Lecturer

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Title

Estimation of the mechanical efficiency of a multicylinder petrol engine and its corresponding emission.

Objective

You are required to estimate the mechanical efficiency of a multicylinder petrol engine using two methods:

1. The Morse Test.
2. The Willan's Line Method.

And compare the results between both methods.

You are also required to measure the exhaust emissions for CO_2, CO, and UHC for all stages of the Morse Test.

Do an error analysis of your results.

Equipment

Multicylinder petrol engine, Engine test rig which includes a dynamometer and instrumentation, and a Portable gas analyzer.

Introduction

Friction in an internal combustion engine originated from all moving parts such as the piston ring rubbing against the cylinder wall, crankshaft, valvetrain and all existing gears. Determination of friction loss in an engine is important in increasing its efficiency and reducing the fuel consumption. Furthermore, excessive friction will also reduce the life of the engine. This is useful in designing a better engine.

There are several methods to estimate the friction loss, hence the mechanical efficiency of an engine. Each method has its own advantages and disadvantages. In this experiment, we will compare the results obtained from the Morse Test and the Willan's Line.

Theory

Friction loss can be considered constant at a given speed and independent of load. Based on these assumptions, methods were proposed to estimate the friction power.

1. **Morse Test**

   In this test, the brake power is determined for a given load. Then, the cylinders are turned off in turns and the load is reduced to attain the same speed as before. The difference of brake power between the cylinder off conditions and all cylinder onis assumed to be the indicated power of the cylinder if it were on. Totaled up for all cylinders will give us the indicated power of the engine.

2. **Willan's Line**

   This method is modified from the steam turbine field. At a given speed, the load is reduced and the fuel consumption is measured. The fuel consumption is then plotted against the brake power. At zero brake power, all fuel is used just to overcome friction. Assuming the plot to be linear, the graph is extrapolated to zero fuel consumption, and the difference indicates the friction power.

In the Morse Test, when a cylinder is shut off, the fuel-air mixture distribution among cylinders might change and this will give a varying exhaust emissions. Observe if the emissions can be related to the emission for all-cylinder-on condition.

Guideline

Members of the group will acquire a common set of data for the given particular experiment, and each member will submit an individual laboratory report.

Students must study the experiment's requirements thoroughly before starting. The technician's job is not to do the experiment for you. Instead, the technician will familiarize you with the equipment and software. You will need to decide for yourself, how best to collect the data to answer the questions posed in the handout.

Report

Each lab student will turn in his/her report for each experiment. Reports must be typed on A4-size papers. Reports should be concise but complete. Use your own words; verbatim copying of the hand-out should be avoided. Do NOT pad the length of a report unnecessarily.

The report should contain the following sections:

1. **Title page**
   - Title of experiment
   - Group ID; names of group members
   - Date experiment was performed
   - Date report was submitted
2. **Objectives**

   They are normally stated in the lab handout.

3. **Theoretical background**
    - What principle is this experiment designed to illustrate?
    - Describe the theory and any relevant equations/derivations.
4. **Equipment**
    - Describe all components used during the experiment.
    - Include a neat schematic diagram with all parts labeled and dimensioned (as required). Copying sections of a report, or sharing sketches with other groups is NOT permitted.
    - Provide a definition of all symbols used.
5. **Procedure** For each objective in a given experiment:
    - Initial setup
    - Procedure
    - Parameters varied
6. **Results**
    - Raw data should be arranged in tabular form. Some data may be tabulated in an Appendix.
    - A completely worked-out sample calculation is required for repetitive calculations.
    - Use Matlab/Octave/LibreOffice Calc/MS Excel (or any other spreadsheet program) for tabulation and graph plotting.
7. **Error analysis**
    - Perform an analysis to show how all the individual errors in your measurement contribute to the total error in the final quantity. (See **Error Analysis** handout.)
    - Suggest ways to reduce error in the final result.
8. **Discussion and conclusions**
    - What did you learn from this experiment?
    - What discrepancies did you notice between theory and experiment?
    - What would you do to improve it?
9. **Appendices**

    In a laboratory report, appendices often are included to present information that is too detailed to be placed into the report's text. For example, if you had a long table giving voltage-current measurements for an RLC circuit, you might place this tabular information in an appendix and include a graph of the data in the report's text.

10. **References**

    This section lists all articles or books cited in your report. It is not the same as a bibliography, which simply lists references regardless of whether they were cited in the report. The listing should be alphabetized by the last names of the authors.

Students will be given a number of experiments to perform throughout the course. Objectives of the experiments are to:

1. illustrate the physical concepts of engineering phenomena developed in class,
2. demonstrate the limitations and applicability of engineering theories,
3. encourage creativity in the use of experimental apparatus and data acquisition,
4. foster self-reliance required for open-ended experiments and reduce dependence on a cookbook approach,
5. develop the ability for team work,
6. develop effective communication of technical information, and
7. develop computer skills for acquiring data, data reduction, error analysis, and plotting.