Aircraft Piston Engines

4 days **MPAERO-EN-P**

Overview

LEVEL

Knowledge

PURPOSE

This course provides newcomers and staff working in the field of aeronautics with a deeper knowledge on the characteristics of aerospace piston engine operation for aircrafts (airplanes and helicopters).

It gives an overview of their design and applications and covers the characteristics of piston engine operation for aircrafts (airplanes and helicopters).

LEARNING OBJECTIVES

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

assess needs and constraints related to aircraft piston engines based on their use (private civilian aircraft, military, drone, helicopter, … propulsion, power generation),

know the main stages of an aircraft piston engine life in propulsion and auxiliary power supply,

master the basic principles and specifications of piston engines developed for the aerospace industry,

understand the operating principles of 2 stroke and 4 stroke, spark ignition, diesel and supercharged piston engines for aviation applications,

understand the components characteristics of aircraft piston engines,

choose the architecture of a piston engine: 2 or 4 stroke, spark ignition or diesel, rotary or reciprocating pistons, …,

calculate simple characteristics and parameters of a piston engine and turbocharger,

know the certification requirements for these technologies.

WAYS AND MEANS

Mainly interactive, supported by real examples, it addresses the main technical areas of aircraft piston engines.

Focus on turbocharged engines.

Exercises of choice of engine architecture.

Sizing engines and associated systems exercises.

Agenda

INTRODUCTION TO AIRCRAFT ENGINE SPECIFICATIONS — 0.5 d

Reminders of aviation piston engines: generic technical definitions, architectures, general operating principles, examples of use.
Aeronautical technology reminders, reminders airplane and helicopter structures. Reminders on the principles of operation.
Technical positioning of piston engines in the world of aviation engines. Type of use, conditions of use, range of power, efficiency propulsion, aircraft type associated.
Issues and context: consumption, noise, mass, specific power, supercharching, reliability, the safety, durability, performance, maintenance, integration, pollution, the cost of manufacturing, meaning of life vs cost.
Maintenance, operating costs and operating.
Engine manufacturers and major alliances. Products, strategies and markets for piston engines.

Engines mission profiles by type of aircraft and type of aircraft operations. Stages of life. Operating points, operating times. Definition of power requirement. Operations stabilized and transient operation related to flight mechanics. Influence of the environment: altitude, pressure, temperature, speed, ice, resistance to damage (lightning, obstacles etc.). Specifications for auxiliary power generation unit (APU).
Design and production: digital model, the various materials used in aircraft piston engines and their locations, assembling and producing.Regulation and certification.

AIRCRAFT PISTON ENGINE PERFORMANCE

0.5 d

Reminders of air flows: physical properties, boundary layer; rotary wing and propeller; profiles (geometrical, aerodynamic forces, transonic conditions); gas velocity; notion of static pressure, dynamic and total pressure.
Review of thermodynamics: definition of thermodynamic quantities, fundamentals of thermodynamics, thermodynamic reference cycles, power calculation and yields (energy balance).
Performance piston engines: specific power, thermal and propulsive efficiency, calculating returns, parameter optimization, choosing optimum architecture (2-stroke, 4-stroke, spark ignition or diesel), choice of materials, first ideas on the impact of altitude on the design of the supercharger, performance depending on the mission profile of the flight, performance for APU use, calculation exercises.

AEROSPACE SUPERCHARGING

1.25 d

Reminders: boost technology, displacement compressors, air compressor, turbo … What are suited to aerospace technologies?
Interest and limitations of supercharging and turbocompressor: use of energy of the exhaust gas, the increase in specific power of the engine, the cylinder pressure, temperature, heat stress, of the turbine control.
Centrifugal compressor, compressor aerodynamics, isentropic compression efficiency, critical speed.
Compressor field: characteristic curves and operating points of the engine in the compression ratio diagram/flow corrected. Tuning parameters of the compressor: inlet diameter, wheel diameter, variable geometry. Technology limitations.
Centripetal turbine: energy supplied by the turbine, isentropic efficiency of relaxation, mechanical efficiency; flow and corrected/expansion ratio diagram; energy recovery from exhaust; choice of turbine; wastegate; variable geometry turbine; turbine "twin-scroll"; turbine technology and limitations and temperature, vibration vanes, fatigue, lubrication; bearings, seals.
Adaptation of a turbocharger to an engine piston, effect of altitude: supervised exercises.
Environmental effect compensation functions (pressure and temperature) on the operating points of the turbocharger. Specific design of a turbocharger for an aircraft engine, effect of the correction coefficients.
Determining flow rate and air density at the inlet of the cylinder head, calculating the corrected flow rate, choice of compressor, calculating the driving capacity of the compressor, the expansion ratio calculation and selection of the turbine, calculating flow rate in a wastegate, choosing a variable geometry turbine, various types of assemblies, interest disadvantages.

AIRCRAFT PISTON ENGINES SPECIFIC TECHNOLOGY

1.25 d

Specificities of aircraft spark ignition engine aircraft ordered: architecture (2 stroke, 4 stroke, number and arrangement of cylinders), design (depending on use) characteristics of the moving parts, the balancing system, the engine block, the top head, supercharging, the fuel system, injection system, lubrication system, air intake and exhaust chain, engine control, pollution, materials, life parts, phases of life, engine certification.
Specificities of aircraft diesel engines: architecture (2 stroke, 4 stroke, number and arrangement of cylinders), design (depending on use) characteristics of the moving parts, the balancing system, engine block, cylinder head, supercharging, the fuel system, injection system, lubrication system, the air intake and exhaust chain, engine control, pollution control, materials, phases of life of the engine, certification.
Materials and alloys (Ti, Mg).

FUEL & AIRCRAFT PISTON ENGINES

0.25 d

Reminders on the jet fuel: specification, nature, desired properties. Evolution of fuel, biofuel.
Fuel compatibility: compatibility with jet fuel piston engines.

AIRCRAFT PISTON ENGINE EVOLUTION

0.25 d

Issues: improved performance, noise reduction, weight reduction, vibration reduction.
Technological developments: aeronautical projects, announcement of manufacturers and engine.