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Preparation and Characterization of Rubber Lining Material For 33% Diluted Hcl Acid Storage Tank

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ABSTRACT

The purpose of rubber lining is to protect the vessels, tanks and piping against corrosion and/or erosion damage and increasing the life of their service. In present work isoprene/natural rubber is used to prepare the lining material for 33% diluted Hcl acid storage tank. The required parameters for rubber lining material are minimum tensile strength of 110kgf/cm², minimum elongation at break 350%, maximum ash content 35% and maximum acid absorbed 12%. To achieve the above said results a rubber lining material with appropriate composition is prepared in the form of sheet with desired thickness and the sheets are cut in to the specimens as per ASTM/IS Standards and tests like tensile strength, Ash content test and Acid bleed tests were performed and the results obtained are tensile strength=112.80kgf/cm², Elongation at break are 438.92%, ash content=31.85% and acid absorbed =7.85%.

KEYWORDS: *Natural Rubber, Vulcanization, Auto Clave, Rubber Lining, Acid Bleed , Tensile Strength*

I. INTRODUCTION

In 1893 Charles good year discovered the process called vulcanization [1]. A soft amorphous mass of natural rubber cross linked in to a resilient elastomeric material with excellent elongation, tensile strength and modulus by vulcanization process. Rubber is used as a material for manufacturing of Vehicle tires, roofing materials, latex erasers, surgical gloves, pond liners and many other products [2]. Rubber is also used in protection of storage tanks from corrosion and abrasion. Rubber in the form of prefabricated sheets will be used as a lining material in water box condenser, storage tanks, FGD Units, pipe lines, mixers, valves, chemical scrubbers and pumps. Natural rubbers are compounded in three forms soft, semi hard and hard natural rubbers [3-5]. Depending upon the requirement we can opt any one of the type of natural rubber. In present work soft natural rubber is used to prepare the rubber lining material for acid tank which is having excellent abrasion resistance, good resistance to many acids and alkalis, remains flexible to very low temperatures, good resistance to mechanical and thermal shocks, less price and it is easy to install and repair.

II. MATERIALS AND METHODS

The following section will elaborate in detail the experimental procedure carried out to prepare the rubber lining material and tests to be performed on Rubber lining material as per ASTM/IS. The steps

involved are [6-8]:

Raw Material for Rubber Sheets Preparation

Raw Materials shall be purchased from reputed agencies/authorized stockiest. Random check shall be carried out by in-house facility. Procurement of quality raw material is very important for achieving quality sheets to meet physical and chemical properties. All Raw materials chemicals shall be sieved properly to avoid any foreign particles. All Raw materials shall be kept in a separate covered shed only and free from moisture condition.

Composition for the preparation of rubber lining material

Table 2.1 composition of Raw Material for Rubber lining Preparation

Material	Function	PHR
Polymer(Natural Rubber)	Matrix Material	100
Carbon Black	Reinforcement	20
Anti Oxidants	Agent	2
Barium Sulphate	Reinforcement	40
Oil(Aromatic Rubber Process Oil)	Blending agent	7 to 8
Anti Degradants	Agent	1.5 to 2
Accelerator	To speed up the reactions in vulcanization	2.5
sulfur	Cross linking agent	2.5

Rubber Mixing and Sheet Drawing

Raw Rubber shall be pre-warmed properly and kept separately before mixing with ingredients. Necessary Batches shall be kept separately after weighing. Pre-warmed raw rubber and chemicals shall be mixed in a kneader/Roller Mill. Master Batches shall be kept separately so that accelerator can be added before sheeting. After adding accelerator all individual batches sample tested and physical and chemical properties of final compound shall be drawn in sheet from a Calendar/Roller Mill. Calendared sheet shall be wrapped with Nylon cloth and to avoid sticking each other and shall be kept in a stand before sending them for vulcanizing in an auto-clave.

Production of Lining Material

The thickness tolerance on nominal dimensions of the rubber sheet shall be ±10%.The sheet shall be free from blisters, imperfections which would affect the quality of the lining. Physical properties shall be checked before sheeting to ensure the requirements to meet the duty conditions. Thickness of the sheet shall be uniformly maintained. Unvulcanized sheet sample shall be vulcanized by keeping in the Autoclave to find the hardness before going for mass production. Chemical resistance test shall be carried out with the respective fluids being handled during operation. Resistance to the fluid shall be achieved before going for mass production. Adhesion system and application shall be done on a sample piece to meet the Requirement before taking bulk quantity of lining materials. Un-vulcanized sheet shall be wrapped as per requirement in rolls. Paper cores or PVC pipes shall be used for wrapping purpose.

Cold Bonding Lining Process

Raw material used for Rubber lining such as Natural Rubber, Carbon Black and Chemicals will be checked for specific gravity and purity after that the rubber and Chemicals are mixed in Mixing Mill.

Sheets Preparation

Sheets of suitable thickness are drawn from the machine with gada cloth as liner will be wrapped on the paper core according to the thickness. The wrapped sheets are then placed on a stand.

Vulcanization

The sheets are then placed in an Auto Clave for vulcanization process. It is suggested to carry out the vulcanization in stage wise in the Auto clave. Steam will be passed through steam hoses/GI pipes and maintained to achieve a Temperature of 100 degrees. The same temperature will be maintained till achieving the required hardness. Once the process of vulcanization is completed the sheets are unwrapped and are allowed to dry.

III. TESTS AND RESULTS

For 33% diluted Hcl acid storage tanks the rubber lining material which is used to protect the tank from corrosion requires:

Table 3.1 Required Parameters for Rubber Lining Material

Minimum Tensile strength	110kg/cm^2
Minimum Elongation at break	350%
Maximum Ash content	35%
Maximum acid absorbed (acid bleed test)	12%

After the preparation of rubber lining sheet with the composition, the sheet is cut in to specimens as per ASTM/IS Standards to determine the tensile strength, elongation at break, ash content and acid absorbed.

Tensile Strength & Elongation at Break

Tensile Testing is a way of determining how something will react when it is pulled apart, when a force is applied it in tension. It is one of the simplest and most widely used mechanical test by measuring the force required to elongate a specimen to breaking point, Material properties can be determined that will allow designers and quality mangers to predict how material and product will behave in their intended applications. The tensile test is carried out by applying longitudinal or axial load at a specific extension rate to a standard tensile specimen with known dimensions until failure occurs. The applied tensile load and extensions are recorded during the test for the calculation of tensile strength and elongation percentage. Test was performed on Universal Testing Machine (UTM). The dimensions of the specimen is as per ASTM D638 having length of 165mm, width of 19mm, thickness of 2.5mm. The specimen is loaded between to manually adjustable grips of 25tons computerized UTM. Test was repeated twice and average value is taken to calculate the tensile strength of the prepared composites. The result is expressed in kg/cm^2.

Table 3.2 Tensile Strength & Elongation at break

Rubber Lining Sheet	Tensile Strength(kg/cm^2)	Elongation (%)
Trial-I	112.80	438.92
Trial-II	112.00	439.00
Trial-III	113.60	438.84

Table 3.3 Average values of Tensile Strength & Elongation at break

Rubber Lining Sheet	Tensile Strength(kg/cm^2)	Elongation (%)
	112.80	**438.92**

It is observed that the results of Tensile Strength and Elongation at break obtained after experimentation From Table 3.3 are satisfactory when compared with the results of tensile strength and elongation at break from Table 3.1.

Ash Content

One of the major properties of rubber is the percentage of ash content in rubber. This can be done by burning the rubber component at a specific temperature and for a specific period of time in a muffle furnace. Along with this setting accurate time and temperature to treat the rubber and to determine the actual percentage of ash in the material is also important.

The procedure of ash content test is as follows:

First take a sample as per IS4862-I from prepared rubber lining sheet and weight it along with crucible. Place the crucible in muffle furnace by setting a temperature at which rubber will burn for a time interval of 20 minutes. Remove the crucible from muffle furnace and again weight the crucible after test

Ash%= ((wt. of ash after test-wt. of sample before test)/ wt. of sample before test)*100.

Table 3.4 ash content test

Rubber Lining Sheet	Ash content (%)
Trial-I	31.88
Trial-II	32
Trial-III	31.67

Table 3.5 Average Ash content

Rubber Lining Sheet	Ash content (%)
	31.85

It is observed that the results of % of ash content obtained after experimentation From Table 3.5 are satisfactory when compared with the % of ash content results in Table 3.1.

Acid Bleed Test (acid absorption test)

Acid absorption test is used to determine the amount of acid absorbed under specific conditions by rubber lining sheet. The rate of absorption depends on type of polymer, additives used, temperature and time of exposure. It sheds light on the performance of rubber lining material in acid and water environment. Procedure of acid bleed test as follows:

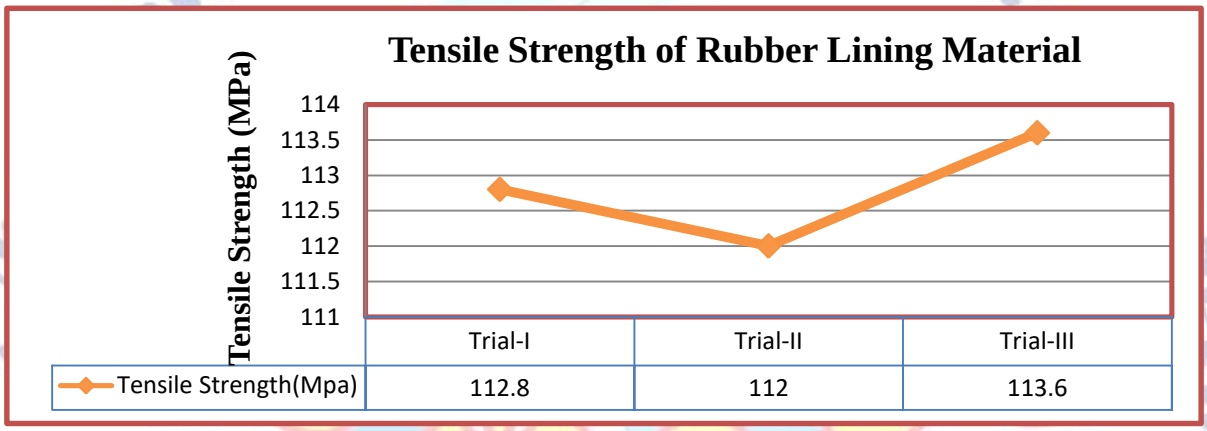
First the sample as per IS 4862-I is considered and it is dried in an oven for a specified time and temperature and then placed in desiccators to cool. Immediately after cooling the specimen is weighed, and it is assumed as weight of the specimen before test. It is then emerged in acid bath at 50^{0}C for 72hrs again the specimen is weighed and it is assumed as weight of the specimen after test % of Acid absorbed= ((weight after test-weight before test)/weight before test)*100.

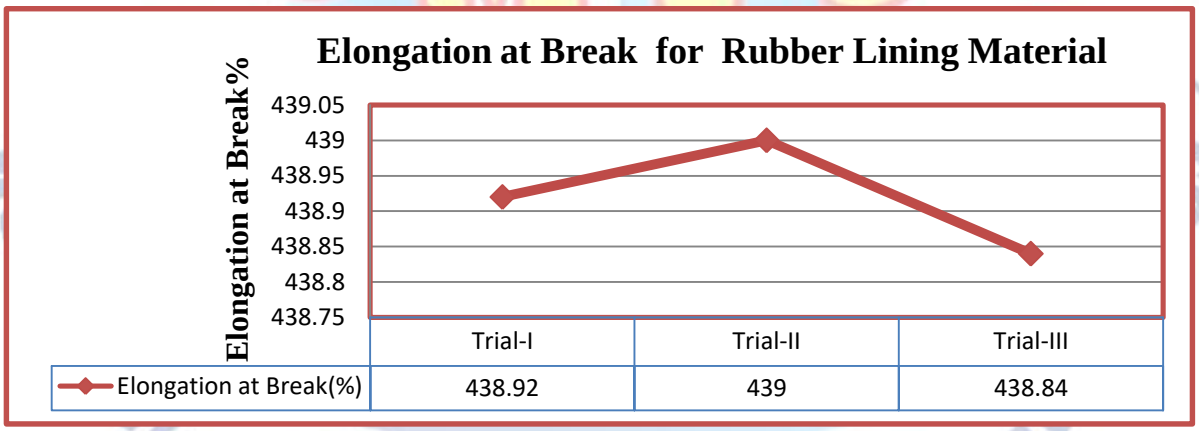
Table 3.6 acid bleed test	
Rubber Lining Sheet	**Acid Absorbed (%)**
Trial-I	7.85
Trial-II	7.90
Trial-III	7.80

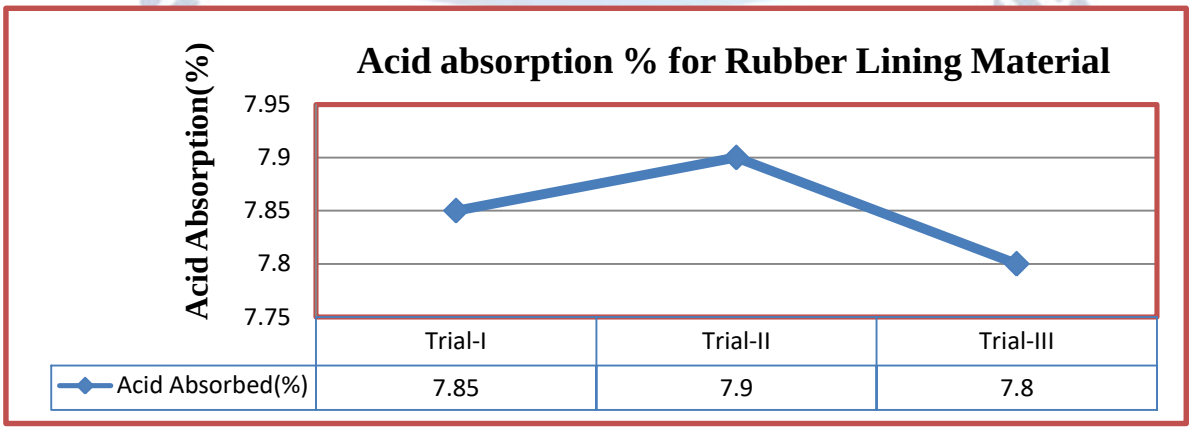
Table 3.7 Average acid content	
Rubber Lining Sheet	**Acid Absorbed (%)**
	7.85

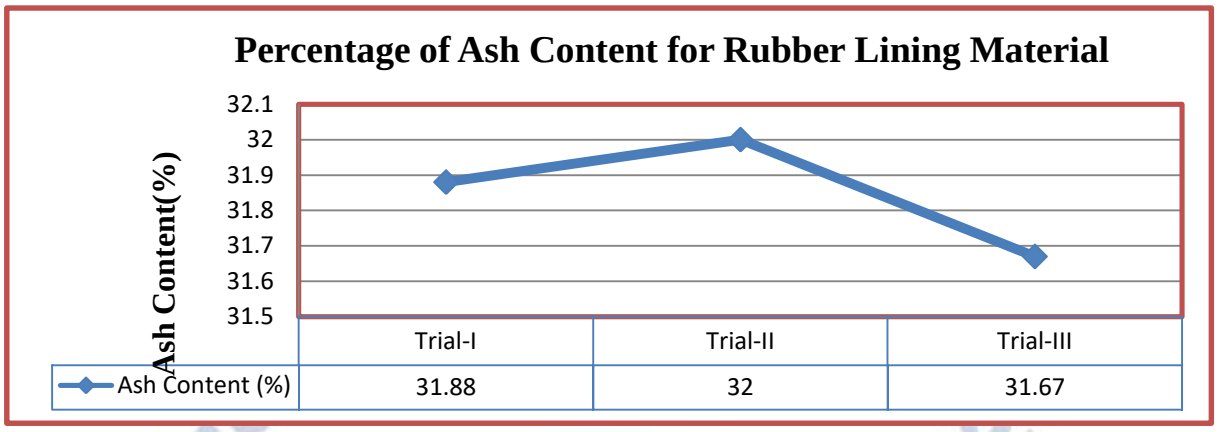
It is observed that the results of % of acid content obtained after experimentation From Table 3.7 are satisfactory when compared with the % of acid content results in Table 3.1.

IV. GRAPHS FOR EXPERIMENTAL RESULTS









V. CONCLUSIONS

Fabrication of Rubber lining sheet with appropriate composition has been done. Tests like Tensile Strength, % of Elongation at break, Ash Content Test and Acid Bleed Test has been done and the results obtained are as per the requirement for an Hcl acid storage tank.

VI. SCOPE FOR FUTURE WORK

With the addition of other filler materials as reinforcements to the natural rubber we can prepare a new class of rubber lining material with required Taylor made properties. By using other type of rubber materials instead of Natural Rubber we can prepare lining material for Hcl tanks and water storage tanks We can perform other tests like compression test , spark test, Hardness test, bond strength test, lining thickness test etc.,

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