International Journal of New Technology and Research (IJNTR)
ISSN: 2454-4116, Volume-8, Issue-4, April 2022 Pages 29-32

Mechanical and Insulation Property Analysis of Silicon Rubber Mixed with Al_2O_3 Insulation for Subsea Pipelines

Mahesh Tate, .Sandeep S. Wangikar

***Abstract*— The research has been carried out to check mechanical properties of RTV Silicon rubber when mixed Al2O3 Insulation. As offshore oil and gas production moves deeper into the sea, the likelihood of hydrate filling of pipelines and flow lines grows, as does the cost of removing any such plugs. Blowing down, hot oiling, and methanol injection are all expensive and ineffective methods of preventing hydrate blockages. For example, where the subsea manifold is on top of the riser base, or where the flow line route includes significant high and low areas to entice gas, the method of emission gas is quite advanced. Silicon rubber insulation is solution for such kind of problems. The light-weight insulation material with magnificent performance square measure with success fancied employing Al2O3 as a substance. The addition of different particle sizes of Al2O3 has a positive impact on the qualities of light-weight insulation material. Synthetic rubber is a rubber-like material made out of compound|siloxane|polymer, which is a polymer having semiconductor on the side of carbon, hydrogen, and oxygen. Polymer rubbers square measure widely used in commerce, and their square measure numerous formulas. Polymer rubbers are typically one- or two-part polymers that should contain fillers to improve characteristics or reduce cost.**

***Index Terms*— RTV Silicon rubber, Synthetic rubber .**

I. INTRODUCTION

The current invention relates to an insulation material to be employed on subsea oil and gas production equipment. Once subsea oil and gas wells are drilled to depths of 5,000 feet or more, the pipelines and wellhead instruments are exposed to saline that is several degrees hotter than cooling. This temperature will be found in shallow water at extreme latitudes, such as the sea. During a temporary well closure, hot produced fluids within the assembly instrumentation get stagnant and are cooled by the surrounding saltwater. If the stagnant fluids reach brine temperature, hydrates will form within the device and obstruct fluid movement. Thermal insulation is commonly installed around subsea pipes and wellheads.

Nanoparticles crammed synthetic rubber having insulating properties, thermal and optical stability. nano-Al2O3 synthetic rubber composites having high tensile strength [1]. A larger Al2O3 powder mass fraction results in a better thermal physical phenomena of the composites [2], Also Al2O3 impacts Thermal conductivity of silicon rubber [3]. Silicon rubber generally shows change in mechanical properties when used with Nano partials like Al2O3, FlyAsh, CNTs etc. [4]. Silicone rubber has very good joint strength as like other newly involved materials like FRP[5]. Silicon rubber has terribly high pursuit resistance, flame retardancy and electrical erosion resistance[6]. Also granularity of mixing element having impact on mechanical properties of Silicon rubber composite [7].

Mahesh Tate, . Department of Mechanical Engineering, SVERI's College of Engineering Pandharpur
Sandeep S. Wangikar, Department of Mechanical Engineering, SVERI's College of Engineering Pandharpur

II. MATERIALS AND METHODS

Our main goal was to create a homogeneous sample that could be used in subsea pipe lines for oil and gas by utilizing liquid synthetic rubber (LSR). Table one shows the parameters of liquid synthetic rubber in the following Table1.

Table 1: Specifications of Liquid Silicone Rubber

Sr No	Typical Properties	
1	Durometer - Shore A	40 Shore A
2	Elongation	325 %
3	Shelf Life	540 Days
4	Appearance (as cured)	Yellow
5	Viscosity (base)	55,000 cP
6	Viscosity (curing agent)	300 cP
7	Specific gravity	1.08
8	Tensile strength	5.5 MPa

A. Making Silicone Rubber with and without Fillers

First take G.I. sheet then mold it to required shape & size (100 X 100 X 8) mm thickness. Take required amount of silicone gel in a bowl. the hardener, in the required quantities, added to the silicone polymer liquid. When making the Al2O3 mixture, add required amount of Al2O3 in 5,10, & 15 % respectively. Stir well and make sure no air caught by mixture. Fill the tray with same and allow to set few hours.

B. Test for analysis of silicon rubber without and with filler Al_2O_3

The properties of silicon rubber without and with filler Al_2O_3 were analyzed. The Wear, chemical (salt test, acid) and tensile test were conducted. The analyses of results are

discussed in next section.

III. Results and Discussion

A. Test for analysis of silicon rubber

Microstructure analysis

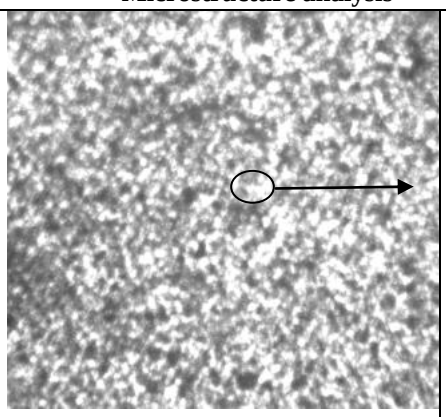

Fig (a) 50x

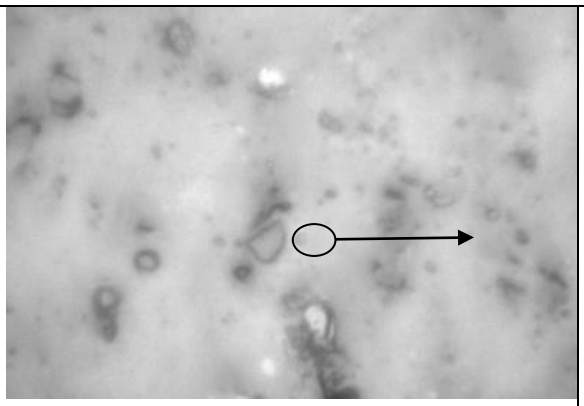

Fig (b) 500x

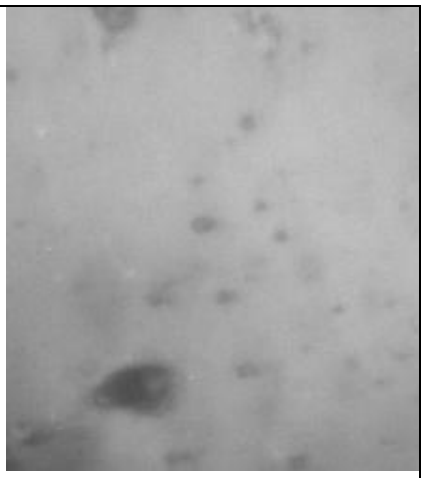

Fig (c) 1000x

Al2O3 is mixed with RTV synthetic rubber shows sensible bonding between particles. on top of microscopic analysis shows that there no bubbles found once Al2O3 is mixed with RTV silicone polymer. Analysis is meted out at fifty X, 500X and 1000X severally. Microscopic analysis show that RTV is mixed with Al2O3 that increase the mechanical properties.

Chemical Test

(A) Salt test: The slat test is performed by immersing a five-weight percentage of Al2O3 specimen in a NACL solution produced with 5, 10, and 15% distilled water. This experiment was carried out to determine the effect of sea water on Silicon rubber mixed with Al2O3.

Fig (d) Salt Test of Silicone Rubber with and without Al_2O_3

Table 2: Salt Test of Silicone Rubber with and without Al_2O_3

Time in (min)	NaCl Solution (NaCl gms)	Distilled water(ml)	Weight of Silicone Rubber Before Test (milligram)		Weight of Silicone Rubber After Test (milligram)	
			Without Al_2O_3	With Al_2O_3	Without Al_2O_3	With Al_2O_3
300	5	100	1864	1957	1864	1957
	10		1860	1953	1860	1953
	15		1862	1955	1862	1955
600	5		1864	1957	1864	1957

	10		1860	1953	1860	1953
	15		1862	1955	1862	1955
900	5		1864	1957	1864	1957
	10		1860	1953	1860	1953
	15		1862	1955	1862	1955

(B) Acid test:

The Acid test involves submerging a five-weight percentage Al2O3 specimen in a dilute HCL solution. The purpose of this experiment was to test the effect of acid on Silicon rubber combined with Al2O3. The outcomes are as follows.

Table 3: Acid Test of Silicone Rubber with and without Al2O3

Time in min	HCL in (ml)	Weight of Silicone Rubber Before Test (milligram)		Weight of Silicone Rubber After Test (milligram)	
		Without Al_2O_3	With Al_2O_3	Without Al_2O_3	With Al_2O_3
60	100	1670	1753	1670	1753
240	100	1674	1758	1670	1758

(C) Elongation Test: Elongation is very parameter when it comes to application of insulation on subsea pipeline. We have performed elongation test using UTM to check elongation of silicon rubber mixed with Al2O3 of weight percentage of 10.

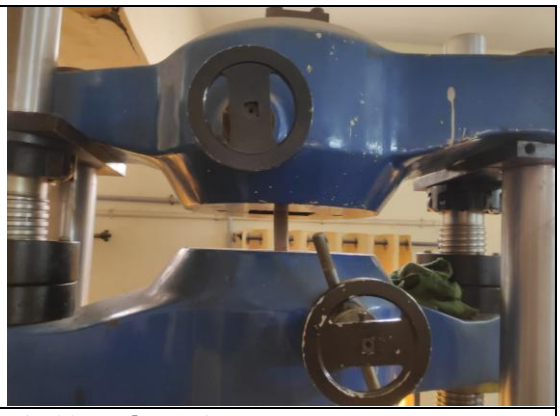

Fig (e) Elongation Test

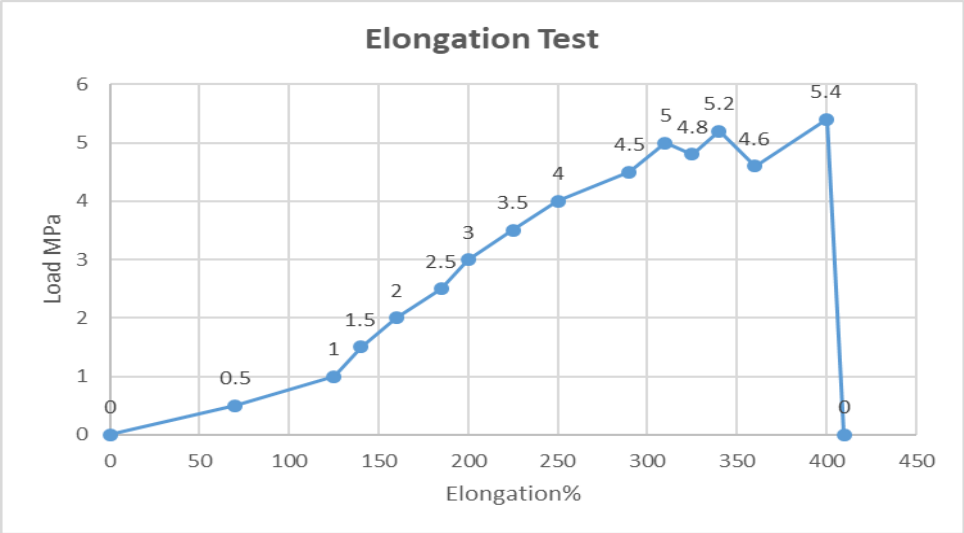

Fig (f) Elongation of Silicon Rubber Mixed with Al2O3

With Al203 The above graph illustrates that Liquid silicone rubber with Al2O3 as filler had a peak load of 50MPa, whereas elongation break was at 5.4 MPa

IV. Conclusions

The experimental results show that silicon rubber mixed with Al2O3 has no effect from salt water or acidic conditions. To perform successfully in this environment, a thermal insulation material should have an occasional thermal physical phenomenon, acceptable mechanical properties such as flexibility and impact resistance, and be inexpensive to install. The insulating requirements square measure any complicated by the acute temperatures of the organic chemical fluids in numerous subsea wells, specifically those in danger. Chemical element rubber combined with Al2O3 exhibits improved performance and smart mechanical qualities, allowing this mixture to meet such insulating requirements. Furthermore, this mixture will withstand up to three hundred nothing elongation, which is the minimal demand for subsea insulation material.

References

[1] Xu, Y., Gao, Q., Ouyang, C. F., Guo, H., & Xiang, X. (2014, June). Study on the Properties of Nano-Al2O3/Phenyl Silicone Rubber Composites. In 2015 International Conference on Material Science and Applications (icmsa-15) (pp. 1031-1036). Atlantis Press.

[2] Lin, J. L., Su, S. M., He, Y. B., & Kang, F. Y. (2020). Improving thermal and mechanical properties of the alumina filled silicone rubber composite by incorporating carbon nanotubes. New Carbon Materials, 35(1), 66-72.

[3] Kim, Y. K., Chung, J. Y., Lee, J. G., Baek, Y. K., & Shin, P. W. (2017). Synergistic effect of spherical Al2O3 particles and BN nanoplates on the thermal transport properties of polymer composites Part A Applied science and manufacturing.

[4] Sam Markkula," Uniaxial tension and compression characterization of hybrid CNS–glass fiber epoxy composites." Composite Structures 95 (2013) 337–345.

[5] Wei Xiong," The effect of composite orientation on the mechanical properties of hybrid joints strengthened by surfi-sculpt." Composite Structures 134 (2015) 587–592.

[6] Qiu, J., Lai, X., Fang, W., Li, H., & Zeng, X. (2017). An efficient strategy for simultaneously improving tracking resistance and flame retardancy of addition-cure liquid silicone rubber. Polymer Degradation and Stability, 144, 176-186.

[7] Hu, Y., Mei, R., An, Z., & Zhang, J. (2013). Silicon rubber/hollow glass microsphere composites: Influence of broken hollow glass microsphere on mechanical and thermal insulation property. Composites Science and Technology, 79, 64-69.