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Vibration Exposure Analysis of the Polysiloxane Reinforced with Rice Husk Silica

Shahruddin Mahzan[1, a], Mohd Azham Azmi [1,b], Hariati Taib [1,c] and Nurul Emi Nur Ain Mohammad [1,d]

[1] Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia

[a] sharudin@uthm.edu.my , [b] azham@uthm.edu.my, [c] hariati@uthm.edu.my, [d] mimi.ain202@gmail.com

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Abstract. One of approaches to protect devices from unpleasant vibrating disturbances is by employing a vibration absorber. This paper explores the viability of polysiloxane as raw material, added with rice husk silica fillers to produce a vibration absorbent sheet. The polysiloxane reinforced with rice husk sheets were made using hot compression moulding technique. The samples were tested for its density and tensile tests according to related standards. As for vibration test, a portable hand grinder was used to estimate the vibration exposure experienced by the users. The polysiloxane sheets were strapped on the tool's handle and the vibration exposure was measured. The result shows that by applying the polysiloxane sheets on the tool grinder reduces the vibration magnitude by a maximum value of 38 percents. The longest vibration time exposure was recorded for 6.42 hours, improved by 150 percents from the original vibration time exposure of 2.52 hours. The results also demonstrated that polysiloxane with 4 wt. % rice husk silica was the optimum combination for vibration application since it produced highest vibration magnitude reduction and longest vibration exposure time of grinder applications.

Introduction

Polysiloxane or polymerised siloxane is basically silicones mixed with multiple inorganic-organic polymers. It is already recognised by the industries as the latest generic class of high performance protective coating [1]. Polysiloxane has become one of the important organo-silicon polymers used in the polymer chemistry due to significant improvements for heat stability, chemical and oxidation resistance and degradation [1]. Also, polysiloxane rubbers have attracted wide industrial use due to several advantages such as good weatherbility, flexibility, good electrical isolation, permeability to gases, low surface energy and resistance to oil [2,3]. Despite various advantages of polysiloxane, elastomers generally have too low elastic modulus to serve as a matrix for rigid structural composites. This silicone rubber has a good performance of the resistance for high and low temperature but poor in mechanical damping properties. Therefore, polysiloxane rubber requires reinforcements to increase its strength.

The ability of polysiloxane rubber sheets to absorb vibration is rarely found in an application such as in industry, packaging and transportation [4]. In most cases, researcher provides a tuned vibration absorber (TVA) for suspension for their applications [5,6,7]. The amount of damping are depending on the materials for which the part was made, design, geometry and mass. It involved adjustment to any involving elements thus creating a system that reduced the vibration.

This paper explores the viability of polysiloxane rubbers to be employed as a vibration absorber. Fillers are used to improve the mechanical properties of rubbers whereas reducing the elasticity [8]. Here, rice husk silica was used as the reinforcement. Rice husk silica was added to the rubber formulations to promote the improvement of their mechanical properties including modulus, hardness and rupture energy [3,8,9]. Our study will provide further understanding of the influence of the filler to the vibration characteristic and physical properties based on polysiloxane.

Materials and Methodology

Preparation of Polysiloxane Filled Rice Husk Silica. This investigation used two main of raw elements, namely the silicon rubber and rice husk silica. The type of silicone rubber used was Xiameter RTV-4130-J, whereas the rice husk silica was derived from the rice husk. The rice husk was initially washed in order to remove clay and impurities before dried in an oven at 120°C for 24 hour. The rice husk was then burnt at 700ºC for 8 hour with hold time 10C/min to produce the rice husk silica. In order to produce the polysiloxane sheet, the silicone rubber (polysiloxane) was mixed together with curing agent and silicone oil via portable stirrer. The rice husk silica was then added into the compound according to specified weight percentage. The mixtures were cured by compression moulding at 65°C with pressure of 1.0MPa for 0.5hour until homogenous in shape and thicknesses were achieved. The polysiloxane rubber sheets were prepared from 0 wt. % until 14 wt. % of fillers with a dimension of 30 x 30 x 3 cm.

Experimental Works

All the experimental works were done in UTHM laboratory. The polysiloxane reinforced with rice husk silica samples were tested for density, tensile and vibration tests. As for density test, the Archimedes principle was employed by utilising the weighing scale unit according to the ASTM D792. The tensile test was conducted using Shimadzu 1000kN universal testing machine following the ASTM D412. The UTM machine was equipped with a 10KN load cell operating at a cross head speed of 10mm/min. The vibration analysis was conducted for a portable grinder according to the ISO 8662 P4. Here, the vibration exposure level was measured through the handle of the grinder machine, as demonstrated in Fig. 1. The rubber sheets were tested to determine the effects of filler percentage into the polysiloxane compounds.

Fig. 1: Portable grinder attached with the polysiloxane sheets

Results and Discussion

Density Analysis of Polysiloxane Filled Rice Husk Silica. The density test was conducted to identify the variation of different weight percentages of silica in polysiloxane composite. The average density of the polysiloxane sheets of eight samples was tabulated in Table 1. The density of polysiloxane filled with 14 wt. % rice husk silica was found higher than density of polysiloxane filled with 0 wt. % rice husk silica which was about 1.358 g/cm^3 and 1.247g/cm^3 respectively. This was due to the porosity structure of both composites samples. It was well known that the higher the density, the higher the weight of polysiloxane compounds obtained [4, 10].These factors happened when the mass of mixture increased, the density also increased.

Table 1: Density for Polysiloxane filled rice husk silica

Sample (%wt)	Density (g/cm^3)	Sample(%wt)	Density (g/cm^3)
0	1.247	8	1.293
2	1.260	10	1.296
4	1.269	12	1.303
6	1.278	14	1.358

Tensile Test of Polysiloxane Filled Rice Husk Silica. The maximum stresses of polysiloxane rubber sheets were also tested for different percentages of fillers. The values of maximum stress of rubber sheets are demonstrated in Fig. 2. The result shows that the highest maximums stress obtained for composite with 10 wt. % of filler whereas the lowest maximum stress obtained for composites with 14 wt. % of rice husk silica fillers. The maximum stress was recorded at 4.46 MPa and the lowest maximum stress was 3.58 MPa. It can be seen that increasing in rice husk silica fillers increases the maximum stress. However, the value was dropped after 10 wt. % due to uneven distribution of rice husk silica thus failed to completely fill the entire space in the rubber sheets.

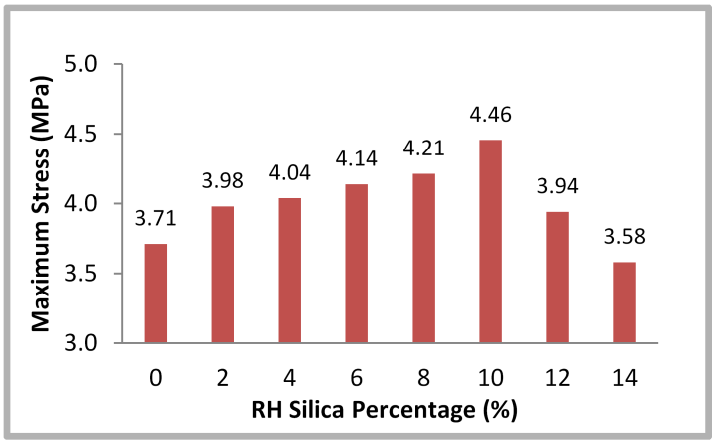

Fig. 2: Maximum stress of polysiloxane filled rice husk silica

Vibration Exposure of Polysiloxane Filled Rice Husk Silica. The polysiloxane composite was attached to a portable grinder machine. The vibration level was measured in terms of vibration magnitude and exposure to operators. The test was conducted in three trials and the unfixed parameter was the wt. % of rice husk silica contents. Fig. 3 shows the vibration exposure magnitudes obtained for nine different rice husk silica contents. The result shows that the vibration magnitude exposure is higher at X1, which was the original measurement without additional rubber sheets. The vibration magnitude was 0.32 m/s². The vibration magnitude was then decreased when the percentage of silica increased up to 4 wt. % of rice husk silica. The lowest value of vibration magnitude obtained at 4wt% where the value was 0.20 m/s². This reduction was equivalent to a 38 percents reduction. The magnitude starts to increase when more silica were added into the polysiloxane. As for vibration magnitude, these variations may due to the factors of filler size, density and surface area. This is because the damping property is related to the effects of fillers and the interactions between filler and matrix [11].

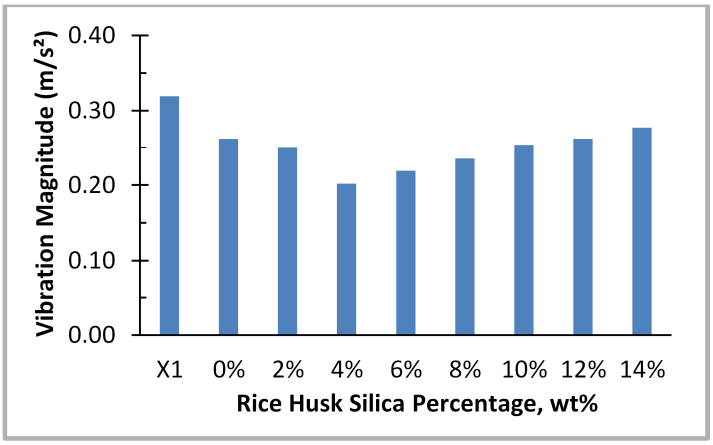

Fig 3: Vibration Exposure Magnitude

In Fig. 4, the vibration time exposure against rice husk silica percentages was illustrated. The result shows that the grinder permits only 2.57 hours to operate without harming the users. By adding the rice husk silica into polysiloxane composite, the number of hours of operation is increased. The longest permissible time to operate the grinder was when 4% of rice husk silica was added, which recorded about 6.42 hours of operations. This was about 150% betterment from the original condition. The other weight percentages of rice husk silica also found to be better than the original condition. This result shows that the tear strength increases with increasing the surface area of the filler. Additional of rice husk silica into the polysiloxane composites improves the handling of the grinder for a longer period of operations.

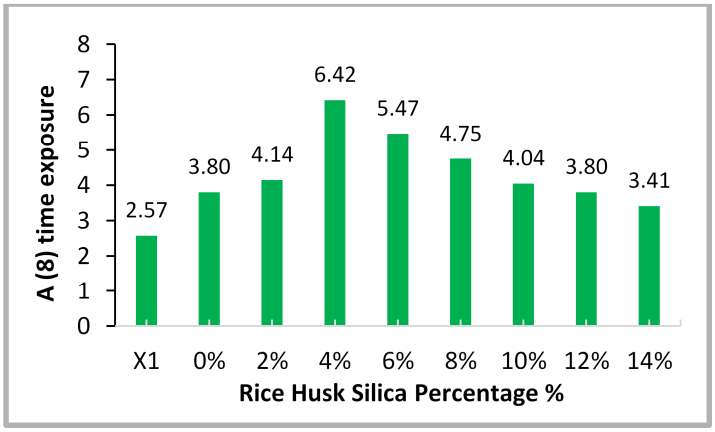

Fig. 4: Vibration Time Exposure

Conclusion

As a conclusion, the polysiloxane added with rice husk silica composite has demonstrated good vibration absorption. The capability of the polysiloxane filled with 4 wt. % of rice husk silica to absorb vibration is higher than the other percentage of the rice husk silica as fillers. The polysiloxane composite was not only reduces the vibration magnitude but also extends the usage of grinder for a longer period of usage time. This provides an operator a healthy operation condition. This rubber sheets can be applied in any application especially in industry field and manufacturing packaging as well as vibration absorbent.

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References

[1] N.R. Mowrer, Polysiloxane: Society of the Plastics Industry, (2003).
[2] L. Sussman, Introduction to Polymers for Polysiloxane, The American Chemical Society (1990).
[3] R. G. Jones, W. Ando, J. Chojnowski, Silicon - Containing Polymers, Kluwer Academic Publisher, (2011).
[4] S.-Y. Fu, X.-Q. Feng, B. Lauke and Y.W. Mai, Effects of Particle Size, particle / matrix interface adhesion and particle loading on mechanical properties of particulate polymer composites, Applied Science - Part B, 39 (2008) 933-961.
[5] Z. X. Xin, X. Z. Zhang, K. Pal, J. U. Byeon, S. H. Lee and J. K. Kim, Study of Microcellular Injection- Molded Polypropylene/Waste Ground Rubber Tire Powder Blend, Mtrls and Design. 31(1) (2010) 589-593.
[6] J. Lee and M. Leea, Passive Vibration Reduction with Silicone Springs and Dynamic Absorber, Physics Procedia. 19 (2011) 431-435.
[7] M. A. Abdullah, Effect of Frequency and Amplitude of Vibration on Void Formation in Dies Poured from Polyvinyl Siloxane Impression, J. of Prothestic Dentistry, (1998) 490 – 494.
[8] L. Sereda, L. L.Y. Visconte, R.C.R. Nunes and C.R.G. Furtado, Effect of Silica and Rice Husk Ash Fillers on the Modulus of Polysiloxane Networks, J. App. Polymer Sci. 90 (2003) 421-429.
[9] J. Brydson, Rubber Materials and Their Compound, (1998), Applied Science : London
[10] M.M., Haslinawati, K.A. Matori, Z.A. Wahab, H.A.A. Sidek and A.T. Zainal, Effect of Temperature on Ceramic from Rice Husk Ash, Int. J. of Basic & App. Sci., 9 (9) (2009) 22 – 25.
[11] Z.A.M. Ishak and A.A. Bakar, An Investigation on the Potential of Rice Husk Ash Fillers for Epoxidised Natural Rubber (ENR). European Polymer Journal, 31 (3) (1995), 259 – 269.