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Simulation and Modeling of Hybrid Fuel Storage System using Compressed Air Energy Storage

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Abstract: In the present work, Hybrid fuel storage system of compressed air is an extensive technology that provides long duration energy storage. It is encouraged in balancing the large scale penetration of intermittent and dispersed sources of power. Such as wind and solar power into electric grids .The existing Compressed air energy storage (CAES) plants utilize natural gas as fuel. In this project we are replacing the natural gas with the composition of air (15 bar), copper oxide (5-20%), and water (50%). validated with the results obtained using Computational Fluid Dynamics (CFD) analysis. Modeling of energy storage tank is done in Computer Aided Three Dimensional Interactive Application (CATIA) software, mesh has been created using ANSYS workbench software and Analysis is done in Fluent Software. The composition is sent from the inlet of the energy storage tank and temperatures are varied like 298k, 373k, 423k, and 473k. Velocities are also varied like 15m/s, 25m/s, 35m/s, 45m/s. This hybrid fuel storage deals with phase change material by using water and copper by heating at different temperatures to get the energy and re-utilized. This device is applicable for renewable energy application to avoid the heat losses new technique of energy saving in suitable forms. This has the lead to the emergence of fuel storage as a management of energy and allowing it to various levels of energy storage. In many parts of the world this storage of energy plays an important role and a new technique of energy saving in suitable forms. This has the lead to the emergence of fuel storage as a management of energy and allowing it to various levels of energy storage.
Keywords: ANSYS, CATIA, CFD Analysis, Storage System, Energy Storage.

I. INTRODUCTION

Composing overview is the most basic progress in programming change process. Before working up the mechanical assembly it is critical to choose the time consider economy association quality. One of these things is satisfied. The ten after stages are choosing the working system and to develop the instrument. This can be considered by working up the proposed structure. In surface of the divider inside the gap facing the fragmented opening is isothermal [1]. Persevering state warm trade by laminar basic convection in two dimensional deficient open dependencies is considered by power and imperativeness and temperature. Dependent upon this the trading of imperativeness can be restricted or extended by picking the mechanical gathering position, temperature etc. The air at a trademark temperature streams warm from the adiabatic valves going up against the fragmentary opening it was inclined at 00. Here the hole is facing upwards to1200 and facing 300 sliding. The numerical system in light of standard of a numerical instrument in perspective of the atom spread work is used to quicken warm fluid stream issue [2]. An outstanding restricted appear differently in relation to third demand precision in space is joined with the twofold masses with warm cross segment Boltzmann exhibit is fine to be a profitable estimations. The Double Distribution Function (DDF) warm Laser Beam Machining (LBM) is joined with restricted difference framework. The constrained qualification system is associated is associated with settle the move in climate conditions term in the speaking to states of Double Distribution Function (DDF) warm Laser Beam Machining (LBM). This mix contributes in empowering us to construct the exactness in both time and space. Remembering the ultimate objective to affirm the proposed appear, a trademark convection of air, rectangular fenced in region with constrained warming from underneath and symmetrical cooling from sides is seen as the customary convection in square despondency with kept warming and cooling has been mulled over. Here air, water and copper oxide pieces are incorporated and this is the subject examinations advancing exploration. In energize future degree aluminum oxide and titanium oxide can be used as a piece of place of copper oxide and attempted and furthermore results can be characterized. We have similarly viewed as different sorts of essentials accumulating in light of electrical [3].we have furthermore mulled over the characteristics and examination of imperativeness amassing based cost, believable, upgrade and particular and money related purposes of enthusiasm of essentials storing [3]. Mass and volume densities of essentials can moreover be considered here.

Hydrogen imperativeness amassing , flywheel essentials accumulating , warm imperativeness storing is furthermore considered and also contemplates are done on it and depending upon that we break down by taking our trial regards for having a change in field of creamer fuel essentials accumulating structures [4]. Money related exhibiting of compacted air imperativeness storing are examined and along these lines it is considered for the change and cost utilize frameworks and besides to research the field [5]. The execution of cross breed fuel storing system is thought about in light of its appraisal criteria, imperativeness rate, general capability, profitability of electrical accumulating and reenactment of the structure and further [5]. Essential parameters of CAES plant are pondering in the midst of wander examination. The issue of free convection and warmth trade of a fluid inside a square dejection having adiabatic obstacle arranged in the point of convergence of the gap has been considered [6]. The fuel cost of the crossbreed fuel CAES fuses Natural Gas (NG) cost and Coal cost. The Natural Gas (NG) cost changes from place to put because of various gas sources and pipeline transportation conditions, for normal areas organized at the Three North district, for example, Gansu, Hebei, Shandong, and Harbin, their NG cost is about \$0.30/Nm3 – \$0.46/Nm3 [7]. A comprehensive temperature bolster was started by developing groupings of Carbon dioxide (CO2) and other nursery gasses Greenhouse Gas (GHG) observable all around [8, 9].China has transformed into the greatest yearly carbon maker [10]. Wind essentials and other clean developments are colossal supporters of pivot this troublesome situation [11-12]. The best strategy to keep up money related advancement and meanwhile reduce the usage of non-sustainable power hot spot for environmental security is an overall test. Distinctive undertakings are being made, for the most part in two points of view to lessen the imperativeness usage by improving essentials profitability and to research spotless and sensible maintainable power sources [12]. Essentials and energy examination of scaled down scale stuffed air imperativeness accumulating and air cycle warming and cooling structure so in that way conduction and convection is thought about and advance degree is considered in light of this [11]; Establishment of practical power source organization Center Rotary Electric-Mechanical Converter (REMC) [12].

II. RESULTS AND DISCUSSIONS

A. *Results*

1) Grid independence studies analysis is carried out for fuel storage system for three different cases.
2) Four different cases were tested for different velocities and temperature investigation. Boundary conditions taken from journal paper inlet velocities & temperatures Turbulence model: K-epsilon, working fluid: water, copper oxide.
3) CASE-I
4) Inlet velocity = 15m/s
5) Temperature = 298k

B. *Discussions*

1) This fuel storage system plays a major role in storing the energy efficiently.
2) It is one of the promising and helpful in utilization of power.
3) It is one of the major part in renewable resources of energy.
4) It plays a major role in saving and wastage of energy and this waste energy can be recycled very easily.
5) This system can be used in automobiles and large scale industries of refrigeration and effective use in the energy storage batteries.
6) As it is important to conclude by using fluent software, we have done the simulation by varying velocity and temperatures to get best results for the output.

We have noticed that by increasing velocity and temperature values at inlet and the output also increases gradually.

III. CONCLUSIONS

A. Flow simulation can be done for different gases like aluminum tri-oxide and titanium oxide at different temperature conditions
B. FEA can be done for different energy storage system for thermal stress and can be discovered efficient & economic energy storage system.

IV. METHODS

A hydro pneumatic tank is a tank containing pressurized water and air in it. It furthermore contains rough particles of Copper oxide. It isn't having bladder and air is clearly in contact with water. Here the compacted air is going about as a cushion apply or holding weight. In this two compressors are used. I.e. low weight and high weight .Two inter-coolers are used i.e. high temp water pump and cold water pump.

Hydro pneumatic tanks work best with an air pad of ¼ to ½ quite far. This pad diminishes as water ingests air and the tank loses its capacity to pressurize the structure. To shield that from happening, there must be a changed approach to manage empowers the air volume. Various stages involved in the energy storage analysis.

A. Hybrid Fuel Storage

This cross breed fuel storing oversees arrange change material by using water and copper by heating at different temperatures to get the imperativeness and re-utilized. In demonstrate imperativeness accumulating is a basic piece of regular daily existence is to save the fuel and essentials and to make the power in various compound organizations and mines. This equipment basically is in tremendous demand to protect the fuel and relentless nature of imperativeness structure in observing of essentials and making the system more demand by lessening the wastage of essentials and capital cost. This contraption is apropos for reasonable influence source application to avoid the glow incidents. This system gives increase in viability of essentials usage and it endless supply of saving the imperativeness with no inconvenience and it is hauled in by taking out various natural issues. In many parts of the world this amassing of imperativeness puts an essential part and another technique of essentials saving in proper structures. This has the provoke the ascent of fuel storing as an organization of essentials and empowering it to various levels of imperativeness accumulating. This will open up another field of use especially due to the advancement and utilization of vitality and essentials.

B. Goals

Essentials amassing structure is more basic for economical power source. The guideline focus of cream fuel amassing course of action of stuffed air essentials using stage change material is one of the promising systems for imperativeness accumulating. When in doubt charging and discharging of high weight or unstable state shapes where the weight extents are charging the extension in the volume and to keep up cost and weight of compacted air essentials system. In this the jobs of exceptional air compressor even to pass on the imperativeness viably and the change of limit structure. In this assignment we are supplanting the combustible gas with the course of action of air (15 bars), copper oxide (5-20%), and water (half). The course of action is sent from the bay of the essentials storing tank and temperatures are changed like 298k, 373k, 423k, and 473k. Paces are also varied like 15m/s, 25m/s, 35m/s, 45m/s.

V. MODELING AND DESIGN OF ENERGY STORAGE SYSTEM

A. Design of Tank

To design a tank firstly a model is created using CATIA software. Followed up with meshing the model created in CATIA. The detailed step by step procedure of analysis in CFD is explained by the below mentioned flowchart.

Create the Model in CATIA

↓

Mesh the model drawn by selecting suitable mesh type and determine all the required parameters in Ansys Workbench

↓

Save the completed mesh model and export into ".msh" file to be read in FLUENT.

↓

Open the ".msh" file in FLUENT and set up all the required input parameters and boundary condition for the simulation.

↓

Initialize the flow in the Solve command and run iteration in FLUENT until it converges and flattens.

↓

View the results of the simulation by Display command where the flow characteristics and other parameters can be analyzed.

B. *Producing a Specification*

The particular of an issue is essential in detail so as the experts can get a thought how to tackle an issue in CFD.
This should be possible when the experts are great in considering three things:

1) The demonstrating of the geometry.
2) Easy path in planning the model.
3) The reenactment is required.

C. *Modeling the Geometry*

The body about which stream is to be examined requires demonstrating. This all things considered incorporates showing the geometry with a Computer Aided Drafting (CAD) programming pack. Approximations of the geometry and separations may be required to allow an examination with sensible effort. Of course, decisions are made with respect to the level of the constrained stream space in which the stream is to be reenacted. Bits of the breaking point of the stream zone relate with the surfaces of the body geometry. Diverse surfaces are free breaking points over which stream enters or gets out. The given geometry and stream region are shown in order to offer commitment to the system age. In this way, the showing consistently considers the structure and topology of the cross section age.

D. *Establish the point of confinement and Beginning Conditions.*

As we presumably know a restricted stream space is resolved, physical conditions are required on the points of confinement of the stream territory. The reenactment generally starts from a hidden course of action and uses an iterative method to accomplish a last stream field plan.

E. *Meshing*

Cross section is the procedure of discrimination of room in which stream happens. Cross section is the fundamental advance in building a PC show for a stream issue. Contingent upon the discrimination system utilized, coinciding technique differs. The beginning stage for all issues is "geometry."

1) The geometry depicts the condition of the issue to be analyzed.
2) Can involve volumes, faces (surfaces), edges (curves) and vertices (centers).
3) Geometries can be made down or base up.
4) Top-down suggests an approach where the computational region is made by performing legitimate operations on primitive shapes, for example, chambers, pieces, and circles.
5) Bottom-up implies an approach where one at first makes vertices (centers), relates those to outline edges (lines), interfaces the edges to make faces, and joins the faces to make volumes.
6) Geometries can be made utilizing the same pre-processor programming that is utilized to make the matrix, or made utilizing different projects (e.g. Computer aided design, illustrations).

VI. BOUNDARY CONDITIONS

1) Turbulence Model : k-epsilon
2) Working fluid : Water(50 %), CuO(5 to 20 %).Air(15 bar)
3) Inlet conditions: Exhaust Gas: Velocity varying from 15m/s, 25m/s, 35m/s, 45m/s & Temperatures are varied like 298k, 373k, 423k, and 473k. @ atmospheric Pressure 1.0 bar,
4) Outlet conditions: 1.1 bars.
5) Energy storage system: Porous Media.

VII. ABBREVIATIONS

CAES, Compressed Air Energy Storage; CFD, Computational Fluid Dynamics; CATIA, Computer Aided Three Dimensional Interactive Application; ANSYS (Software); CAD, Computer Aided Design; DDF, Double Distribution Function; LBM, Laser Beam Machining; NG, Natural Gas; GHG, Green House Gas; REMC, Rotary Electric-Mechanical Converter; CO2, Carbon-dioxide; FEA, Finite Elements Analysis.

VIII. DECLARATIONS

A. Availability of Data and Material

All datasets and Designs used for supporting the conclusion of this article are taken from the ANSYS, CATIA, and CAD Software.

B. Competing Interests

The Authors declare that they don't have any Competing Interests.

C. Funding

This Research was Self Funded by all the Authors Mentioned Above.

D. Authors Contribution

"Mohd Suleman developed an idea of Simulation and Modeling of Hybrid Fuel Storage System and was a major contributor in writing the original manuscript, Mohd Nadeeem Suleman visualized the data and was a major contributor in designing the prototypes in different software (CATIA, ANSYS, and CAD), Mohammed Haneef Uddin supervised the research work, Mohammed Taher validated and reviewed the manuscript, and Mohd Sameeroddin edited the manuscript. Mohd Habeeb Ali has Supervised the work . All authors read and approved the final manuscript".

IX. ACKNOWLEDGEMENT

None

REFERENCES

[1] H. oztop "Characteristic convection warm move in somewhat open slanted square cavities" diary of Heat and Mass exchange 48 (2005) 1470-1479.
[2] Nor azwadi che slidik "Expectation of Natural convection in a square depression in part Heated from Below and Symmetrical Cooling from Sides by the Finite Difference Lattice Boltzmann Method European Journal of Scientific Research" ISSN 1450-216X Vol.35 NO.3 (2009), PP.347-354 Euro diaries Publishing, Inc.2009.
[3] H. Ibrahima,b,* , A. Ilincaa , J. Perronb Energy Storage frameworks – Characteristics and correlation.
[4] Wenyi Liu Linzhi Liu,Gang Xu * , Feifei Liang, Yongping Yang, Weide Zhang and Ying Wu A NOVEL HYBRID – FUEL STORAGE SYSTEM OF COMPRESSED AIR ENERGY FOR CHINA .
[5] Gu Y.; Mccalley, J.; Ni, M.; Bo, R. Financial displaying of compacted air vitality stockpiling. Energies 2013, 6, 2241.
[6] Impact Analysis of Gas Price Regulation on Natural Gas Industrial Train, 2013. Accessible on the web: http://www.china5e.com/index.php?m=content&c=index&a=show&catid=13&id=841614 (got to on 9 July 2014). (In Chinese)
[7] Liu, T.; Xu, G.; Cai, P.; Tian, L.; Huang, Q. Advancement estimate of sustainable power source control age in China and its impact on the GHG control system of the nation. Reestablish. Vitality 2011, 36, 1284– 1292.
[8] Working Group III of the Intergovernmental Panel on Climate Change (IPCC). IPCC's Fourth Assessment Report (AR4): Mitigation of Climate Change; Cambridge University Press: Cambridge, UK, 2007.
[9] Wang, S.; Lai, X.; Cheng, S. An investigation of prospects for utilization of huge scale vitality innovation in Power frameworks. Autom. Electr. Power Syst. 2013, 37, 3– 8. [CrossRef]
[10] Youngmin Kim korea establishment of innovation. Vitality and Exergy examination of smazl scale packed air vitality stockpiling and air cycle warming and cooling framework.
[11] Consortium partners, college of Oldenburg, Germany Fraunhofer.

TABLES AND FIGURES

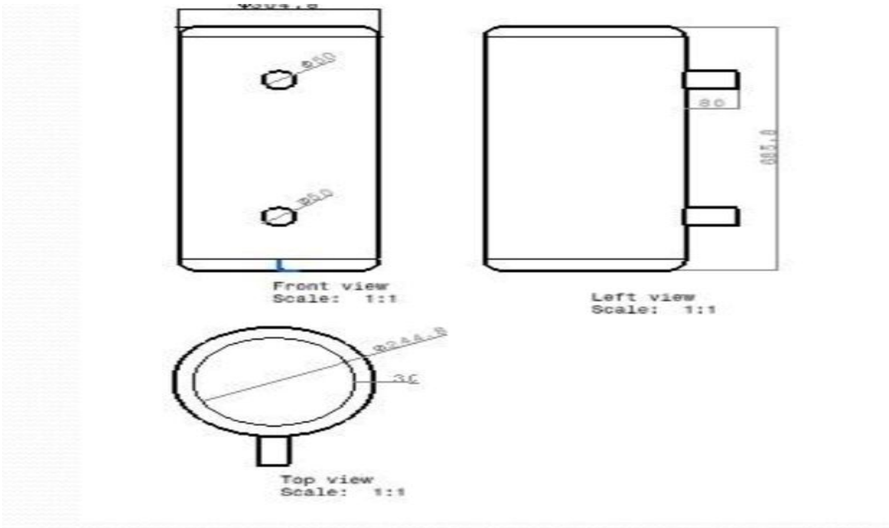


Fig: 1. Dimensions of Hybrid Fuel Storage System

Case -1: Results of fuel storage system velocity = 15m/s and temperature= 298k

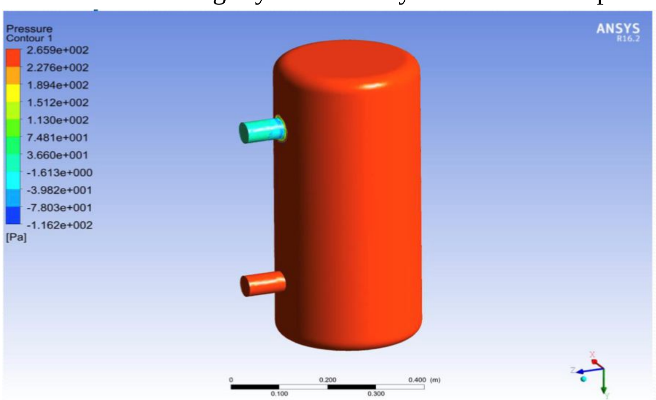
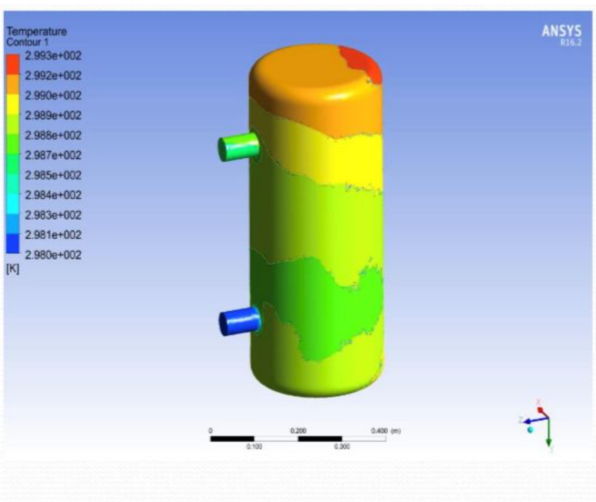


Fig: 2. Contours of static pressure



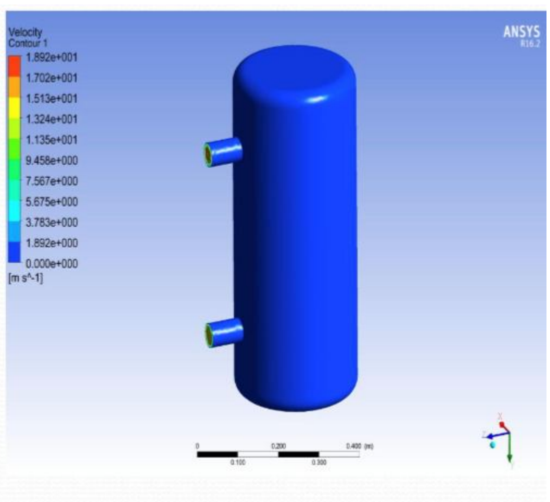


Fig: 3. Contours of static temperature

Fig: 4. Contours of velocity magnitude

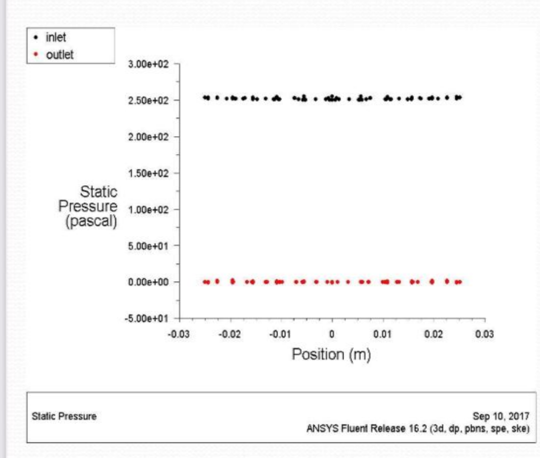


Fig: 5. Graph of Static Pressure at Inlet and Outlet.

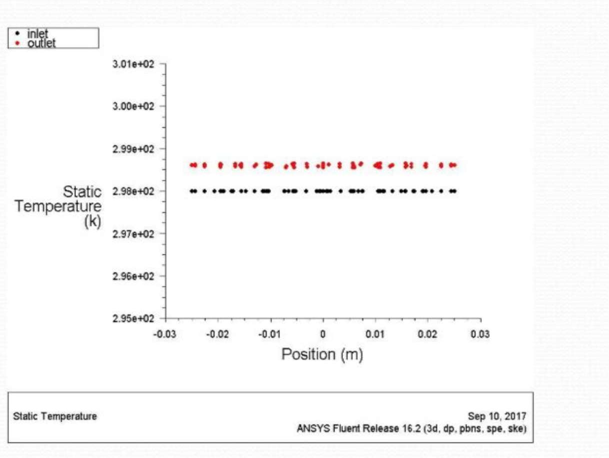


Fig: 6. Graph of Static Temperature at Inlet and Outlet.

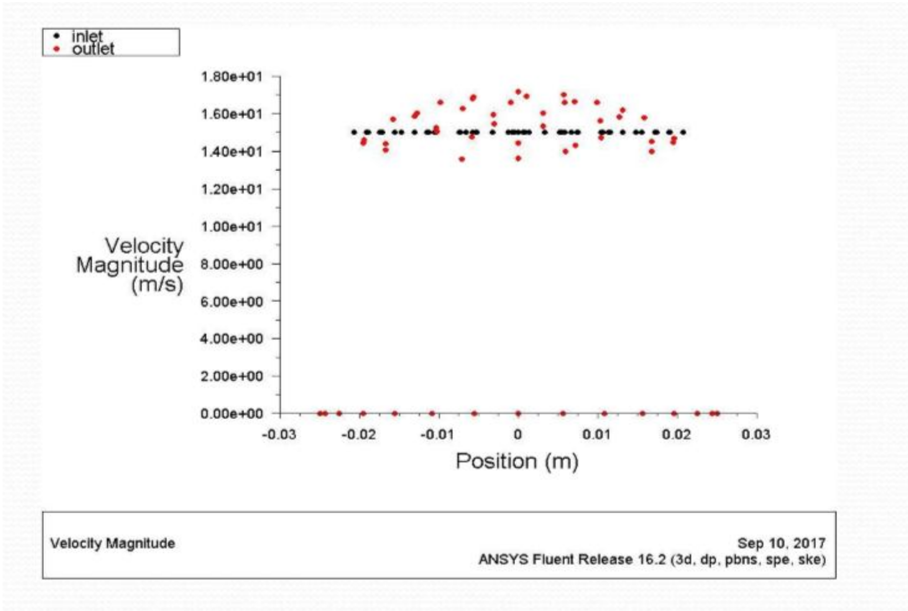


Fig: 7. Graph of velocity magnitude at inlet and outlet

Case -2: Results of fuel storage system velocity = 25m/s and temperature = 373k

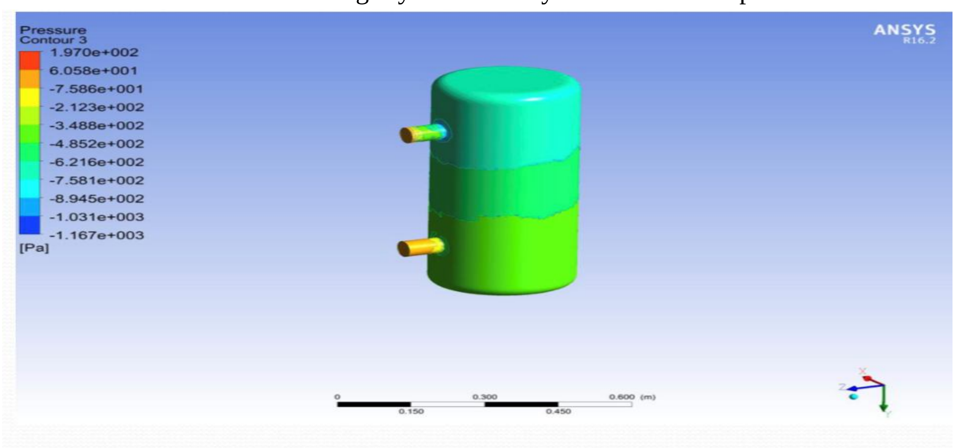


Fig: 8. Contours of static pressure

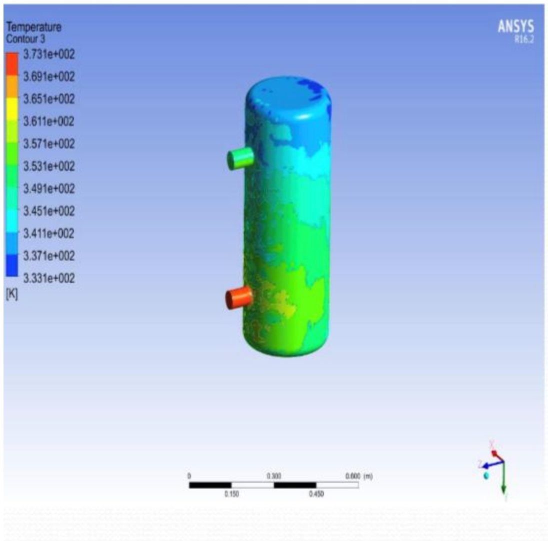


Fig: 9. Contours of static temperature

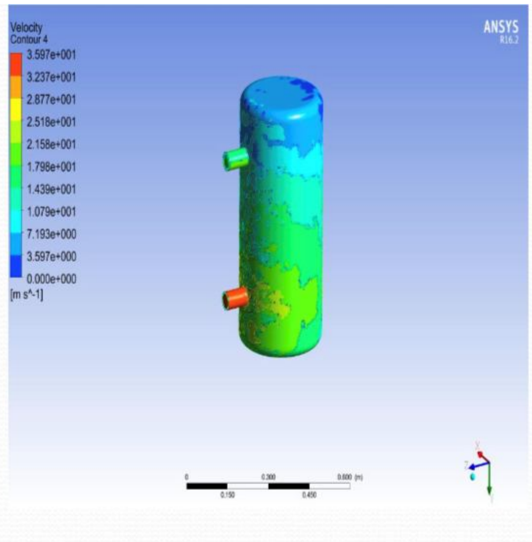


Fig: 10. Contours of velocity magnitude

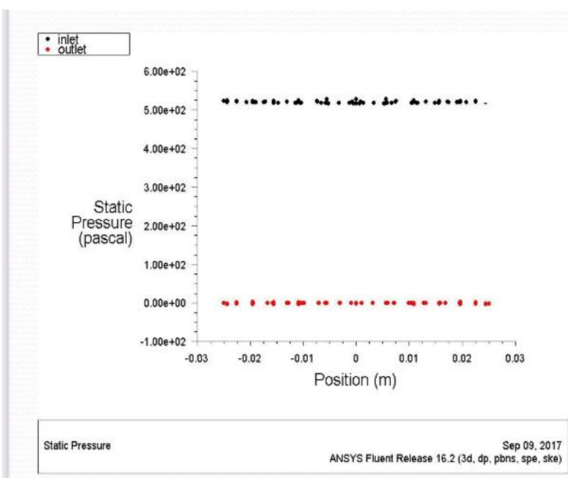


Fig: 11. Graph of static pressure at inlet and outlet.

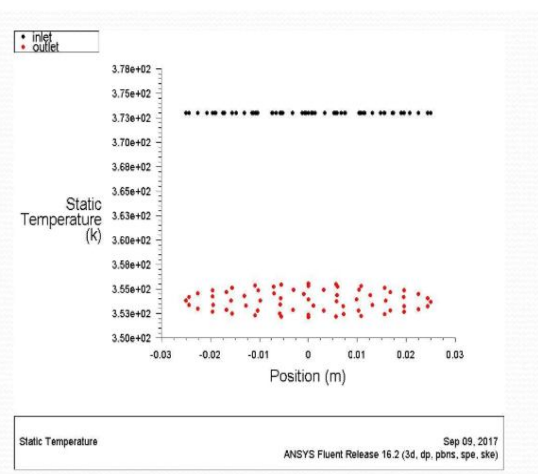


Fig: 12. Graph of static temperature at inlet and outlet

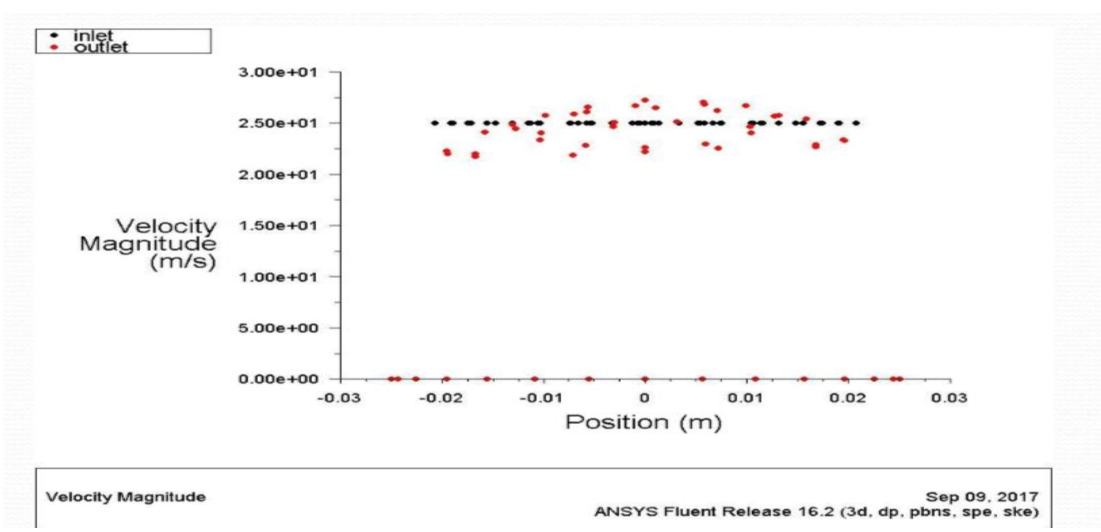


Fig: 13. Graph of velocity magnitude at inlet and outlet

Summary of Energy storage system with different Velocity and temperatures

Results of Energy storage system			
	Pressure(pa)	**Temperature(k)**	**Velocity(m/s)**
Case 1	-1.16e2 to 2.66e2	2.98e2e to 2.99e2	0 to 1.89e1
Case 2	-1.17e3 to 1.97e2	3.33e3 to 3.73e2	0 to 3.61e1
Case 3	-3.36e2 to 7.60e2	3.98e2 to 5.23e2	0 to 3.96e1
Case 4	-5.03e2to 1.17e3	4.30e2 to 5.73e2	0 to 5.09e1

Design of Energy Storage System Using CATIA and ANSYS Software:

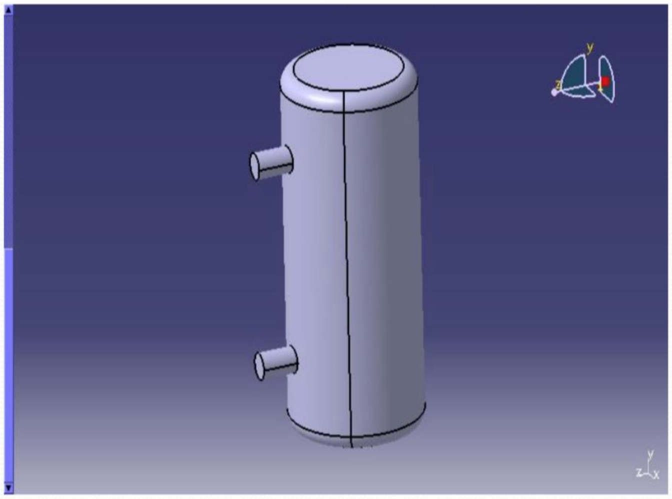


Fig: 14. Geometric Model of Energy Storage System using CATIA

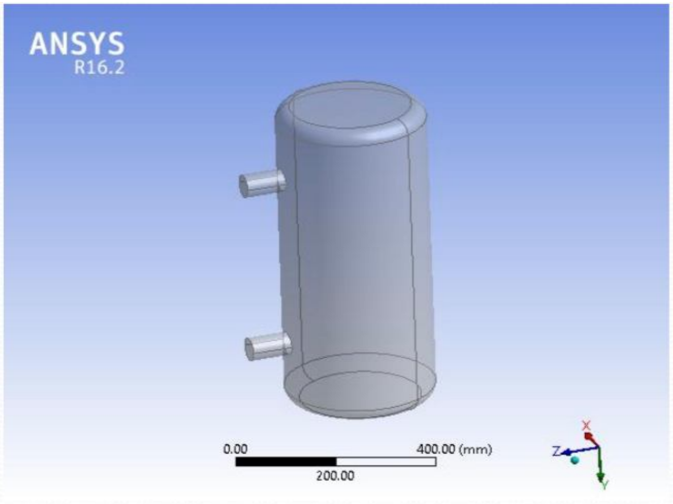


Fig: 15. Geometric model of energy storage system in ANSYS Workbench

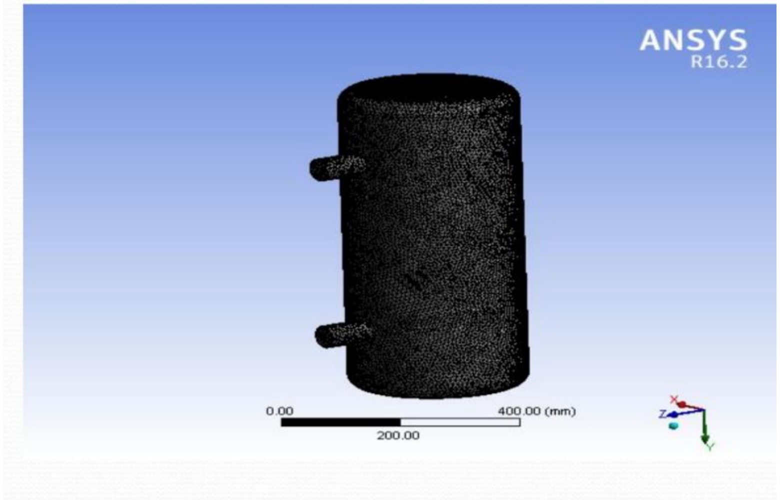


Fig: 16. Mesh model of energy storage system in Workbench

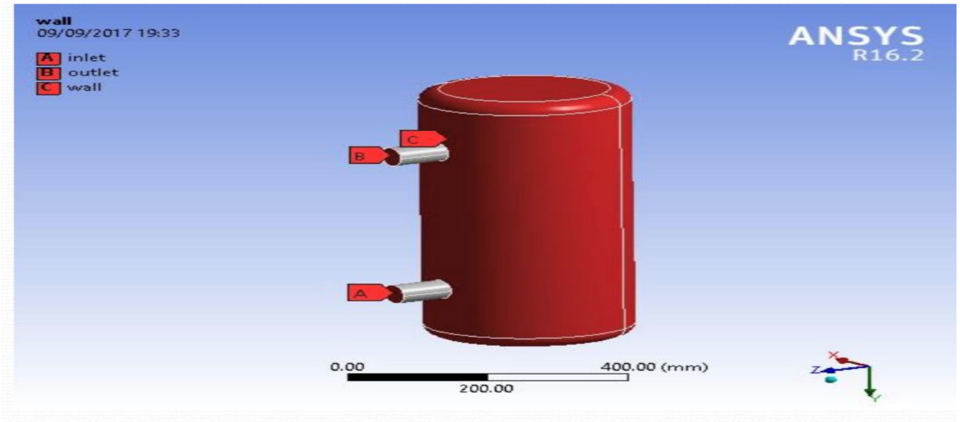
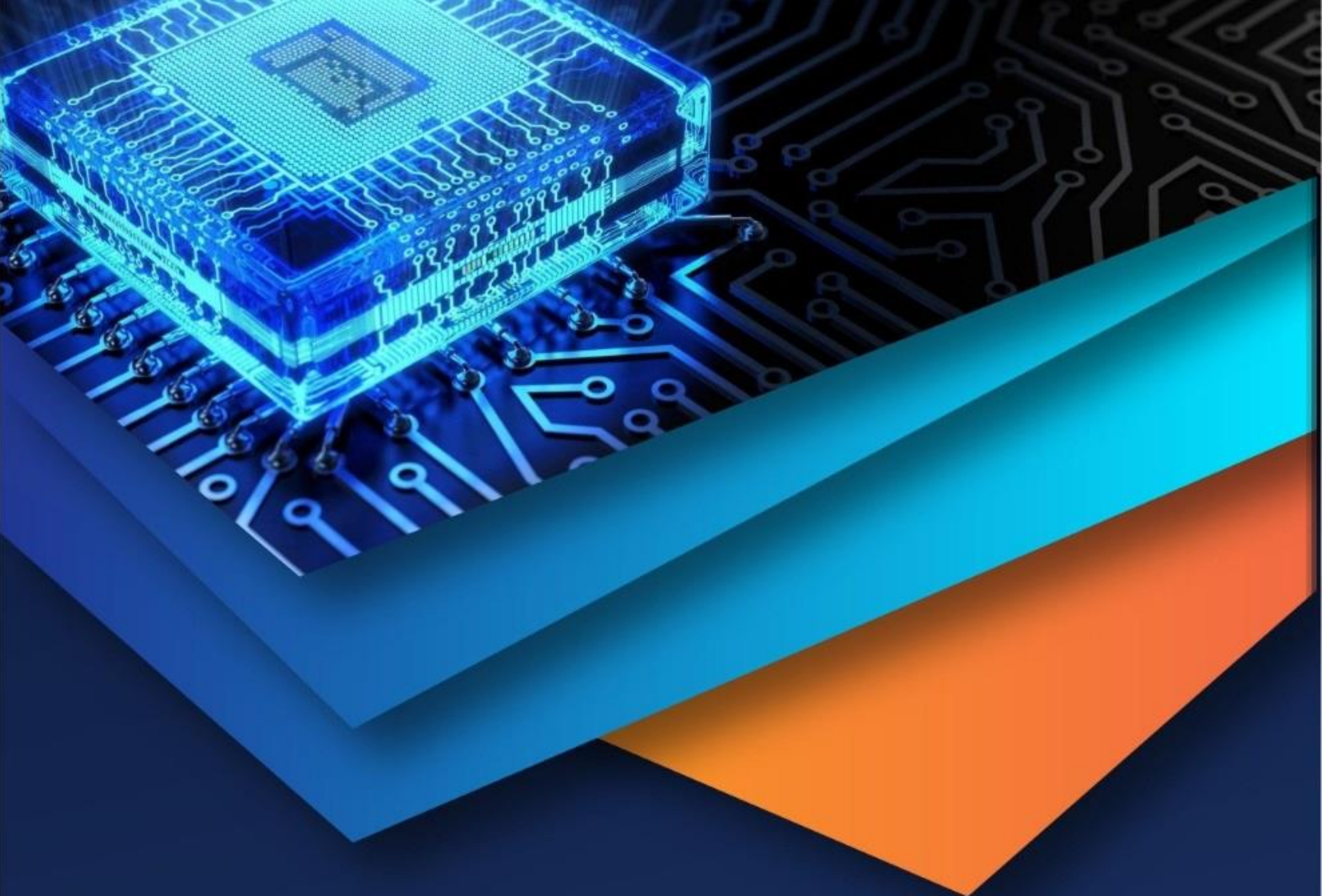


Fig: 17. Boundary conditions of Energy Storage system in workbench



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