INVESTIGATION OF SNOW ACCUMULATION IN AIR INDUCTION SYSTEM

M.Saravanan, V. Vigneshwaran, R. Ashok Kumar, S.Joe Mueth Deepak, V.Raveendran

Department of Mechanical Engineering
SMK Fomra Institute of Technology, Chennai-603 103

Abstract - In air induction system how much snow particles enter in to the engine, so how we can rectify the snow particles enter into the engine. In this case various size diameter of snow particles passes through the engine. In this case the snow particles go to engine there is lot of problems may happen in the engine side as like mechanically and chemically. So I am study how the snow particles accumulate in the air intake system, in this cases air intake have some dust particles in that way only we need to check the how much snow particles going inside the engine.

1. INTRODUCTION

The early history of the automobile can be divided into a number of eras, based on the prevalent means of propulsion. Later periods were defined by trends in exterior styling, size, and utility preferences. In 1769 the first steam-powered automobile capable of human transportation was built by Nicolas-Joseph Cugnot.

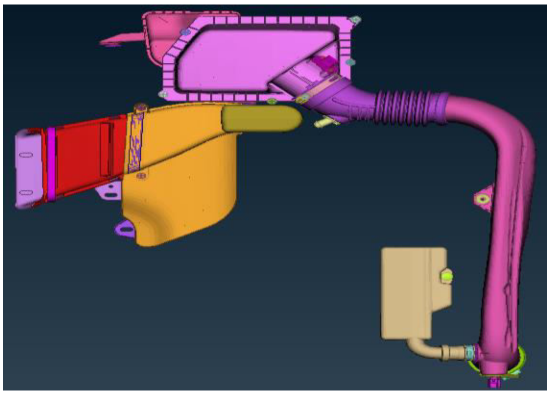
In 1808, Francois Isaac de Rivaz designed the first car powered by the de Rivaz enginean internal combustion engine that was fueled by hydrogen. In 1870 Siegfried Marcus built the first gasoline powered combustion engine, which he placed on a pushcart, building four progressively more sophisticated combustion-engine cars over a 10-to-15-year span that influenced later cars. Marcus created the two-cycle combustion engine. The car's second incarnation in 1880 introduced a four-cycle, gasoline-powered engine, an ingenious carburetor design and magneto ignition. He created an additional two models further refining his design with steering, a clutch and a brake.

The four-stroke petrol (gasoline) internal combustion engine that still constitutes the most prevalent form of modern automotive propulsion was patented by Nikolaus Otto. The similar four-stroke diesel engine was invented by Rudolf Diesel. The hydrogen fuel cell, one of the technologies hailed as a replacement for gasoline as an energy source for cars, was discovered in principle by Christian Friedrich

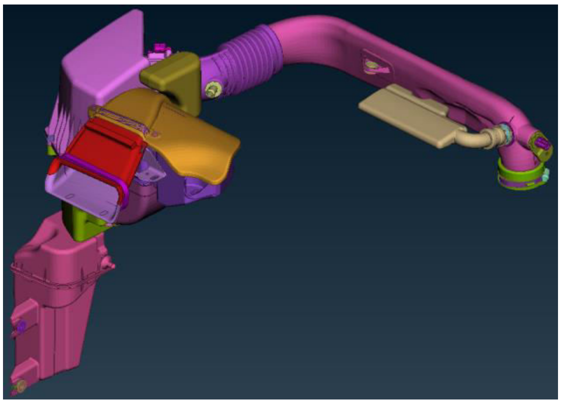
Schonbein in 1838. The battery electric car owes its beginnings to Anyos Jedlik one of the inventors of the electric motor, and Gaston Plante, who invented the lead–acid battery in 1859. In 1885, Karl Benz developed a petrol or gasoline powered automobile. This is also considered to be the first "production" vehicle as Benz made several other identical copies. The automobile was powered by a single cylinder four-stroke engine.shown in theFig.2.1.

The behavior of turbulent flows are more difficult predict than laminar flows since the presence of turbulence will make the flow unsteady. A mathematical approach in CFD to handle turbulent flow is to introduce two-equation turbulence models where two more transport equations are modelled and solved together with the continuity and momentum equations. The choice of right turbulence model is crucial since some of the models are very CPU and time demanding. One of the most common turbulence models is the k-ε modeland is described in the nextsection.

2. GEOMETRY CONFIGURATIONS



Front view



ISO view

FIGURE 2.1: AIS with Different Positions

The geometry considered was of a short range, AIS with clean side box and dirty side box Figure 2.1 shows that an underlying attachment is present with the clean side and dirty side duct also placed in this model.

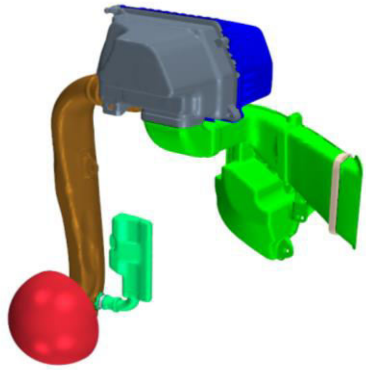


Figure 2.2: AIS Geometry

Theinletandintake sectionislocatedinthebottomleftinthefigurefromwhichtheairisguidedintothefilter box section.Theairisthenledthroughthefilter, located in the black box but is not visible, to the inlet to the main engine.Notethatthemostoftheinletpartiscoveredunderthegreyplastic engineshell.Asecondintake,butnotvisibleinthefigure,ispresentintheAISandislocated at the other end of the filter box section to where dirty air enter. It is used as an alternative intake if the primary intake will be filled with too much snow or dirt and is unable to guide theairtotheengine.Duetotheprimaryandsecondaryintakethefilter boxsectionisdivided by a thin wall into two smallersections.

A model of the air intake system is shown in Fig.2.2 above and there we can see how the air intake system is constructed in detail. The inlet of the intake section is covered by a plastic shield which protects from snow and heavier dust particles, but air is able to enter from the rightandleftoftheprotectiveshield,asindicatedbythearrows.Onecanobserveasectionof ribs along the intake duct and these are assembly ribs which are for the intake system to be properly installed under the bonnet. The ribs are removed in this project in order to have a smoothgeometry,sincereportsofithavingtroublewithsharp edges. This section is also removed but the entrancetothefilter boxsectionisletopenfortheairtoflowinto.

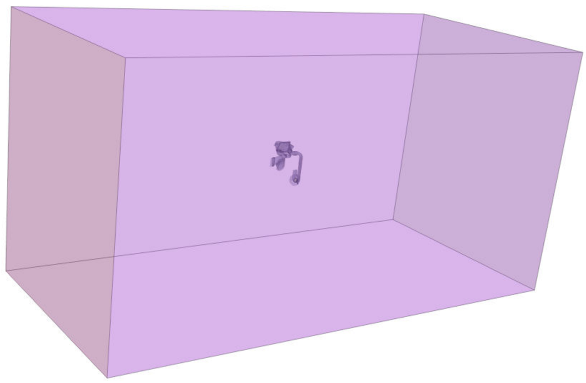


Figure 2.3 AIS with Domain

The intake system is also equipped with a drainpipe, with the hose mounted at the ground walls of the intake duct directly after the assembly ribs. It is functioned to lead the incoming water downwards and out of the system before it enters the filter box. A photograph of the intakesectionwithdrainpipeandfilter boxsection.Thelengthofthedrain hose in this picture is a prolonged modification of its original version and has been tested in thewindtunneltoseeifalongerhosewillimprovethedrainagesystem.

3. CASE SETUP AND BOUNDARY CONDITIONS

3.1 IN OUR CASE SETUP IS TWO DIFFERENT RUN CONDITIONS:

- Steady
- Implicit unsteady

TABLE 3.1 STEADY STATE CASE SETUP

Boundary condition	Boundary	Value
Velocity inlet	Tunnel Inlet	15 MPh
Stagnation inlet	Tunnel Side, Bottom & exit	
Wall	AIS	
Turbulence	K-Epsilon turbulence	

TABLE 3.2 IMPLICIT UNSTEADY

Lagrangian phase	Snow	Density – 111.7 Kg/m3
Snow Particle Diameter	Injectors	0.65, 2, 4.5 mm
Injectors	Surface injector – Tunnel Inlet	Particle flow rate (100000/s)
Time stepping		0.1 s

Step1:

A flow field (Velocity/pressure) was generated by using only steady state condition without Lagrangian particles.

Step2:

Solver is changes to Implicit unsteady with 0.001 s time stepping to implement Lagrangian flow tracking.

Step 3:

Turbulence and flow field are frozen. Implicit time stepping is carried out to visualize the snow particles flow through AIS.

Step 4:

Particle count measurement

- Inlet – 100000/s (15 sec = Total particles 1500000)
- Outlet – Incident mass flow rate
- Calculations
- 1 particle mass of snow
- Incident mass flux * time
- (Incident mass flux*time)/1 particle mass = number of particles (outlet)

Calculations:

Outlet – 1.178 e-4 g/s

Time = 0.1*150 = 15 sec

Outlet = 1.178e-4 * 1.5 = 1.767e-4 g

Inlet = 100000 * 1.5 = 1500000 particles

1 particle = 111.7 kg/m3 * (4/3)*3.14*(0.65e-3)^3 = 1.284e-4 g

4. POST PROCESSING AND RESULTS

4.1 POST-PROCESSING

- Contours
- Stream Lines
- Vectors

4.2 POST-PROCESSING TOOL

- STARCCM+ 1306

4.3 RESULTS

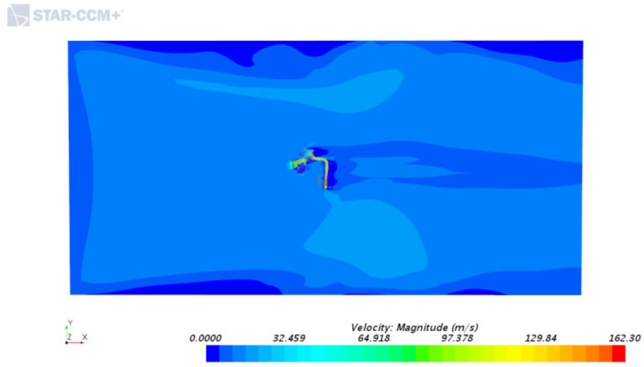


Figure 4.1: Flow Field Domain with AIS

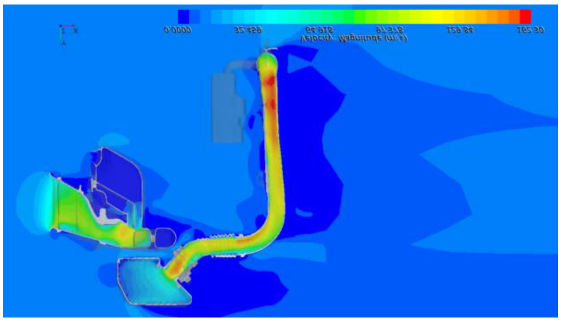


Figure 4.2: Flow Field of AIS

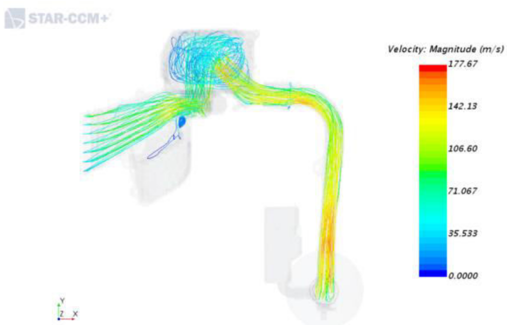


Figure 4.3: Stream Line Passes Through Inside the Air Intake System

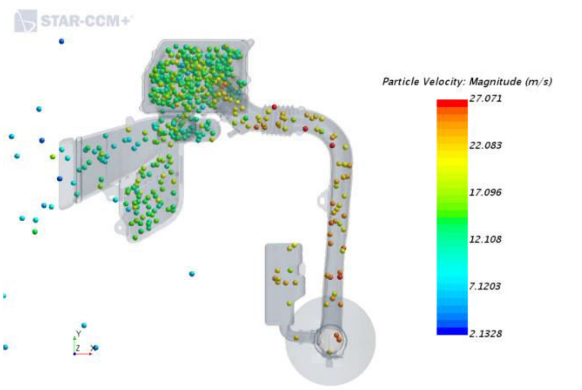


Figure 4.4: Particle Velocity of 0.65 MM DIA

Figure 4.7: Particle Velocity of 2MM DIA

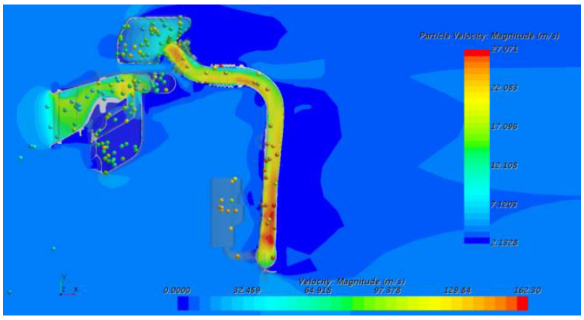


Figure 4.5 Flow Field And Particle Velocity Of 0.65 MM DIA

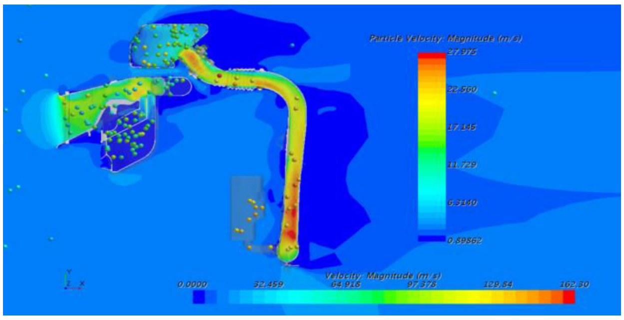


Figure 4.8: Flow Field and Particle Velocity of 2 MM Dia

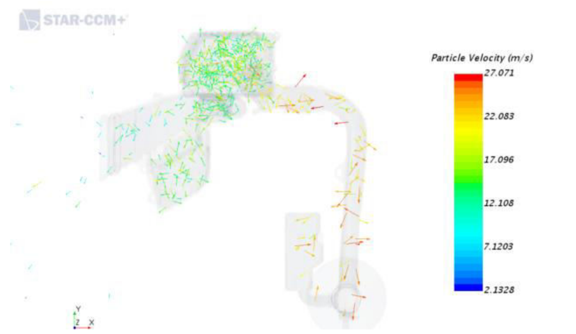


Figure 4.6: Velocity Vectors of 0.65MM DIA

Figure 4.9: Velocity Vectors of 2 MM Dia

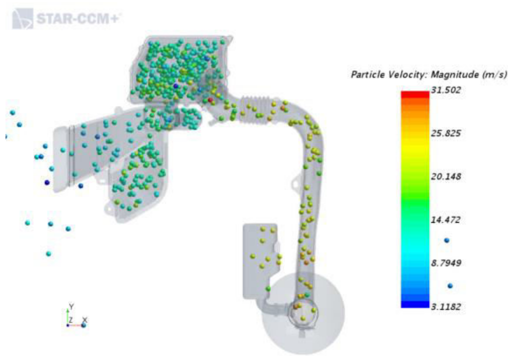


Figure 4.10: Particle Velocity of 4.5 MM DIA

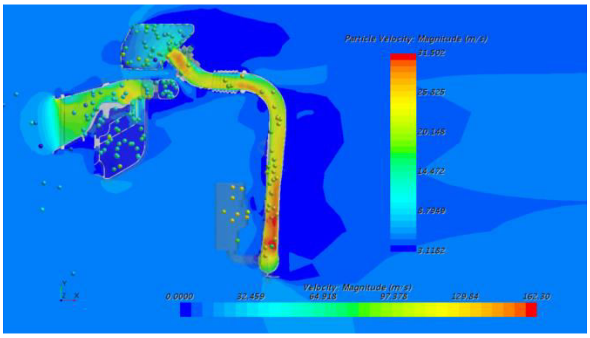


Figure 4.11: Flow Field and Particle Velocity of 4.5 MM DIA

Figure 4.12: Velocity Vectors of 4.5 MM DIA

CONCLUSION

We modeled the AIS system in this simulation process work in this thesis shows that there is an uncertainty in the prediction snow amountthat will be sucked into the system. To investigate if the snow flows in the system will be increased, the snow particles how much entered into the air intake system. We got how much particles exit to the outlet and how it works the air intake system.For better comparison of how many particles enter into the AIS is total amount of particles enter into the domain is 0.95% of particles enter into the air intake system goes through inlet to outlet of AIS.

REFERENCES

1. Integration of tracing with computational fluid dynamics for industrial process investigation.https://www.iaea.org/publications/7090/integration-of-tracing-with-computational-fluid-dynamics-for-industrial-process-investigation-final-report-of-a-coordinated-research-project-2001-2003.

2. Modeling Lagrangian Accumulation Rates onto a Moving

Vehiclehttps://diswlogin.siemens.com.

3. CFD modeling of water ingestion in air intake systemhttp://www.diva-portal.org/smash/get/diva2:1019567/FULLTEXT01.pdf

4. CFD Modeling of Snow Contamination on cars. https://www.chalmers.se/en/departments/chem/Education/Documents/IMplementation%20of%20a%20snow%20adhesion%20model%20for%20CFD%20stimulations%20of%20vehicle%20contamination.pdf