DESIGN AND ANALYSIS OF LPG CYLINDER

E. Sammaiah[1], Vasuboyina Sri Harsha[2], Chinta Dheeraj[3]. P. Mani Sri Harika[4]
[1]Assistant Professor, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad, India
[2,3,4] Student, Department of Mechanical Engineering, CMR College of Engineering & Technology, Hyderabad, India

Abstract

LPG cylinder is a kind of pressure vessel that requires high tensile and compressive strength to store pressurized gases. This study aims at reducing the weight of Liquid petroleum gas cylinders. The commonly used material for the manufacturing of LPG cylinders is steel. But the steel is heavier and has got some safety problems. Inaddition to this, the steel progressively corrodes. So there arises a need to rectify these problems using someother alternatives. In this journal, different alternatives are examined and appropriate material is selected. Thefinite element analysis of Liquefied Petroleum Gas (LPG) cylinders made of Steel, Aluminium 6061T6 alloy,andAluminium5052-H38alloyhasbeencarriedout.ThemodelsaremadeinCATIAV5R20andareimportedtoANSYS.Finiteelementanalysisofthecylindersubjectedtointernalpressureisperformed.Theanalysisdonein ANSYS is compared with classical mathematical formulations. Calculations are performed to determine theweight of the cylinders and the least weighed material is chosen for the new LPG cylinder. The cost estimationisalso performed to check the economicviability ofthe new LPG cylinder.

Keywords: LPGcylinder,Steel,Al 6061T6,Al5052-H38, ANSYS,CATIA

1. INTRODUCTION

LPG(propaneorbutane)isacolourlessliquidwhichreadilyevaporatesintoagas.Ithasnosmell,althoughitwillnormallyhaveanodouraddedtohelpdetectleaks.Whenmixedwithair,thegascanburnorexplodewhen it meets a source of ignition. It is heavier than air, so it tends to sink towards the ground. LiquefiedPetroleum (LP) Gas is composed predominantly of a mixture of the following hydrocarbons: propane,propylene,butaneorbutylenes.LiquefiedPetroleum(LP)Gasisstoredandhandledasaliquidwhenunderpressure inside an LP-Gas container. When compressed moderately at normal temperature, it becomesliquid. When gas is withdrawn, the pressure drops and the liquid reverts to gas. This means that it can betransported and stored as liquid and burnt as gas. The expansion ratio of gas from the liquid is 270:1 atatmospheric pressure. It is this expansion factor which makes LP-Gas more economical to transport andstorelargequantities of gaseous fuel in asmallcontainer in liquid state.LP-gas inside a container is in two states of matter, liquid and vapour. The liquid portion of container is inthe bottom and the vapour is in the uppermost part of the vessel, i.e. the space above the liquid level.Containersarenormallyfilled80-85%liquid,leavinga15-20%vapourspaceforexpansionduetotemperatureincrease.Thevapourpressureofpropaneincreasesastheliquidtemperatureincreases.Propaneat -42^{0}C inside a container would register zero pressure. At 0^{0}C, propane vapour pressure will increase to380kPa. At 38^{0}C, the vapourpressureof propanewould be1200 kPa.LP gas is odourless and non-toxic. A distinct-smelling odorant such as ethyl mercaptan is added as adetection agent for all domestic and most commercial and industrial LP-gas. The purpose is to introducesufficientodorantsothatthepresenceofunburntgascanbereadilydetectedbeforeitreachesamixturethatis flammableand comes in contact with asourceof ignition.

2 IMPLEMENTATION

Objective:

The focus of this paper is on designing and selecting the best possible material for LPG cylinders. According toa study of the literature on alternative materials for LPG cylinders and research has been conducted. However,certainsimplecustomerspecifications,suchasfuellevel,rust-free,andlessweight,muststillbemet.Liquefied Petroleum Gas (LPG) cylinders fabricated of steel, aluminium 6061T6 alloy, and aluminium 5052-H38 weresubjectedtofiniteelementanalysis.CatiaV5isusedtocreatethemodels,whicharethenimportedintoANSYS.A cylinder with internal pressure is subjected to a finite element analysis. The results of the ANSYS study arecontrastedwithtraditionalmathematicalformulations.Theweightofthecylindersiscalculated,andthematerialwiththeleast weight is chosen forthe new LPG cylinder.

Table3.1:MaterialProperties

Properties	Steel	Aluminium 5052-H38	Aluminium 6061-T6
Density	7800 Kg/m^3	2680 Kg/m^3	2700 Kg/m^3
Tensile yield Strength	260 Mpa	255 Mpa	276 Mpa
Ultimate Tensile Strength	650 Mpa	290 Mpa	310 Mpa
Poisson's ratio	0.29	0.33	0.33
Modulus of elasticity	200 Gpa	70.3 Gpa	68.9 Gpa
Stress reduction factor	1	1	1

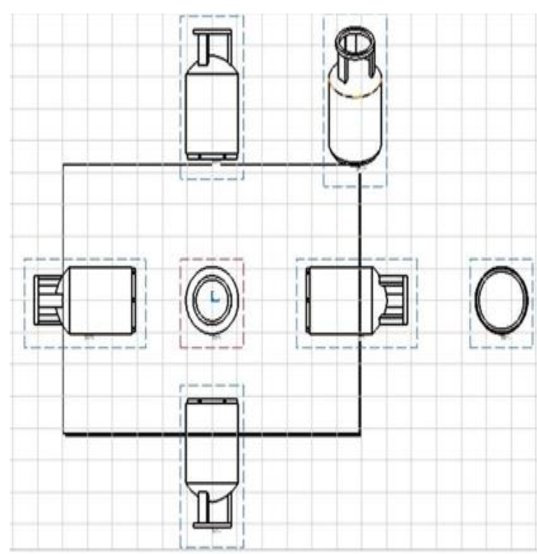


Fig:12D LPGCylinder

3. EXPERIMENTAL RESULTS

ModellingOfLPGCylinderInCATIA:

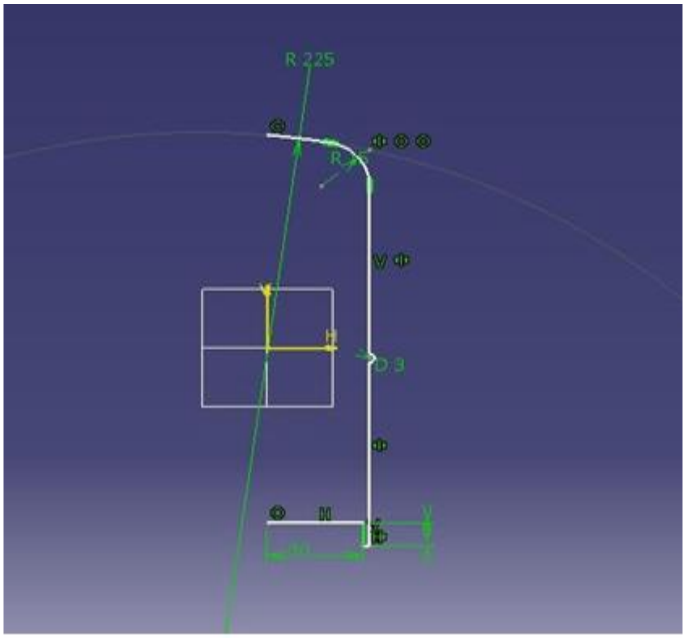


Fig: 2SketchusedformakingLPGcylinder

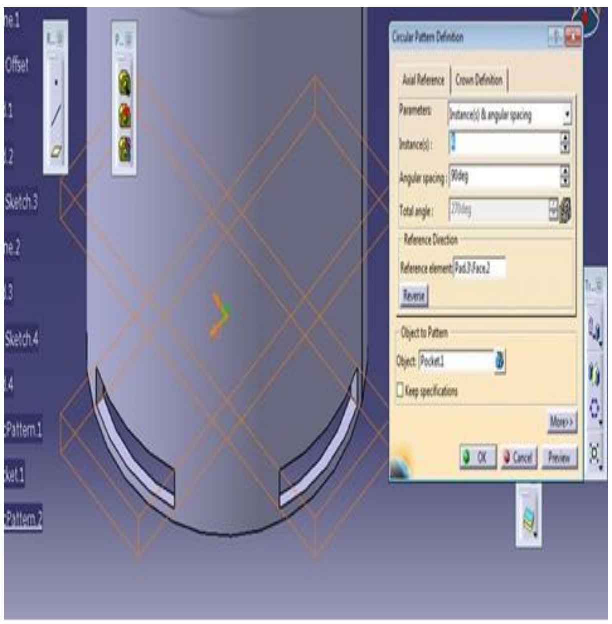


Fig: 3 Modelling ofbaseforthe cylinder

TableOfAnalysisandDefinitions:

Table1:Table ofAnalysisAndDefinitions

Name of analysis	Application of loads	Solution determines
Explicit dynamics	Loads with respect to time	Total deformation or impact deformation
Fluid flow (cfx)	Compressible or incompressible of air or gases	Heat transfer or flow of air
Fluid flow (cfd)	Compressible or incompressible of fluid	Heat transfer fluid
Harmonic response	Periodic or sinusoidal loads	Resonance, fatigue, and effect of forced vibration.
Rigid dynamics	Constraints and motion loads	Forces or direction analysis
Static structural	Static load conditions	Deformation, stresses and strains, fatigue tool, life, damages, safety factor
Steady state thermal	Temperature or thermal loads	Heat flux or temperatures
Transient structural	Varying of load conditions with changing of times	Deformation, stresses and strains, fatigue tool, life, damages, safety factor
Transient thermal	Varying of temperature or thermal loads with changing of times	Heat flux or temperatures

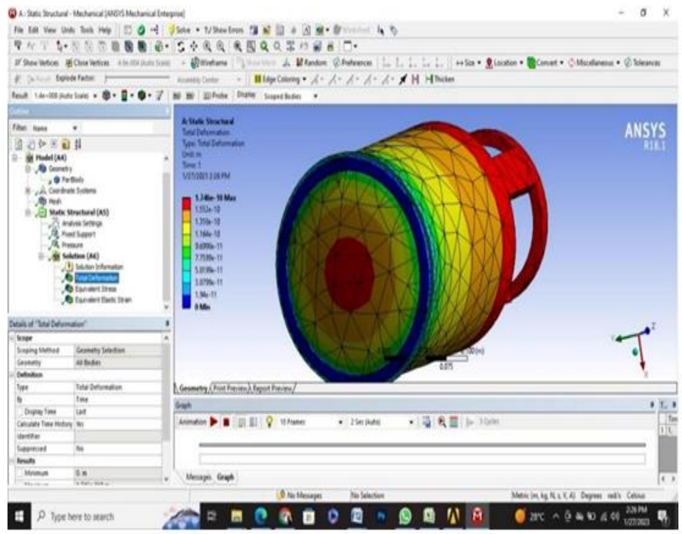
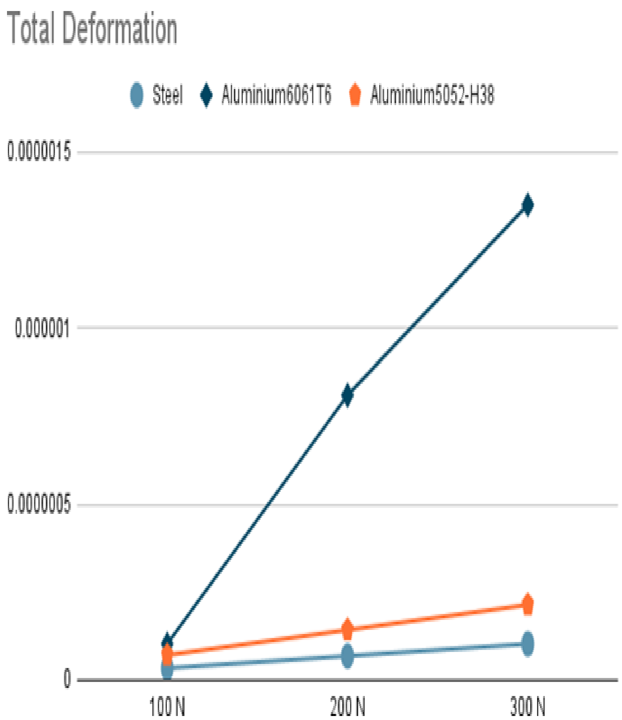


Fig:4 TotalDeformation

ResultsofTotalDeformation:

Table:2 ResultsofTotalDeformation

	Steel	Aluminium6061T6	Aluminium5052-H
100 N	$3.4408e^{-8}$	$1.0322e^{-7}$	$7.14e^{-8}$
200 N	$6.8815e^{-8}$	$8.9997e^{-7}$	$1.428e^{-7}$
300 N	$1.0322e^{-7}$	$1.35e^{-6}$	$2.142e^{-7}$



Graph:1TotalDeformation

4. CONCLUSION:

In this analysis, we have tried to replace the domestic steel cylinder with aluminium 6061-T6and aluminium 5052-H38 with help of structural analysis under the conditions of EquivalentStress, Equivalent elastic strain, and total deformation. By the analysis, both aluminium 5052-H38 and steel are near with equal results in all the conditions. Hence aluminium 5052-H38 canbereplaced with steelcylinder.

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