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Inquiry for supply of Three-dimensional (3D) Computational Fluid Dynamics (CFD) Simulation Software for Engine Combustion

The 3D CFD simulation software for engine combustion modelling should offer detailed solutions for the flow, spray, and combustion processes inside a diesel engine, with movement of intake & exhaust valves (open cycle) & piston, and flow inside the ports. It should also be able to simulate a 'diesel engine sector' (in case of axisymmetric bowl), and a full cylinder (for offset bowl or inclined injector). The software should have advanced models for spray breakup, droplet collision & coalescence, and wall interaction, and for advanced soot modelling with detailed chemistry.

General Features of the software

Operating System:

- The software should be able to run on Windows, Linux & Unix architecture
- It should be able to support network license / floating license

Pre-processor:

- The software should be able to import CAD data in a simple file format which is compatible with all CAD software
- It must have the capability to repair the surface for errors such as holes, non-manifold edges, and intersections.
- The meshing should be completely automatic. As the engine has moving parts, and meshing is very critical & time consuming, the software should be able to handle the meshing without much intervention & time consumption of the user. However the user should have full control over meshing, and the parameters defined from within the pre-processor.
- It should be able to translate boundaries (for e.g. piston, valves) along a measured direction
- In-built examples/ templates for different types of engines
- Ability to define engine parameters such as bore, stroke, connecting rod length etc. directly through the software
- Ability to have time varying and spatially varying boundary conditions, imported in the form of tables

- Initial conditions for species mass fractions should be calculated by the software based on equivalence ratio and EGR%
- All physical models should be fully defined from the pre-processor, and it should have a facility to check the settings for any errors

Solver:

The solver should have all the following capabilities:

- Finite volume solver which should be robust and should work in both steady state and transient cases
- Variable time step algorithm based on CFL number, to get better accuracy (by reducing time step when required) and faster run time (by increasing it when gradients are low)
- Model the valve opening & closing events
- Ability to define fine mesh in desired locations (for e.g. valve curtain, or spray), and the ability to turn it off when not required (i.e. after closure of the valve, or end of spray)
- Automatically refine the mesh during the simulation to capture the high gradients in the flow. This could be during valve opening/closing events, and during combustion when the gradients are very high.
- The solver should have various RANS based Turbulence models, and for advanced turbulence modelling it should also have LES & DES turbulence models.
- Advanced models for spray modelling such as Injector modelling, Particle Size distribution, Spray breakup & Droplet Drag, Collision and coalescence, Droplet wall interaction models, Liquid film models, and Eulerian-Lagrangian Spray Atomization model
- The solver should have an in-built detailed chemistry solver utilizing complex reaction mechanisms for various fuels, and yet have an algorithm to reduce the computational cost
- The detailed chemistry solver should be able to import mechanisms in Chemkin format
- It should also have the following simplified models (G-Equation, ECFM-3Z, Shell ignition, CTC model, & Surface chemistry)
- Ability to model emissions using one of the above models (preferably detailed chemistry) such as NOx, CO, HC, and Soot
- In addition, it should have advanced soot models as follows: Hiroyashu Soot model, Phenomenological Soot models such as Gokul, Dalian and Waseda, and more advanced models to determine the Soot inception, surface reactions, coagulation and condensation.
- It should also give the soot number density & mass, also required is the Soot Particle size distribution.
- The solver should have the ability to do Conjugate Heat Transfer, and solve combustion and solid conduction at the same time. The Conjugate Heat Transfer model should have a method to reduce the computational time for the solid to reach steady state.
- Volume of Fluid (VOF): To model flow in nozzles along with cavitation, this model is required. One should also be able to model VOF-Lagrangian coupling
- Solver should have an in-built optimization tool based on the 'Genetic Algorithm'. This module should be able to optimize based on various input conditions, and also geometry that is defined parametrically (i.e. piston bowl)
- Capable to couple with GT-Suite or other 1-D software for 1D-3D co-simulation
- The solver should provide the ability to have user coding (UDFs) for adding customized capability

Post Processing:

- The Software should output data in simple text files showing various quantities (for e.g. Pressure, Temp, Turbulence, Species etc) during the simulation. This data should be able to be plotted in graphs, and the software should have 2-D plotting capability

- The software should provide a 3D post processor, or be able to export data into various formats to be post processed with third party software

Other applications and advanced features:

- The software should be able to do engine after-treatment (exhaust) modelling (for e.g. SCR systems)
- Ability to model multiple sprays with different fuel properties
- Capable of doing multi-cylinder analyses
- Should be able to model bio-diesel and alternative fuels

Terms & Conditions:

1. The supplier must validate his software by solving one problem comprehensive, as suggested by ERL.
2. The quote should include two weeks in-house training for ERL staff members and students at ERL, IIT Kanpur.
3. Provide "Authorization certificate" from the manufacturer, in case the quotation is submitted by an Indian Agent.
4. Prices should be FOB/ CIF up to Delhi.
5. Validity of quotation should be at least for 90 days.
6. The license should be for Three Years from the date of Installation of hand-over to ERL. Anything missing in the tender document to prove/ validate the software is also the responsibility of the supplier.
7. Training and installation and proving out on an engine setup at ERL, IIT Kanpur is the responsibility of the supplier. Suitable accommodation for the staff and food will be provided by ERL.

Kindly send your best Technical and Commercial offer (Separately for two bid-system) so as to reach us on or before April 20th, 2018 to the following address:

The undersigned reserves the right to accept the offer in part or full or reject completely without assigning any reasons.

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In case of any queries/clarification related to this tender, you may contact Mr. Nikhil Sharma) (+91 9455504117)