DBDYNO - DEVELOPMENT AND IMPLEMENTATION OF A BRAKE DYNAMOMETER CONTROL SYSTEM FOR REPRODUCING ON ROAD BRAKE DURABILITY ROUTES

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ABSTRACT

Research and/or Engineering Questions/Objective:
Brake dynamometer testing is fundamental for brake component development and investigation. In order to provide accurate vehicle-independent brake performance data not only energy route characterisation applies but also real application profiles. In this paper, the development and implementation of a control system, called dbDyno, which allows the reproduction of on vehicle conducted brake durability routes onto brake dynamometers is presented.

Methodology:
A brake dynamometer was built for development purposes consisting of basic components: motor, inertia flywheels, brake disc, calliper assembly and load arm. Additionally, pressure, load (torque), speed and temperature sensors were fitted.
At a first stage, real-time PID control algorithms were developed independently in modules (speed and pressure controllers). PID control algorithms have shown simplicity, robustness and flexibility over time which made them the optimal choice. By having speed and pressure parameters controlled, deceleration is a consequence of the amount of rotating inertia combined with the brake system friction and the pressure applied to it.
Next, once all the main parameters of the dynamometer were controllable (speed, pressure and therefore deceleration), the data acquisition system was developed and built into the controller. The developed architecture eliminates the need of additional subsystems to acquire the dynamometer data, which keeps the system as simple as possible. The acquisition system acquires the brake dynamometer data (low sample rate data acquisition) as well as NVH data (high sample rate).
At the final stage a module was developed to input the metrics of the test. The test metrics can be defined either manually by the dynamometer user or by processing on-service logged vehicle data and automatically converting it into control sequences.

Results:
The control system has been deployed on four brake dynamometers, each one of them mechanically and electrically different, demonstrating the versatility of the system. System usage is wide: it can perform standard brake tests (AKMaster and AKNoise, defined in SAE J2521 and SAE J2522 respectively), brake durability routes (Mojácar, Los Ángeles, etc.), homologation standards (ECE R90, ECE R13, etc.) and WLTP cycles (which will possibly be the standard test for brake emissions). Customized procedures are also possible.

Limitations of this study:
Precise route reproduction involves many variables which are difficult to emulate onto brake dynamometers: cooling flow rate variations are important but difficult to measure and replicate properly as well as climate simulation, which requires major infrastructure. Other physical constraints are involved such as inertia, which is fixed in dynamometer and it does not take into account the load transfer in real vehicle and electric power of the motor, which limits the maximum speed and acceleration of the rotor. The current lack of regenerative brake simulation also narrows the potential of this development.

Conclusion:
The control system functionalities developed up to date are satisfactory: the system has shown robustness over time, scalability and ease of deployment, flexibility in usage and precision in performance. To cover the full range of vehicle types in the market the implementation of regenerative simulation capabilities is currently being investigated.