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ENGINE CYCLE SIMULATION

---- An Engine Simulation Program Using 1-D Gas Dynamics for 4-Valve, Direct-Injection Engines.

A one-dimensional code has been developed for engine cycle simulation with the Method of Characteristics. This software is capable of modeling not only the gas flows in the intake and exhaust system, but also the in-cylinder combustion process. It can be used either as a independent engine cycle simulator or in conjunction with other models. The code tracks species throughout the flow field, which makes it possible to provide initial conditions for multi-dimensional modeling of engines (e.g., using KIVA) and for species information for the development of catalytic converters.

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1. Structure

The code consists of a main program, nearly 30 subroutines and one common block. Subroutines are called by the main routine or other subroutines.

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2. Preparation of Input Data Files

The data files needed for calculation include:
(1) the intake and exhaust valve lift profiles - (liftin.in, liftex.in);
(2) the intake and exhaust valve discharge coefficient - (cd.in);
(3) the fuel injection rate - (rate.in);
(4) the operating conditions - (input.in) - constants, timings, operating conditions, engine cylinder geometry, and wall temperatures, etc.
(5) intake.geo - geometric data of the intake duct used for generation of mesh.
(6) exhaust.geo - geometric data of the exhaust duct used for generation of mesh.

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3. Suggestions for Use of the Code

Users need to replace the input data files (rate.in, liftin.in, liftex.in, cd.dat, intake.geo, and exhaust.geo) with that of your own in the same format as in the examples.(Note: the example file cd.in may be tentatively used if you have no such data).

Then, you just need to adjust parameters in input.in for the engine and operating conditions you will simulate. These parameters usually include SOI, dui,P0,T0,Pb, Tb, and xegr etc. The wall temperatures(especially the cylinder wall temperature), which need to be estimated by users, are useful in matching the air mass flow rate.

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4. The results of the simulation are output and saved in the files as follows:

a. oput1.dat --- general parameters such as pressure, velocity and temperatures at valves and in the cylinder;
b. oput2.dat --- species densities of all kinds in the cylinder versus crank angles;

c. oput3.dat --- species fractions of all kinds in the cylinder versus crank angles;

d. oput4.dat --- information outlined for KIVA simulation, such as Pivc, Tivc, species densities in the cylinder at IVC. The mass flow rate of the intake air, volumetric efficiency of the intake charge, and residual gas fraction at IVC are also included in this file.

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Appendix:

1. Schematic of the 'branch' used in the input.dat for grid generation

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      _____________________________     ________________________________
                                   !   !
     -----> branch 1        branch !   ! branch        branch 6   ---->
      _______________      ____    !   !    ____      __________________
                     !     !  !    !   !    !  !     !
                     !  2  !  ! 3  !   ! 4  !  !  5  !
                   __!     !__!    !___!    !__!     !__
                  !                                     !
                  !                                     !
                  !                                     !
                  !                                     !
                  !                                     !
                  !   ______________________________    !
                  !  !                              !   !
                  !  !                              !   !
                  !  !                              !   !
                  !  !            piston            !   !
                  !  !                              !   !
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2. Definition of 'sections' used in determining the resistance coefficients of
   ducts

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            _______________
                           -_
                             -_
                               -__________________

   =====>      section 1     2         3   ====>
                                __________________
                             _-
                           _-
            ______________-
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