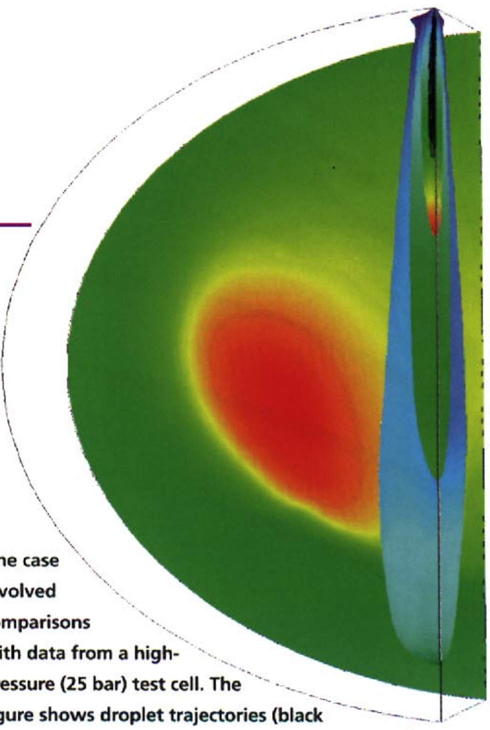
Particulate matter from diesel engines

by **Phil Stopford**, AEA Technology, UK



One case involved comparisons with data from a high-pressure (25 bar) test cell. The figure shows droplet trajectories (black lines spreading down from top right corner), iso-contours of speed colored with fuel vapour fraction and the soot concentration at the back plane 2.5 ms after start of injection. Predicted soot concentrations and soot temperature (~2000K) were in good agreement with experiment

AS LEGISLATIVE controls on diesel engine particulate emissions become more stringent, attention is being focused on the influence of fuel composition. In the light of this trend, AEA Technology has been involved in a European Commission Joule Programme research project to investigate the impact of fuel technology on these emissions.

AEA Technology and its partners carried out a series of measurements for a matrix of test fuels. These ranged from premixed laminar flames and a high-pressure diesel spray experiment to tests on passenger car and light truck engines. The results have formed the basis for the development of detailed models intended to distinguish the physical and chemical effects of fuel composition on combustion, especially the roles of aromatics content and oxygenate additives.

The starting point for the modelling was the existing Lagrangian model in CFX-4, which was enhanced to describe the processes of transient fuel injection and in-cylinder combustion. Key features include transient particle tracking, evaporation of multi-component liquid fuel droplets, droplet agglomeration/break-up and spray-wall interaction. The fuel combustion and soot formation were calculated by linking CFX to a detailed chemical kinetics model especially developed for the project. This accounts for ~800 elementary reactions and models realistic diesel fuel blends and soot growth up to four aromatic rings.

An important finding of the work is that differences in particulate emissions between the test fuels are mainly associated with the physical properties such as density and viscosity, which affect fuel injection rate and timing. The composition of the fuel itself was shown to influence the soot formation process in the laboratory experiments, but had a negligible effect in real engines because of the near-total oxidation of the soot from the flame in the post-flame region. Another outcome was the demonstration of how a detailed fuel combustion chemistry model could be linked to CFX-4 through the use of 'look-up' tables.

Gridgen/CFX grid for a helical intake port

by **Richard Matus**, Pointwise, US

CFD CAN play an important role in the design and optimization of intake ports in internal combustion engines, where it provides detailed flow field information which is difficult to capture experimentally. The CFD results tell the designer not only the extent of mixing, but also the mechanisms behind it and how changes in the geometry affect performance.

This study considered the flow through a helical intake port. The multiblock grid for the problem was created at the University of Wisconsin Engine Research Center using Gridgen, a commercially-available grid generator from Pointwise, Inc. The geometry is imported into Gridgen as IGES data or through one of several proprietary input formats, and the designer then builds the grid on top of this interactively using Gridgen's automatic grid generation tools. The final step of the process is to set the boundary condition locations, after which Gridgen writes a CFX-4 geometry file directly.

The 23-block grid for this study contains 87,862 cells, which is a moderate size suitable for preliminary design studies. Once the design is narrowed down, a finer grid would be used to verify the results. The automatic grid redimensioning tools in Gridgen makes this a simple task.

Gridgen grid for the helical intake port of an internal combustion engine