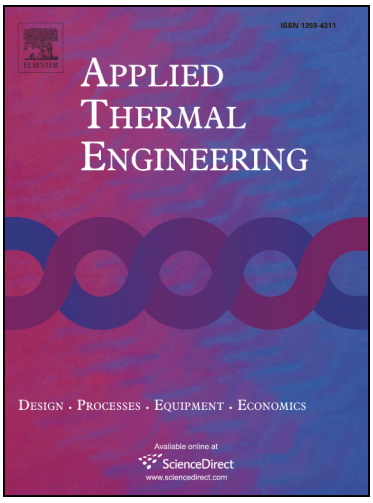

Machine Learning for Nano-scale Particulate matter distribution from Gasoline Direct Injection Engine

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ABSTRACT

Predicting the amount of combustion generated nano-scale particulate matter (PM) emitted by gasoline direct injection (GDI) is a challenging task, but immensely useful for engine calibration engineers in order to meet the stringent emission legislation norms. The present work aimed to link the in-cylinder combustion with engine-out nano-scale PM for the size range of 23.7 to 1000 nm diameter. Neural network with a single hidden layer using first 8 principal components of cylinder pressure was employed for training and predicting the number of nano-scale PM number count. Using a systematic computational approach and comparing its results with experimental data this work demonstrates that machine-learning approach based on neural network is sufficient for predicting engine out nano-scale PM count as a function of engine load and speed.

KEYWORDS: Nano-scale particulate matter, Gasoline direct injected engine, Machine learning, Principal component analysis

1. INTRODUCTION

Ever since the relationship between the combustion generated pollutants and adverse health impact was established [1], identifying the source of pollution and limiting the levels of pollutants have become a major task. The internal combustion engines mainly used in automotive applications are the main contributors to the increased levels of air pollution in major cities. The definition of types of pollutants, their levels and their link with human health has also been changing over the time. Several factors have contributed to these changes. Firstly, the understanding of the formation mechanism of these pollutants has improved over time. Secondly, more evidence has emerged over time linking the toxicity of these pollutants with adverse human health. Thirdly, technological advances in measurement technology in the field of aerosol measurement have enabled researchers to measure ultrafine particles in-situ, which was not possible in the past. Finally, it has become possible to model and calibrate the engine system to meet stringent emission targets.

For example, European commission introduced test protocol and target values for permissible levels of exhaust Carbon Monoxide (CO) and Hydrocarbon (HC) [2]. Since then new pollutants have been added to the list [3]. One of the pollutants recently added to the list is the number count of the nano-scale PM from gasoline-powered engines. Legislation since 1972 [4] specially included the link between diesel engine and smoke generated by