Loading & Supercharging

3 days **REMP-EN-A**

Overview

LEVEL

Expert

PURPOSE

This course provides a deeper knowledge on the air supply of atmospheric, turbocharged and supercharged engines in order to improve specific performances.

LEARNING OBJECTIVES

Upon completion of the course, participants will be able to:

explain the intake and exhaust pressure losses and pressure wave losses phenomena, which govern the engine air loading and how they affect mouth noise,

realize the building activities (shapes and dimensions of inserts, intake and exhaust volumes, settings of the valve-lift laws), aiming at optimizing loading, illustrated by examples of simple calculations,

determine a turbocharger for a given application, illustrated by an example to be handled by the participants,

identify the reactions of the engine and turbocharger systems depending on the conditions of use.

WAYS AND MEANS

One of our bestsellers.

Interactive training with real life examples.

Practical approach is provided by design and matching exercises.

MORE INFO

This program can be extended by modeling and simulation and more knowledge about supercharging technologies, choose the next page course “Advanced filling & supercharging modeling & simulation” REMPS.

Agenda

ENGINE AIR LOADING — 1.5 d

Characteristic sizes: volumetric efficiency, delivery efficiency.
Elementary phenomena that govern discharge.
Pressure losses: Bernoulli equation, equivalent section, relative share of each element of the intake circuit, measurement on stationary test bench, influence on full load engine performances.
Acoustic intake.
Use of pressure waves to improve loading; mono-cylinder (high speed) or multi-cylinder (low speed) typed acoustic modes. Use of parameters without dimension (Broome number) to characterize the wave phase difference and amplitude. Acoustics and pressure losses trade-off.
Multi-cylinder engine optimization: influence of the cylinders number, the elements of the intake circuit upstream of the plenum. Variable acoustics: variation of the pipes length, volumes trade-off with pressure losses. Use of acoustic phenomena on turbocharged engines.
Trade-off between the mouth noise generated by pressure pulsations and performances.
Exhaust acoustic: influence of pressure in the manifold and of angular orientation of the Exhaust Valve Opening (EVO). Mono-cylinder and multi-cylinder modes. Influence of the cylinder numbers and of the exhaust line architecture: “3y” or “4 in 1” type exhausts. Exhaust variable acoustics.

Timing: optimizing the opening and closing angles and of the lift law forms of intake and exhaust valves. Variable timing: different types, interest.

TURBOCHARGING

1.5 d

Supercharging benefit and limits: use of the exhaust gas energy, increase in the engine power but also in cylinder pressures, temperatures, thermal constraints; need to be able to make turbine permeability change by waste-gate or variable geometry.
Centrifugal compressor: aerodynamics in the compressor, pumping, isentropic efficiency compression, critical speed. Air compression work. Compressor field: characteristic curves and representation of the engine operating points in the compression/corrected flow ratio diagram. Compressor tuning parameters: inlet diameter, impeller diameter, volute section, blade shape, ported shroud, variable geometry. Technology, limits (burst, temperature).
Centripetal turbine: energy supplied by the turbine, expansion isentropic efficiency, mechanical efficiency. Characteristic curves in the corrected rate/expansion rate diagram. Exhaust boost energy recovery. Choice of turbine. Waste-gate. Variable geometry turbine. “Twin-scroll” turbine. Turbine and bearing housing technology and limits: temperature, blade vibrations, fatigue, lubrication. Bearings, seals.
Matching a turbocharger to a given engine: exercise in classroom.
Determining air flow rate and density at cylinder head inlet, calculating the corrected flow, choosing the compressor, calculating the compressor driving power, calculating the expansion ratio and choosing the turbine, calculating the flow in the waste-gate, choosing a variable geometry turbine, case of operating at altitude.
Twin turbocharging: different assembly types, interest, drawbacks.