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# Influence of filter structural parameters on pressure drop characteristics in $no_2$ assisted regeneration process

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**Abstract.** With Continuous Regeneration-Diesel Particulate Filter (CR-DPF) as the research object, the author established the mathematical model of one-dimensional for $NO_2$ auxiliary heat regeneration and numerical analyzed study on the influence of the pressure drop characteristics resulted from filter structure of CR-DPF in $NO_2$ regeneration process. Through simulating analysis of the influence of filter length, pore path density as well as wall thickness of pore path on Pressure drop characteristics in $NO_2$ assisted regeneration process, analysis results showed that: The pressure drop would be increased as increasing the filter length of CR-DPF; When initial particle amount in filter was less than the critical value, the pressure drop would be increased as increasing the density of pore path; The pressure drop would be decreased as increasing wall thickness of pore path.

**Key words.** Diesel particulate filter(dpf), structural parameters, regeneration process, pressure drop characteristics, $no_2$ assisted regeneration, continuous regeneration, pressure drop characteristics.

## 1. Introduction

Notwithstanding Diesel fuel owns the property of low oil consumption, reliable performance and high dynamic performance, its emission pollutants, especially emission particles has been seriously restricted the development of diesel engines. [1-2] The diesel particulate filter (DPF) is the most effective and simple method for reducing the emission of diesel particles. And the diesel particulate filter (DPF) regeneration technique is the key problem of the practical application of particle catcher. [3] At present, a large number of theoretical and experimental studies have been

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carried out on the regenerative technique of particle catcher in China and abroad. In continuous regeneration process, the NO from exhaust airflow would be cataleptically oxidized to $NO_2$ with strong oxidizing, which generated oxidizing reaction with particle under exhaust temperature at about 350 , therefore the DPF regeneration had been achieved.Because of its low cost, simple structure and regeneration of window width, and requires NO additional control system with heat source advantages, continuous regeneration particulate filter is considered to be owned the most research value and development prospects of regenerative way. Therefore, it is necessary to research the pressure loss in $NO_2$ assisted regeneration process of CR-DPF influenced by exhaust parameters and filter structural parameters, which has a tutorial meaning to optimize the working performance of CR-DPF. In this paper, by establishing mathematical model of CR-DPF, simulation study on pressure drop characteristics in $NO_2$assisted regeneration process of CR-DPF influenced by filter structural parameters were performed, thus providing theoretical basis for optimizing design of CR-DPF.

## 2. The working principle of diesel particulate filter (DPF)

As shown in Figure1, DPF comprises an air inlet pipe, expansion pipe, filter, shrink pipe and exhaust pipe. Black smoke with carbon particles exhaust from diesel engine entered into DPF through special pipeline and flow through its internal intensive setting filter, meanwhile carbon particles are absorbed on the wall-flow honeycomb ceramic filter. Along with the operating time growing, particulate particles are increased gradually which will cause engine back pressure increasing so that resulting in reducing engine performance. Deposition particles were removed by means of recycling technology and then filtration performance of DPF was recovered.

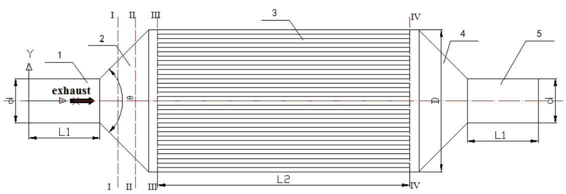


Fig. 1. Structure of diesel particulate filter

1-air inlet pipe; 2-expansion pipe; 3-filter;
4-shrink pipe; 5-exhaust pipe

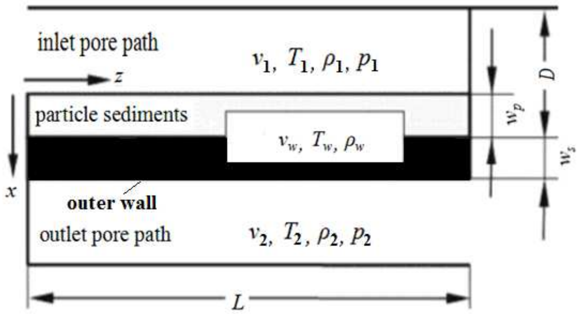


Fig. 2. Flow model of inside pore path in cr-dpf

## 3. The influence of filter structural parameters on pressure drop characteristics in NO2 assisted regeneration process

### *3.1. The influence of filter length*

Under working case 1, initial particle mass concentration in CR-DPF was assumed to be 7.5g/L and operating parameters of diesel engine and diameter parameters of filter keep kept in constant. The influence of pressure drop Δp of CR-DPF by changing filter length, results could be seen from Figure3. The initial pressure drop would be increased by shorting filter length; this was mainly due to the pore path structure of filter and airflow flow on the pore path of alternating blockage. But the inlet-end of pore path is blocked, so the airflow could only seepage from the particle deposition layer and the filter wall. Therefore, the shorter the length flowed through the pore path was, the faster the airflow seepage velocity was, so did the seepage resistance was. Furthermore, the faster NO2 assisted regeneration rate was, which would cause the pressure drop reduced.

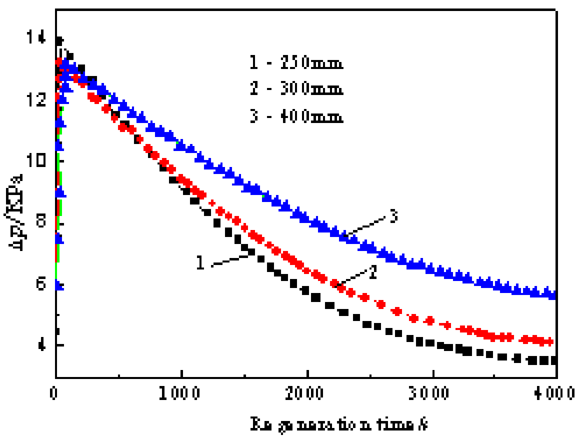


Fig. 3. The influence of filter length on pressure drop in filter

From Figure 3 also could be informed that after a period of equal regeneration time, the total pressure drop value of 250 mm was larger than that length of 300mm and 400mm f the filter. However, the total volume of filter would be changed by changing the filter length, which affected oxidation regeneration capacity of filter particle in unit time, so the filter length selection should be integrated into account two factors–regeneration and trapping.

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### *3.2. The influence of pore path density*

Under working case 1, initial particle mass concentration in CR-DPF was assumed to be 7.5g/L and operating parameters of diesel engine and diameter parameters of filter keep kept in constant. The influence of pressure drop $\Delta p$ of CR-DPF by changing pore path density of filter, results could be seen from Figure 4.The pressure drop would be increased with increasing of pore path density of filter, this was mainly due to when pore path thickness kept in constant, airflow velocity inside pore path would increase as increasing its density, then the gas flow inside pore path increased would cause the along frictional resistance from filter wall increased. At the same time, while maintaining the filtering diameter parameters and pore path wall thickness parameters unchanged, the pore path width parameter became small with increased its density.

### *3.3. The influence of pore path densityThe influence of wall thickness of pore path*

Figure 5 showed the influence of different wall thickness of pore path on pressure drop in filter. From Figure5, it could be seen that the influence was great. This was mainly due to the increased thickness of the pore wall caused seepage resistance increased from exhaust airflow through particle deposition layer and filter wall. Because the collection efficiency was influenced by wall thickness of pore path, increasing the pore wall thickness could not only improve the filter collector efficiency but also could prolong the service life of the CR-DPF. While if wall thickness was small, it would increase the difficulty of design and manufacture. So, it should be integrated into account two indicators of collection efficiency and pressure loss to select a continuous regeneration type trap filter.

## 4. Conclusions

When the exhaust temperature was below 400C, if M (NO2) /m (PM) was too small, particle inside filter showed a net increase state leading to exhaust back pres-

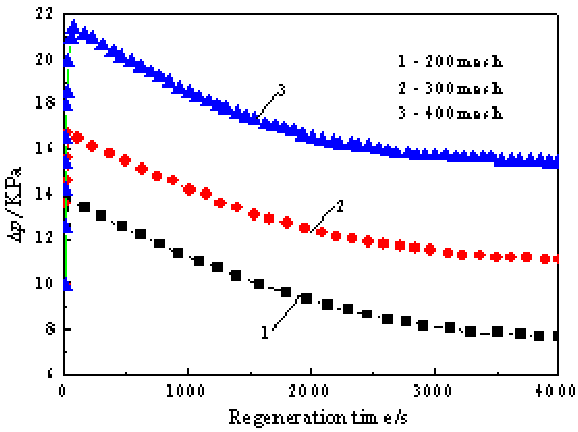


Fig. 4. The influence of pore path density

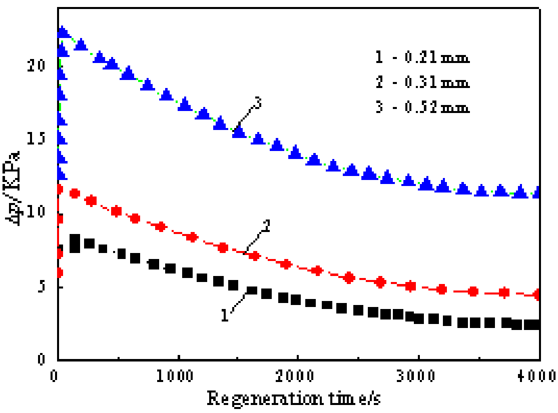


Fig. 5. The influence of wall thickness of pore path

sure increased, the economy and power of diesel engine fuel would be affected. When filter body diameter parameters remained constant, the pressure drop would be increased by filter length increasing. The influence of pore path density on pressure drop characteristics in filter was relevant with initial particle volume, which owned a critical value. If the filter particles exceeded this critical value, the filter pressure drop did not change with pore density. If that less than this critical value it would lead to the rise of the filter pressure drop;The wall thickness of pore path on the trapping effect of pressure loss was relatively large, pressure loss would decreased with its wall thickness decreasing. So the design of wall thickness of pore path in filter should be integrated into account the mechanical strength, collection efficiency and pressure loss to choose smaller wall thickness as far as possible.

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