Enhancement in Performance Parameters and Reduction in Exhaust Emissions of a Compression Ignition Engine using Stable Nanofuel Suspension

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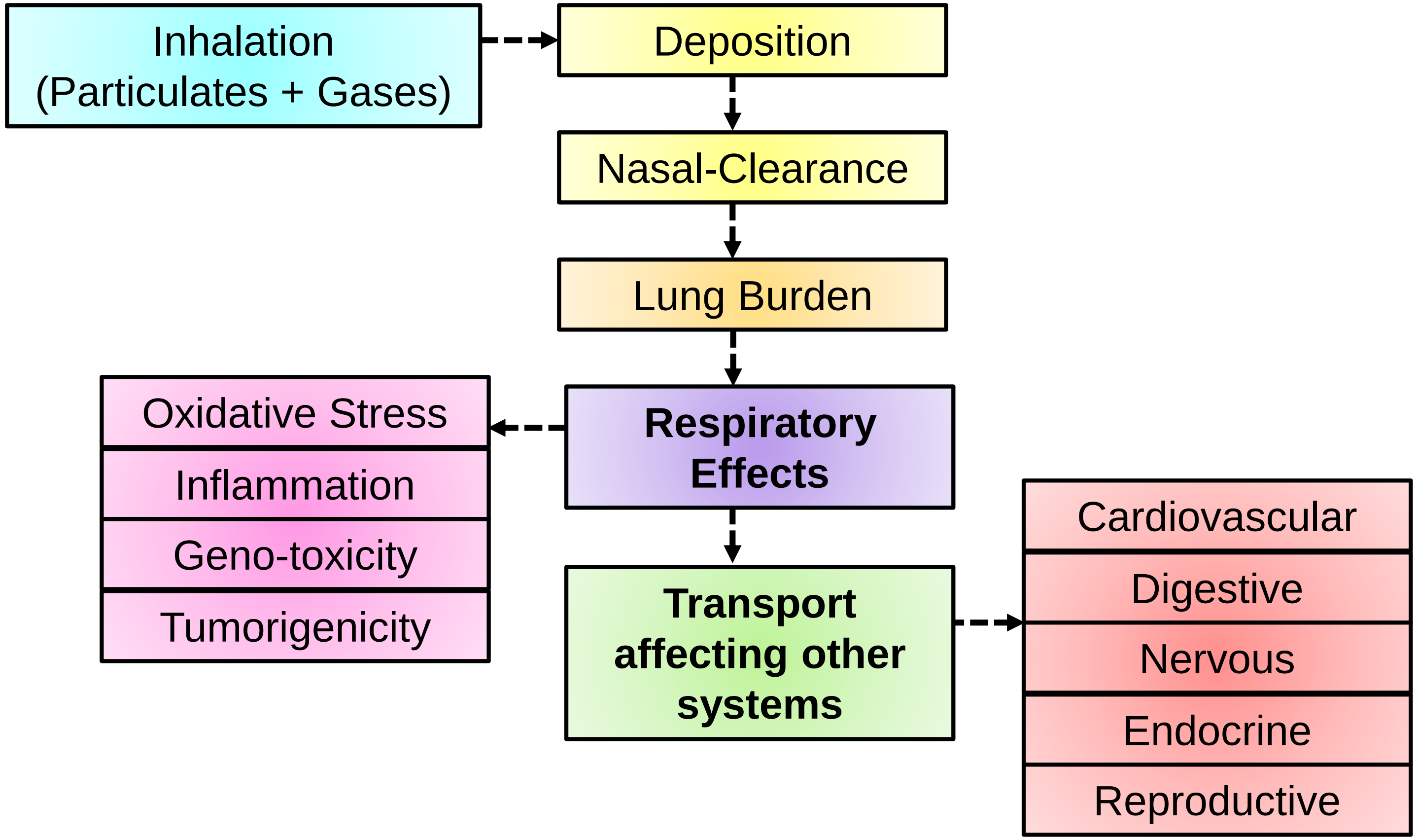
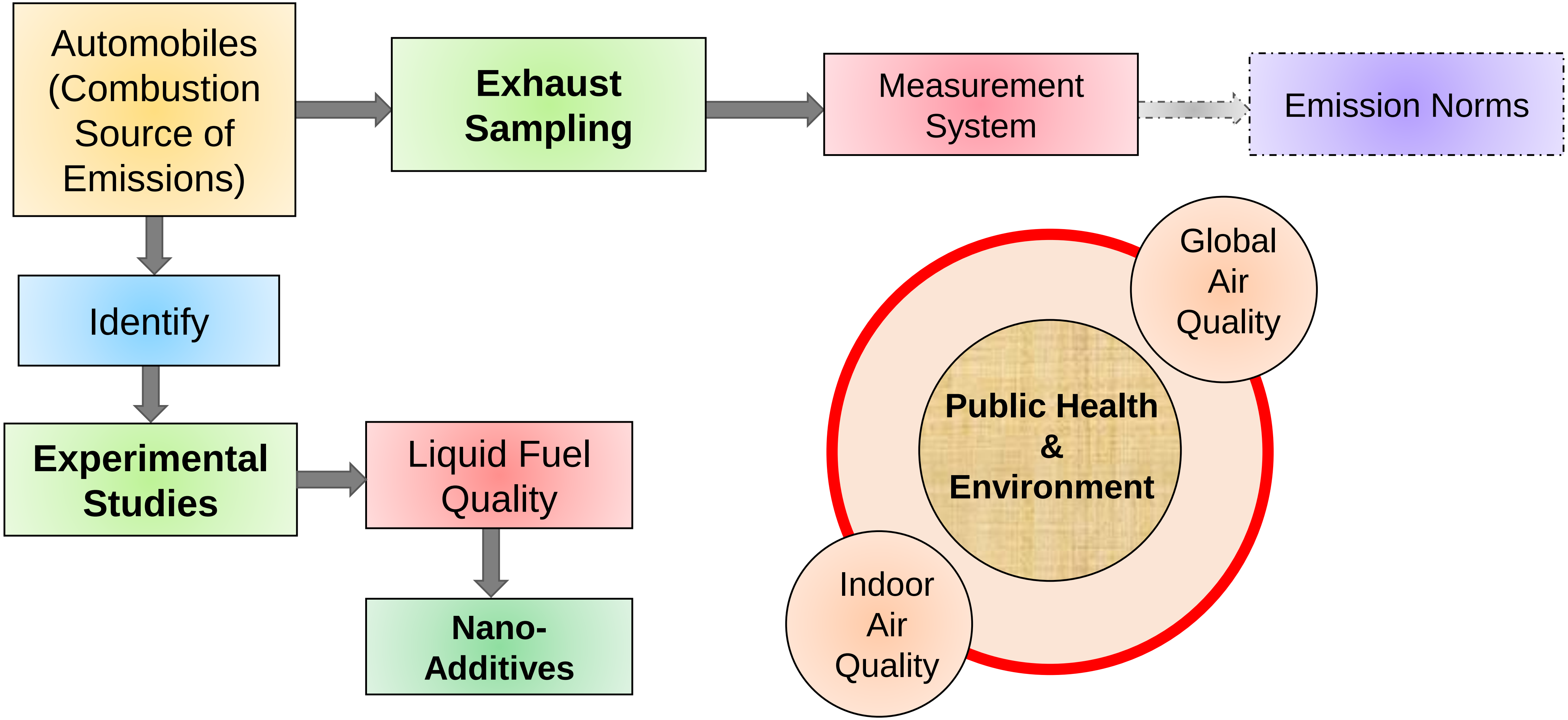
Introduction

Pathway of Aerosols from inhalation to disease site



MatoomMi, "Girl Wearing N95 Air Pollution Mask, "Vector Stock. https://www.vectorstock.com/royalty-free-vector/girl-wearing-n95-air-pollution-mask-for-protect-vector-25090852.
Sonwani, S. *et al.*, "Inhalation Exposure to Atmospheric Nanoparticles and Its Associated Impacts on Human Health: A Review". *Frontiers, Sustainable Cities* 3, 1–20 (2021).

Research Outline

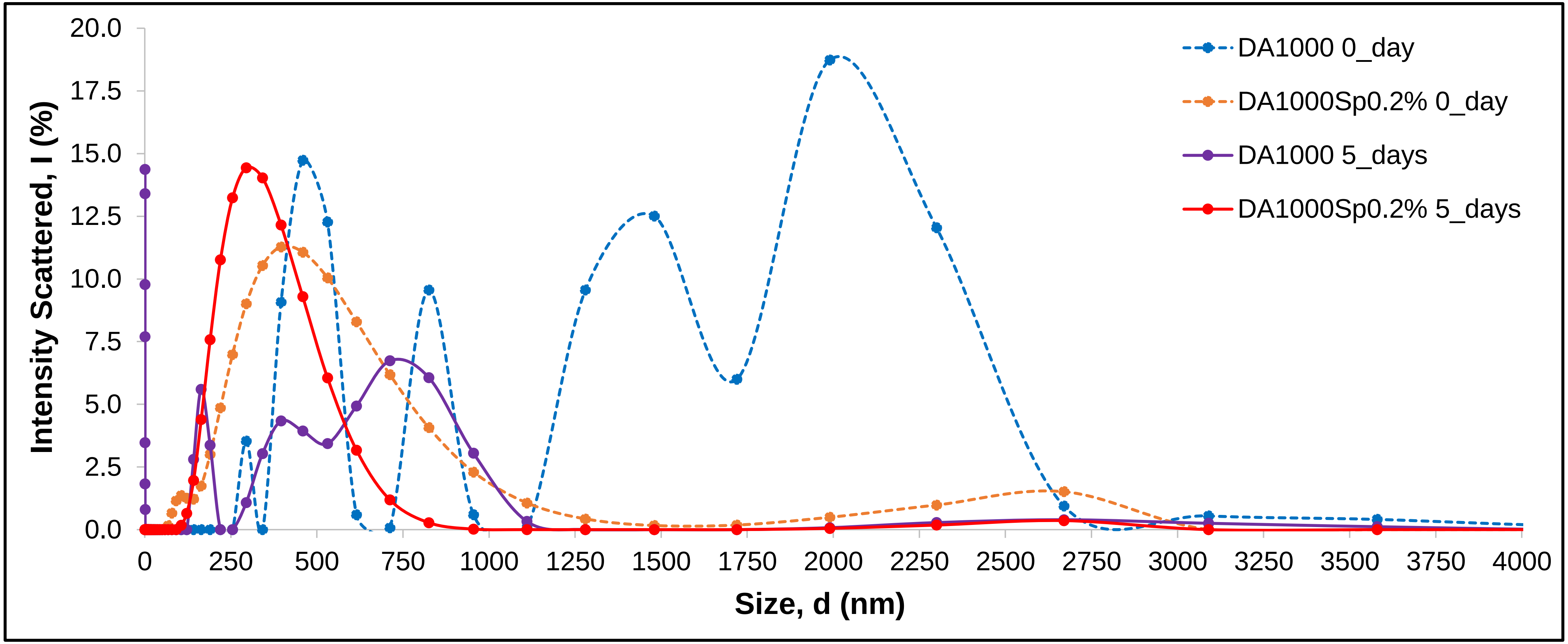


Experimental Set-up

- Variable compression ratio (VCR) engine details:
- Single-cylinder, 4-stroke engine
- Common rail diesel injection (CRDI) mode
- Compression ratio (CR) = 20
- Engine Speed = 1100±5 RPM
- Nanofuel samples preparation:
- Aluminium oxide (Al_2O_3) nanoparticles added to diesel.
- Surfactant – span80 (sorbitan monooleate)
- Magnetic stirring (MS) – helps in uniform mixing of nanofuel suspension.
- Nanofuel samples naming:
  - DA1000 (1000 ppm of Al_2O_3 + Diesel)
  - DA1000Sp0.2% (1000 ppm of Al_2O_3 + 0.2% wt. of Span80 + Diesel)
  - DA50Sp0.01% (50 ppm of Al_2O_3 + 0.01% wt. of Span80 + Diesel)
  - DA100Sp0.02% (100 ppm of Al_2O_3 + 0.02% wt. of Span80 + Diesel)
- AVL gas analyser 444N – Measurements of exhaust gases.

VCR engine set-up

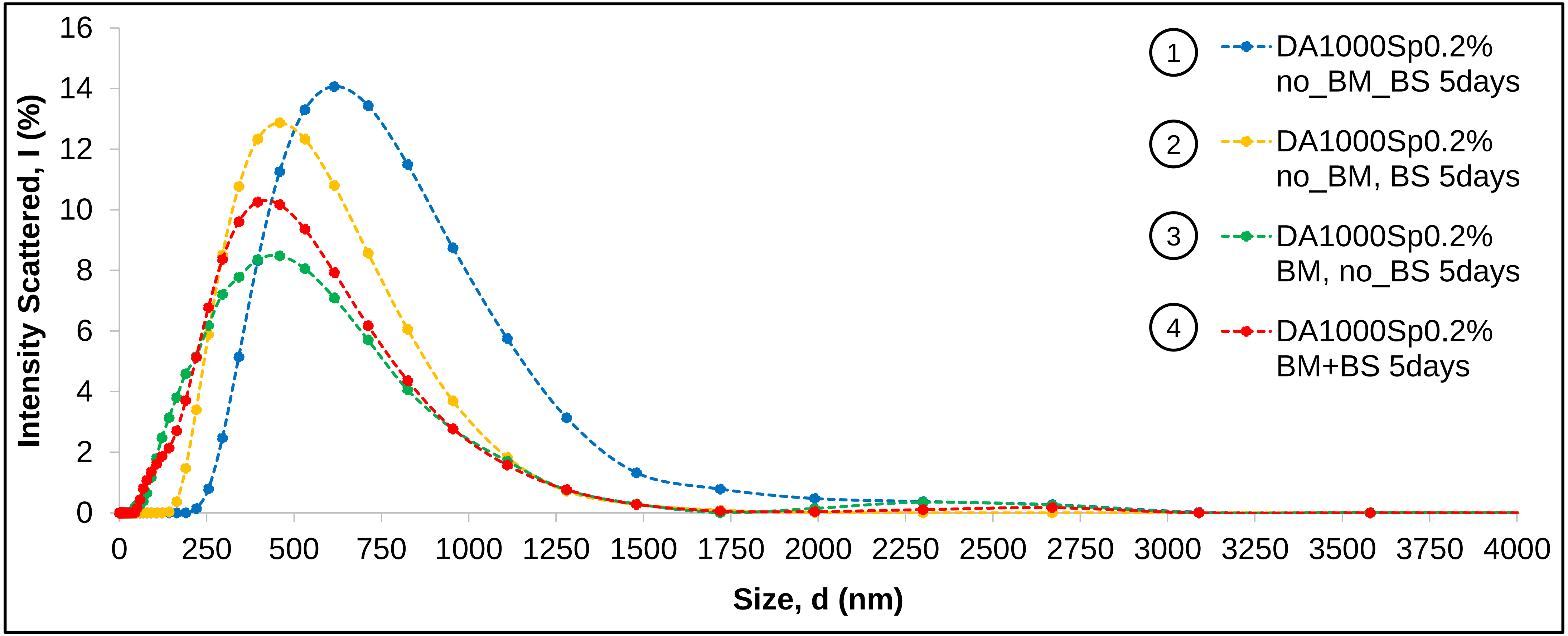
Nanofuel Stability – Particle Stabilization



Size analysis using Dynamic Light Scattering (DLS):

Plot of light intensity scattered (%) w.r.t. particles' size (d, in nm) for 2 samples; (a) Al_2O_3 added to diesel: DA1000, (b) Al_2O_3 added to diesel and span80 solution: DA1000Sp0.2%; on 0^{th} day and 5^{th} day.

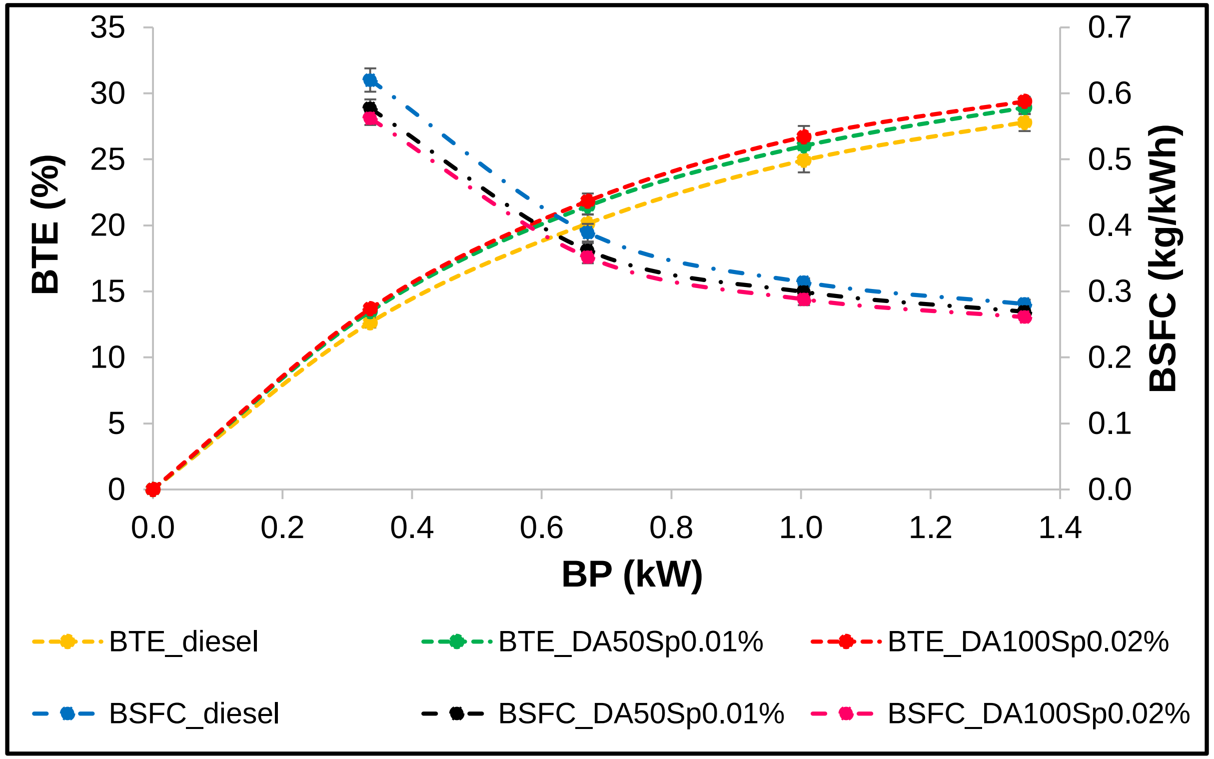
Nanofuel Stability – Particle Size Reduction



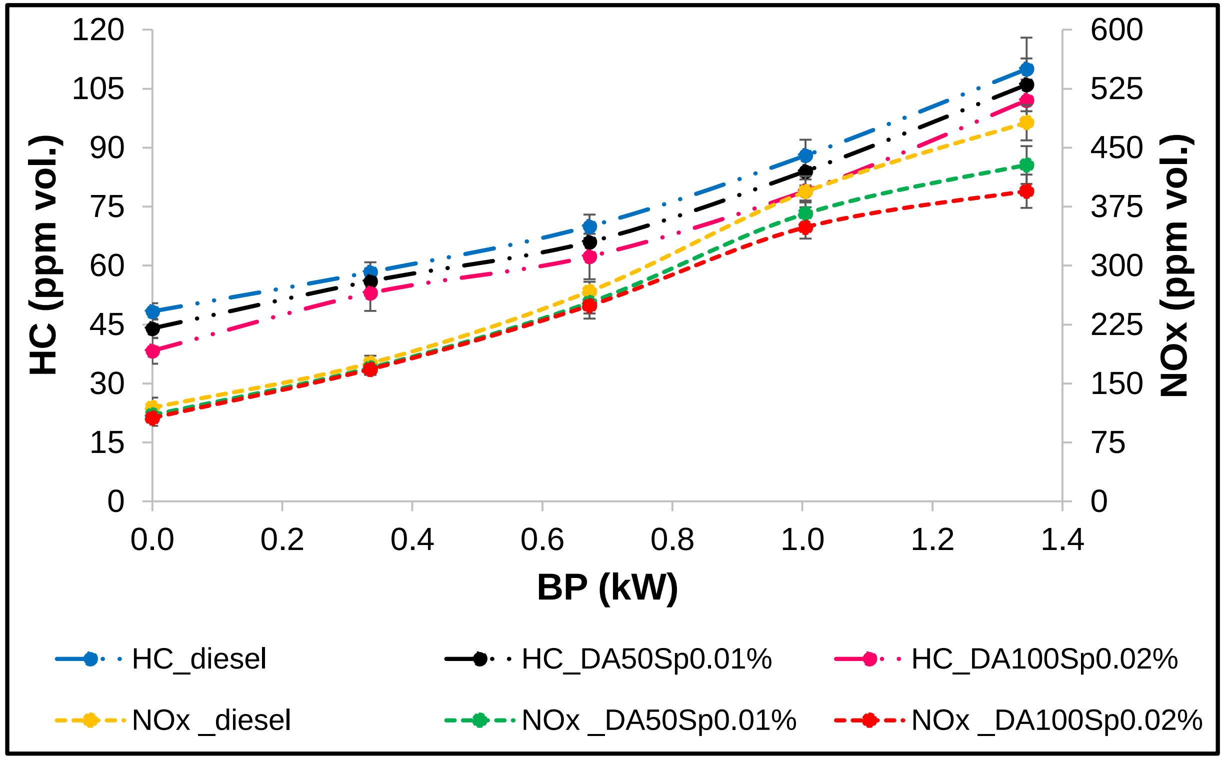
Size analysis using Dynamic Light Scattering (DLS):

Plot of light intensity scattered (%) w.r.t. particles' size (d, in nm) for 4 nanofuel samples; (a) DA1000Sp0.2% no_BM_BS, (b) DA1000Sp0.2% no_BM, BS, (c) DA1000Sp0.2% BM, no_BS, (d) DA1000Sp0.2% BM+BS; on 5th day [BM – ball-milling, BS – bath sonication]

Results and Discussion – Performance & Emission Characteristics



Brake thermal efficiency (BTE) and brake-specific fuel consumption (BSFC) w.r.t. brake power (BP) for: (a) Neat diesel, (b) 50ppm-Al_2O_3 nanofuel (DA50Sp0.01%), and (c) 100ppm-Al_2O_3 nanofuel (DA100Sp0.02%)
[@1100±5 RPM, CR = 20, CRDI mode]



Hydrocarbon (HC) and Nitrogen Oxides (NOx) emissions w.r.t. brake power (BP) for: (a) Neat diesel, (b) 50ppm-Al_2O_3 nanofuel (DA50Sp0.01%), and (c) 100ppm-Al_2O_3 nanofuel (DA100Sp0.02%)
[@1100±5 RPM, CR = 20, CRDI mode]

Conclusion

- The concept of blending nano-additives (NAs) to liquid fossil fuel is a promising way as it leads to the improvement in combustion performance and emission characteristics of the engine.
- Stability of nanofuel suspension (diesel blended with Al_2O_3) has been studied using DLS.

Percentage Improvement in engine parameters using Al_2O_3 nanofuel as compared to neat diesel

Parameters	**DA50Sp0.01%**	**DA100Sp0.02%**
BTE	(↑) 4.1% - 6.6 %	(↑) 5.7% - 8.3 %
BSFC	(↓) 4.3% - 6.9%	(↓) 7.1% - 9.5%
HC emissions	(↓) 3.6% - 8.9%	(↓) 7.2% - 20.7%
NOx emissions	(↓) 3.4% - 11.2%	(↓) 4.5% - 18.1%

- Currently, the focus is on the measurements of ultrafine particles (UFPs) and particulate matter (PM) from the exhaust pipe of the engine, to study the effect of nano-additives.

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CENTER OF EXCELLENCE
IN PARTICULATES, COLLOIDS, AND INTERFACES

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Ministry of Education
Government of India

Thank you