

IC Engines: Combustion and Emissions - Web course

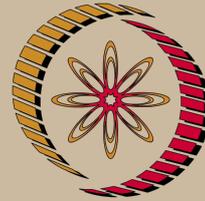
COURSE OUTLINE

Introduction to air pollutants and pollution; Thermo-chemistry and thermodynamics of combustion; In-cylinder air motion; Laminar and turbulent premixed flames, Premixed engine combustion; Spray formation and atomization, Direct injection and CI engine combustion; Combustion systems and management; Genesis and formation of engine emissions, NO kinetics, Soot formation and oxidation.

Emission standards and measurement; Control of emissions in SI and CI engines, engine design parameters, exhaust after treatment, lean de-NO_x catalysts, DISC and HCCI engines; Alternative propulsion systems e.g., HEV, FCV etc.; Engine fuel impacts on emissions, alternative fuels e.g., CNG, alcohols, biodiesel, hydrogen, GTL.

COURSE DETAIL

Sl. No	Topics
1.	Introduction to air pollution from IC engines, photochemical smog, primary and secondary pollutants.
2.	Thermodynamics of combustion : Stoichiometry of combustion, heats of reaction and formation, adiabatic flame temperature.
3,4.	Chemical equilibrium, properties of equilibrium combustion products of air-fuel mixtures, application to IC engines.
5.	Introduction to chemical kinetics, order of reaction, reaction rates, engine application.
6,7.	Premixed combustion, Flammability limits, SIT, flame structure, laminar and turbulent flames, flame speeds, effect of EGR.
8.	Conceptual SI engine combustion models, features of SI engine combustion processes, combustion process characterization.
9.	Thermodynamic analysis of burned and unburned mixture states, mixed and unmixed combustion models.
10.	Combustion variations, factors affecting it and their effect on performance and emissions, effect of EGR.
11.	Features of CI engine combustion process, conceptual CI engine combustion models, combustion process characterization.



NP-TEL

NPTEL

<http://nptel.iitm.ac.in>

Mechanical Engineering

Pre-requisites:

- Basic Engineering Thermodynamics
- A first course on IC engines

Additional Reading:

1. Internal Combustion Engine Handbook, Ed. Richard Van Basshuysen and Fred Schafer, SAE International, 2004.
2. C.R. Ferguson, A. T. Kirkpatrick, Internal. Combustion Engines, 2nd Edition, John Wiley & Sons, 2001.

Coordinators:

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12,13.	Fuel injection, spray structure, atomization, penetration, drop size distribution, spray evaporation.
14.	Ignition delay, factors affecting delay.
15.	Mixing controlled combustion, heat release rates , effect of engine design variables, swirl, injection rates.
16.	Thermodynamic analysis of CI engine combustion.
17,18.	Formation of NO and NO ₂ in SI Engines, Prompt and thermal NO, kinetics of NO formation.
19.	Formation of NO and NO ₂ in CI engines, NO formation in premixed and diffusion combustion periods.
20.	Formation of CO, kinetic effects, effect of engine variables.
21.	Flame quenching in SI engines.
22.	Unburned HC formation in SI engines, crevice HC, oil film HC and other sources.
23.	HC oxidation in the cylinder and exhaust, exodus of HC , contribution of different sources.
24.	Formation of HC in CI engines, undermining and overmixing, effect of nozzle design and other variables.
25,26.	Composition of particulates, soot structure, soot formation-stoichiometric considerations, nucleation, growth and oxidation, effect of engine variables.
27,28.	Trends in vehicle emission standards, emission limits, test procedures, driving cycles.
29.	Measurement of emissions, instrumentation for CO HC, NO _x , PM.
30.	Strategies for control of emissions in SI engines; Add on systems to control emissions inside the engine: EGR, crankcase and evaporative emission control.
31.	Exhaust gas after treatment, Thermal and catalytic reactors, Elements of catalytic reactors, catalysts and substrates.
32,33.	Oxidation, reduction and 3-waycatalytic reactors, closed loop feedback control, catalyst deactivation mechanism, cold start HC control.

34.	Lean de-NOx catalysts, NOx traps and SCR.
35.	Diesel particulate filters (DPF), DPF regeneration, CRT.
36.	Advanced Engines and Systems: VVT, VTEC, Ultra high pressure injection in diesel.
37.	Advanced Engines and Systems: GDI and DISC Engines.
38.	HCCI engine concepts, CAI-SI engines, HCCI-Diesel Engines.
39.	HEV and FCV propulsion systems.
40.	Petroleum fuels : impact of fuel characteristics including oxygenates on emissions.
41,42.	Alternative fuels to reduce emissions: Alcohols, natural gas, biodiesel, hydrogen, DME.

References:

1. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
2. B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.
3. Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Ed. Eran Sher, Academic Press, 1998.