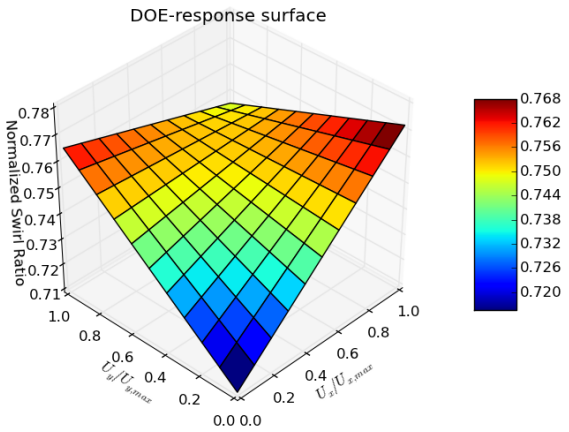


Figure 9.Response surface generated from design of experiments using fractional factorial approach

*Optimization using GA code*

The optimization part is executed through a custom Python script called Genetic Algorithm code. The predicted ANN model is used to find the objective function (normalized swirl ratio The specifications about the algorithm is shown in Table 2. The python script houses the ANN code, whose trained output function is used for evaluating the objective function in the genetic algorithm code. The output from the code evaluation is shown in Fig. 10. The variables start at a random value in the given range and oscillate towards finding the optimum while undergoing the iteration loop in the algorithm to find the maximum normalized swirl ratio. A CFD simulation is carried out to verify the optimal GA.

TABLE 2. GA-CODE SPECIFICATIONS

| | |
|---|---|
| Coding Method | Real |
| Size of population | 52 |
| Crossover method | single point (half width) |
| Probability of cross-over | 0.5 |
| Mutation method | single point |
| Probability of Mutation | 0.05 |
| Selection | Tournament |

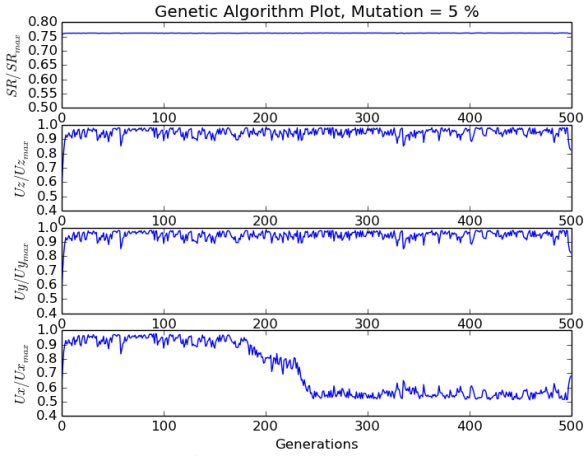


Figure 10. Solution output from optimization using GA python code

The CFD study for the optimized configuration is carried out and normalized swirl ratio is evaluated. It is found that the normalized SR coefficient values are found to be 0.745 and 0.76from ANN and CFD codes. This is observed in Fig. 11 with an improved velocity field from the case (g). The flow components are changed but the mass flow rate is maintained constant, yielding an improved SR.

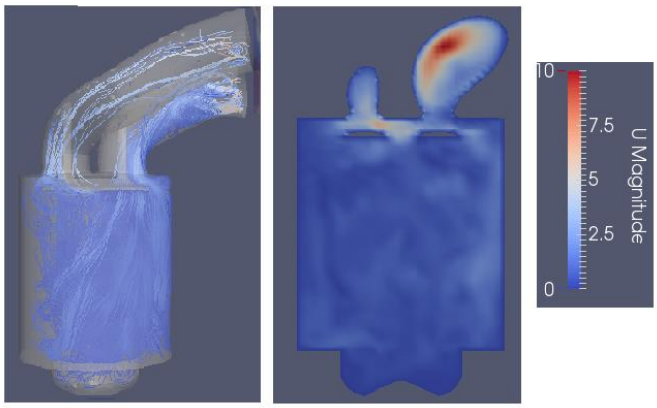


Figure 11. Stream lines and velocity magnitude in the cylinder for optimized flow components

*D. Conclusions*

A quick procedure for optimization of an intake physical flow process with respect to swirl ratio has been developed and investigated. The optimization method employs the genetic algorithm coupled with DOE and ANN responses from respective studies. The swirl ratio increases effectively by using the coupled CFD-ANN-GA optimization codes. The normalized swirl ratio is found to increase from 0.64 to 0.76. This results in the change in flow field, towards increasing the tendency of swirl ratio. The future work includes the quality and size of the database of GA, DoE and ANN.

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