Numerical study of homogeneous cylinder-to-cylinder distribution of EGR/blowby to intake manifold

P. B. SHAHABI
Ph. D. student of Mech. Engineering, Ferdowsi University of Mashhad
Faculty of Engineering, P.O. Box 91775-1111, Mashhad, Iran

M. R. MODARRES RAZAVI
Professor of Mech. Engineering, Ferdowsi University of Mashhad
Faculty of Engineering, P.O. Box 91775-1111, Mashhad, Iran

H. NIAZMAND
Associate professor of Mech. Engineering, Ferdowsi University of Mashhad
Faculty of Engineering, P.O. Box 91775-1111, Mashhad, Iran

SUMMERY

Exhaust Gas Recirculation (EGR) method has already shown its benefits on controlling NO_x emissions in internal combustion engines. By using EGR, power reduction and increase of other pollutants may be appeared; therefore use of this method needs an accurate regulation system limiting EGR cylinder-to-cylinder maldistribution. On the other hand, emission law limitations make engine manufacturers to recycle back blowby gases into the cylinders. As the same reasons, mentioned above, homogeneous distribution of blowby gases show better performance and more emission reduction. Geometrical parameters and injection location of EGR/blowby have substantial effects on homogenous cylinder-to-cylinder distribution of EGR/blowby. Therefore a numerical simulation of air flow with another species gas (for example CO_2 injection inside intake manifold as EGR/blowby) is needed to evaluate the maldistribution quantitatively. In this study, the flow field of compressible and unsteady turbulent flow is solved for different injection locations to compare EGR/blowby maldistribution of each location. Although this method is practicable, it is time consuming because of various injection locations and long solution duration. Furthermore a new method based on particle tracking is proposed which decreases the time and effort needed to find appropriate injection locations.

1. Introduction

Exhaust gas recirculation (EGR) and lean burn utilize the diluents into the engine cylinder to control combustion leading to enhanced fuel economy and reduced emissions such as NO_x of internal combustion engines [1-3]. However such benefits can be only observed with an accurate regulation system limiting EGR cylinder-to-cylinder maldistribution, otherwise a risk of opposite effect (no NO_x reduction) may result and considerable fall in power and higher increase of other pollutants may appears [4-5].

In this study it is tried to distinguish the best location of EGR/blowby for the least maldistribution, with the aid of numerical simulation of air in the intake manifold and particle tracking.

2. Geometrical model and method

In this study numerical simulation is done for turbo charged EF7 intake manifold engine. Manifold structure is shown in figure 1 which consists of a plenum and four runners. For comparison and analysis of different EGR/blowby injection points, 39 locations are considered as shown in figure 2. With the aid of particle tracking method, evaluation of cylinder-to-cylinder EGR/blowby distribution for the entire injection locations and their combinations can be done with just one solution of flow field.

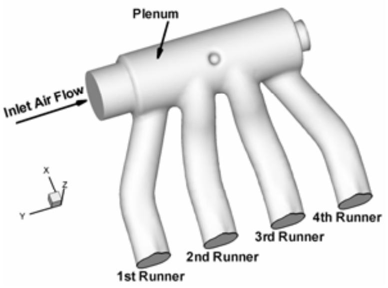

Fig. 1 Structure of EF7 intake manifold

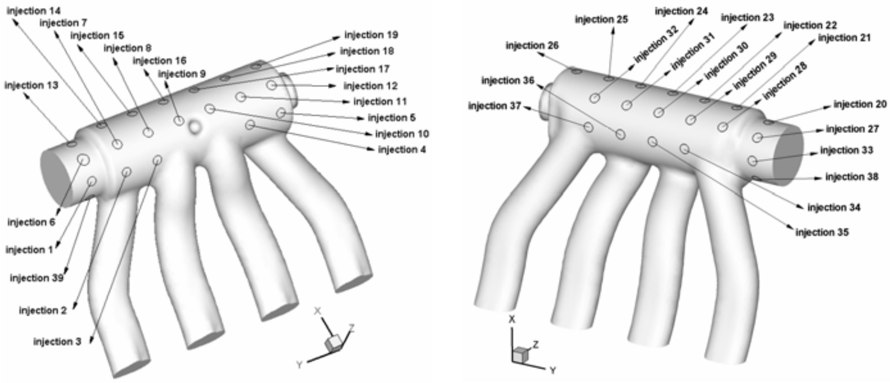

Fig. 2 EGR/blowby injection locations on EF7 intake manifold (39 cases)

3. Results and discussions

3.1. EGR/blowby Evaluation of single injection point by Particle tracking method

EGR/Blowby distribution in four runners was studied for each location. It is revealed that single injection point for EGR/blowby can not prepare perfect homogeneous distribution in four runners. Among 39 cases the injection point 34 is the best injection point, which causes the least maldistribution.

3.2. EGR/blowby Evaluation of double injection points by Particle tracking method

The effect of double injection point is examined by particle tracking method. Because of multiplicity of cases for considering the double injection points just cases with maximum difference of 1000 escaped particles between runners are stated here. In all of these cases the injection point 39 is included as one of the two injection points. The best case is the combination of injection points of 13 and 39 with maximum escaped particles difference of 449.

4. References

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