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Virtual Analysis on Mufflers and Noise Level Correlation

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ABSTRACT

A muffler being the major element of the exhaust system, importance of its acoustic performance is essential. Back pressure and insertion losses are the components that define the muffler performance. This work aims at looking for reactive mufflers and comparing them with a combination muffler design without taking absorptive part in to consideration. The three dimensional modelling of muffler bodies was done in ANSYS R15.0 and solution was carried out using FLUENT. The pressure variation of contrasting mufflers was compared on bases of back pressure criteria. For an ordinary reactive muffler back pressure was seen to be affecting the outgoing gases. For comparative model with perforation and various chambers the back pressure was seen to be decreasing asserting the assumption of being superior

Keywords : Muffler, Fluent, Pressure Drop

I. INTRODUCTION

Automobiles is everywhere, a day without the use of automobiles is unthinkable. There is luxurious ones, sporty editions, to convenient home usage ones. We are very much fascinated about each and every one of them but noise produced by them is un-tolerable. The pollution by them are increasing as each day is passing by. Exhaust system of an automobile do the work of taking exhaust from engine manifold and final transfer to atmosphere. In such a system muffler plays a key part in muffling th noise coming to its end. Muffler or silencer as it fondly called comes in various shape and sizes.

A muffler can be reactive or absorptive. The reactive muffler uses constructive and destructive interference of on-going waves to produce muffling action with providing various geometry criteria. There can be chamber design or they can be perforation design all tend to reduce noise coming out at end. The absorptive muffler provides material absorption phenomena to reduce pressure thus reducing the sound coming out. Aerogel is such emerging material which tend to increase such effect with minimized area. An automobile with out usage of muffler is actally illegal if sound pressure level increase dangerously beyond 90 db.

Here study is carried out by performing analysis for importance of perforation and chambers for muffler design.

II. METHODS AND ANALYSIS

On basis of data regarding a 6hp diesel engine the model of muffler was created fig 1. The calculation of diesel engine shows that a velocity of 7 m/s was acting on inlet section of the muffler thus for comparison of various model a inlet velocity boundary condition was chosen with zero gauge pressure. The second model which is a complex multi-chamber model fig 2 with multi baffle positions was chosen next. The final model was a simple reactive muffler of single chamber design which can be considered as the benchmark.

A. *Models, Schemes, Solver for FEA*

The geometry of muffler was created using ANSYS workbench. The complexity of model forced the issue of making the model in 3 dimension rather than in 2 dimension symmetry.

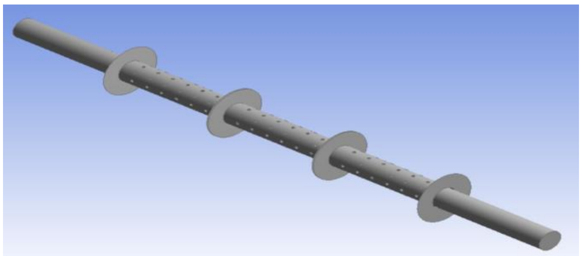

Figure 1: Design A having x number of holes.

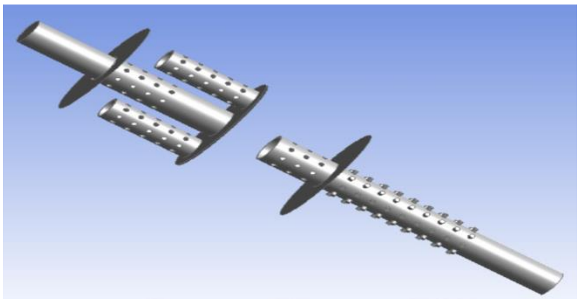

Figure 2: Design B with circumferential baffle positing.

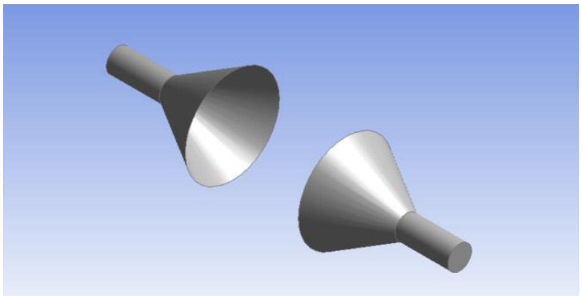

Figure 3: Design C of simple nature.

Each model in own terms was difficult in terms of no of elements and no of nodes present in it. Deign 1 an design 2 had 2092377 and 1026873 elements respectively. Where design 3 had due to simple nature had 301579 elements. Due to such enormous array of elements after meshing the design 1 and design 2 had taken mush time for satisfiable convergence. As the flow was in-compressible in nature pressure based solver was selected to keep pressure field from oscillating and with transient flow operation.

A standard k-e epsilon wall function was selected due to swirls which will happen inside perforations. To generalize the flow air was chosen with outlet boundary condition as outflow due to unknown nature of outside condition.

III. RESULTS AND DISCUSSION

After giving time for solver to converge it converged and results was obtained. Each results obtained in stream line profile and fluent graph profile is as follows

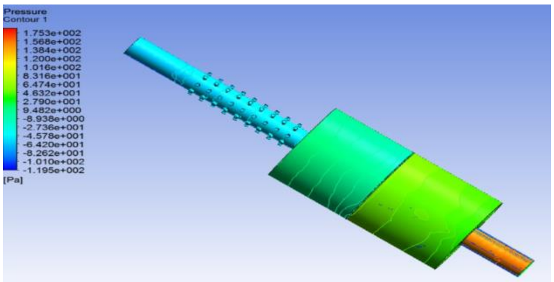

Figure 4: Pressure contour for design B

Pressure contour of the design 1 shows the pressure variation which occur in the model from inlet to outlet,this shows the verification of pressure drop which occur from inlet.

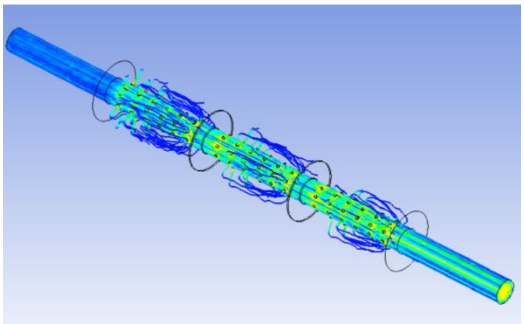

Figure 5: Stream line for design A

The stream line profile with 1000 lines shows that maximum velocity was seen to be occurring at perforations provided. Similar case was seen for design 2 as well.

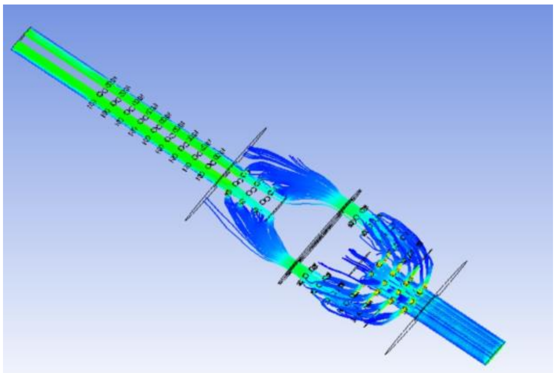

Figure 6: Stream line for design B

Design 3 all so shows the indication of pressure getting reduced from inlet to outlet.

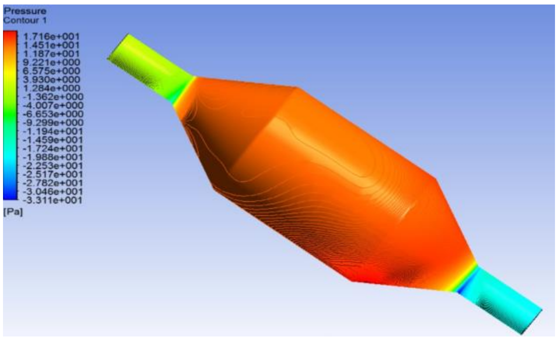

Figure 7: Pressure contour for design C

As indicated in all designs the pressure was seen to be decreasing from inlet to outlet not in a linear fashion but definitely. The maximum pressure was at middle stages in design 3 due to better expansion provide on the design where the maximum pressure was in seen on other design on the inlet where gaseous are in-coming. For better understanding of the pressure drop the figure 4 to 6 shows the variation of the pressure with ongoing distance.

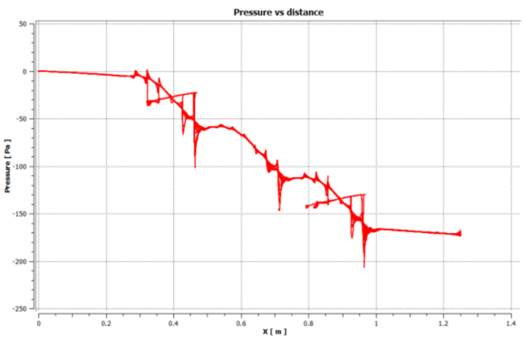

Figure 8: Pressure variation for design A

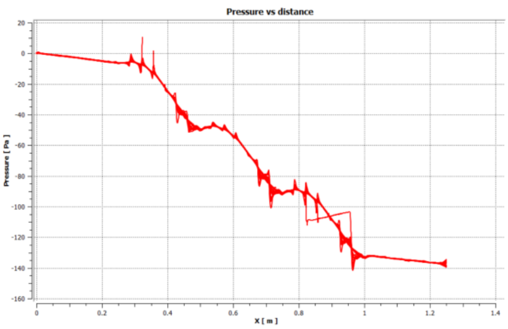

Figure 9: Pressure variation for design B

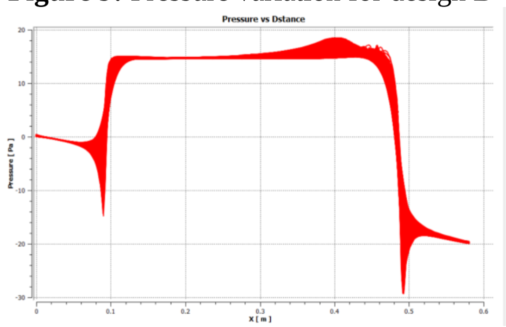

Figure 10: Pressure variation for design C

Figure x shows the variation of pressure for the design 1,as indicated pressure is reducing to a lower at outlet. The variation of pressure for design 3 is very much less than all other designs. Even though design 3 have pressure reduction the value of the reduction is not much as compared to design 2 where reduction is decreasing in a more constant manner. Design 3 as seen is having a increasing decreasing variation indicating higher expansion occurring.

Model	Pressure drop (kpa)
Design 1	0.17
Design 2	0.14
Design 3	0.02

Table 1: Pressure drop all designs.

The result of three models show that maximum pressure reduction is achieved in the model 1 having perforation around face centre of baffles having 3 chambers. The pressure drop in model 2 and model 3 is having pressure drop but the value is having difference from 0.17 kpa with least value occurring in the design of number of perforation and single chamber. So it is a direct indication that perforation is a major part of muffler design and increasing perforation will increase the pressure drop from input to output. As design 1 have perforation provided more so in face centre making it different from design 2 having perforation baffle at circumference of the chamber wall. Which stands out the case that baffle positing is a key element when` high value of pressure drop is to be achieved. Increasing the chambers is also reducing the pressure at outlet further reducing the resistance against exhaust flow so better sounding muffler with more effective pressure reduction. The design having more pressure drop was seen to be model 1 on all such consideration will provide best muffling.

IV. CONCLUSION

Carrying out Fluent analysis of three different muffler designs for looking out pressure drop for better sounding muffler it is seen that muffler design effectiveness is very particular for perforation numbers and perforation baffle positing. Increased perforation and chambers is in-definitely reducing the pressure seen at outlet of a muffler with reduced pressure at end decreasing the level of resistance helping smooth flow of exhaust.

V. REFERENCES

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