New Developments in Spark-Ignition Engines

5 days **MOT/MOTE-E**

Overview

LEVEL

Foundation

PURPOSE

This course provides a better technical knowledge of spark ignition engines, in order to help people working on a specific problem to communicate efficiently with every person involved, whichever field they're from.

LEARNING OBJECTIVES

Upon completion of the course, participants will be able to:
know the main characteristics required for a good gasoline engine behavior,
know normal and abnormal combustion mechanisms,
understand the influence of engine tuning parameters on combustion and pollutant emissions,
understand the influence of engine design parameters on volumetric efficiency and full load performances,
know the advantages of Gasoline Direct Injection (GDI) and downsizing,
know the principles of forced induction systems and developments,
choose after-treatment systems to reduce exhaust emissions: Three-Way Catalyst (TWC), NOx Trap,
know engine control systems: sensors, actuators, strategies.

WAYS AND MEANS

Various interactive talks, adapted to the participants' fields of activity.
Videos.

PREREQUISITES

No prerequisites for this course.

Agenda

COMBUSTION IN GASOLINE ENGINES — 1.5 d

How does a spark engine work?
Chemical reaction equation, stoichiometric air/fuel ratio, equivalence ratio, specific heat value.
Composition of exhaust gas. Flammability limits, flame propagation in normal combustion. Abnormal combustion: knock, pre-ignition, rumble. Heat release rate, combustion timing: influence on efficiency and on emissions. Residual exhaust gas and influence on combustion and emissions.
Influence of pumping losses and friction losses on brake specific fuel consumption (BSFC). Unburnt hydrocarbons: why they are found in the exhaust and how reducing them.
CAI (Controlled Auto Ignition): characteristics of CAI combustion; improvements of efficiency.

GASOLINE CHARACTERISTICS — 0.5 d

Market evolution and sharing among the different gasoline fuels.
Properties of automotive gasoline and impact on the engine: volatility (vapor pressure, ASTM distillation), combustion (decisive factors, knock nature and incidence, definition and measurement of gasoline octane rating), toxicity (benzene, aromatics and olefins contents). Corrosiveness and stability. Automotive fuels

production process pattern. Characteristics of the different oil basis produced by refineries. Alternative fuels: alcohols, MTBE, ETBE, GNV, GPL.

AIR SUPPLY - PERFORMANCES & FORCED INDUCTION

0.75 d

Air supply: pressure waves in inlet and exhaust ducts, influence on volumetric efficiency and on full load performance. Design of intake/exhaust valves to optimize volumetric efficiency (1/4 waves, …).
Performances: potential of each technology, parameters affecting the performances.
Forced induction: role, limits and dimensioning of intake boosting systems. Materials. Overview of the different architectures (twin-scroll, parallel/sequential turbochargers, …). Future developments.

TECHNOLOGY

1.25 d

Gasoline Direct Injection (GDI):
GDI advantages and drawbacks. Operational strategies (stoichiometric, stratified, …).
Components-injectors system, HP pump, regulator, fuel supply, power supply. GDI systems.
Variable Valve Actuation (VVA):
Classical valve actuation: principles, limits.
Variable valve actuation: advantages compared with conventional valve actuation, classification.
Current technologies: variable valve timing systems, 2-step systems (Honda VTEC, Porsche-INA variocam), continuous systems (BMW valvetronic), camless systems (FEV-Valeo).
Downsizing:
Situation, issues, motivation (efficiency improvements), problems to overcome. Reasons for combining GDI and forced induction. Control of engine knock. Contribution of variable valve actuation to downsizing.

EXHAUST GAS AFTER-TREATMENT

0.5 d

Three-way catalyst (TWC): efficiency versus relative air/fuel ratio, oxygen storage capacity (OSC), structure and manufacturing, light-off temperature, ageing.
NOx Trap.

ENGINE MANAGEMENT SYSTEM

0.5 d

Functions of the engine management system, sensors, actuators, strategies: air flow control by electrical engine actuated throttle; fuel injection, air flow measurement or calculation, relative air fuel ratio closed loop control by single or dual oxygen sensor (lambda probe); speed and crankshaft angular position measurement; spark ignition timing, anti-knock strategy; canister control diagnostic.