Questions

(6.1) A diesel engine is fitted with mechanical injection pump with 60MPa peak injection pressure. Another engine of the same size developing the same power is employing common rail injection system with 160 MPa injection pressure. Both the engines operate at the same rated speed. Discus the likely differences between the two engines with respect to (i) injection duration (ii) nozzle hole size (iii) atomization and droplet size (iv) injection timing (v) fuel evaporation , mixing (vi) ignition delay and premixed combustion (vii) over all combustion rates (vi) PM and NOx emissions.

(6.2) Calculate stoichiometric NH_3/ NO_x ratio for reduction of NO_x in SCR catalysts if the entire NO_x is only NO, and consists of 5 and 10% NO_2 by volume. If 20 % more NH_3 than stoichiometric requirements is supplied calculate ammonia slip in ppm if the NO_x concentration in the exhaust gas before conversion was 2000 ppm.

(6.3) A diesel particulate filter (DPF) fitted to a 12 litre DI diesel engine is to be regenerated. The engine has volumetric efficiency of 88%, is operating at 67 % excess air and 2000 rpm. The ambient air conditions are 101 kPa and 300 K. For burning the soot collected on the DPF, the exhaust gas temperature is to be raised to 540º C. The exhaust gas temperature entering the DPF is 350º C. Determine the power of an electric heater to raise the exhaust gas temperature to the required level if the entire exhaust gas is to be heated. The specific heat of the gases in the relevant temperature range is N_2 = 30.27, CO_2 = 46.56, O_2 = 31.96, 36.44 kJ/kmol. K.

(6.4) Given the LHV of soot = 33.8 MJ/kg , if in a DPF of 1 litre volume 10 g of soot is burned estimate the temperature reached in the DPF. The combustion of soot begins at 540º C. The mass of the DPF is 400 g and its specific heat is 0.9 kJ/kg.K.

(6.5) Refer Fig 6.20. Discuss how various technologies have helped in reduction of engine out emissions from the diesel engines.

(6.6) A diesel engine has BSFC = 240 g/kWh. In the engine cylinder, lubricating oil enters through piston rings and valve guides which amounts to 0.2 % by mass of the fuel consumption. Of the engine oil in the cylinder, 80% is burned and rest is exhausted as SOF of particulate emissions. Estimate the specific PM emissions solely contributed by the engine oil. How do these compare with the Euro IV PM emission limits for heavy duty engines?