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NANOTECHNOLOGY IN PAINT INDUSTRY

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Abstract—*As construction and industry grow, it is expected that the application of antimicrobial, antifungal and antibacterial biocides will continue to rise as well. Biocides in paint allow for the prevention of the unwanted growth of fungus, algae and bacteria that can be extremely destructive to painted surfaces. The outstanding properties of nanoparticles have enhanced the way in which a number of industries around the world operate. With regards to the paint and coatings industry, researchers believe that nanoparticles can improve the hardening, UV-light absorption and biocide properties tremendously. While adequate biocides are currently used in the market today, researchers expect that the future application of nanomaterial biocides into paints may have superior antimicrobial properties at a reduced cost.*

Keywords- *antimicrobial, antifungal, paint, coating, nanoparticles, Nano paint*

I. INTRODUCTION

The paint industry has long been aware of the problems of microbial attack on painted surfaces. Microbial growth can lead to both aesthetic and physical degradation of the coating or painted surface. In addition to the obvious aesthetic effects of mold, mildew and algae growth, physical deterioration by their enzymes can lead to physical degradation. This degradation can include an increase in porosity of the surface coating or a loss of adhesion to the substrate. Moisture penetration can lead to fungal decay of the underlying wood. Biodegradation is not limited to the surface coating or dry paint films; it can also occur during production and storage of the paint.

Coatings formulators face a number of challenges in the selection of dry film biocides. One of the formulator’s main goals is to select dry film biocides so as to achieve broad-spectrum and long-lasting protection of the paint film. One of the challenges is that relatively few biocide active agents are available, and those actives must simultaneously meet multiple requirements. Evaluation of fungicides and algaecides in the context of a paint formulation biocide program invariably involves outdoor exposure testing. Testing of this type involves a complex mix of variables. This is particularly true when it is desired that the results have relevance for more than one geographical region. In addition to consideration of the properties, microbial spectrum and regulatory status of the biocide active agents, there are procedural variables that must be considered. These include the type of substrate to be coated, the coating application method, the panel orientation and direction, the number of replicates, and the inclusion of appropriate controls. Given the number of variables involved, choices must be made to narrow the scope of the panel study experimental design. As constraints for each variable are selected, the resulting matrix forms the study design. One such selection matrix approach is described in this article.

II. MICROORGANISMS AND PAINT

- Deterioration of both exterior and interior paints often occurs as a result of exposure to microorganisms. These microorganisms are typically fungal species that are attracted to moisture, such as external environments of high temperatures and humidity levels, as well as interior locations, such as the kitchen or bathroom, where such conditions are accommodating for this type of microbial growth.
- When microorganisms attack paint, the paint surface is covered with a network of cells that can sometimes discolor the paint through their spore production, or by allowing for increased dirt retention[1]. Subsequent discoloration and disfigurement of the painted surface will also occur.

III. TRADITIONAL PAINT BIOCIDES

Some of the earliest biocides that were originally integrated into paints contained highly toxic heavy metal ingredients such as phenyl mercuric acetate (PMA) and tributyl tin (TBT)[1]. The ability of these metals to severely damage the environment combined with their limited effectiveness as antimicrobial additives caused for their ultimate replacement in the market. The following table describes current biocides that are used in the paint industry based on their specific targeted biological organism[2].

Classification of Biocide	Examples
Fungicide	• Carbendazim (BCM) • Chlorothalonil (CTL) • Iodopropynylbutylcarbamate (IPBC) • Octylisothiazolinone (OIT) • Dichlorooctylisothiazolinone (DCOIT) • n-butyl-benzisothiazolinone (BBIT) • Zinc Pyrithione (ZnPT)
Algaecide	• 3-(3,4-dichlorophenyl)-1,1-dimethylurea (diuron) • 2-(tert-butylamino)-4-(cyclopropylamino)-6-(methylthio)-1,3,5-triazine (Irgarol^{TM}) • 2-(tert-butylamino)-4-(ethylamino)-6-(methylthio)-s-triazine (terbutryn)

Therefore mentioned biocides that are currently incorporated into paint products exhibit a high specificity to the targeted organism, however these products are often very costly and lack the overall performance of the traditional metallic biocides.

IV. NANOMATERIAL BIOCIDES IN PAINT

The outstanding properties of nanoparticles have enhanced the way in which a number of industries around the world operate. With regards to the paint and coatings industry, researchers believe that nanoparticles can improve the hardening, UV-light absorption and biocide properties tremendously. Currently, titanium dioxide (TiO_2) and silicon dioxide are the most relevant nanomaterial used in paints, however further investigation on the potential of silver, zinc oxide, aluminum oxide, cerium dioxide, copper oxide and magnesium oxide must still be conducted.

4.1. *Nanosilver*

The high antimicrobial properties of both silver ions and nanosilver is attributed to the ability of this material to bind to bacteria cell proteins to induce cell death. Previous uses of nanosilver paint products have shown that the overall antimicrobial, deodorizing and protection of paint surfaces from mildew and various bacteria strains is superior to current biocides. Additionally, nanosilver also showed to be far less toxic to the environment as compared to other popular paint biocides.

4.2. *Nanotitantium Dioxide*

When combined with sunlight or UV light, TiO_2 nanoparticles are well known nanomaterials for their photocatalytic activity that produces hydroxyl radicals in water to ultimately attack organic compounds, such as cellular proteins in bacterial organisms. This unique activity allows TiO_2 nanoparticles to exhibit self-cleaning properties that have already found successful application in indoor paints, however further investigation on these nanoparticles must be conducted so that full oxidation of organic compounds can be achieved.

4.3. *Nanocopper*

As a commonly used component of agricultural pesticides, copper, as well as its nanoparticle form, induces cell death by the generation of reactive oxygen species (ROS), which is highly damaging to most biological molecules including DNA, protein and lipids. Copper toxicity is dependent upon the ratio of organic and/or inorganic copper in solution, however nanocopper is significantly less toxic as compared to its bulk counterpart. Nanocopper exhibits effective antimicrobial activity in concentrations as low as 40-60 mg/mol^3.

V. PROPERTIES OF NANOPARTICLES

In this process the size of the Nano particles are smaller to the wave length but it is visible to the light since it is the very smaller particle. The most critical characteristics of the Nano particles is it will have the very high volume ratio and it will have the desired chemical properties such as heat resistance weight reduction and some other properties. It will also have the electron resistance and magnetic force compared with the high metabolic substances. The formulations of paints and coating have the higher rate of substance for the Nano particles that will be process the main product of systems that will achieves to develop the paint formulation in the Nano technologies. It will also provide the self cleaning process.

This will extends to produce the unique composition and better strength and flexibility. The Nano material also has the UV protection. The metal oxides like zinc oxide and the UV blocker this will incur the Nano particles and act as a repellent for the ultraviolet radiation. It will also act as a sun protector.

5.1. ***SCRATCH RESISTANCE NATURE***

In this process the Nano paints will have the micron sized inorganic fillers which will have the Nano powder that consist of 40 to 60 nm of effective fillers and the Nano particle includes $ZrO2$, $AlOOH$, $SiO2$.The Nano particle will have the homogeneous distribution that will provide more reliability and provide the resistance structure for the scratching. The Nano particle will have the alumina substances which will protect them from the ultra violet radiations. The performance of alumina contains the composite coating that will provide the unimolecular structure. It will provide the better surface appearance and more chemical resistance. The evident of the Nano particle which will provide the UV curable coating and the nine fold module statement.

5.1. ***OIL RESISTANCE NATURE***

This paint will also provide the nature of oil repellent nature. The paint will have the self cleaning property the Nano particle will have the fluro methyl group which will provide the natural properties if the carbon components along with this it will have the ammonium poly phosphate and melamine that reduces the chemical and mechanical properties of the substrates.

The incorporation of Nano particles will improve the density of coating that will produce the organic substances. The synthesis of inorganic Nano particles will have the superior tri biological properties. It will also provide the oil based and water based lubricants that will give the efficient process in the Nano paint.

This process will also have the anti-fouling properties which have the adhesion of microbes under the marine organisms which underneath some material products that will produce the neat cleaning process. The Nano coating components will provide the repellent structure from the germs, virus, algae and other metal components. The Nano particle will also extents it future for the anti-finger print products in this the adhesion will reduce the oxidation of durability and will provide the time to clean the surface of the process that will reduce the significance. The tri biological properties of Nano particles will provide the frictional loss and the material wear property.

This Nano paint will also have the corrosion resistance for coating that is influenced by the pigment binner. The properties of coating will be determined by the transportation. And it was specified by the electrolyte in the coating system. This will have the anti corrosion property which will be already proved by taking the samples of Nano paints. The arrangements of Nano pigments in the Nano paints will be used to change the colors in the Nano paints will be exposed the field of attraction. This concept was relatively applicable in the automobile sector.

This will provide the uniform surface with the high quality of glass coating surface which will have the scattering power of Nano particles that will eradicate the discontinuous film and the coating system.

VI . USES OF NANO PAINTS

The Nano paints are useful for the asthma patients in the medical field it will be useful in the hospitals, homes industrial locations and in storage rooms which will reduce the bad odor and also prevent by the plastering materials. The dampness will causes the expensive to peel off form the structure. Also the paints and the coats are very useful for the asset maintenance it will also used as the water proofing agent. The application of multi functional material will improve the anti corrosive characteristic that will form the protective surface layer which will act against the pollution.

The Nano paint will also use the hybrid technology. It will have the comprehensive property which will be added advantage for the Nano particles for the oil repellent nature and behavior. These kind of surface in the paints can be prepared by the optimum surface and by the surface energy. The increasing roughness in the water will repell the Nano particles. The titanium dioxide in the Nano paint will be oxidized as a safer substance which will detect the humans form the harmful effects. It will be acted as the catalytic agent which will give more preferable solutions in Nano paints and the coatings. The Nano paints will be different from the other conversion paints since it has more atoms located in the surface of Nano particles.

VII. CONCLUSION

This paper provides the solution for the nano particles that will be used in the paints to create more beneficiary effects in the field of chemical engineering. The nano paint will take a new version in this paper which has the properties of oil repellent factor, scratch resistance, the anti corrosion resistance and flame resistance. Therefore it is more secure and reliable. This nano paint will have the properties of hybrid coating structure which will produce more advantageous factors in the chemical field as well as to the environment and the human being. Also it extends the future of corrosion protection of metal resistance with the chemical and physiochemical properties. It will have the positive potential power not only in the economic development also for the human growth. It will also conserve the natural resources. Currently, the replacement of engineered nanoparticles for biocides used in paints is still in its early stages, therefore a great deal of research must still be conducted on how the impressive antimicrobial properties of these nanoparticles can prove useful for these industries.

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