

HW#6 Internal Combustion Engines

1) What factors contribute to knock in an SI engine? List them and indicate which direction they change to aggravate knock (eg. Color: Dark cars have a greater tendency to knock). What factors contribute to knock in CI engines?

2A) A north American passenger car operates at stoichiometric and has a good 3-way catalyst. While cruising the engine out emissions are: CO: 1.1% HC: 750 ppm CO₂: 13.2% O₂: 1.5% and NO_x: 1000 ppm. Assuming the catalyst is operating well what are the tail-pipe out emissions?

2B) How would the catalysts conversion efficiency change as a function of Catalyst temperature? Sketch the overall conversion efficiency of the catalyst from ambient temperature to max operating temperature. Label the axis and provide approximate numbers.

2C) If we were to use EGR *instead* of a 3-way CAT to improve emissions, what are the best numbers we could expect? What would the % EGR be? What are the disadvantages of this approach compared to the 3-way catalyst?

2D) How could we change valve timings to get more EGR?

2E) How would the %EGR change as a function of engine speed?

3) A Diesel engine produces 75 kW at a mechanical efficiency of 80% and an overall brake thermal efficiency of 37%. If a turbocharger is added with a boost of 45%, what is the new power output? You may assume the frictional power does not increase significantly. What is the BSFC before and after the conversion? Sketch the energy flow diagram and give numbers for: Fuel input, Heat Losses, Frictional Losses, and Break Power.