Proceeding International Conference on Religion, Science and Education (2022) **1**, 645-649

Characteristics of Quality Requirements for LPG Rubber Hose and LPG Thermoplastic Elastomer Hose in Indonesia

Ary Budi Mulyono*, Endi Hari Purwanto
National Research and Innovation Agency
PUSPIPTEK Area, Banten, Indonesia.

Corresponding author*
arybudimulyono01@gmail.com

Abstract: One of the causes of LPG gas cylinder explosion cases in Indonesia is the leakage of LPG gas hoses. LPG hoses are susceptible to corrosiveness to hydrocarbons and ozone. Standards or technical specifications of a product can guarantee product quality and improve product safety. This study aims to identify the characteristics of quality requirements of LPG rubber hose and LPG thermoplastic elastomer hose related to resistance to n-pentane (hydrocarbon) and ozone compounds (parameter in Indonesian National Standard (SNI). This study used a qualitative descriptive method based on primary data (test results) and secondary data (literature study). Sampling test using purposive sampling. This study concluded that there were differences in characteristics of LPG hose quality requirements for resistance to n-pentane and ozone.

Keywords: quality requirements, rubber hose, standard, thermoplastic elastomer hose.

Introduction

The kerosene to Liquefied Petroleum Gas (LPG) conversion program was established by the government to support the energy diversification program. The transition of LPG as an energy substitute for kerosene has experienced several problems, including leakage and explosion of LPG gas cylinders. Most of the gas cylinder explosions are caused by leaks in valves, regulators, and hoses (Saefullah, Syahrial, and Santoso 2012). The vulnerability of LPG hoses is strongly suspected as one of the causes of fires (Kusriyanto, Yulianto, and Kurniawan 2018; Dewi and Somantri 2018). Several factors cause LPG hose leaks, including sharp object cuts, rat bites, exposure to flames, and contact with the environment.

In terms of raw materials, LPG hoses are divided into 2 types, rubber hoses, and thermoplastic elastomeric hoses. Based on the rubber raw materials used, rubber hoses are divided into 2 types, natural rubber-based hoses, and synthetic rubber-based hoses. Rubber has a weakness in mechanical properties that is not resistant to chemicals, non-polar oils, solvents, oxygen, ozone, sunlight, and UV rays. Rubber also has corrosive susceptibility to hydrocarbon compounds including butane and propane (Kinasih and Fathurrohman 2018).

Thermoplastic Elastomer (TPE) is a material made from a mixture of thermoplastic and rubber (Hutagalung and Bukit 2018). The name thermoplastic is derived from the nature of this plastic which can be reshaped by heating. TPE has characteristics similar to vulcanized rubber and can be melted like thermoplastic at high temperatures (Sondari et al. 2010)(Nurhajati, Supraptiningsih and Sarengat 2015). TPE has thermoplastic and elastic properties so that it is easy to mold to be used as industrial products, one of which is LPG hose products. However, thermoplastics are not ideal elastics because they can undergo permanent deformation and decrease in strength over time (Triwardhani et al. 2019). TPE based on rubber–plastic mixtures can be divided into two main classes, namely: TPO (olefin thermoplastic) and TPV (vulcanized thermoplastic) (Setiorini 2019).

Copyright: © 2022 by the authors. This article is an open access article distributed under a CC BY license.
ISSN 2829-3355 | EISSN 2828-8467

According to Law number 20 of 2014, Standards are technical requirements that are prepared based on the consensus of all relevant parties (government, producers, consumers, experts) taking into account the terms of safety, security, health, environment, development of science and technology, experience, and present and future developments to get the maximum benefit. Standards are prepared based on the needs and consensus results of stakeholders to achieve order in various economic, social, environmental aspects. The application of standards can guarantee product quality and improve product safety (Sialagan 2013)(Ulfiati 2018)(Badan Standardisasi Nasional 2009). Indonesian National Standards (SNI) are standards set by the National Standardization Agency of Indonesia (BSN) and applicable in Indonesia. The Indonesian National Standards (SNI) concern the interests of safety, security, health, and the preservation of environmental functions, its implementation is mandatory by technical agencies. The National Standardization Agency of Indonesia (BSN) has determined 2 (two) mandatory SNI related to LPG hose specifications, namely SNI 7213:2014 Rubber hose for LPG gas stove and SNI 8022:2014 Thermoplastic elastomer hose for LPG gas stove.

Until now, there have not been many studies examining the fulfillment of the quality requirements for LPG rubber hoses and LPG thermoplastic elastomer hoses in Indonesia (especially for the resistance to n-pentane and ozone) based on SNI 7213:2014 and SNI 8022:2014. This study aims to identify the characteristics of quality requirements of LPG rubber hose and LPG thermoplastic elastomer hose related to resistance to n-pentane (hydrocarbon) and ozone.

Methods

This study used the descriptive qualitative method. Descriptive qualitative is a technique that describes and interprets the meaning of the data that has been collected by paying attention and recording as many aspects of the situation and obtaining a general and comprehensive picture of the actual situation. Primary data was collected by testing rubber hoses and thermoplastic elastomeric hoses for quality requirements of resistance to n-pentane (hydrocarbon) and ozone. Meanwhile, secondary data was collected through literature studies and reviews of international standards, national standards, and association standards. The scope of this research is testing for SNI quality requirements using only 2 (two) samples of rubber hoses and 2 (two) thermoplastic hoses (purposive sampling) taken from the manufacturer (new LPG hoses). The SNI quality requirements tested are only resistance to n-pentane and resistance to ozone. LPG hose sample testing is carried out in a rubber and thermoplastic product testing laboratory that has been accredited by the National Accreditation Committee (KAN).

Results and Discussion

Quality Requirements for LPG Rubber Hose and LPG Thermoplastic Elastomer Hose

In this study, testing of LPG rubber hose and LPG thermoplastic elastomer hose was carried out to analyze the fulfillment of quality requirements for pentane and ozone resistance based on SNI 7213:2014 and SNI 8022:2014. The results of testing samples of rubber hoses and thermoplastic elastomeric hoses can be seen in Tables 1 and Tables 2.

Table 1. Rubber Hose Test Results (Based on SNI 7213:2014)

No.	Test	Quality Requirement in SNI 7213:2014		Test result for Rubber Hose A		Test result for Rubber Hose B	
		Inner	Outer	Inner	Outer	Inner	Outer
1.	Resistance to n-pentane						
	Mass addition %	Max. + 10	-	3.35		3.41	
	Mass reduction %	Max. - 10	-	11.68		12.15	
2	Ozone resistance, outer 50 pphm, 40^{0}C, for 72 hours 20% strain	-	No Crack	-	No Crack	-	No Crack

Table 2. Thermoplastic Elastomer Hose Test Results (Based on SNI 8022:2014)

No.	Test	Quality Requirement in SNI 8022:2014		Test result for TPE Hose X		Test result for TPE Hose Y	
		Inner	Outer	Inner	Outer	Inner	Outer
1.	Resistance to n-pentane						
	Liquid pentane absorbed %	Max. 15	-	2.94		3.37	
	Extracted material %	Max. 10	-	9.40		8.19	
2	Ozone resistance, outer 50 pphm, 40^{0}C, for 72 hours 20% strain	-	No Crack		No Crack		No Crack

Rubber and Elastomer Products Storage Procedures Based on Standards

This study also conducted a review of international standards and national standards regarding proper storage procedures for rubber products and elastomer products. This step aims to identify how to store rubber products and elastomeric products to avoid damage due to the influence of ozone and liquid or semi-solid contact. From the identification results obtained 3 (three) standards:

1. ISO 2230: 2002 Rubber products - Guidelines for storage;
2. DIN 7716: 1982 Rubber products; requirements for storage, cleaning, and maintenance,
3. BS 4F 68: 2002 Controlled storage of vulcanized rubbers for use in aerospace.

The procedures for storing rubber and elastomer products are based on these standards as can be seen in Table 3.

Table 3. Storage Recommendation for Rubber and Elastomer Products Based on Standard

Storage Parameters	Storage recommendation
Oxygen dan Ozone	Elastomeric material must be protected from air circulation by wrapping packages or airtight packages. Because Ozone is destructive to elastomers, storage space must not contain equipment that produces ozone.
Liquid or semi-solid contact	Avoid contact with solvents, oils, greases, or other semi-solid materials during storage

Discussion

The resistance of Rubber to LPG was approached through testing the resistance of rubber to the non-polar solvent n-pentane (Kinasih and Fathurrohman 2018). The resistance of the rubber can be seen in how much the rubber is dissolved in the solution, which is indicated by the expansion of the vulcanize in the solution(Narathichat et al. 2012; Hassan et al. 2013). The Rubber resistance to the solution is a form of rubber resistance to not expand in the solution (Ismail, Abdul Majid and Mat Taib 2016; Ismail, Ishak and Hamid 2015).

Therefore the less the expansion volume, the more resistant the rubber to n-pentane.

Based on Table 1, it can be seen that 100% of the rubber hose samples passed the quality requirements for pentane resistance and ozone resistance (based on SNI 7213:2014). The results of the resistance test to n-Pentane, the addition of mass addition % for Rubber hose A and Rubber hose B still show a value that is far from the maximum limit value set (maximum +10%). The same thing also happened for the % mass reduction, where the value of the test results was still far from the maximum value set (maximum -10%). For improvement, several previous studies have shown that the addition of a compatibilizer in rubber can improve oil resistance (Thomas, Mathew, and Marykutty 2012).

The results of this study indicate an increase in the fulfillment of the quality requirements for ozone resistance from the previous study. In 2009, The Center for Research and Development of Standardization – National Standardization Agency of Indonesia (BSN) concluded that the ozone resistance of rubber hoses is one of the quality requirements that need to be improved. The results of the study also recommend the need for rubber hose manufacturers to evaluate the quality level of raw materials and rubber hose production processes to improve product quality and fulfill SNI quality requirements.

The results of the thermoplastic elastomer (TPE) hose test (based on SNI 8022:2014) show that 100% of thermoplastic elastomer hoses samples passed the quality requirements of pentane resistance and ozone resistance (see Table 2). However, the results of the resistance test to n-pentane extracted material for the TPE hose X showed a value of 9.40% which was close to the maximum limit value of the extracted material in SNI 8022:2014 (maximum limit value is 10%). This indicates the need for corrective steps that must be taken by the TPE hose X manufacturer so that the quality of TPE hose X can reach a more optimal value.

Thermoplastic products have good chemical resistance but have low impact strength in ideal conditions (Setiorini 2019). The manufacture of thermoplastic elastomer hoses uses different raw materials (rubber and plastic) and additional materials (additives) that will result in different characteristics of the resulting hose. Some additional materials (additives) include antioxidants, colorants, heat stabilizers, and ultraviolet stabilizers. The resistance of n-pentane can also be affected by the addition of a colorant. This is because the colorant affects the resistance of plastic products to heat and chemicals (Mujiarto 2005). The quality of rubber and TPE hoses is also affected by storage conditions. The storage of rubber and TPE hose should follow the procedures as described in Table 3 so that the fulfillment of quality requirements for n-pentane and ozone resistance can also increase.

Conclusions

Overall, the rubber hose and thermoplastic elastomer (TPE) hose samples passed the quality requirements for pentane resistance and ozone resistance (based on SNI 7213:2014 and SNI 7213:2014). However, the fulfillment of resistance to n-pentane for rubber hoses is better than thermoplastic elastomeric hoses. This can be seen from the test results where the resistance of n-pentane (for extracted material) is close to the maximum limit value (Thermoplastic elastomer hose X). For ozone resistance, all rubber hose and thermoplastic elastomer (TPE) hose samples were not cracked after the test was carried out.

Acknowledgements: The authors would like to thank the National Standardization Agency (BSN) for supporting the implementation of this research. The authors also thank Mr. Mangasa Ritonga for his guidance in this research.

Conflict of Interest: The authors declare that there are no conflicts of interest concerning the publication of this article.

References

Badan Standardisasi Nasional. 2009. Pengantar standardisasi, Jakarta.

Dewi L, and Somantri Y. 2018. Wireless Sensor Network on LPG Gas Leak Detection and Automatic Gas Regulator

System Using Arduino; IOP Conference Series: Materials Science and Engineering. IOP Publishing.

Hassan MM, Aly RO, El-Ghandour AH, and Abdelnaby HA. 2013. Effect of gamma irradiation on some properties of reclaimed rubber/nitrile–butadiene rubber blend and its swelling in motor and brake oils. Journal of Elastomers & Plastics, 45(1):77–94.

Hutagalung EA, and Bukit N. 2018. Analisis Sifat Mekanik Nanokomposit Termoplastik Elastomer (TPE). EINSTEIN (e-Journal), 6(1).

Ismail H, Abdul M, and Mat Taib R. 2016. Effects of dynamic vulcanization on tensile, morphological, and swelling properties of poly (vinyl chloride) (PVC)/epoxidized natural rubber (ENR)/(Kenaf core powder) composites. Journal of Vinyl and Additive Technology, 22(3): 206–212.

Ismail H, Ishak S, and Hamid ZAA. 2015. Effect of blend ratio on cure characteristics, tensile properties, thermal and swelling properties of mica-filled (ethylene-propylene-diene monomer)/(recycled ethylene-propylene-diene monomer)(EPDM/r-EPDM) blends. Journal of Vinyl and Additive Technology, 21(1): 1–6.

Kinasih NA, and Fathurrohman MI. 2018. Pengaruh kondisi reaksi terhadap karakteristik ketahanan karet alam epoksi dalam n-pentana. Jurnal Sains Materi Indonesia, 17(3):102–109.

Kusriyanto M, Yulianto A, and Kurniawan S. 2018. Early detection of LPG gas leakage based Wireless Sensor Networking; MATEC Web of Conferences. EDP Sciences.p.1045.

Mujiarto I. 2005. Sifat dan karakteristik material plastik dan bahan aditif. Traksi, 3(2), p.65.

Narathichat M, Kummerlöwe C, Vennemann N, Sahakaro K, and Nakason C. 2012. Influence of epoxide level and reactive blending on properties of epoxidized natural rubber and nylon-12 blends. Advances in Polymer Technology, 31(2): 118–129.

Nurhajati DW, Supraptiningsih S, and Sarengat N. 2015. Pengaruh pemlastis nabati terhadap sifat elastomer termoplastik berbasis campuran karet alam/poli propilena. Majalah Kulit, Karet, dan Plastik, 31(2): 75–84.

Saefullah A, Syahrial H, and Santoso A. 2012. Pendeteksi Kebocoran Tabung Gas Lpg Menggunakan Mikrokontroller At89S2051 Melalui Handphone Sebagai Media Informasi. 2012(Semantik): 18–25.

Setiorini IA. 2019. Karakteristik Termoplastik Elastomer dari Karet Alam dan Polipropilena dengan Penambahan Carbon Black Filler. Jurnal Teknik Patra Akademika, 10(02): 41–44.

Sialagan S. 2013. Pengendalian Mutu Dalam Manajemen Mutu ISO 9000. Majalah Ilmiah Bina Teknik, 1(1): 23–27.

Sondari D, Haryono A, Ghozali M, Randy A, Suhardjo KA, Ariyadi B, and Surasno S. 2010. Pembuatan Elastomer Termoplastik Menggunakan Inisiator Potassium Persulfate Dan Ammonium Peroxydisulfate. Jurnal Sains Materi Indonesia, 12(1): 41–45.