Session summary: Engine Flows
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Contributors: same

Background:
At ECN1, it was proposed to add experiments in a complete engine geometry to the ECN's activities. The ECN web page already contains data from two optical engines: U. Michigan's two-valve research engine, and Sandia's four-valve hydrogen DI engine. However, the corresponding activities were not represented at ECN1 (neither experiments nor modeling), and in the case of Sandia's engine there is currently no prospect of adding to the data base. Thus, as a first step, an Engine Group was formed at ECN1. Dave Reuss presented the U. Michigan engine to this group at the Nov. 2011 group web meeting.
One of the salient features of ECN target experiments is that they can be performed in multiple locations. In the case of engines, this is difficult to achieve. At both the Nov. 2011 web meeting and the Jan. 2012 ECN 1.1 web conference discussion of the importance of such "multiplicity of location" was a prominent part of the session. Since agreement on a particular engine geometry seems unlikely in the near future, at ECN 1.1 a standardized experiment was proposed. The experiment consists of measuring the velocity field in the central vertical plane of the motored engine using PIV. Detailed specification of the boundary conditions and data acquisition to be used were distributed after ECN 1.1, can be requested from sebastian.kaiser@uni-due.de, and will be posted in the engine group's space on the ECN web site at https://share.sandia.gov//ecnwg/engineflow/. Most of the specs are also on slides 9 and 10 of the ECN2 engine flow presentation.

Session
Sebastian Kaiser summarized past activities and current situation of the ECN's engine group and presented the standardized flow experiment. Three universities had expressed interest in contributing to the flow experiment: U. College of London, TU Darmstadt (TUD), U. Duisburg-Essen (UDE). At the time of ECN2, contributions from the last two were available. Brian Peterson from TU Darmstadt presented the results.
Apart from different engine geometries (bore and stoke very similar, heads are different but both 4V pentroof, CR 8.5 at TUD, 10 at UDE), the experiments differed in intake pressure (0.7 bar at TUD, as specified, but 1.0 bar at UDE).
During the intake stroke, mean velocity fields are similar in pattern between the two engines, with velocity magnitudes higher in the UDE engine. The RMS is also higher at UDE. The general similarity in mean-flow pattern persists throughout the compression stroke, but now velocity magnitudes are higher at TUD, while the RMS continues to be higher at UDE. A physical explanation for the qualitative differences was not found.
In the ensuing discussion, N. Peters remarked that tumble is a bad flow for such a cross-platform comparison, since it is known to be highly unstable, potentially amplifying small differences in boundary conditions. S. Kaiser considered this consistent with the fact that in diesel-engine simulations, where the flow generally is swirling, the simple assumption of solid-body rotation towards the end of compression has had remarkable success.
V. Sick warned of any cross-engine comparison and suggested a major contribution of the ECN's engine activities could be to identify the essential questions in the field.

Another member of the audience reminded that part of the TNF's success lies in having a hierarchy of experiments, which transferred to the ECN's engine group may mean having simpler experiments than those in an actual engine, for example flow below a single intake or a whole head on a flow bench. Several members of the audience commented that such arrangements were too simplistic.

The presenters again invited all interested parties to perform the standardized experiment and thereby contribute to an initial data base. UDE will repeat the experiment at the "correct" intake pressure of 0.7 bar. No communally agreed conclusion on other future steps was reached.

Andreas Dreizler (TU Darmstadt) and Sebastian Kaiser further asked who from the modeling side would be interested in modeling such engine data as what was presented at ECN 2. A fair number of groups expressed interest, but no final commitment was made. Sibendu Som (Argonne Nat'l Lab) expressed that additional information about EGR and temperature would be needed to for modeling (EGR when operating fired).