CAVITATION SIMULATION AND EXPERIMENTAL VERIFICATION USING A NEW DIESEL NOZZLE DESIGN CONCEPT

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ABSTRACT – The onset and development of cavitation in a new Diesel injector nozzle design is investigated both computationally through use of CFD and experimentally using transparent nozzle replicas. The injector design eliminates the sac volume and isolates the flow path that links adjacent holes. It is proved that this results to elimination of vortex cavitation and profound spray stability. Unlike most existing nozzle designs, geometric cavitation becomes a controlled flow characteristic that can be used to determine fuel atomisation and near-nozzle spray angle. Modelling of cavitation is performed using various sub-models for nucleation and bubble formation, further bubble growth and collapse, as well as bubble break-up and transport are incorporated into the model. Simulations are performed both under fixed and transient needle lift conditions. Mesh generation is performed using a new feature of ANSA called Hexa-Block that allows for hexahedral meshes to be located throughout the computational domain; that is found to increase model accuracy, particularly at cases of low needle lift where distorted cells inevitably decrease numerical accuracy. Model validation is performed against experimental data performed in transparent nozzle replicas operating under steady-state flow conditions. Measurements include, in addition to nozzle discharge coefficient, images of the geometric hole cavitation at various combinations of needle lifts, Reynolds and cavitation number.