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Design of Rubber composite for Cement Packing

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Abstract:
The aim of this research is to produce an improved rubber valve by adding reinforced nanoparticles (zinc oxide) used to increase the protection of the rubber valve against tearing and wear and to improve the flexibility and service life of the valve. Nano zinc oxide have been prepared in vitro. Nano zinc oxide were tested for[X-rays (XRD), Scanning Electron Microscopy (SEM), Chemical Analysis (EDS)].The results showed that zinc oxide produced with a high surface area of less than 100 nm nanoscale, confirmed by scanning electron microscopy (SEM) and X-ray examination (XRD) in addition to 100% purity through the (EDS) test .Zinc oxide nanoparticles were used as fillers in different percentages ofpphr (0.2, 0.6, 0.8, 1 , 1.2) to rubber pastry consisting of (100 % butyl rubber and 5 % neoprene rubber).In order to ensure that the nanoparticle (zinc oxide) added to the rubber affects the mechanical properties of the rubber, the following test were carried out (hardness).The results showed a decrease in hardness with increased ratios.The results are sequentially as follows (49 ,49 , 45.6, 44.8 , 42.4).

Keywords: *butyl rubber ,nano zinc oxide, neoprene rubber.*

I. INTRODUCTION

Due to its desirable requirements such as flexibility, light weight and other requirements, rubber has played a major role in modern civilization. There are various rubber types, such as natural rubber (NR), synthetic rubber (SBR), (BR) and others. Rubber comes as a base material in overlapping products (composite materials) where raw rubber is combined with other additives necessary for making the rubber product suitable for theapplication for which it was made, it should be noted that the rubber material specifications are highly dependent on the vulcanization process or (entanglement).In the vulcanization process, other materials are applied to the rubber in order to improve some of its characteristics in order to promote its production or reduce costs.Zinc oxide, citric acid, accelerators and carbon dioxide are one of the most important additives in rubber vulcanization. If nano-scale zinc oxide minutes are used to trigger the rubber dough and the quantity of zinc oxide reacts almost entirely due to its large surface area and remains a marginal excess that can be overlooked and strongly linked to the polymeric network.The Sol-Gel technique is one of the distinct methods for the production of zinc oxide nanoparticles. This is because of its simple mechanism, low price and low operating temperature requirements, Several science studies have looked at the impact of nano scale zinc oxide on different kinds of rubber [1] .

The purpose of this paper is improved mechanical properties of the rubber spout and boost the operating life of the spout, thereby lowering the costs of the repeated replacement of the rubber spout due to fast failure.

II. EXPERIMENTAL PART

2.1 Materials Used

ZnO powder prepared using zinc acetate dihydrate, oxalic acid sol-gel method, using ethanol as a solvent. The following materials have been used to treat O-xylene, Olic acid, Toluene.

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Table (1) shows the requirements for the components used in nanozinc oxide preparation and therapy

Table 1.Specification for materials used for the preparation and treatment of zinc oxide nanoparticles

Material	Toluene	O – Xylene	zinc acetate	Oxalic acid	Olic acid
	C6 H5-CH3			HOOCCOOH.2H2O	
		C6H4(CH3)2	C4H6O4Zn.2H2O		C18 H 34 O2
Molecular Weight	92.14	106.2	219.5	126.07	282.46
Country of Origin	China	USA	Switzerland	China	Germany
Purity	…..	…..	…..	99.60%	99.90%

Table 2.The Composition of the Master Batch (Recipe) of RubberSpout

Item	compounding ingredients	pphr					
1	Butyl rubber IIR	100	100	100	100	100	100
2	Neoprene CR	5	5	5	5	5	5
3	Traditional ZnO	5	…….	…….	…….	…….	…….
4	Nano ZnO	…….	0.2	0.6	0.8	1	1.2
5	Vulkaresen	10	10	10	10	10	10
6	Castor oil	5	5	5	5	5	5
7	HAF Black	60	60	60	60	60	60

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Total	185	180.2	180.6	180.8	181	181.2

2.2 Synthesis of ZnO nanoparticles

An 11 g of the zinc acetate dehydrate, oxalic acid 12.6 g, and 500ml ethanol its purity of 99.90% was used in the following steps:

1. Dissolve: Dissolves zinc acetate dehydratesalt(Zn(CH3COO)2 • 2H2O) in 300 ml of ethanol at a temperature of 60 C˚ for 30 minutes and in another bowl, dissolve oxalic acid (HOOCCOOH.2H2O) with 200 ml of ethanol at a temperature of 50 C˚.

2 .Mixing: Adding warm acetate solution to the oxalic acid solution which remains under constant mixing for 24 hours, where the white thick liquid is noticed.

3. Evaporating and Drying: At this stage, the excess humidity is removed by evaporation on a hot plate at 80 C˚ for 20 hours, then drying in an oven at temperature 600 C˚ for 3 hours. After evaporation, the material was weighed. The weight of the resulting ZnO nanoparticles prepared by this procedure was 7 g27. Then, the resulting ZnO nano particles were modified to get perfect homogeneity of nano ZnO by the introduction of reactive groups to the filler surface. The modification process was achieved by using Oleic acid for the surface modification of ZnO nanoparticles. (9 ml) was dissolved in 300 ml o-xylene to form an oleic acid solution. Then, the prepared ZnO nano-particles (6 g) were added to the above solution and allowed the reaction to perform at 50 °C under stirring for 1 h. Finally, the particles were separated by centrifuge at 15000 rpm for 15 minutes and washed three times with toluene, to remove the un-reacted coupling agents and then dried. The flask was covered by para film and standing for 1 days. Then the modified ZnO nanoparticles become ready to use [1,2] .

2.3 Tests for fillers materials:

2.3.1 X-Ray Diffraction Analysis (XRD):

X-ray diffraction gives the effect of the overlap of similar structures inthe size and wavelength of radiation, which is used to examine the orderly of arrangments of molecules and atoms through the interaction of electromagnetic radiation which gives information on the geometry of scattering structures[3].

2.3.2Scanning Electron Microscopy (SEM):

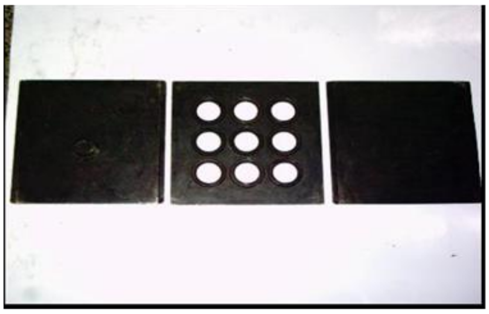
Scanning Electron Microscopy scans a focused electron beam over a surface to create an image. The electrons in the beam interact with the sample, producing various signals that can be used to obtain information about the surface topography and composition[4].In these analyses, the surface of the specimen were coated with gold. The specimens were tested at different magnifications. These analyses are done by using SEM type (Tescan,Chic).

2.3.3Energy Dispersive X-Ray Spectroscopy (EDS):

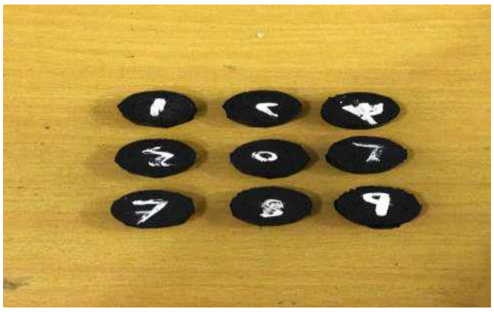
This technique provides information about the chemical composition of the particles as when a material is irradiated with an electron beam, X-rays are generated and can be detected . The obtained EDS spectrum is obtained after collecting the photons emitted by the sample for a certain period of time (minutes). It allows identifying and quantifying the different elements present in the material. This technique is coupled to transmission or scanning electron microscopes and X-ray microscopes[5].

2.3.4 Hardness Test:

Preparation of the sample for the purpose of testing the hardness , where the use of a template containing three parts of the bottom of the base and the top part is considered as a cover with dimensions 150 * 150 * 10 mm, the middle part is a dimension of 200 * 180 * 6.5. Contains 9 circles open where are placed The samples are enclosed and sealed by the upper part and placed in a hydraulic press for vulcanization at pressure 500 PSI and temperature 160ºC for 30min. The samples are taken off from the mould and left for 24hr for cooling before test as shown in fig 1.a,b



1. (a)



1. (b)

Figure 1.a show the mold of hardness sample Fig 1. b show the sample of hardness test

Sample testing:

International Hardness Testing one of the most important measurements of solid ball penetration in a rubber sample is in certain conditions where the test is performed according to ASTM-2240 standard using (Shore A) endurance scale fig 2, where the hardness gauge is used directly through the needle surface to measure the rigidity. Each sample has(5) readings to verify the accuracy of the test[6].

Figure 2. Hardness (Shore A) Test Equipment

III. RESULTS AND DISCUSSION

3.1 Analysis of the Results of Nano-Zinc

3.1.a X-Ray Diffraction Analysis (XRD)

From the results of the test of the treated zinc oxide sample at different angles (5˚ to 100˚), it can be seen that the top of the curve at (2θ = 36.24) indicates the appearance of a crystalline structure. This indicates that the crystalline material prepared corresponds to the results with [7].

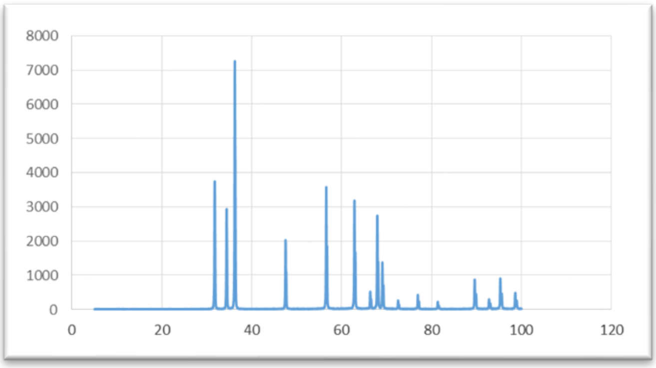


Fig 3. X- Ray Diffraction Analysis of Zinc Oxide Treated

3.1.b Energy Dispersive X-Ray Spectroscopy (EDS)

Fig(4) shows the spectrum of zinc oxide nano crystals where the purity of zinc oxide is 100 percent, since the surface treatment did not affect its purity and these findings correspond to [8,9].

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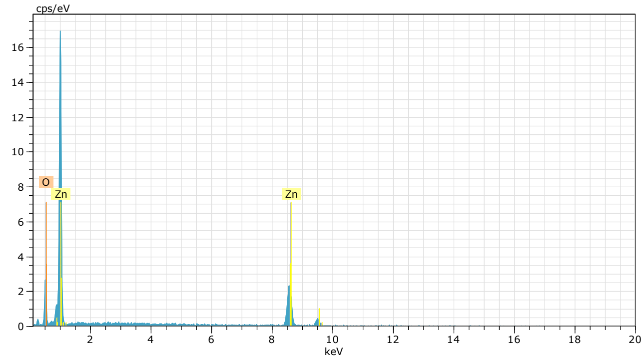

Figure 4. EDS Spectroscopy of Treated Nanoparticles of Zinc Oxide

3.1.c Scanning Electron Microscopy (SEM)

Tested zinc oxide nanoparticles showed a clear distribution of zinc oxide and non-caking, analyzes have also shown nanoparticle diameters[8].

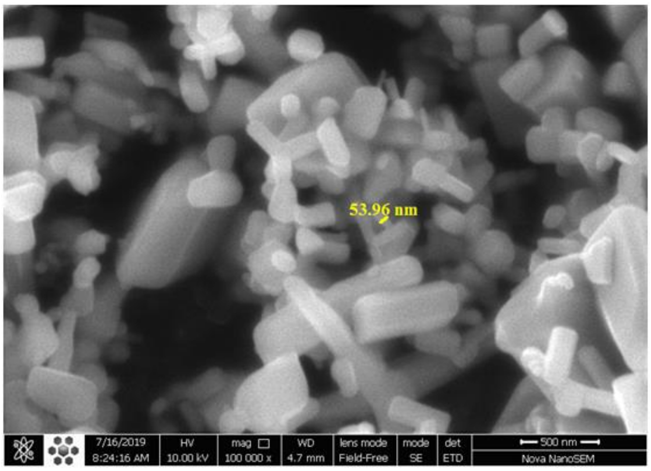

Figure 5. SEM Microscopic Image of the Treated Zinc Oxide

3.1.d Hardness

Fig(6) when zinc nanoparticles are added to rubber at distinct proportions (0.2, 0.6, 0.8, 1.0, 1.2) pphr, a slight reduction in butyl rubber hardness values is noted when the proportion of nano zinc oxide added is increased. which may have been the outcome of zno being partly devulcanized by the accelerator. The method of devulcanization produced gases that could have acted as a foaming agent, this is in line with studies[10] .

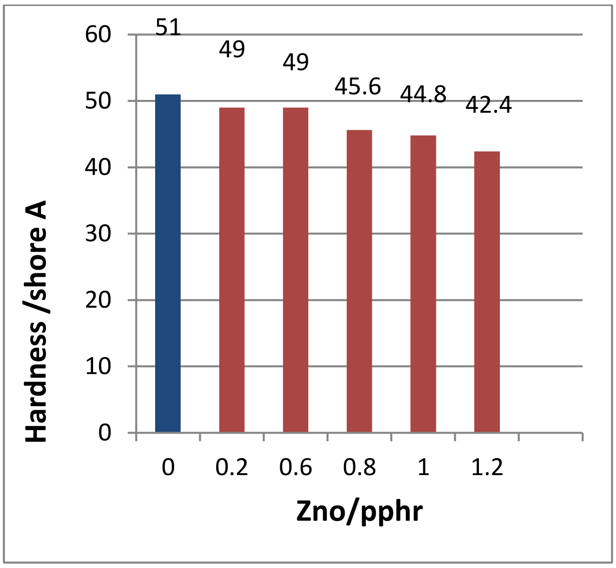

Figure 6. Effect of the Addition Quantities of Modified Nano Zinc on the Hardness of the Rubber Compound

IV. CONCLUSIONS

The best fillers percentage that can deliver the best results is (0.6).Adding small quantities of nano-fillers to rubber improves mechanical and physical properties, butby adding a large amount of fillers, aggregates of material result in weakening the properties in particular.

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