THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	Validation of roadside vehicle emissions sensing by tailpipe tests
Author's name:	Vijayakumar Koushik
Type of thesis :	master
Faculty/Institute:	Faculty of Mechanical Engineering (FME)
Department:	Department of Automotive, Internal Combustion Engines and Rail Vehicles
Thesis reviewer:	Laurence Windell
Reviewer's department:	UCHP - CAS

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	**challenging**
How demanding was the assigned project?	

The assigned project required a good understanding of the principles of vehicle emission sampling. A combination of multiple instruments was required, most of which have complex principles. Sampling vehicle emissions can often be difficult and require careful planning, especially in terms of sampling setup and interpreting results.

Fulfilment of assignment	**fulfilled**
How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.	

The project allowed for the production of a database of cars passing the site, their fuel types, PM number concentration emissions, and emission factors. The different methods of sampling were compared using correlations between certain parameters, and in most cases, good agreements were found. The main tasks were achieved. The results provide information that adds to our knowledge of traffic emissions and ways to sample them, with implications for current and future regulation changes. The structure of the thesis is good; it has a good introduction to the topic, reasons behind the research, explanation of core concepts of traffic and the measurements of their emissions, methods section, and results and discussion.

Methodology	**correct**
Comment on the correctness of the approach and/or the solution methods.	

The sampling methods used raise some questions, in particular the use of background subtractions and the inherent designs of the EEPS and NM3 systems. Aside from these points, the project was well-designed and presented a good comparison between different methodologies.

Technical level	**C - good.**
Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?	

For the most part, the thesis is technically sound (see 'methodology' section). While the student does not have a background in aerosols, they have been able to use the core principles of aerosol sampling to run a comparison of methodologies for sampling exhaust emissions. While some concepts may be difficult to understand for readers not in the field, the student has explained the contents of the project. Figures and charts have been used where necessary.

Formal and language level, scope of thesis	**D - satisfactory.**
Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?	

Multiple grammar, spelling and formatting mistakes can be found throughout the document, and must be amended. E.g., basic mistakes such as those in the description of Figure 10 on page 28. While subject vocabulary is used, English language errors take away some of the impact of the thesis, as they make the thesis harder to read. However, the concepts and results are conveyed. The thesis is organized logically and thoroughly, covering the whole topic.

Selection of sources, citation correctness	E - sufficient.
Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?	
A greater number of citations to relevant literature is required in the literature review. For example, there are no references included in Section 2.3. Although this information may be true, linking it to sources in the literature is required. References to some core literature is used, mostly in the introduction. Some references are used when comparing results to the literature. The reference list has errors in terms of format; the format should be consistent, including the order of information (author, title, date, etc.) and capitalization.	

Additional commentary and evaluation (optional)
Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.
The aim was to compare the different methods available for analyzing measurements such as particle number concentration, size distribution, and gas concentrations. In particular, roadside measurements were compared to direct tailpipe measurements. The equipment was set up on a university campus, to measure emissions from passing cars, both by the roadside and in the exhausts themselves. Using number plate and car model recognition, they were able to determine car models and fuel types, and link these to emission data. Emission factors were calculated and used to detect high and low emitters, as identifications of the former are critical; these high emitters contribute highly to total emissions and can be attributed to the lack of, or damage to, exhaust filters, specifically DPFs in diesel cars. The novelty of the thesis is clear. It combats difficulties in sampling vehicle emissions, and provides important comparisons between two main types of vehicle emission sampling. As mentioned, these results may be used for decisions made on methods of sampling traffic emissions, a topic that has great impacts in environmental pollution.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

The topic at hand was not easy, especially at the master's level. The project was planned out and had clear goals. Good results were found and interpreted appropriately. These results may have greater implications in the field. The structure of the thesis was sufficient. However, there are some questions that must be answered in terms of the choice of instruments, the background subtraction method and the lack of meteorological data. The use of citations and their format within the bibliography were not up to standard. The standard of English could be improved.

1. EEPS/Nanomet3 – These systems do not give us information on the charge distribution of particles. How does the lack of knowledge about charge distribution affect measurements of particle number concentration?
2. Background subtraction method:
    a. How stable was the 'baseline' background noise during the sampling period, i.e., before and after vehicle passing, or across the whole day?
    b. Figure 21, page 55 – Can you explain the drop below baseline after the passing of a vehicle?
    c. How can this method be applied to real-world sampling of busy traffic sites, such as in the case of dual carriageways?
3. Lack of meteorological data – I notice no meteorological sensors or data were included in the analysis. How could wind speed and/or direction affect results?
4. Figures 26 and 28 – We see multiple datapoints (in the high emitter category) where number concentration from tail pipe measurements (X axis) seems to be equal. Four in Figure 26 and six in Figure 28. Did the instrument reach its maximum limit of detection?

The grade that I award for the thesis is **C - good.**

Date: **25.8.2023**   Signature: