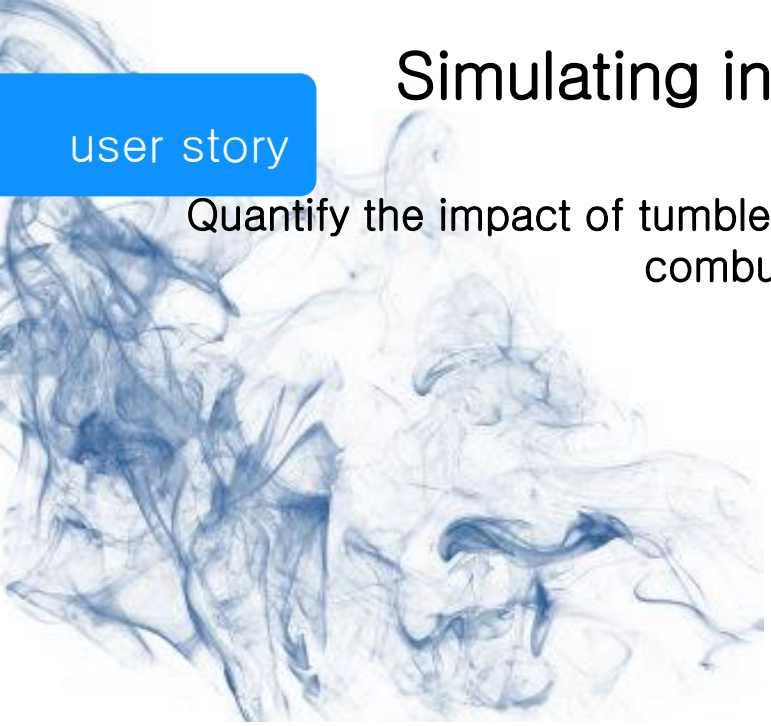
user story

Simulating in-cylinder turbulence & bulk flows

Quantify the impact of tumble, swirl, injection and squish on combustion and emissions formation



A major design consideration for ultra low emission combustion modes for IC engines is in-cylinder flow and turbulence. Critically, it is the interaction of these flows together with localised injection events and reactive flames which influence emission formation and heat release.

THE CHALLENGE

To build an advanced turbulence model with sufficient detail to simulate the most important engine flow field design parameters (swirl, tumble, squish, injection etc.) and integrate these models into the **srm engine suite**. In line with the srm engine suite, computational times were expected to be minimal, simple to use, retain the minimum number of input parameters and achieve predictive capability in line with or better than conventional CFD methods.

SOLUTION

Based on $k-\varepsilon$ turbulence generation and dissipation methods, a set of novel algorithms were developed specifically for IC engine applications. The results were then validated against an extensive 3D CFD database to quantify swirl and tumble rotational energy and its decay down to the turbulent mixing scales. Furthermore other turbulence generation sources must be considered (squish, injection, density changed). An example of the model output is presented in Figure 1.

RESULT

A well validated and highly effective fast response turbulence and bulk flow sub-model. As would be expected, swirl and tumble decayed and dissipated down to turbulence mixing scales. In addition, the impact of injection events also influenced in-cylinder combustion and emissions formation significantly. An example of the model performance with respect to experimental data is presented in Figure 1c.

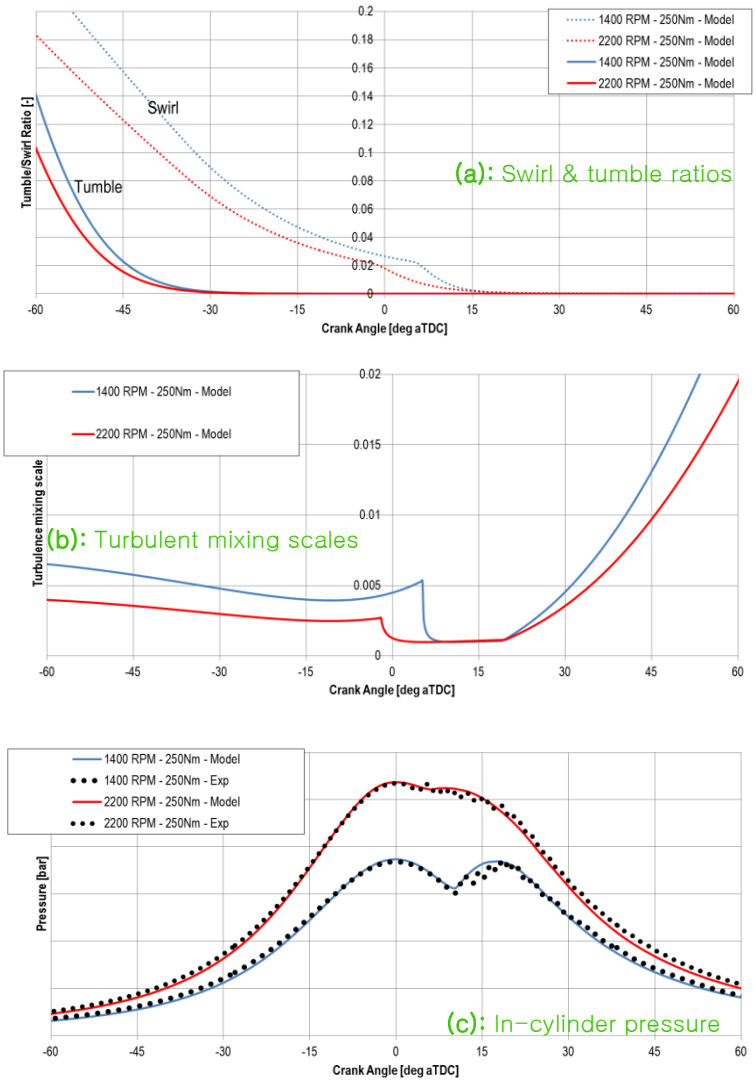


Figure 1: srm engine suite (model) response and comparison with observed experimental data

SUMMARY

- A new fast response turbulence and bulk flow sub-model was developed and implemented into the srm engine suite.
- The model was successfully validated against a database of CFD data and experimentally derived engine combustion and emissions data.

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