VIRTUAL ENGINE TEST BENCH v0.1 – PROGRESS REPORT

This is the start of a long journey. The project aims to simulate real workflows of an engine test engineer. v0.1 sets up the baseline to build upcoming modules. In this version airflow, torque and power calculations are integrated into the model.

Engine model in this version is as simplistic as it gets. Air density, volumetric efficiency(VE), combustion efficiency($\eta_{combustion}$) and Air-Fuel-Ratio(AFR) assumed to be constant. Each of these parameters will be improved in the following versions to make the model more realistic and dynamic.

Equations used in v0.1:

- Airflow: $\dot{m}_{air} = V_{displacement} * VE * p * \frac{RPM}{2*60}$
- Fuel rate: $\dot{m}_{fuel} = throttle * \frac{\dot{m}_{air}}{AFR}$
- Torque: $T = \dot{m}_{fuel} * LHV * \eta_{combustion} \Big/ \frac{RPM*2\pi}{60}$
- Power: $P = T * \frac{RPM*2\pi}{60}$

Volumetric efficiency and engine combustion efficiency is assumed to be constant which makes this version a more like a calculator. Nevertheless, main goal of this version waws to perform a base pipeline check to ensure data is flowing accurately and being exported to a csv document to imitate real world calibration and tuning tools.

Volumetric efficiency and combustion efficiency are assumed constant. This makes v0.1 closer to a calculator. The goal here was to do a baseline pipeline check: make sure data flows correctly, user inputs are handled safely and results are exported as CSV, just like a real calibration and tuning workflow.

The model is written in Python using pandas for data handling and export. Code is modular with separate scripts for test modes and reporting. Input validation is included to keep everything inside defined ranges. The CLI asks the user for engine displacement and VE. For each selected test, extra RPM data is requested. Boundary checks prevent invalid inputs.

In v0.1, three test modes are included:

- Single Run: single RPM at all throttle positions (increments of 0.1)
- Full Throttle Response: torque and power at full throttle between selected min and max RPM (100 RPM increments)
- Full Range Sweep: torque and power across RPM range for all throttle positions (100 RPM increments)

After running a test, the user can name the file and choose where to save it. If the folder is left empty, results go into a default Results folder. Each file is timestamped to avoid overwriting.

Demo video for the Full Sweep test

Validation pending: Data from Professor Stephen Samuel(Reader, Oxford Brookes) will be collected. The plan is to compare torque and power vs RPM curves.

Current limitations: no spark timing, no boost, no transient dynamics, no knock modelling.

Future versions will add VE maps, spark advance maps, BSFC, turbocharging, and emissions prediction.