Evaluation of Performance of DPF Cell Structure for Soot Loading, Regeneration and Pressure Drop using CFD Simulation

Student's Name	**M. Y. Raghu**	**AE (PT-2011)**
Academic Supervisor(s)	H. K. Narahari and S. Umesh	
Industrial Supervisor(s)	Senthur Pandian, Mahindra & Mahindra Ltd., Chennai	

M. Y. Raghu
myraghu63@gmail.com
Ph. No: 0 98405 73019

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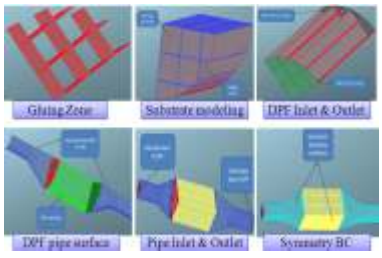
Abstract:

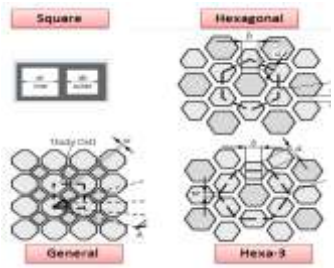
In recent times, diesel powered vehicles are becoming popular due to improved performance and reduced exhaust emissions. In future, the market share of diesel passenger cars are expected to reach 60%. In compliance with future emission standards, for diesel powered vehicles, it is required to use diesel particulate filters (DPF) along with other exhaust emission control devices. There is a need for more optimised DPF cell structure to collect maximum soot load with low pressure drop and improved exhaust performance in Indian driving conditions.

In this project, a detailed parametric study was carried out on different DPF cell structures like Square, Hexagonal and combined cell geometry. The performances of different cell structure was evaluated for maximum soot loading capacity and regeneration rate, pressure drop, temperature distribution across the cell structure. Experimental study on four cylinder diesel engine was carried out on a test bed under standard driving cycle for the base line cell structure to get soot load and pressure drop characteristics. Steady state CFD simulation was carried out on baseline and different cell structure configuration using AVL fire software. Temperature distribution across a cell structure was obtained under maximum soot loading conditions to analyse the thermal stability of DPF. CFD simulations were correlated with experimental results for the evaluation of DPF performance with different cell structures.

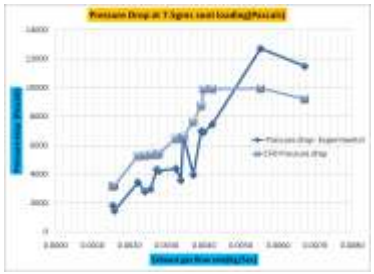
Numerical and experimental investigation was successfully carried out on various cell structure configurations of DPF for diesel engine. The pressure drop performance, soot load capacity and thermal stability during regeneration were evaluated. From the parametric studies, it was found that Hex 3 DPF cell structure has got maximum soot load and low pressure drop characteristics compared to other DPF cell structure. Hence, Hex 3 DPF cell structure was suggested for diesel vehicles incompliance with present and future emission norms for reduced particulate matter emissions.



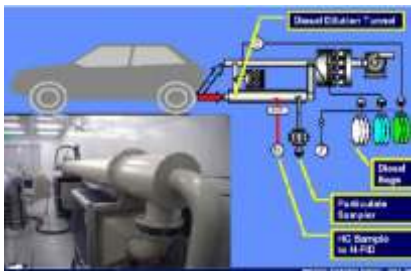
Modeling DPF in AVL Fire



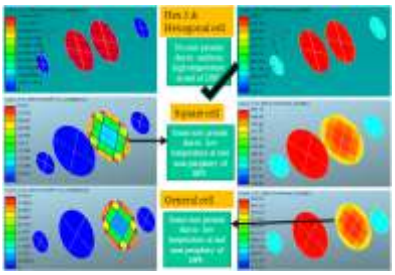
Parametric studies on various DPF cell structure



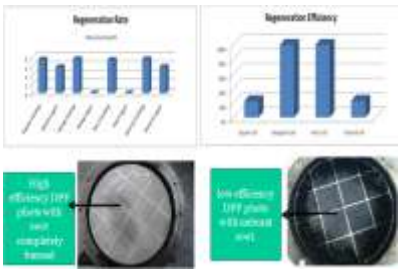
Pressure drop plot for SD082 DPF cell structure



DPF test on chassis dynamometer



Regeneration and temperature plots



Regeneration efficiency