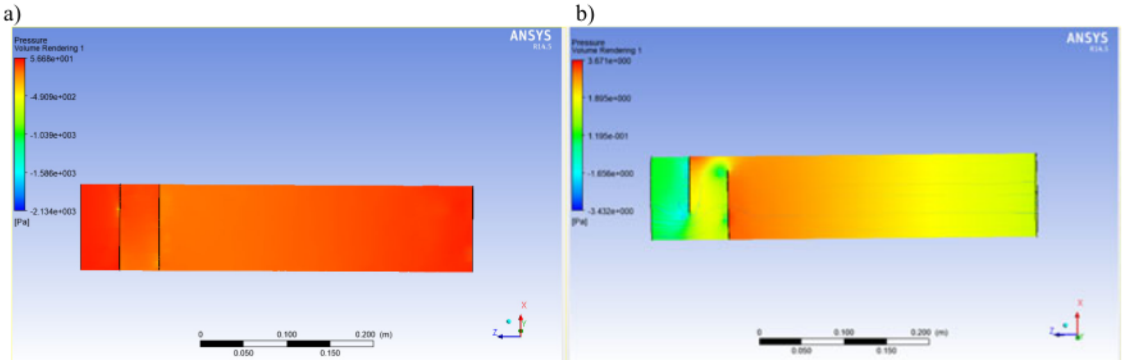

Fig. 8. Incoming pressure distribution of 1.5 atm: a) 2 filter-not-cut and b) 2 filter-cut

a) b)

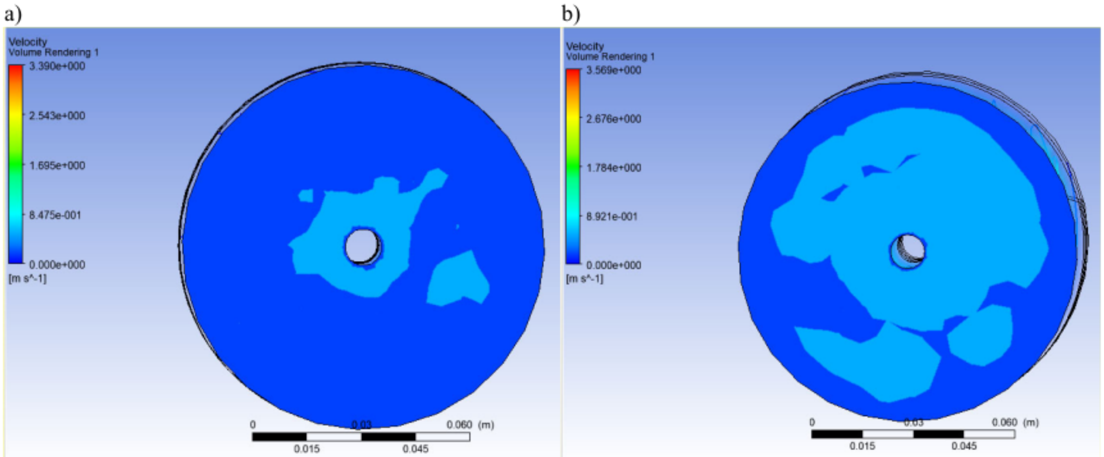

Fig. 9. Distribution of inlet velocity of 1 m/s at a pressure of 1.5 atm: a) 4 filter-not-cut and b) 4 filter-cut

The opposite occurs in the 5 filter-not-cut and filter-cut variation (Fig. 12a,b) where there is a significant change in pressure height, the pressure on the filter-cut tends to be higher than the not-cut pressure. This shows that cutting the filter no longer has an effect on increasing the speed of the exhaust gas flow, so the contact time between the filter and the exhaust gas is quite effective in this variation.

The weakness of this design is that in the area in front of the 4th filter-not-cut filter the vacuum region appears, this is caused by the low intake pressure. But it is different in the filter-cut design where the vacuum area is less and the flow pattern formed is turbulent.

Filter-not-cut experienced a significant pressure increase in the number of 3 filters, where the pressure increase

a) b)

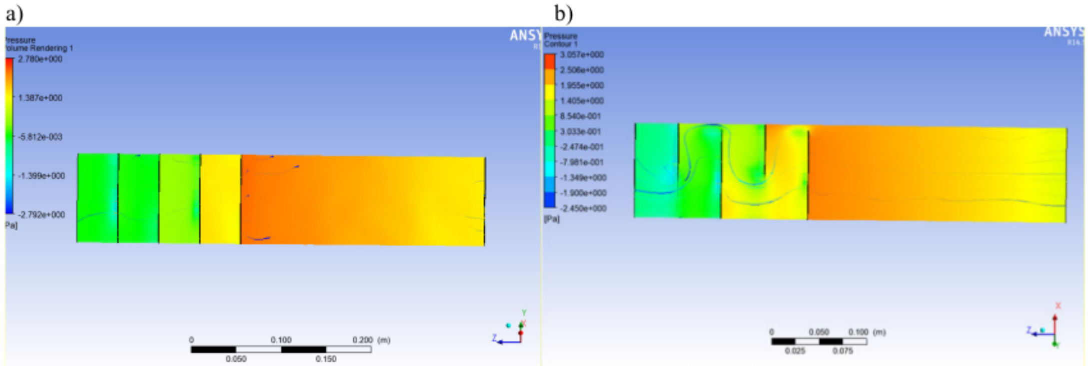

Fig. 10. Incoming pressure distribution 1.5 atm: a) 4 filter-not-cut and b) 4 filter-cut

a) b)

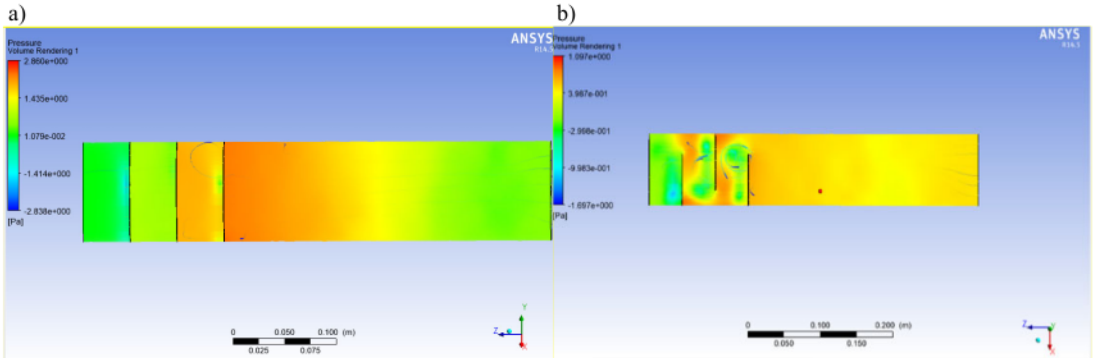

Fig. 11. Incoming pressure distribution 0.5 atm: a) 3 filter-not-cut and b) 3 filter-cut

Table 4.
Difference in pressure percentage at 0.5 atm inlet pressure

Number of filters	Inlet Speed, m/s	Filter-not-cut design speed, m/s	Filter-not-cut speed increase percentage, %	Filter-cut design exit speed, m/s	Percentage increase in filter-cut speed, %	Difference in percentage of speed, %
2	0.5	2.083	316.6	2.305	361.0	-44,4
3		2.860	472.0	1.097	119.4	+352.6
4		2.283	356.6	1.929	285.8	+70.8
5		1.809	261.8	2.114	322.8	-61.0

reached 150.8% as shown in Table 5 (gray vertical shading). This applies vice versa to the number 2 filters where the filter-not-cut pressure has the highest compressive decrease of 66.4% as shown in Table 5 (gray horizontal shading).

In the 1 atm pressure distribution, 2 filter-not-cut Figure 13a, the pressure tends to be homogeneous different than the filter-cut which tends to vary and the flow is turbulent. Turbulent exhaust gas flow tends to be advantageous in the contact process between the exhaust gas and the catalytic converter.

The pressure distribution at 3 filter-not-cut and filter-cut is shown in Figure 14, the condition begins to change in the formation of 2 filters as shown in Figure 13, where the pressure at the filter-not-cut tends to be higher, while the

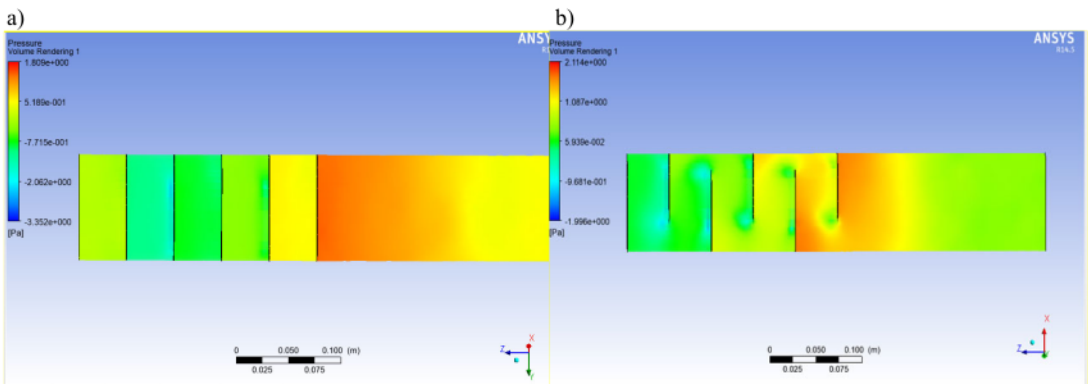

Fig. 12. Incoming pressure distribution 0.5 atm: a) 5 filter-not-cut and b) 5 filter-cut

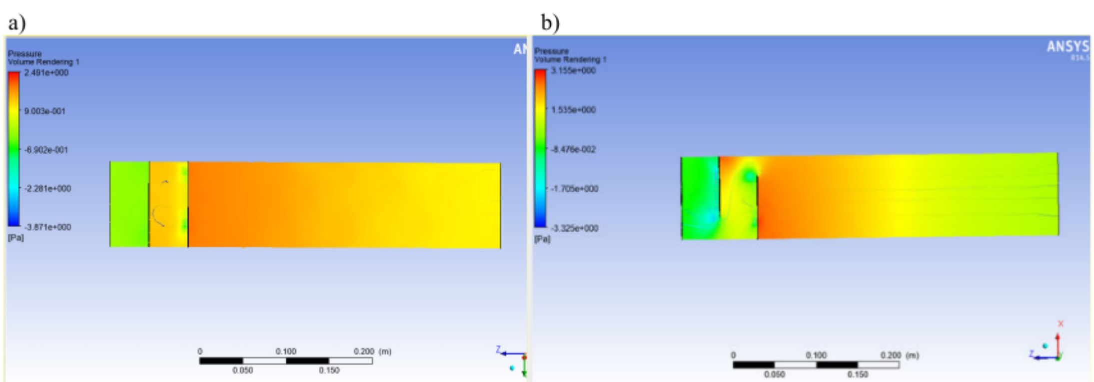

Fig. 13. Pressure distribution in 1 atm: a) 2 filter-not-cut and b) 2 filter-cut

Table 5.
Difference in pressure percentage at 1 atm inlet pressure

Number of filters	Inlet Speed, m/s	Filter-not-cut design speed, m/s	Filter-not-cut speed increase percentage, %	Filter-cut design exit speed, m/s	Percentage increase in filter-cut speed, %	Difference in percentage of speed, %
2	1	2.491	149.1	3.155	215.5	-66.4
3		3.389	238.9	1.881	88.1	+150.8
4		2.736	173.6	2.207	120.7	+52.9
5		2.506	150.6	1.802	80.2	+70.4

filter-cut decreases due to the influence of cutting the filter has no effect on the pressure increase.

Table 6. shows the variation of 1.5 atm inlet pressure on the catalytic converter.

The highest percentage increase in pressure occurs in 2 filter-not-cut with a percentage of 134.467% as shown (gray horizontal shading). The lowest pressure drop occurred at 4 filter-not-cut with a percentage of 18.5% as shown (gray vertical shading). At a pressure of 1.5 atm, the highest pressure value occurs at the number of filter-not-cut: 2, 3, and 5, while at filter-cut only occurs at the number of 4 filters.

Figure 15 shows a graph of the relationship between the number of filters and the exhaust gas velocity at 0.5, 1 and 1.5 atm pressure variations. Broadly speaking, filter-not-cut always has a lower exhaust gas speed, this is due to the resistance of each filter that is greater than the filter-cut. But there are some conditions where the filter-cut has the same flue gas velocity conditions as the filter-not-cut, this occurs in the number of 5 filter-cut with a pressure of 0.5, 1 and 1.5 atm (ellipse mark). At 5 filter-cut with pressure (0.5-1.5) atm turbulent flow occurs as shown in Figure 3b and 12b. In this condition turbulence flow is very strong so that the difference in speed reaches the best value in the filter-cut. In turbulent flow conditions, disruption of the exhaust gas flow occurs, resulting in friction between the gas particles, the casing and the catalytic converter so that the flow slows down. Previous research [12] found the best filter formation on 3 filter-cut due to this condition having the same speed as 3 filter-not-cut while the advantage is to have a low pressure as shown in Figure 16.

In Figure 4.14, the graph shows the relationship between the number of filters and the exhaust pressure at the inlet pressure of 0.5, 1, and 1.5 atm. The results of this design analysis that meet the best speed and pressure requirements are obtained in filter-not-cut and filter-cut with a number of 5 filters at a pressure of 0.5-1.5 atm. Where the results are obtained with a low speed value, which supports the best contact between catalytic and exhaust gases. At 1 atm pressure, the results of previous research showed 3 best filter-cut pieces, this is due to the consideration of pressure and low speed [12].

Filter-cut tends to flow turbulence due to the winding channel so that the pressure that occurs fluctuates greatly as shown in Figure 3b and 12b. Gas flow through filter-cut causes turbulence flow along the catalytic, so the pressure becomes varied. The exhaust gas pressure directly behind the filter decreases due to backflow of gas hitting the filter wall.

a) b)

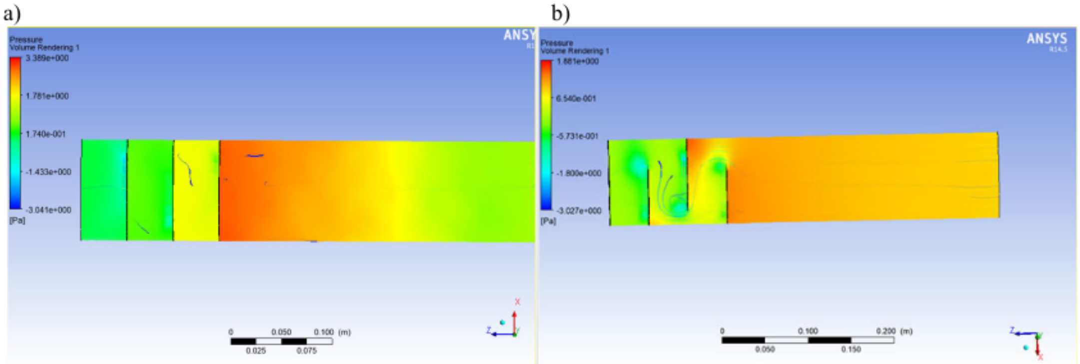

Fig. 14. Pressure distribution in 1 atm: a) 3 filter-not-cut and b) 3 filter-cut

Table 6.
Difference in percentage pressure at 1.5 atm inlet pressure

Number of filters	Inlet Speed, m/s	Filter-not-cut design speed, m/s	Filter-not-cut speed increase percentage, %	Filter-cut design exit speed, m/s	Percentage increase in filter-cut speed, %	Difference in percentage of speed, %
2	1.5	5.688	279.2	3.671	144.733	+134.467
3		3.645	143	3.289	119.267	+23.733
4		2.780	85.3	3.057	103.800	-18.5
5		3.012	100.8	2.658	77.200	+23.6

The catalytic converter has a dual function as a filter and also a directing blade at the exhaust gas flow, so that the exhaust gas flow becomes non-uniform velocity.

In the filter-cut Figure 12b, the backflow of exhaust gases is reduced, caused by the effect of the flow through the gap in the filter-cut. This phenomenon is characterized by the appearance of green which appears in front of the fourth filter-cut and red in front of the fifth filter-cut. The best analysis of velocity and pressure is good at a pressure of 0.5 atm at type 5 filter-not-cut (ellipse mark), whereas at pressure (1-1.5 atm) type 5 filter-cut is best (ellipse sign).

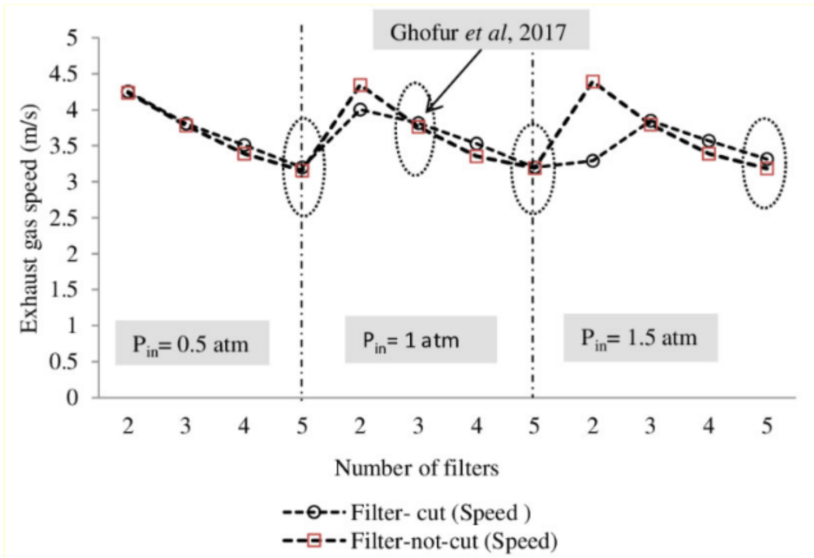

Fig. 15. Graph of the relationship of the number of filters to the exhaust gas velocity on the pressure inlet variation (0.5-1.5) atm

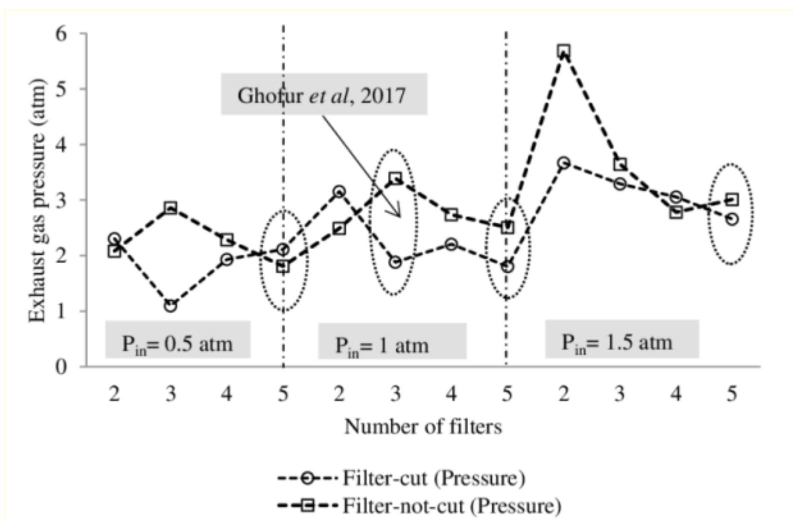

Fig. 16. Graph of the relationship of the number of filters to the exhaust gas pressure in the variation of the inlet pressure (0.5-1.5) atm

5. Conclusions

The results of this research can be concluded as follows:

a. In the variation of inlet pressure between 0.5-1 atm, the effect of increasing the number of filters is still dominant to the decrease in speed and this phenomenon begins to change at a pressure of 1.5 atm, where increasing the number of filter-cut does not affect the decrease in velocity. At the inlet pressure of 0.5-1 atm, the outlet pressure at the filter-not-cut and filter-cut fluctuates in value and this phenomenon changes at the filter-cut at a pressure of 1.5 atm, where the value of the outward pressure decreases proportionally with the addition of the number of filters.
b. Under pressure variations, it is recommended to design an odd number of filter-cut: 3, 5, better than the others because it has the lowest speed. In the variation of velocity, the number of 5 filters shows almost the same value, in contrast to the even filter which shows a large difference between the two. Based on the results of this consideration filter-not-cut and filter-cut have the best value on the number of 5 filters.
c. By finding the connection point between the pressure and the exit speed, the number of filters cut 5 is the best because it has a lower pressure and velocity value. So that the contact between the catalytic converter and the exhaust gas is more effective.

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