This course can be adapted to virtual classroom mode

Module 2: Spark Ignition Engines

SI Engines

3 days **MOT2-EN-A**

Overview

LEVEL

Knowledge

PURPOSE

This course provides a deeper knowledge on spark ignition SI engines.

LEARNING OBJECTIVES

Upon completion of the course, participants will be able to:
understand the fundamentals behind combustion systems' design and construction,
understand how the gasoline characteristics affect the engine behavior,
understand the structure and the basics of the engine control operation,
select depollution strategies: raw emissions improvement and/or after-treatment,
select a timing system,
build a quick diagnostic in case of operation failure.

WAYS AND MEANS

All trainers are industry experts, delivering real life examples.

Agenda

COMBUSTION SYSTEMS CHARACTERISTICS — 1 d

Objectives and design restrictions linked to the combustion chamber (shape, valves arrangement).
Combustion characteristics: combustion physics, volumetric efficiency (valve lift curve, IVO, EVO, IVC, EVC, crossing), combustion and cycle efficiencies, fuel/air ratio distribution, abnormal combustions (knocking, pre-ignition).
Combustion modes: stoichiometric combustion (basic system, downsizing), lean mixture combustion (indirect or direct injection, homogeneous or stratified), direct injection and supercharging. Validity of these combustion modes facing the current and future restrictions (emissions, consumption, …).
Design and adjustment parameters: combustion system optimization in stoichiometric or lean mixture mode.
Raw emissions reduction: pollutants formation mechanisms. Performance/depollution tradeoff at the engine level (preparing the mixture, EGR, dead volumes, variable timing, …).

CHARACTERIZATION - BREATHING & SUPERCHARGING — 0.5 d

Breathing: volumetric efficiency, timing, acoustic inlet (Kadenacy effect, ¼ wave,…), and exhaust (3Y manifolds, separate exhaust lines, …) optimization.
Performances: potential of the different technologies, parameters affecting the performances.
Link between breathing and performances.
Supercharging: supercharging types, turbocharger operating and technology, mapping (characteristic fields), adaptation to engine, trade-off to carry out.

SPARK IGNITION ENGINE FUELS CHARACTERISTICS — 0.5 d

Gasoline main characteristics and specifications: density, octane rating, volatility, chemical composition, sulfur, and impact on the engine behavior.
Impact of the fuel composition on regulated and non regulated pollutant emissions.
New fuels: evolution of specifications and oxygen compounds (alcohols and esters). E85 and flexfuel.
Gaseous fuels: natural gas vehicles (GNV) and liquefied natural gas (GPL).

ENGINE MANAGEMENT SYSTEM

0.5 d

Engine control system: role, definitions, history.
Acquiring the operating point: different sensors (speed, glow, pressure, temperature, positioning, …).
Ignition: components (coils, plugs), anti-knock.
Air management: motorized throttle valve, variable timing, supercharging.
Depollution: fuel-air ratio control (oxygen sensor), evaporative emission system (canister), exhaust gas recirculation (EGR), exhaust air injection (EAI).
Strategy: torque structure and diagnostic.

SPARK IGNITION ENGINE AFTER-TREATMENT

0.5 d

Situation, history and general issues, regulation restrictions, operating of a catalyst.
3-way catalyst: stoichiometric conditions, fuel-air ratio control, cold start (hydrocarbons, exhaust thermal management), high power loop opening.
Lean mixture NOx treatment (homogeneous/stratified): NOx traps operating principles, exhaust heat exchanger.
Operating limits of gasoline catalysts ageing. Gasoline on Board Diagnostics (OBD).