

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 9, Issue 1, January 2020

Experimental Study on Synthesis of Corrosion Resistive Nano Carbon Poly Vinyl Chloride and Analysis of Corrosion Report for Various Chemicals and Heat Test in Different Medium

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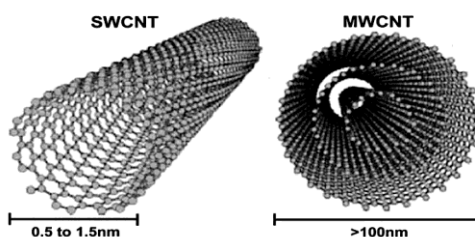
ABSTRACT: In this project, I have synthesized a Nano carbon material blended with vinyl chloride. I have synthesized the Nano carbon tubes (CNT) which is multi walled CNT when blended with vinyl chloride to achieve good strength and higher corrosion resistive material. The processes involved in my project study are synthesis of Carbon Nano Tubes (CNT), Synthesis of Vinyl chloride from acetylene, Blending and polymerisation of Nano Carbon Poly Vinyl chloride and test the properties of the yield.

We have tested with water dip test, thermal test and corrosion test with Hydro chloric acid, Sulphuric Acid. The Carbon Nano tubes are tested alone for the factors of reactivity, corrosion resistivity, temperature capability etc., and also we have tested after blending with the Vinyl Chloride.

I. INTRODUCTION

We have need to cover the following topics for this study. They are

- i. Nano Science
- ii. Polymers and Polymerisation
- iii. Corrosion



Carbon Nano Tubes

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And also we move up with Polymers and polymerization to brief a look about vinyl chloride and its synthesis methods, Disadvantages of Vinyl Chloride monomer. Beyond this, we have studied about corrosion and its causes, effects, classifications, factors influencing rate of corrosion, corrosion control etc.,

II. AIM AND OBJECTIVE

The aim and objective of this project study is to synthesising a highly corrosive resistance vinyl chloride polymer for chemical usages. And also test the synthesized Carbon Nano tubes and Carbon Nano tube blended Vinyl chloride polymer under heat, acids and some other chemicals. The tested chemicals are hydrochloric acid, sulphuric acid, Nitric acid, oil and water. The synthesized blended polymer is showing the result of strong bonding, water proof, high temperature withstanding ability, non-corrosive nature. Among the positive results, the polymer will show those results only after blending the both Nano tubes and vinyl chloride. Before blending, the nano tubes are more reactive and easily corrode by acids and the vinyl chloride will not show the property mentioned above. **Literature Review**

Nano chemistry is the combination of chemistry and nanoscience. Nano chemistry is associated with synthesis of building blocks which are dependent on size, surface, shape and defect properties. Nano chemistry is being used in chemical, materials and physical, science as well as engineering, biological and medical applications. Nano chemistry and other nanoscience fields have the same core concepts but the usages of those concepts are different.

The Nano prefix was given to Nano chemistry when scientists observed the odd changes on materials when they were in nanometre-scale size.

Nano chemistry can be characterized by concepts of size, shape, self-assembly, defects and bio-Nano; So the synthesis of any new Nano-construct is associated with all these concepts. Nano-construct synthesis is dependent on how the surface, size and shape will lead to self-assembly of the building blocks into the functional structures; they probably have functional defects and might be useful for electronic, photonic, medical or bioanalytical problems.

Overall, Nano chemistry is not related to the atomic structure of compounds. Rather, it is about different ways to transform materials into solutions to solve problems. Chemistry mainly deals with degrees of freedom of atoms in the periodic table however Nano chemistry brought other degrees of freedom that controls material's behaviours. Nano chemical methods can be used to create carbon nanomaterials such as carbon nanotubes (CNT), graphene and fullerenes which have gained attention in recent years due to their remarkable mechanical and electrical properties.

Nano Particles:

Nano particles are the particles, the size which ranges from 1-50 nm. Generally they are obtained as colloids. The colloidal particles have a tendency to remain single crystal and hence are called nano crystals. A large percentage of atoms in nano particles are present on the surface.

Nano Materials:

Nano Materials are the materials having components with size less than 100 nm at least in one dimension.

One Dimension	Two Dimension	Three Dimension
Thin Films Surface Coatings	Nano Tubes Nano Wires	Precipitates Colloids

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Synthesis of Nano Materials:

The Synthesis of nano materials are done by two following methods. They are

- i. Top - Down methods
- ii. Bottom – Up Methods

Synthesis methods of Nano materials

Top – Down Methods:

Top-down approach (also known as stepwise design and in some cases used as a synonym of decomposition) is essentially the breaking down of a system to gain insight into its compositional sub-systems in a reverse engineering fashion. In a top-down approach an overview of the system is formulated, specifying, but not detailing, any first-level subsystems. Each subsystem is then refined in yet greater detail, sometimes in many additional subsystem levels, until the entire specification is reduced to base elements.

A top-down model is often specified with the assistance of "black boxes", which makes it easier to manipulate. However, black boxes may fail to clarify elementary mechanisms or be detailed enough to realistically validate the model. Top down approach starts with the big picture. It breaks down from there into smaller segments.

Some of the Top – Down methods of Synthesizing nano materials are as follows

- Laser Ablation
- Chemical Vapour Deposition
- Electro – Deposition

Laser Ablation:

Laser ablation or photo ablation is the process of removing material from a solid (or occasionally liquid) surface by irradiating it with a laser beam. At low laser flux, the material is heated by the absorbed laser energy and evaporates or sublimates.

At high laser flux, the material is typically converted to a plasma. Usually, laser ablation refers to removing material with a pulsed laser, but it is possible to ablate material with a continuous wave laser beam if the laser intensity is high enough. Excimer lasers of deep ultra-violet light are mainly used in photo ablation; the wavelength of laser used in photo ablation is approximately 200 nm.

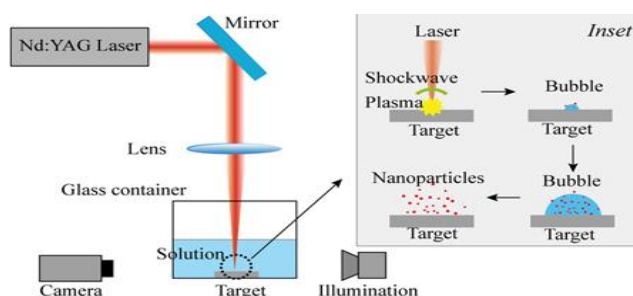
The depth over which the laser energy is absorbed, and thus the amount of material removed by a single laser pulse, depends on the material's optical properties and the laser wavelength and pulse length. The total mass ablated from the target per laser pulse is usually referred to as ablation rate. Such features of laser radiation as laser beam scanning velocity and the covering of scanning lines can significantly influence the ablation process.

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Chemical Vapour Deposition:

It is a process of chemically reacting a volatile compound of a material with other gases, to produce a non – volatile solid that deposits automatically on a suitably placed substrate. CVD reaction requires activation energy to proceed. This energy can be provided by several methods. They are

- i. Thermal CVD
- ii. Plasma CVD
- iii. Laser CVD
- iv. Photo – Laser CVD

Laser CVD:

In Laser CVD, pyrolysis occurs when laser thermal energy of laser heats falls on an absorbing substrate.

Photo – Laser CVD:

In Photo – laser CVD, the chemical reaction is induced by ultra violet radiation, which has sufficient photo energy, to break the chemical bond in the reactant molecules.

Thermal CVD:

In thermal CVD, The reaction is activated by high temperature above 900 degree Celsius. Typical apparatus comprises of gas supply system, deposition chamber and an exhaust system.

Carbon Nano Tubes (CNT):

Carbon nanotubes (CNTs) are tubes made of carbon with diameters typically measured in nanometers. Carbon nanotubes often refers to single-wall carbon nanotubes (SWCNTs) with diameters in the range of a nanometer. They were discovered independently by Iijima and Ichihashi and Bethune in carbon arc chambers similar to those used to produce fullerenes. Single-wall carbon nanotubes are one of the allotropes of carbon, intermediate between fullerene cages and flat graphene.

Although not made this way, single-wall carbon nanotubes can be thought of as cut-outs from a two-dimensional hexagonal lattice of carbon atoms rolled up along one of the Bravais lattice vectors of the hexagonal lattice to form a hollow cylinder. In this construction, periodic boundary conditions are imposed over the length of this roll up vector to yield a lattice with helical symmetry of seamlessly bonded carbon atoms on the cylinder surface.

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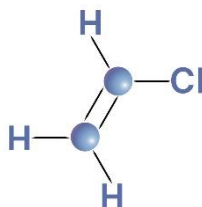
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Carbon nanotubes also often refer to multi-wall carbon nanotubes (MWCNTs) consisting of nested single-wall carbon nanotubes. If not identical, these tubes are very similar to Oberlin, Endo and Koyama's long straight and parallel carbon layers cylindrically rolled around a hollow tube. Multi-wall carbon nanotubes are also sometimes used to refer to double- and triple-wall carbon nanotubes.

Carbon nanotubes can also refer to tubes with an undetermined carbon-wall structure and diameters less than 100 nanometers. Such tubes were discovered by Radushkevich and Lukyanovich. While nanotubes of other compositions exist, most research has been focused on the carbon ones. Therefore, the "carbon" qualifier is often left implicit in the acronyms, and the names are abbreviated NT, SWNT, and MWNT.

Vinyl Chloride:

Vinyl chloride is an organochloride with the formula $H_2C=CHCl$ that is also called vinyl chloride monomer (VCM) or chloroethene. This colorless compound is an important industrial chemical chiefly used to produce the polymer polyvinyl chloride (PVC). About 13 billion kilograms are produced annually. VCM is among the top twenty largest petrochemicals (petroleum-derived chemicals) in world production. The United States currently remains the largest VCM manufacturing region because of its low-production-cost position in chlorine and ethylene raw materials.



Corrosion:

Corrosion is a natural process that converts a refined metal into a more chemically-stable form such as oxide, hydroxide, or sulfide. It is the gradual destruction of materials (usually metals) by chemical and/or electrochemical reaction with their environment.

Materials and Methods

The materials used here are Carbon Nano Tubes and Vinyl Chloride. The synthesis method of CNT is based on Chemical Vapour Deposition and vinyl chloride from acetylene. And then polymerization process takes place to blend the CNT and vinyl chloride. After the product is synthesized, we move up towards various tests as follows in the report.

Synthesis of CNT by Chemical Vapour Deposition:

This process involves decomposition of hydrocarbons at high temperature in presence of catalyst supported MgO or Al₂O₃. And then carbon atoms are deposited on the cooler surface of the catalysts. We are using acetylene as a hydrocarbon. The acetylene is heated at the temperature of 1100 degree Celsius in presence of iron supported MgO as catalyst.

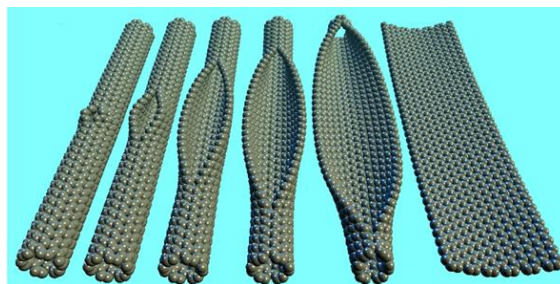
The synthesized carbon atoms are deposited as a sheet on the surface of iron which will be the cooler surface of the setup. The deposited carbon atoms are taken as a sheet and rolled as a Carbon Nano tube.

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CNT Formation

Synthesis of Vinyl Chloride from acetylene:

The vinyl chloride is synthesized from acetylene react with anhydrous HCl in the presence of Mercuric Chloride as a catalyst. We have obtained vinyl chloride monomer as a yield without any eliminations.



Polymerization of Nano Carbon Poly vinyl chloride:

The polymerization of Nano carbon poly vinyl chloride takes place under inert condition of synthesized carbon Nano tubes and the vinyl chloride at 77 degrees Celsius at 13 atm. By this process we can get the Nano Carbon Poly Vinyl Chloride.

Corrosion Test

The corrosion test is done with

- Hydrochloric acid
- Sulphuric acid
- Nitric Acid

The test results are shown in the below graphical representation and table.

Corrosion report for Hydrochloric acid

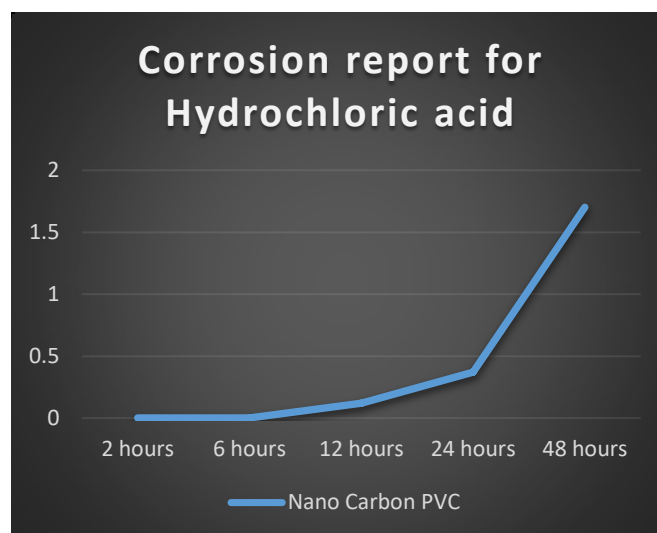
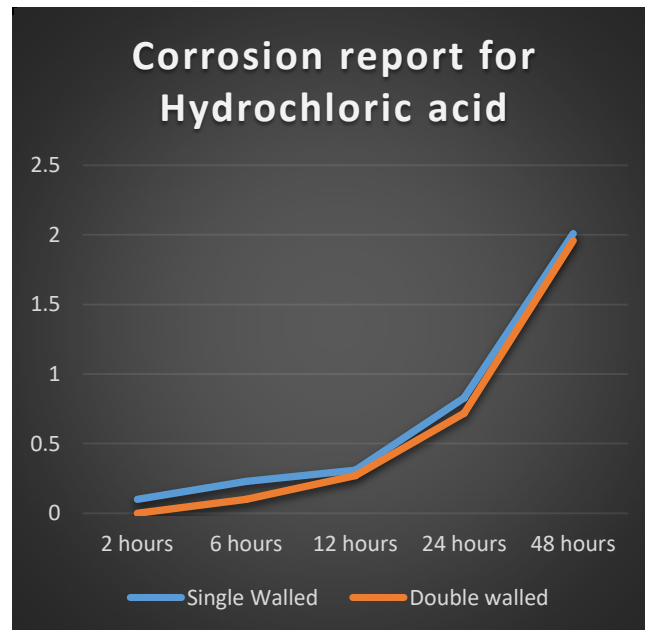
The following table and graph is the corrosion report for CNT and Nano carbon pvc are dipped in Hydrochloric acid separately based on 48 hours of observation.

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Corrosion report for Sulphuric acid

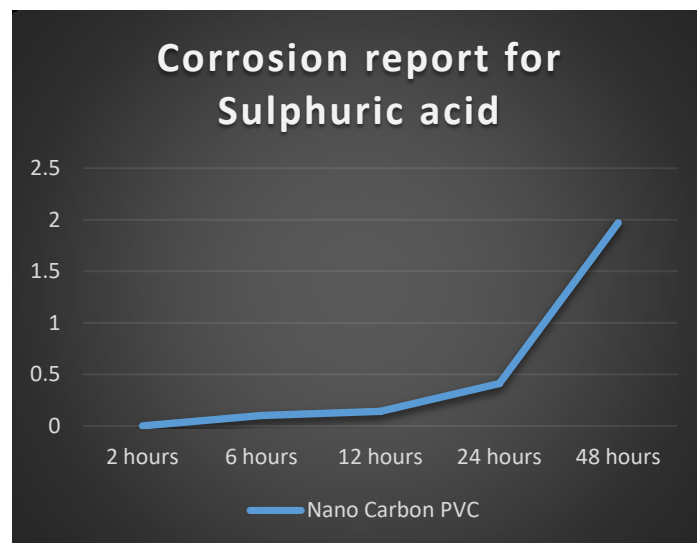
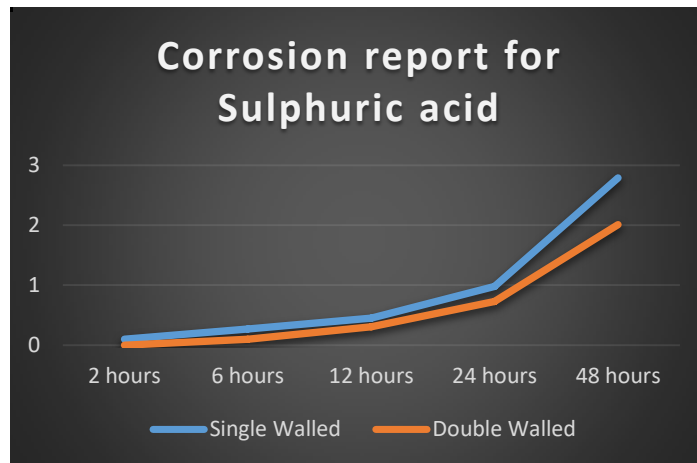
The following table and graph is the corrosion report for CNT and Nano carbon pvc are dipped in Sulphuric acid separately based on 48 hours of observation.

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Corrosion report for Nitric Acid

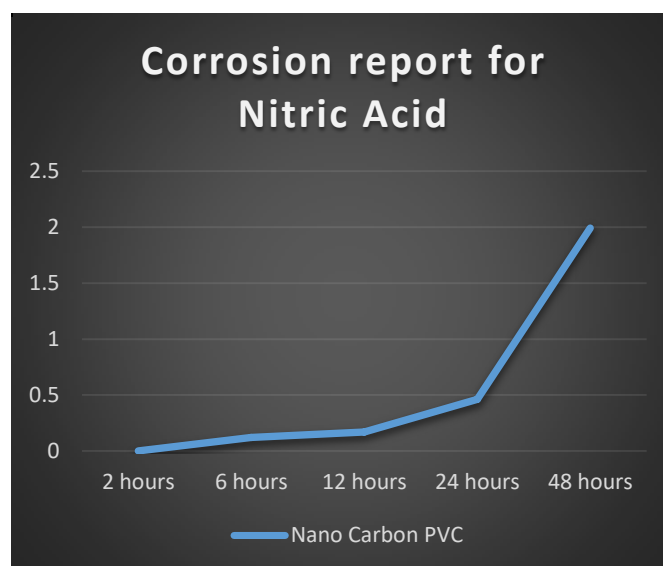
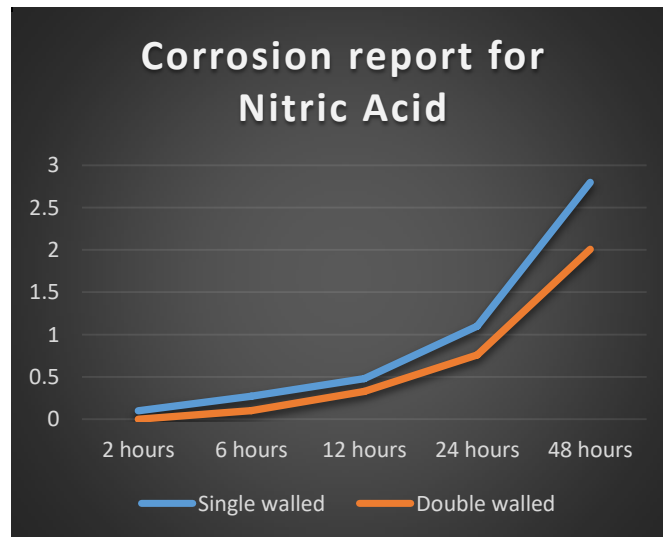
The following table and graph is the corrosion report for CNT and Nano carbon pvc are dipped in Nitric acid separately based on 48 hours of observation.

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Corrosion report for High Temperature and high pressure water

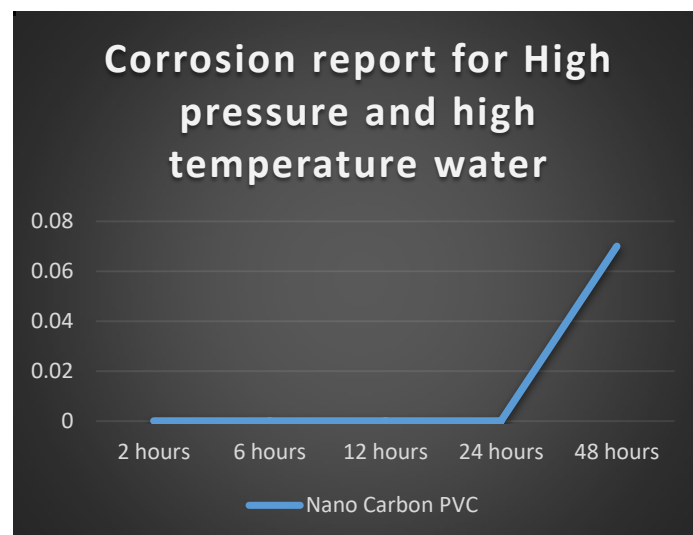
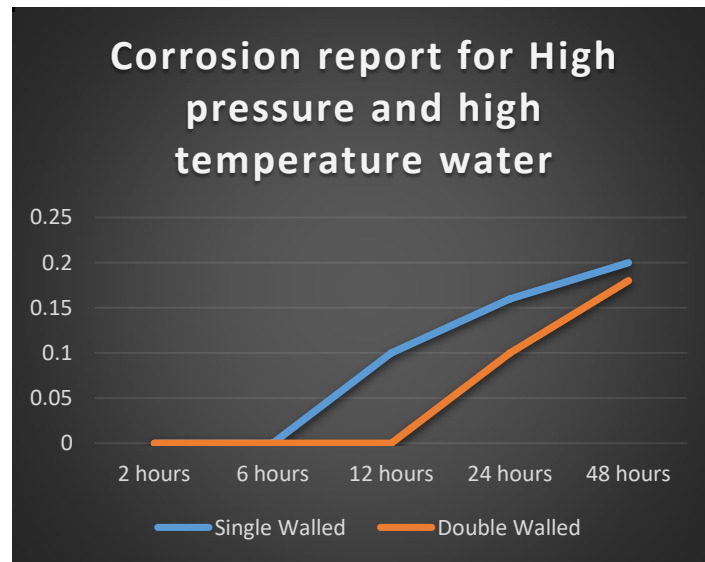
The following table and graph is the corrosion report for synthesized CNT and Nano carbon PVC are dipped in water under high temperature and high pressure separately based on 48 hours of observation.

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Heat test

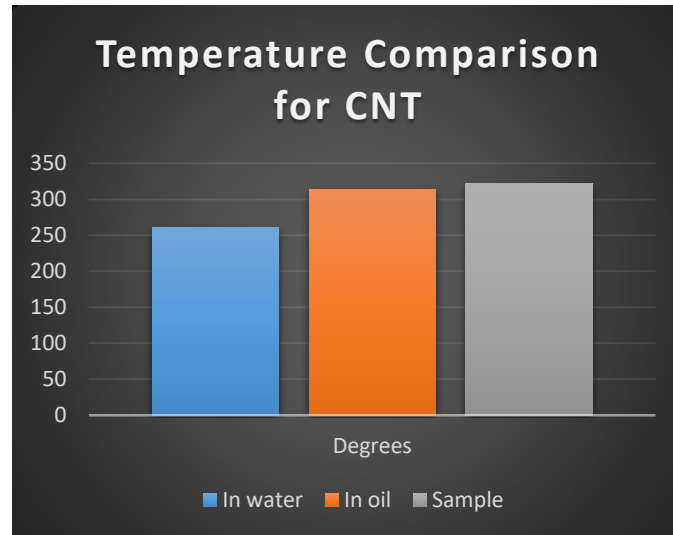
The heat test was done by the Nano Carbon PVC is heated with oil and water in a separate test. The sample is heated alone in a furnace determine the temperature at which it was starts to degrade. The test results are tabulated and represented in the following graph.

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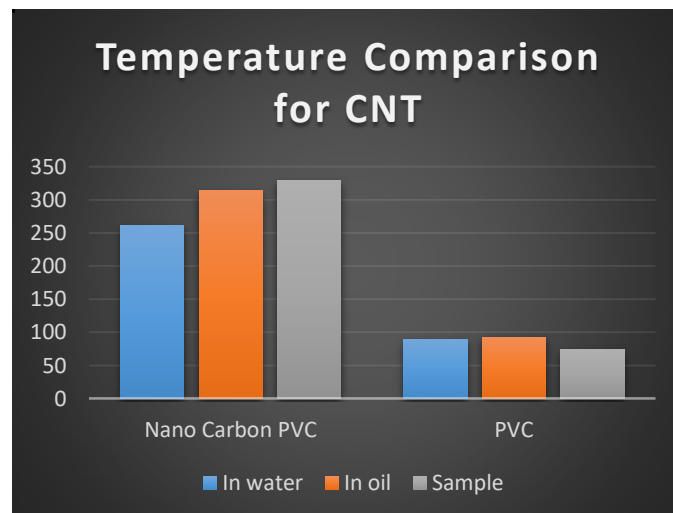
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Based on the above heat test reports, the CNT will increase the heat withstanding ability of the pvcin all the cases. From the above report the synthesized Nano carbon Polymer is highly resist for heat under dense fluid and sample alone at atmospheric condition. When we comparing the ordinary pvc, we have obtained the following graph.



III. RESULTS AND DISCUSSION

Based on the above heat test and corrosion test, the CNT and PVC composition was having good thermal withstanding capacity and most corrosive resistance property to the chemicals. The CNT is to refine for better result of heat withstanding capacity when we are using more layers. In the refinement work, the layers of CNT are increased to get a better resistivity to temperature and corrosive property in chemical mediums.

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Even now the Double walled Nano Carbon PVC is showing good corrosive resistance most of the chemicals in all the cases we have compared. The drawback of composition is highly volatile and easily reacted with most of the atmospheric gases and other chemical compounds when it is not blended.

IV. CONCLUSION

The conclusion of this experimental study of Double Walled Nano Carbon Poly Vinyl Chloride is the improvement in the heat withstanding ability than the conventional PVC synthesized by other methods including unplasticized PVC. This Nano Carbon PVC was corrosion proof to most of the chemicals we have tested. The refinement work in the number of layers of CNT will provide good improvements and make a good revolutionary movement in the PVC market, Chemical Industries. The another refinement in this Nano Carbon PVC is Chlorinating the Compound to obtain more temperature withstanding ability and corrosion resistivity.

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