Feature Article

Vehicle Testing on Chassis Dynamometers

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The 48" center mounted chassis dynamometers are the most common type and are typically used for emission testing and mileage accumulation. They are equipped with rollers and a motor, which is positioned between the rollers. Inline versions with the motor located inline with the rollers are mainly used for NVH testing. The basic chassis dynamometer facility includes roller set, power and control cabinets, an operating PC, a handheld remote unit, a blower, and safety covers and grids. In addition, the mileage accumulation extension consists of an automation system, an autopilot and interface unit for connections between automation system to the autopilot as well as to some required vehicle signals, like engine speed, temperature signals or ignition. The HORIBA 48" chassis dynamometer is capable of achieving averaged accumulated distances of up to 500,000 km per year.

Introduction

In the automotive development process, the most important issue is the speed at which new vehicles and new technologies are developed for production. For vehicle testing on a chassis dynamometer, this means that complex test problems must be solved. HORIBA develops vehicle test stands that simulate the realities of vehicle driving in the most varied situations both precisely and economically. This article gives an introduction in vehicle testing on chassis dynamometers including the typical tests which can be run on a chassis dynamometer integrated in a test cell.

Typical Tests on Chassis Dynamometers

Chassis dynamometers have a long history; first versions were developed in the early 20th century, and in spite of new vehicle simulation tools, they continue to be important tools in the development process. New demands from environmental protection legislation and much more sophisticated vehicle functionality such as complex exhaust after treatment systems demand new tests and new requirements resulting in more testing on chassis dynamometers.

Typical tests done on a chassis dynamometer are:

- Performance and endurance mileage accumulation tests
- Functional tests and lifetime tests on vehicles and vehicle components (fuel system, cooling system, brake system, electrics/electronics, heating/air conditioning system)
- Exhaust emission testing
- Environmental tests (low / high temperature tests in a climatic chamber)
- Fuel consumption tests, injection fine tuning
- Exhaust and catalyst tuning
- Noise vibration harshness (NVH) tests
- Electro magnetic compliance (EMC) tests

Basic Configuration of Chassis Dynamometers

A chassis dynamometer measures the power from the engine through the wheels. As the tractive force of the vehicle tires is transferred through the rollers, the chassis dynamometer controls the speed and resistive force of the rollers. For emission testing the dynamometer simulates the vehicle rolling resistances during the tests to provide the same load on the engine as when driving the vehicle on the road.

The 48" center mounted chassis dynamometer is the most common type and is primarily designed to meet the regulations of the US Environmental Protection Agency (EPA) for emission testing, but this type is also frequently used for mileage accumulation tests as well. They are equipped with rollers with a diameter of 48 inches (=1.2192 m) and the center mounted refers to the motor being positioned between the rollers. Inline versions with the motor located inline with the rollers but to one side are used for example for noise testing. For application of NVH (noise, vibration and harshness) testing, chassis dynamometers with roller diameter of 1.6 m, 2.0 m and 75 inches in an inline configuration are used.

Figure 1 shows a typical center mounted configuration, and Figure 2 shows inline version.

Figure 1 Four Wheel Drive (4WD) Center Mounted Chassis Dynamometer

Figure 2 4WD Inline NVH Chassis Dynamometer

48" Chassis Dynamometer for Mileage Accumulation (MACD)

Mileage accumulation are long-running tests, possibly lasting several weeks and will include legally required mileage accumulation tests, freely programmable tests, company-specific mileage accumulation tests (e.g. time efficient compressed high load tests) and special tests (e.g. cycles recorded on the road, to be repeated on the chassis dynamometer). The most significant difference to a chassis dynamometer for emission tests, for which only limited operating condition is required, is that for mileage accumulation testing the chassis dynamometer should have an ability to simulate all driving conditions.

Configuration of MACD

The basic test facility components are the dynamometer including power and control cabinets, automation system, an operating PC, a handheld remote unit, a blower, safety covers and grids for contact protection of rollers and wheels. In addition, the mileage accumulation extension consists of an autopilot or robot driver including boom box for connections between automation system to the autopilot as well as to some required vehicle signals like engine speed, temperature signals or ignition. Signals may also be provided via a digital CAN-bus interface to the vehicle engine control unit (ECU).

The autopilot is directly connected to the automation system. Most test data to be entered, e.g. test cycle, monitoring data, virtual driver data, and shifting characteristics are stored and managed in automation system data base, therefore available via network to any chassis dynamometer in the mileage accumulation laboratory.

Since mileage Accumulation test labs usually are located outdoors, environmental conditions like temperature, air pressure and humidity may influence the test results. In order to correct measured force or power data of the vehicle via correction formulae, the current meteorological data is measured by an optional meteorological station. Refueling pumps for gasoline, diesel, etc. for automated refueling of the vehicle are integrated near each dynamometer (Figure 3, Figure 4).

Figure 5 gives an overview of a single mileage accumulation chassis dynamometer, which may be a component of a larger mileage accumulation test laboratory with automatic refueling system.

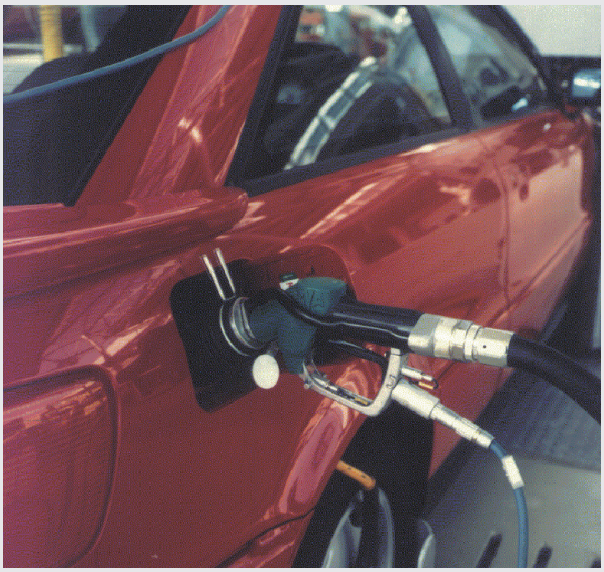

Figure 3 Fuel Nozzle for Automated Refueling of the Vehicle

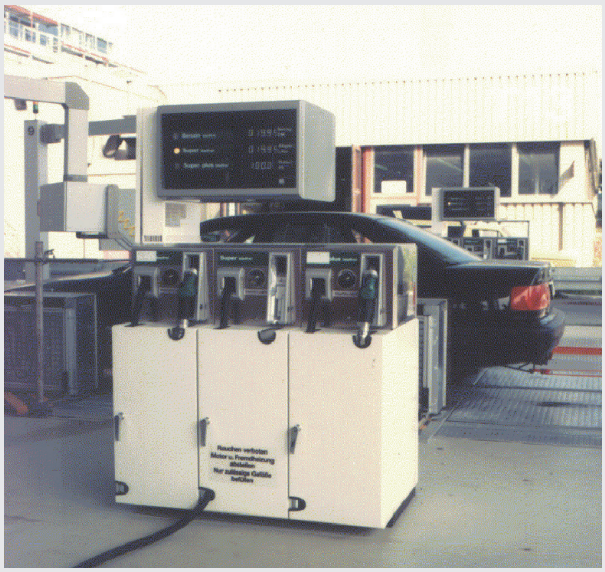

Figure 4 Fuel Pumps for Automated Refueling of the Vehicle

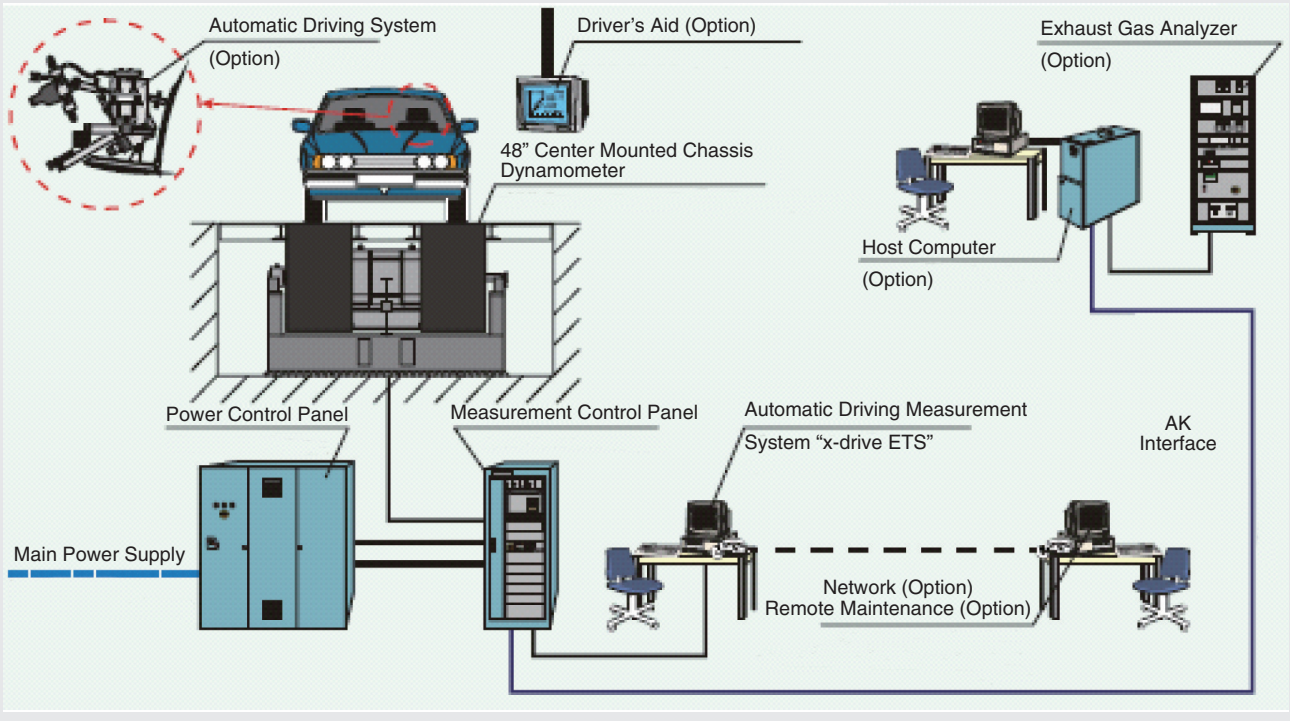

Figure 5 Chassis Dynamometer with Robot Driver for Mileage Accumulation

Management by Automation System

Very often a mileage accumulation test laboratory consists of two or more chassis dynamometers. For optimal utilization of the total laboratory, a time management of the test beds is mandatory.

The test cell automation systems (from each test cell) are linked to a data base where the test data, test cycle, monitoring data and driver data are stored and can be used on other test cells. For example an interrupted test cycle has to be continued at a position, where start-up is easily possible. Therefore, certain predefined restart steps within a cycle will be used. The original, interrupted, test report will be continued in a way that finally one contiguous test report will be created (including log-information about the interim service).

Figure 6 shows some typical mileage accumulation data of a laboratory with two HORIBA chassis dynamometers. An accumulated distance of 250,000 km per chassis dynamometer per year can typically be achieved, driving standard test cycles like Automotive Manufacturers Association (AMA). Using customer specific high speed cycles averaged accumulated distances of up to 500,000 km per chassis dynamometer per year are achieved. These accumulated distances also include periods of vehicle installation/dismounting or interruptions due to vehicle malfunction.

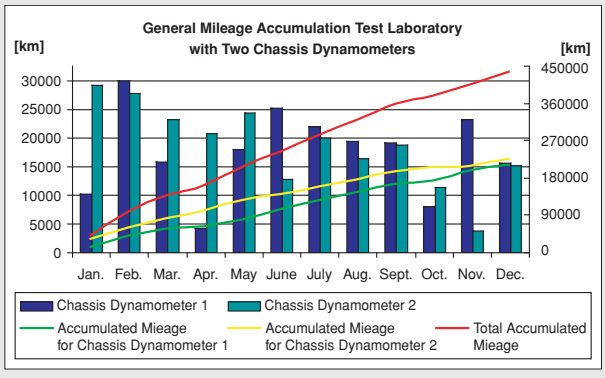

Figure 6 Mileage Accumulation Statistics with Two Chassis Dynamometers

New Developments on 48" Chassis Dynamometer

HORIBA have developed a new modular flexible design for a chassis dynamometer mechanics, e.g. base frame, motor, load cell assembly, and support structure.

The main goals for this development were:

- A flexible system design based on modules which can be pre-manufactured and held on stock
- Attractive price
- Due to the flexible modular design, a short lead time for the whole system
- Short installation and commissioning times on customer site
- Predefined interfaces for e.g. pit sizes, mains power supply, housekeeping

Conclusion

Chassis dynamometers are used for broad applications. The most common 48" type is mainly used for emission tests, mileage accumulation and climatic temperature testing. HORIBA has around 80 years of experience in the design, manufacturing, assemble, installation and commissioning of chassis dynamometers, including the period they are provided by Carl Schenck AG. The improvement of the chassis dynamometers based on this experience will help to provide the best solutions for our customers in the automotive testing field.

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