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STRESS DISTRIBUTION BY WELDED LPG CONTAINER

N.Vukojević, F.Hadžikadunić
University of Zenica,
Faculty of Mechanical Engineering,
Fakultetska 1, Zenica,
Bosnia and Herzegovina

M. Šutković
Proming d.o.o.
Šehitluci bb, Bugojno
Bosnia and Herzegovina

ABSTRACT

Pressure vessels for LPG are simple and small vessels made with two circular and one longitudinal weld joint. Geometrical failure caused by welds and opening in shells make unwanted stress concentration. This concentration in some circumstances can achive greate magnitudes which overhang safety of vessel.

This paper present stress analysis of LPG tank made by numerical and experimental approach. Numerical analysis is made by FEM and for experimental analysis is used strain gage method.

Keywords: Pressure vessels, stress-strain analyse, stress concentration.

1. INTRODUCTION

Liquid Petrol Gas (LPG) container designed for wheeled vehicles are defined by adequate strandards and technical regulations. Containers for storage of LPG are cylindrical container with a cylindrical shell, and two dished ends and required opening. All components of container body and all the parts are welded. There are two types of LPG container: one type consist of longitudinal and circumferential butt welds, and the other one only of circumferential butt welds.

The butt welds on the stress-resistant shell may not be located in any area where there are changes of profil and must not be located in region of maximal stresses, for example stress concentration caused by openings. This locations present potential weak places [3].

Calculation of this type of containers do not take into account this mentioned weaknesses[1].

Besides welds, which geometrical anomaly disturb structural continuity, occurs openings for instalations which caused stress concentration and can caused failure of continer.

2. NUMERICAL ANALYSIS

LPG container is axisimetrical form with longitudianal and circumferential welds. Container is exposed operating pressure of 3 [MPa]. LPG container treated in this paper consist of: two identical dish ends, cilindrical shell and ring.

All components of the container body and all parts are welded. 3D model of cylindrical container is defined in accordance with real 50 liters container used in experimental researches, Figure 2.

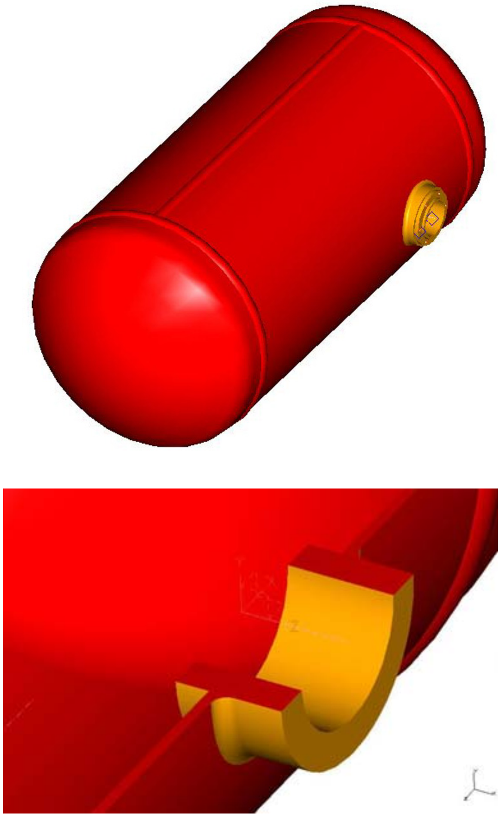

Figure 1. 3D model of LPG tank with openings

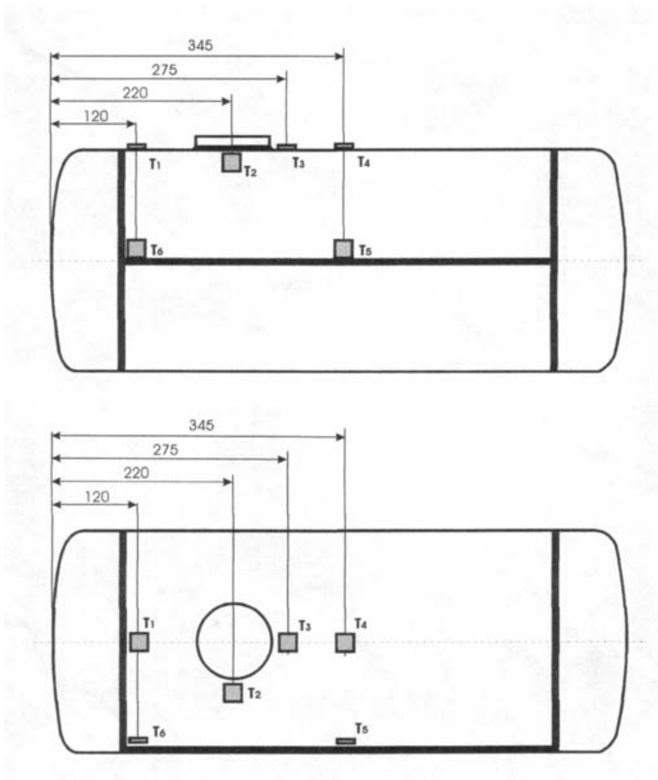

Figure 2. Strain gauges position on tested LPG tank

3D container model is analised as ½ model of finity elements, Figure 1. Stress distribution caused by pressure of 3 [MPa] on inner and outer side of container is presented on Figure 3 and 4[4]. Total stress is taken from same locations where were strain gauges instaled on real container, see Figure 2. Amounts of total sterss defined by numerical estimation are presented in Table 1.

Table 1. Total stress of the tested LPG container models

Strain gauge/location	Experimental	Numerical	Deviation
	σ_{tot} [MPa]	σ_{tot} [MPa]	Exp./num. [%]
T1	104	118	13
T2	200	222÷252	11÷26
T3	139	126	10
T4	137	148	8
T5	131	118	11
T6	112	117	10

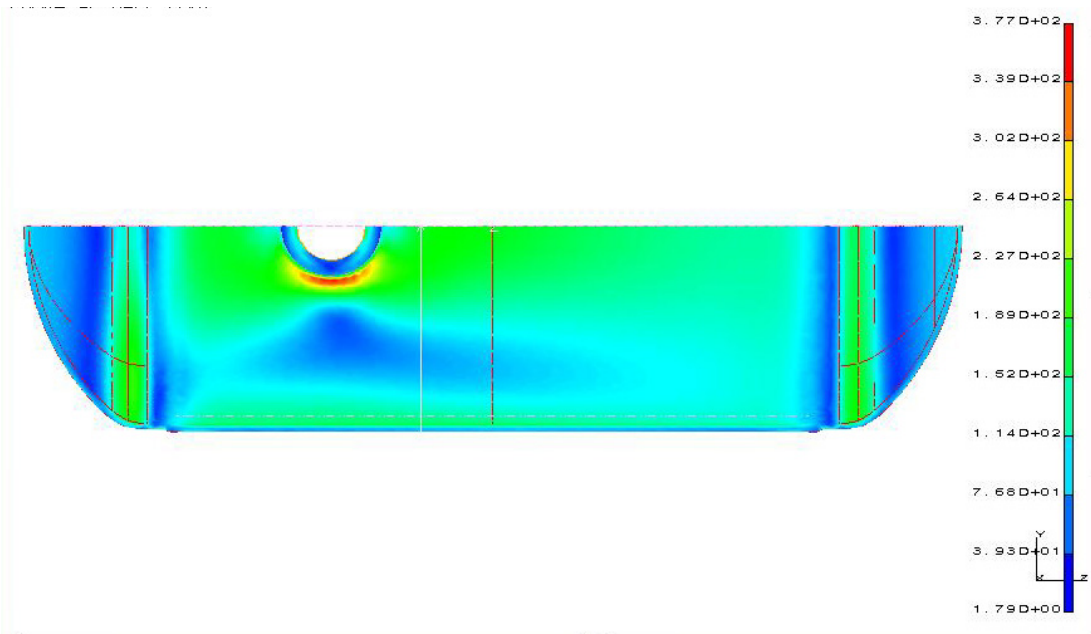

Figure 3. Stress distribution – inner side of LPG tank

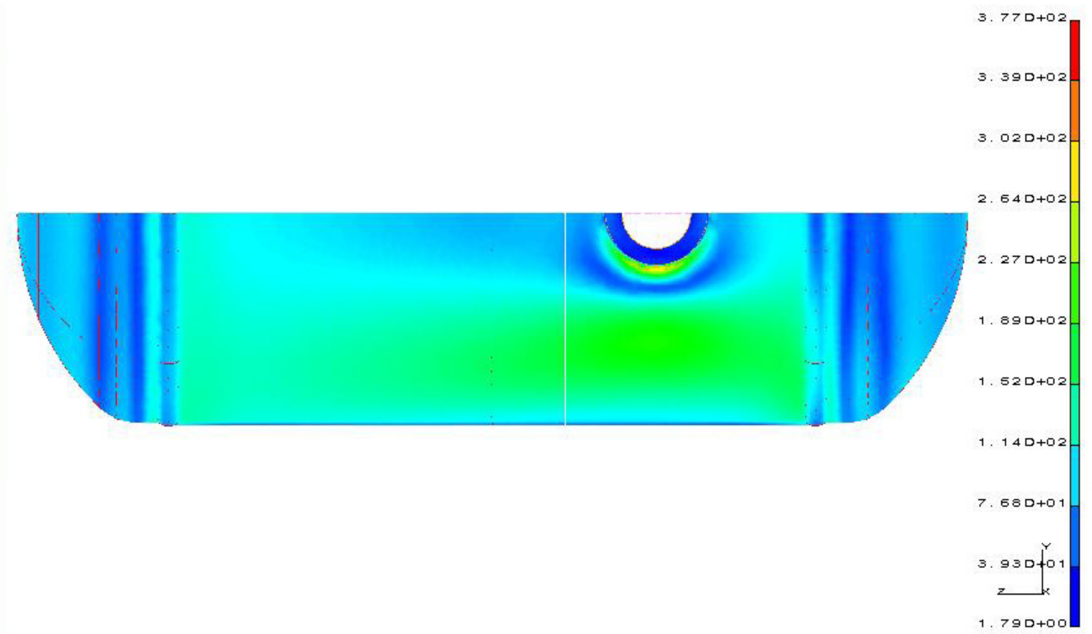

Figure 4. Stress distribution – outer side of LPG tank

3. EXPERIMENTAL ANALYSIS

Strain gauges method[2] is used in experimental assessment of stress-strain distribution on LPG 50 liters container. Locations for strain gauges are chosen to define stress distribution on characteristic locations. For eksperimental researches are used two types of strain gauges:10/120 XY91-for locations T1, T3, T4, T5 and 10/120 RY11 for locations T2 and T6, see Figure 2. Experiment is made durring hidro test with inner pressure of 3 [MPa]. Measured values are presented in Table 1.

All evaluated values of total stress were not proceed yield stress [$\sigma_{tot} < R_{eH}$].

Maximal calculated total sress of 200[MPa] caused by operating inner pressure of 3[MPa] was on location T2. This is unexpected value for this type of container and inner pressure of 3[MPa].

Other measured and calculated values are predictable and suit to geometrical and design characteristics of measure location.

Deviation, presented in Table 1, is probably implication of partial leakage durring hidro test and variaton in geometry of numerical and real container models.

4. CONCLUSIONS

All results of numerical analyse are expected. Deviation between numerical and experimental results of total stresses is accepable and numerical model could be treated as real for further analyse.

All treated models has maximal stress on same locations. Inner side of shell around opening is potential weak place. Geometrical failure caused by welds and opening in shells make unwanted stress concentration. This concentration can achive greate magnitudes which overhang safety of vessel.

Longitudinal and circumferential welds with their geometrical shape did not operate on safety of container.

According to results of numerical and experimental analises openings in shell caused significant sterss concentration and correspon weak place on LPG container.

5. REFERENCES

[1] ECE-Regulation No. 67- Pravilnik o normativima za opremu i uređaje za ukapljeni naftni plin, 2000.
[2] Hoffmann, K.: Eine Einfürung in die Technik des Messens mit Dehnungsmeβstreifen, Hottinger Baldwin Messtechnik GmbH, Darmstadt, 1987.
[3] Helmut Dannbauer, Christian Gaier, Klaus Hofwimmer: Fatigue Analysis of Welding Seams and Spot Joints in Automotive Structures, SAE International., 2004.
[4] Šutković, M.(2007.) Istraživanje uticaja geometrijskih nepravilnosti na sigurnost zavarenih automobilskih plinskih rezervoara, Magistarski rad, Univerzitet u Zenici, 2007.