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Prediction of Velocity Profile in a Rectangular Shape Nozzle

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Abstract
Flow inside diesel injector nozzle is simulated using finite volume technique. Second order scheme is utilized to discretize the equations in order to obtain pressure in the field. It was found that K-ε turbulent model leads to more realistic results compared to K-ω turbulent model.
Keywords: *Cavitation, Multiphase, Omega, Epsilon, Turbulence*

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I. INTRODUCTION

Diesel engine is considered as a highly efficient combustion engine that plays a significant role in agriculture, transportation and industry in which numerous studies were performed in order to investigate the mentioned phenomena [1-8]. There have also been several studies previously that determined cavitation as an important phenomenon that should be investigated thoroughly [9-13].

II. RESULT AND DISCUSSION

Continuity and balance of momentum can be derived as following for an incompressible flow:

$$\frac{\partial \bar{u}_i}{\partial x_i} = 0 \qquad \text{Equation (1)}$$

$$\frac{\partial \bar{u}_i}{\partial t} + \bar{u}_j \frac{\partial \bar{u}_i}{\partial x_j} = -\frac{1}{\rho}\frac{\partial \bar{P}}{\partial x_i} + \upsilon \frac{\partial^2 \bar{u}_i}{\partial x_j \partial x_j} - \frac{\partial}{\partial x_j} R_{ij} \qquad \text{Equation (2)}$$

Where x_i is the position, $\bar{u}_i$ is the mean velocity, t is the time, υ is the kinematic viscosity, $\bar{P}$is the mean pressure, ρ is the constant mass density, and $R_{ij} = \overline{u'_i u'_j}$ is the Reynolds stress tensor. Here, $u'_i = u_i - \bar{u}_i$ is the fluid fluctuation velocity component.

Moreover, mixture approach is used in order to calculate density in the whole domain which consist of vapor and liquid density.

$$\rho_m = \alpha_l \rho_l + \alpha_v \rho_v \qquad \text{Equation (3)}$$

Where l is refering to liquid and v is referring to vapor.

Furthermore, viscosity of the mixture is also defined as following:

$$\mu_m = \alpha_l \mu_l + \alpha_v \rho_v \qquad \text{Equation (4)}$$

Winklhofer [14] nozzle is modeled and simulated in this study. Only half of the velocity shown here is plotted. It can be inferred from figure 1 that k-ε turbulence model has a better agreement with previous experiment done by Winklhofer comparing to k-ω turbulent model. The reason for the mentioned agreement could be the differences between the law of the wall functions.

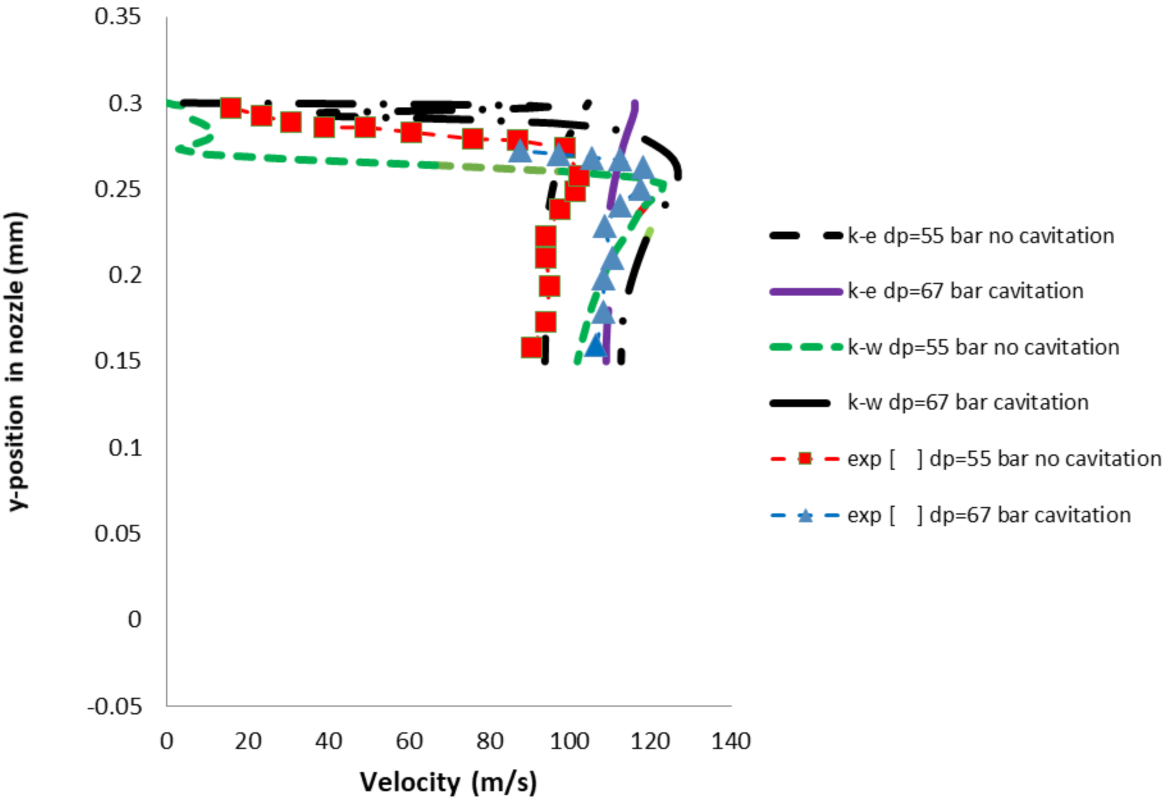

Figure 1. Half velocity profile at the mid Winklhofer orifice.

III. CONCLUSION

In this study, flow inside rectangular shape diesel injector nozzle is simulated using finite volume method. Continuity and momentum equations are solved using coupled scheme and the flow inside diesel injector nozzle is considered as incompressible. It was found that the velocity profile obtained from k-ε scheme has a better agreement with previous experiment done by Winklhofer comparing to k-ω turbulent model.

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