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ANALYSIS AND DESIGN OPTIMIZATION OF CRYOGENIC BALL VALVE WITH THE HELP OF ANSYS WORKBENCH

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ABSTRACT

Natural gas is being hailed as alternative energy sources for a petroleum, because it is almost no emissions of pollutants in the environment. Use of equipment for liquefied natural gas, along with increased demand for natural gas is also growing. Cryogenic ball valve is used to control the liquefied natural gas which temperature is -196*C, supplied pressure is 168kg/cm2. To acquire the safety along with durability of cryogenic ball valve, we should consider the structural mechanics such as stress, deformation and dynamic vibration characteristics and identify those important aspects in the stage of preliminary design engineering.

The main aim of the thesis is to design a cryogenic ball valve, in order to increase the efficiency of the object here multiple materials (stainless steel 304 (existing material), sae1137, s1c5k (new materials)) were chosen to do analyses after calculating deformation, stress and safety factor results along with natural frequency values after knowing these results finally thesis submitted with optimum material, and here calculating supplied pressure values on walls for each material with the help of Ansys fluent tool, by this fluent analysis results it is possible to know that how much pressure value is generated and whether the design capable to bear it or not, finally knowing all these values, thesis can concluded with suitable tables and graphs with optimum material advantages and their limitations, after completing the design and analysis process, final model prototype will be made with the help of rapid prototype technology, and discussing the process behind it,

Key words: (static, dynamic analysis, cfd analysis, s1c5k, sae1137, ss304)

1. INTRODUCTION

Natural gas (also called fossil gas; sometimes just gas), is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulfide, or helium It is formed when layers of decomposing plant and animal matter are exposed to intense heat and pressure under the surface of the Earth over millions of

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years. The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in the gas. Natural gas is a fossil fuel.The process of the formation of natural gas (NG) is similar to that of coal. NG can be produced from oil wells as assistant gas; however, most of it is produced as non-assistant gas. 80~85% of NG is methane (CH4), whose low concentration of hazardous substances makes it a valuable energy resource. However, because NG is difficult to store in large quantities and mass transportation requires a pipeline, technology for NG liquefaction has been developed to solve these problems, enabling mass storage and transportation over long distances. The demand for facilities for the storage, transportation and control of liquefied natural gas (LNG) is rapidly increasing in line with the rising demand for LNG. Most of the high-pressure, cryogenic ball valves are of the side-entry type, the insulation of which has to be cut open to carry out repairs. Therefore, top-entry type cryogenic valves have been adopted recently. Top-entry type, high-pressure, cryogenic ball valves are subject to safety verification to prevent the types of accidents that can be caused by earthquake, fire, or explosion. Their specifications regarding leakage, being very strict, are satisfied by only a few products in the world. In this study, a numerical analysis is conducted for the structural safety and the distribution of thermal stress and deformation by thermal shock under high pressure and very low temperature conditions, in order to assess the safety and reliability of the ball valves for LNG to provide a basis for the design and manufacturing of products which are safe from leakage under conditions of extreme temperature variance

Figure 1 Photo of the valves are installed on vessels

AIM OF THE PROJECT

The main aim of the thesis is to design a cryogenic ball valve, in order to increase the efficiency of the object here multiple materials (stainless steel 304 (existing material), sae1137, s1c5k (new materials)) were chosen to do analyses after calculating deformation, stress and safety factor results along with natural frequency values after knowing these results finally thesis submitted with optimum material, and here calculating supplied pressure values on walls for each material with the help of Ansys fluent tool, by this fluent analysis results it is possible to know that how much pressure value is generated and whether the design capable to bear it or not, finally knowing all these values, thesis can concluded with suitable tables and graphs with optimum material advantages and their limitations, after completing the design and analysis process, final model prototype will be made with the help of rapid prototype technology, and discussing the process behind it,

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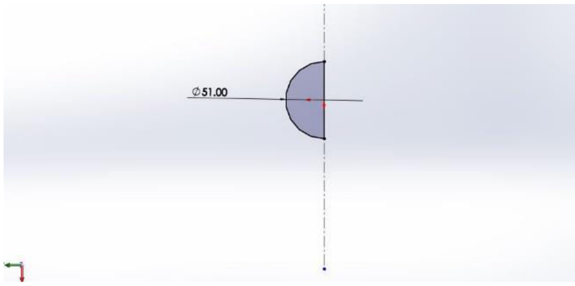
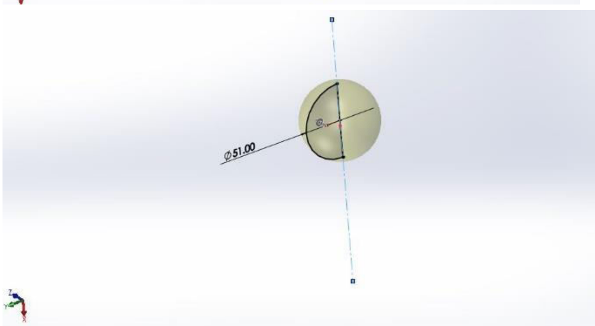
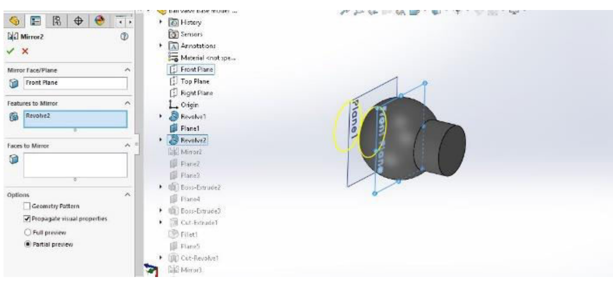
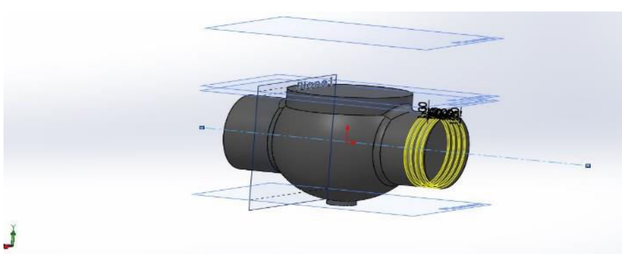
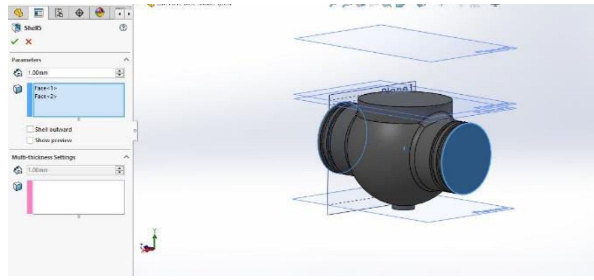
DESIGNING PROCESS STEP BY STEP

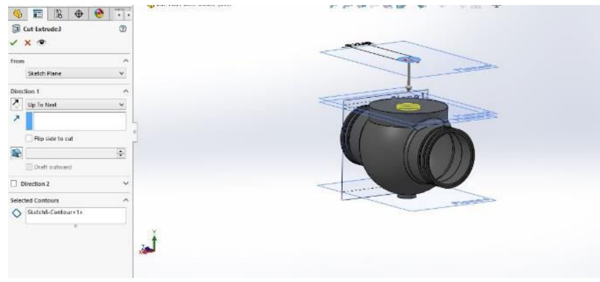


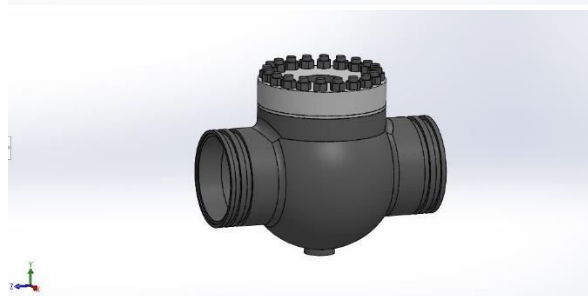








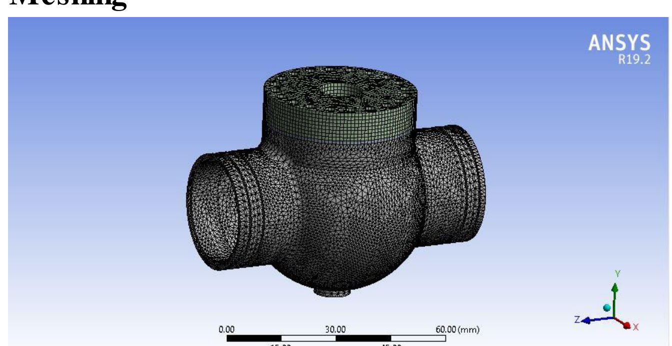




Cryogenic ball valve final assembly model

Ansys process

Meshing



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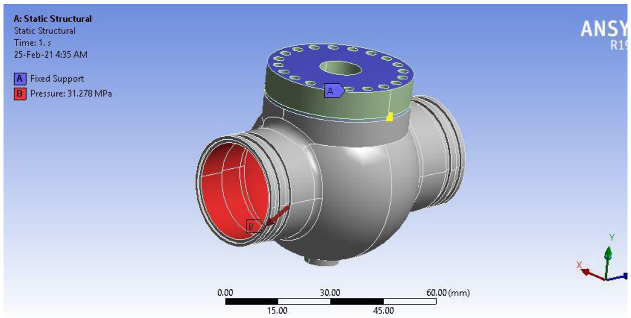
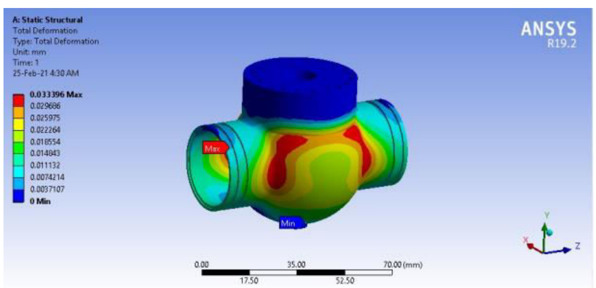
Boundary conditions



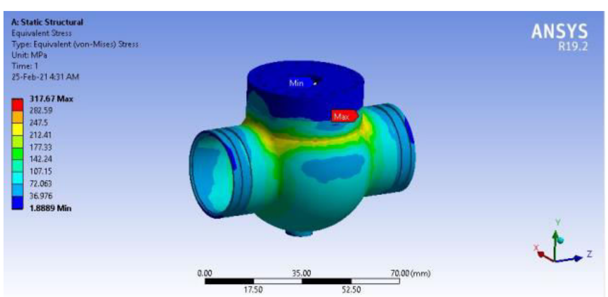
Apply pressure inside of the object, and then enter value as 31.278Mpa, and then solve the required results,

SS-304

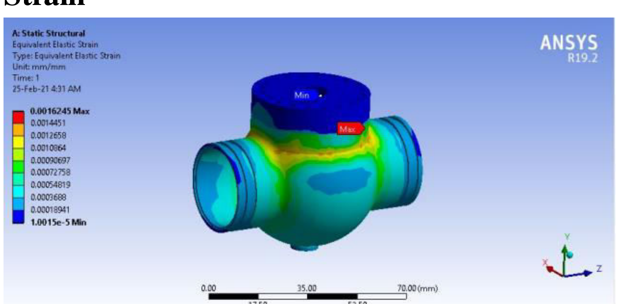
Deformation



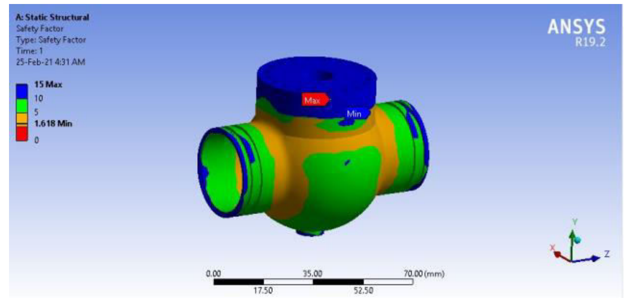
Stress



Strain



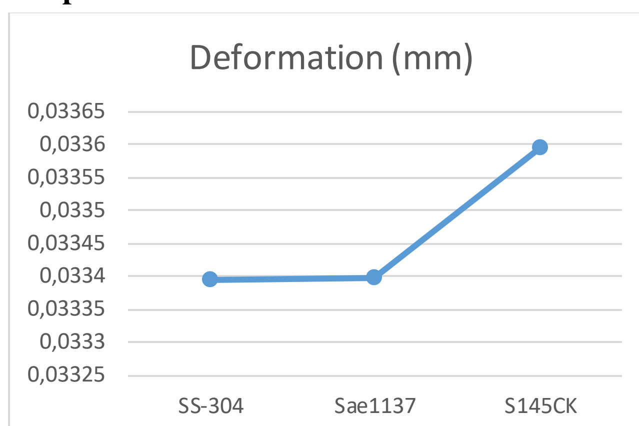
Safety factor

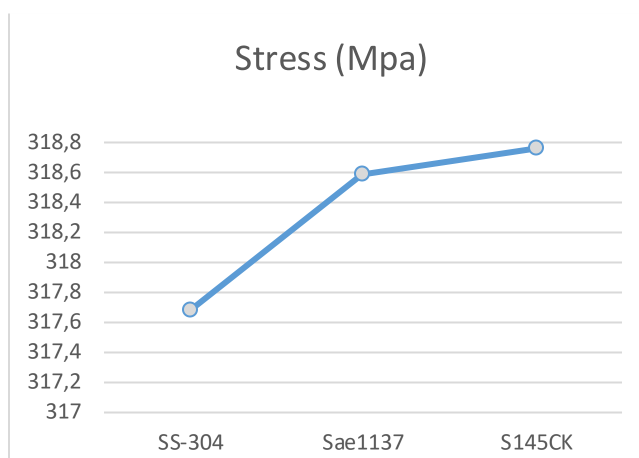


Tables

	SS-304	Sae1137	S145CK
Deformation (mm)	0.033396	0.033399	0.033596
Stress (Mpa)	317.67	318.59	318.76
strain	0.0016245	0.0016221	0.0016312
Safety factor	1.618	1.6479	1.7129

Graphs





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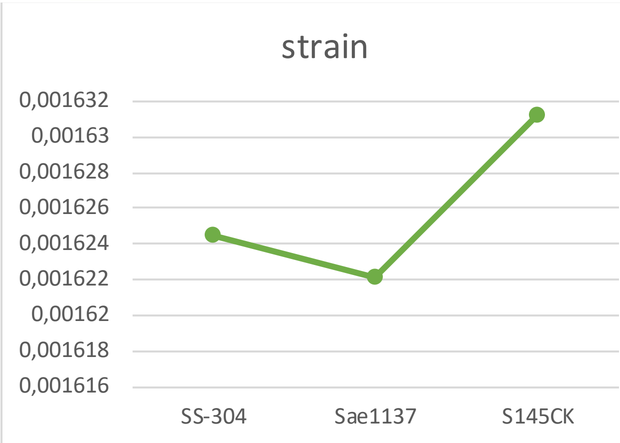
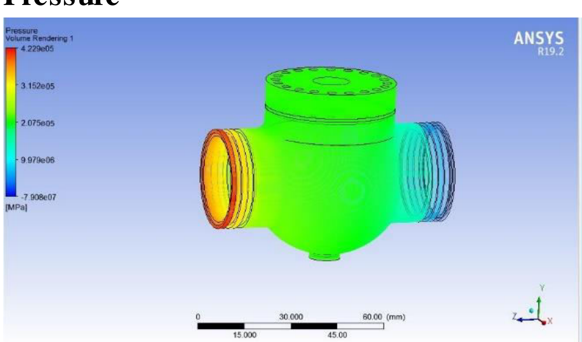


Dynamic analysis results

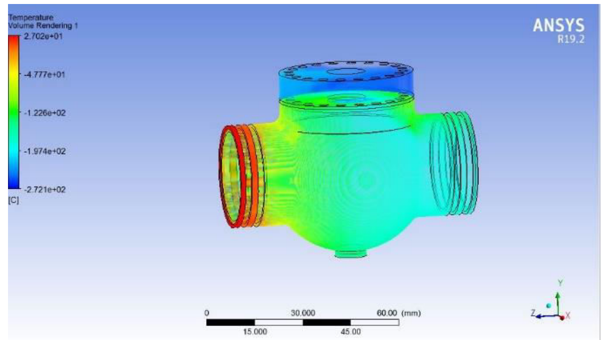
	SS-304	Sae1137	S145CK
Mode1 (Hz)	7196.3	7313.2	7342.8
Mode2 (Hz)	9236.7	9373.6	9409.1
Mode3 (Hz)	9751.9	9884.9	9920.3
Mode4 (Hz)	9832.6	9979.7	10018
Mode5 (Hz)	9864.6	9999.2	10035
Mode6 (Hz)	10529	10693	10735

Fluent analysis results

Pressure



Temperature



CONCLUSION

In this thesis cryogenic ball valve were designed with the help of solid works tool, and then analyzed with the help of Ansys workbench tools, from static analysis results here calculated deformation, stress, strain and safety factor values for this cryogenic ball valve, from this static analysis results it is clear that the existing design with existing material (ss-304) can with stand maximum amount of 31.278Mpa of pressure inside of the object, when materials were changed to sae 1137 or s1045k, the strength of the object is increased, among all s1c45k material is having better strength in both static and dynamic conditions, from static and dynamic analysis results it is clear that object is safe at applied boundary conditions, to consider this material is an optimum material it should maintain optimum temperature values which existing material maintain, to know this value, here cfd analysis were carried on it, and the internal pressure value which is generated on walls is under applied boundary conditions, and also this s1c45k material maintains optimum temperature values too.

REFERENCES

1. Eleftherakis, John G. 1991, "Determining valve contaminant sensitivity effect using two contaminants", SAE TP 910960, pp459464.
2. Thompson G, Askari, A.R. 1986, "Air leak detection through ball plug valves by vibration monitoring", Noise & Vibration control worldwide, V17, pp140-143.
3. Rouss, Gino james Janna, William S. 2003, "Determination of discharge coefficient for ball
Valves with calibrated inserts", 2003 ASME Mechanical engineering congress, pp 1~10.
4. Merati, P., Macelt, M.J, 2001, Flow investigate around a v-sector ball valve□, 2001 ASME Fluids engineering, vol.123, no.3, pp662~671.