Study of Mechanical and Insulation Property of Silicone Rubber Insulation for Subsea Pipelines

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***Abstract*— Silicone Rubber Insulation designed as a flexible material which retains high stability even within extreme environments. The addition-reaction cure in this high-strength silicone rubber sets at room temperature. Regardless of part configuration or degree of confinement, there is no limit to the thickness of the part. The reaction between the base material and the curing agent generates RTV Silicone Rubber Insulation. This polymerization typically takes 10 -12 hours at room temp (25°C) followed by the addition of the curing agent. When used in temperatures below RT, it is recommended that it cure for 24 hours or until the material reaches full hardness before de-molding. Even when exposed to extreme temperatures and confinement, this material will not convert or de-polymerize. Heating the catalyzed substance can hasten vulcanization. When forming at extreme temps, the pace at which a thick part cures is influenced by the magnitude and form of the piece, as well as the capacity of heat to penetrate. Experiment were carried on RTV silicone rubber with mixing of Fly ash produced by CFB boiler for elongation, strength and different salt and acidic environments to check effect of fly ash on silicon rubber properties.**

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

I. INTRODUCTION

RTV Silicon rubber has good Insulation properties with 300% elongation, Subsea pipelines are flexible and need insulation material which accommodate such flexibility in operation. Silicon Rubber insulation is now a days compatible and easy to use solution in such scenarios. Silicon Rubber is also resistance to Sea water containing large amount of salt. In this paper we have investigated resistance of RTV silicon rubber when mixed with Fly ash against salt water, Also wear test is also carried out to understand silicon rubber behavior when there is friction at time of displacement of flexible pipes under sea water. Fly ash is generally available component which shows enhancement in mechanical property when mixed with base material like bricks clay, silicone rubber etc.

RTV Silicon Rubber is utilized in industrial applications such as water repellency of RTV coatings, where thickness is important and should be taken into account while applying the coating [1].Silicone rubber insulating materials with good performance enhance tracking resistance and flame retardancy [2]. Fly ash has been successfully used as a raw material to create a lightweight insulating material with outstanding performance[3].Also this mixture can be used as good insulation materials [4].fly ash has very good compressive strength when mixed with preparation of clay bricks [5], fly ash as it satisfied the minimum criteria of breaking load when mixed with Clay[6], Mixing of Fly ash gives good amount of heat isolation and light density [7], Silicon Rubber have good energy storage function when tested with microcapsules[8]. Higher resistance property can be also achieved when two different grades of silicon rubber Mixture when solidify at room Temperature [9] [10].

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II. MATERIALS AND METHODS

Our Main aim was to create an identical sample which can be used at subsea pipe line for oil and gas by using Liquid Silicone Rubber (LSR). The following are the properties of liquid silicone rubber as shown in Table 1.

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

1. Cut a G.I sheet mold to the desired size (100X1000X8 thickness) mm.
2. Fold the sheet into a tray shape (as per required thickness).
3. Measure out the needed amount of silicone gel in a separate bowl.
4. In the desired proportions, add the hardener to the silicone gel.
5. When making the Fly Ash Mixture, add the needed weight part of fly ash weigh percentage 10, 20, 30, and 40 respectively.
6. Make sure there is no air caught in the mixture by thoroughly stirring it.
7. Fill the tray with the solution. Allow it to set for a few minutes (generally it takes 12 hours).

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

The properties of silicon rubber without and with filler fly ash 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

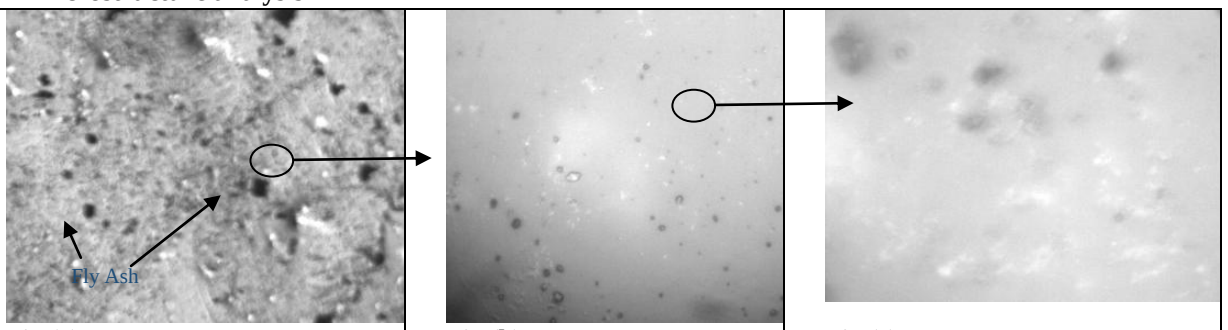

Fig (a) 50x **Fig (b) 500x** **Fig (c) 1000x**

Fly ash is mixed with RTV silicone rubber shows good bonding between particles. Above microscopic analysis shows that there no bubbles found when Fly ash is mixed with RTV Silicone. Analysis is carried out at 50 X, 500X and 1000X respectively. Microscopic analysis show that RTV is mixed with fly ash which increase the mechanical properties.

Chemical Test

(A) Salt test: Nacl solution is prepared with adding slat 10, 20, 30, 40 gms in 100 ml of Distilled water. Specimen with and without filler has kept in salt water for 12, 24, 36 and 48 hrs. respectively and weight of specimen taken for each time interval.

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

NaCl Solution (NaCl gms)	Distilled water (ml)	Weight of Silicone Rubber Before Test (milligram)		Weight of Silicone Rubber After Test (milligram)	
		Without FlyAsh	With FlyAsh	Without FlyAsh	With FlyAsh
10	100	9320	11650	9320	11650
20	100	9315	11650	9315	11650
30	100	9313	11610	9313	11610
40	100	9323	11595	9323	11595

(B) Acid test:

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

Acid	Distilled water (ml)	Weight of Silicone Rubber Before Test (milligram)		Weight of Silicone Rubber After Test (milligram)	
		Without Flyash	With FlyAsh	Without Flyash	With FlyAsh
10	100	9320	11650	9320	11650
20	100	9315	11650	9315	11650

(C) Wear Test:

Fig (d) Wear Test 100 rpm

Fig (d) Wear Test 200 rpm

When a flexible pipe is laying on the seabed, it is exposed to a lot of corrosion and wear. Thus, we conducted wear tests to measure the weight loss and wear of silicon rubber mixed with fly ash under such environmental conditions. Below are the results.

Co-efficient of friction μ= Fn / Wn
Weight Loss Wl = Initial Weight – Final Weight
Wear Rate = Wl / time

Table 4: Wear Test of Silicone Rubber with FlyAsh 20 % mixture

Time in Min	Co-efficient of friction μ	Initial Weight of Specimen Before Test (milligram)	Final Weight of Specimen After Test (milligram)	Speed of Motor (rpm)	Wear Rate
60	0.25	11000	11000	100	0
240			11000	100	0
60	0.23	11000	11000	200	0
240			11000	200	0
60	0.21	11000	11000	300	0
240			10999	300	0.004167
60	0.2	11000	10999	400	0.016667
240			10997	400	0.0125
60	0.19	11000	10998	600	0.033333
240			10997	600	0.0125
60	0.18	11000	10997	750	0.05
240			10995	750	0.020833

IV. Conclusions

The above research was carried out to check the feasibility of silicon rubber when used as insulation material for a very tough environmental conditions like seabed. We found that RTV silicon rubber is withstood extreme conditions and the negative impact of corrosion by seawater, Also wear test proves that there is very less wear, Silicon Rubber-coated surface are very smooth and elastic hence there is very less wear occur on surfaces. Fly ash makes Silicon rubber strength to withstand very high wearable conditions. The mixture of 20 percent of fly ash is a good impact on Silicon rubber mechanical properties.

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