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Preparation of Water Dispersible Powder Putty and Powder Paint Using Sodium Silicate and Vinyl Acetate-Ethylene Copolymer Powder for Architectural Applications

R. H. Dongre and P. A. Mahanwar*

Department of Polymer and Surface Engineering, Institute of Chemical Technology, Mumbai, India

Corresponding author

KEYWORDS

Putty powder, Paint powder, Mechanical and Chemical Properties, Glass Microspheres, Sodium Silicate, RDP Powder, Heat Insulation Coating.

A B S T R A C T

The requirements of coatings are increasing day by day for protecting different substrates from various types of stresses. Today, the decorative paints specifically water based paints are in liquid form resulting in increased handling cost. The purpose of this paper is to develop a single component powder putty and powder paint using easily available nonconventional materials. This paper deals with studies in effect of concentration and mode of addition of various components on properties of paint for decorative applications. These powder putty and powder paint formulations have been evaluated and compared with conventional decorative paints. The powder paint formulations have also been evaluated for exterior applications viz. mechanical, thermally insulating and chemical performance properties. The effects of concentration of glass microspheres on properties of powder paints have also been studied. It has been seen that powder putty and powder paint show satisfactory performance as compared to conventional putty paste and liquid paint. The new Paint formulations, added with glass microspheres are found to give very good heat insulation, where temperature difference is 6 to 8% with respect to surrounding temperature and the coating. These products are based on simple and easily available raw materials. The existing equipment /machinery can be used for preparation of these products. Also this new coating is applicator friendly and easy to apply.

Introduction

Prior to painting interiors of house, includes three main stages i.e. surface preparation, applying the primer to the surface, filling of putty and applying finish coat (1 or 2 Coats). The primer or top coat in case of a latex paint is usually emulsion of acrylics, styrene-acrylic, vinyl etc. The average molecular weight of these materials ranges from 1, 00,000 to 10, 00,000 (Breedveld *et* *al*., 1997). Acrylic polymers are not biodegradable, and may accumulate in the soil of surface waters if not properly treated from effluent treatment plant (Sande, 2000).The alkyd based paints and primers are found to produce 250 to 350 gm/lit of VOC from their formulations (European commission, Final Report, 2000). The materials used in preparation of alkyds apart from oil/fatty acids are not environmentally friendly and requires high temperature processing (Taylor, 1966). In the 19^{th} century, several workers experimented with alkaline silicates. Such paints were two-component systems based on potassium silicate solutions and were required to mature before application. Such systems are rarely used now and are mostly limited to professional specialist applicators (Gettwert *et al*., 1998). Sodium silicate also has been used in present formulation as one of the ingredient having molecular formula Na_2SiO_3. The material is alkaline and hence is best suitable for alkaline surfaces such as cement, plaster of Paris etc. This material has good water solubility, is found to be excellent in water resistance, heat resistance etc.

It can be reacted with variety of materials such as CO_2 gas, $Na_2(CO_3)_2$and NaH_2PO_4.The solution of this when applied as a thin layer on surfaces of other materials dries to form a tough, tightly adhering inorganic bond or film which exhibit longer working lives (PQ Corporation, 2006). The setting agents for sodium silicate can be classified as-inorganic salts, mineral acid, organic acids and inorganic oxides. The sodium silicate reacts with calcium salts [$CaCl_2$, $Ca(OH)_2$] to forms calcium silicate hydrate. Mineral acids such as H_2SO_4, HCl and organic acids such as citric acid, acetic acid and stearic acid are found to act as setting agents for sodium silicate. The inorganic oxides such as magnesium oxide, zinc oxide and calcium oxide etc. are also found to work as setting agents for sodium silicate (Mike McDonal and Janice Hamilton).

Historical monuments found in medieval Indian architecture; made use of Jaggery, lime and calcium oxide for the construction of buildings. These coatings had superior alkali, moisture resistance and color stability. One of the old palm leaf manuscript found in the Padmanabhapuram palace in south India contains the reference for use of variety of herbs, fruits and a particular species of cactus, blended with palm Jaggery to use it as plaster along with lime (Thirumalini *et al*., 2011). In Central India, the famous Charminar (the mosque of four minarets) the historical monument built in1591-1593 by Quali Qutub Shah, the fifth ruler of the Qutub Shahi, made use of granite, lime mortar along with use of shell, Jaggery and white bulk of eggs to enhance the properties of mortars and plasters (Dorn Carran *et al*., 2011). Similarly the historic St. Lourdes Church in Tiruchirappalli, India was rehabilitated and renovated using lime and sand in the ratio of 1:2 along with Jaggery and gall nut (Natarajan *et al*., 2010). Taking the concept of use of Jaggery in these historical monuments, we have used Jaggery along with calcium oxide in few of our formulations. Vinyl Acetate- Ethylene Copolymer has been in use in coating industries for a long time (Herbert *et al*., 1971).Vinyl acetate-ethylene copolymer powders (Redispersible powder termed as RDP) are obtained by spray-drying of corresponding aqueous polymer dispersions while simultaneously adding fine inorganic materials as anti-caking agents. The powders are easily redispersible in water and give plastics mortars of high water resistance. The plaster made from this system is free from cracks (Herbert *et al*., 1975). This RDP powder has been used as binder in our powder putty and powder paint formulations. There are different types of types of vinyl acetate-ethylene redispersible polymer powders offer specialize properties such as vapor permeability, self-leveling, high decorative value etc. (Wacker at ABRAFATI, 2013). The use of hollow microspheres in coatings has been subject of study in the past decade. The microspheres can be classified as organic hollow microspheres (e.g. Polystyrene, polyacrylonitrile or phenolic materials) and inorganic hollow microspheres (e.g. glass, ceramic or fly ash from thermal power plants) (Gade, 2011). Thermal insulating latex paint (Polyacrylic emulsion) for exterior purpose was prepared with difiberedsepiolite and hollow glass microspheres as main functional additives. It has been found that with the use of 8% difiberedsepiolite fibers and6% hollow glass microspheres in the coating, effective reflection of light and heat insulation effect can be achieved (Fei Wang and Jin Sheng Liang, 2008).

The objective of this study is to develop finely ground dry blend of powder putty and powder paint based on principle ingredients such as sodium silicate, aluminum oxide powder, china clay and RDP powder along with different setting agents and compare the properties of these products against standard established putty and premium quality emulsion paint from market. The formulation has been tried with Jaggery and calcium oxide and checked for mechanical and chemical resistance properties. 1% and 2% glass microspheres have been added to this paint to check heat insulation properties. The results have been studied in specially prepared electric oven as shown in schematic diagram no.1; as reported by Mahanwar et.al. up to70°C (Sahu and Mahanwar, 2013).

Experimental

Materials

a) Sodium silicate procured from Otto Chemicals Company of 99% purity was used in the formulations

b) Aluminum oxide powder from S.D. Fine Chemicals Ltd. with 99 % purity was used in the formulation.
c) China clay with oil absorption value of 37 (gm of linseed oil/100gm of pigments) was used.

d) Stearic acid (L.R. Grade) used was supplied by PCL Company, Pune.

e) Glass microspheres sample supplied by 3M of K 1 Grade having typical density of 0.125gm/cc and average particle size of 30 to 120 microns has been used as such without any further testing

f) Jaggery from local grocery shop has been used.

g) Calcium oxide (L.R. Grade) supplied by PCL Company, Pune.

h)TiO_2 (A) from KMLL has been used in the formulations.

i) RDP Powder (Vinyl Acetate- Ethylene Copolymer Powder) from Indofill Chemicals, Mumbai have been used in the formulation.

Method for the Preparation of Putty and Paint

All the raw materials used in the formulations (Putty/ Paint) are in dry form and were added in the lab scale jar mill. The mill was allowed to run overnight. The finely ground material was added with required quantity of water in the ratio from 4:1 to 6:1 to prepare putty paste. The product prepared this way was exhaustively tested for various physio-chemical properties. The paint powder was prepared in the similar manner with addition 5% of TiO_2. After grinding, the powder was diluted with water in the ratio of 1:1 (paint powder: water) to prepare paint and again detailed testing of this type of product for various types of formulations was carried out. The asbestos panels were used for testing purpose.

Method of Preparation of Heat Insulation Coating with Glass Microspheres

The prepared paint samples, from powder paint were added with 1 % to 2 % Glass microspheres under specially developed glass stirrer with stirring rate of 40 to 60 rpm. The prepared paint samples have been applied on metal panels of dimensions150mm x 96mm x 0.8mm and were tested in specially developed electric oven up to temperatures of 50^0C - 70^0C.

Formulations

A) Putty: The different sets of formulations prepared were as follows-

Sodium silicate selected as main ingredient has been used up to 20% (max) in the set of formulations. As per our previous experience, aluminum oxide powder which imparts property of hardness in the film is used maximum up to the level of 10% of total formulation weight. Redispersible powder (RDP) is used to basic minimum level to act as binder in putty and is kept 10 % in the formulation. China clay as an extender has been added to the level of 50 to 60% in the formulation. Several reactive ingredients/setting agents for sodium silicate such as, calcium chloride, calcium hydroxide, sodium carbonate, sulphuric acid, hydrochloric acid etc. have been tried in the formulations. Organic acids such as citric acid, acetic acid and inorganic oxides such as magnesium oxide, zinc oxide were also used. However stearic acid and calcium oxide along with Jaggery are found to act as excellent setting agents for sodium silicate. Based on number of experiments; four set of formulations PY-1, PY-2, PY-3 and PY-4 were finalized for preparation of powder Putty.

Powder Paint

The selected putty formulations were extended for powder paint formulations with increase in content of RDP powder in the formulations and addition of TiO_2 for hiding purpose. Thus PY-1 formulation was further developed as PT-1, PY-2 formulation as PT-2, PY-3 as PT-3 and PY-4 were extended as PT-4. This PT-4 formulation further developed as PT-4D1 and PT-4D2 with marginal increase of RDP powder in the formulation. Thus having kept all other ingredient at constant level in line with putty formulations; RDP % was increased from 10% to 20 % in powder paint formulations. The $TiO_2$was added up to 5% for the hiding purpose. Looking at the poor performance of primary properties of PT-1 powder paint formulation, further tests were not carried out. So, for powder paint formulations total four powder paint formulations namely PT-2, PT-3, PT-4 and its extension to PT-4D1and PT-4D2 were developed. The samples were exhaustively tested for their physiochemical properties and results are shown in table no. 1 to 6 and in figure no 1 to 9.

Testing of Putty and Paint System

The coated panels for putty and paints were tested for their mechanical and chemical properties according to following standard methods –

Weight/liter: Standard ASTM D-1475 method was followed to determine weight per liter content of putty paste samples and paint samples.

% Solids: The ASTM D2697-03 standard procedure was used to determine the percentage solids of the powder putty and powder paint.

Viscosity by Brookfield Viscometer: The viscosity of putty paste was measured in accordance to ASTM D2196-99 standard.

Viscosity by Ford Cup B-4: The viscosity of powder paint after thinning to 1:1 ratio (powder: H_2O on w/w basis) was determined by following ASTM D1200-94) standard procedure.

Hiding: Paint samples tested for their respective hiding power using ASTM D 5150-92 standard.

Drying time: The drying time of applied coating was tested according to ASTM D 5895-03 standards.

Pencil Hardness: ASTM D3363 test method was followed to measure pencil hardness of coatings.

Dry Scrub Resistance: Applied coating specimens of putty as well as paint were tightly rub against finger pressure and results were checked for any traces of removal of paint, powder from the coated panel to finger.

Wet Scrub Resistance: Wet scrub resistance was carried out according to ASTMD 2486 method.

Humidity Resistance: All the panels of putty powder and paint powder were tested for their humidity resistance in accordance to the ASTM 2247-02 standard procedure.

Chemical resistance properties: The exposure of paint film to various chemicals could reduce its gloss, change the color, or produce a swelling or softening of paint film. Resistance to 2% HCl and 2% NaOH was determined by using Indian Standard 101-1985. For this test, the coating was applied on asbestos panels. The panels were removed for examination after 6, 12, 18 and 24 hours from the start of the test and observed for loss of adhesion, blistering, popping or any other deterioration of the film.

Results and Discussion

Evaluation of Powder Putty and Powder Paint Samples for Physical Tests

The powder putty samples were diluted with water from 4:1 to 6:1 ratio, while prepared powder paint samples were diluted in 1:1 ratio with water. Both thinned down products were applied on asbestos panel of dimension 150 mm x 100 mm x 5 mm. The samples were found to have better spreading rate, ability to form smooth, uniform film with excellent drying rate when compared with existing standard putty (SPY) and premium quality emulsion paint (PQP) sample from market. The results are shown in table1& table no 3.

The developed powder putty and powder paint were also tested for important mechanical properties such as dry scrub resistance, wet scrub resistance and resistance to pencil hardness test. In all these tests developed products performed exceptionally well compared to standard products selected for test. The results are shown in table no 2 & 4. The graphical representation is also depicted in figure no. 2 and 3.

Evaluation of Powder Putty and Powder Paint Samples for Chemical Resistance Tests

The developed powder putty and powder paint samples were tested for resistance to humidity in humidity chamber. Here also all developed putty samples and developed paint samples were found to withstand excellent (almost twice) humidity resistance compared to standard selected putty & premium quality emulsion paint sample. The results are shown in figure no 5 & 6.The results obtained showed further correlation with water vapor transmission rate of both developed powder putty & powder paint.

Acid Resistance (2%HCl for 24 Hrs): The coated panels of putty and paint samples after 7 days of hard dry were immersed in the 2% HCl Solution for 24 hrs. For paint samples except PT-2, all other samples including market sample (PQP) have shown no visible damage to the film except change in color i.e. change from yellowish to dark black or from off white to yellowish. The results can be summarized as good to excellent. The results are shown in table no. 5 & 6 and also depicted in figure no 7.

Alkali Resistance (2 % NaOH for 24 hrs): Since the products have been developed for cement/concrete surfaces, their resistances for alkali have been checked by this test method. The coated panels of putty and paint samples after 7 days of hard drying were immersed in the 2% NaOH solution for 24 hrs. For paint sample PY-4 (sample containing Jaggery and calcium oxide) no effect of alkali observed even after 24 hrs except change of color of film (off white to reddish). The putty formulation PY-4 extended for paint formulation with addition of 5% TiO_2 i.e. samples PT-4, PT-4(D1) and PT-4(D2) are found to be excellent for alkali resistance. No effect of alkali observed even after 24 Hrs only with color of film changes to Reddish.

Chalking, cracking and flaking: The fresh applied coating panels of powder putty and powder paint were allowed to expose at ambient air temperature for 500 hrs and were thoroughly checked for any signs of chalking, cracking and flaking tendency. Except in putty sample PY-1, all other putty samples including all applied powder paint coating samples were found to be absolutely free from any chalking, cracking tendency.

Effect of Addition of Glass Microspheres (GM) on Heat Insulation Properties of dispersible Powder Paint: The Thermal Insulating sodium silicate paint system has been developed in two parts as under –

(I) Addition of glass microspheres in 1% and 2 % level of total formulation weight of powder paint is carried out under very slow stirring rate (at 40 to 60 rpm) in above prepared and optimized best paint formulation PT-3 and PT-4(D2). The specialty type of glass stirrer has been used for the dispersion.

(II) The prepared glass microsphere dispersion into paint is tested for its heat insulation properties.

The heat Insulation properties were tested on metal Panels and in specially developed laboratory electric oven as shown in figure 1. The Panels on which Coatings were applied were of the dimensions 150 mm X 96 mm X 0.8 mm (LxBxT). The temperature limit over which heat insulation properties tested was up to the range of 50^0C temperature since in Indian subcontinent 50^0 C temperature is very common in summer season.

Heat Insulation for PT-3 Samples with 1% and 2% Glass Microspheres (GM) Loading

In the paint formulation PT-3; 1% and 2 % glass microspheres added in the varying degree of film thickness. It is observed that for 1% glass loading, heat insulation properties is found to increase at 4 to 5% at average DFT of 75 microns. It is also observed that with increase in film thickness for the same degree of loading of glass microspheres (1%); heat insulation effect is found to increase to the tune of 4 to 6% (figure 8). With 2% loading of glass microspheres in PT-3 formulation; heat insulation is found to increase to the tune of 4 to 5% at average DFT of 75 microns. However with the same degree of loading (2%) and with increase in film thickness (Average 100 micron DFT) heat insulation is found to increase at the rate of 6 to 8 % (figure no 8).

Table.1 Physical Properties of the Powder Putty

Sr. No	Testing	Putty 1 [PY-1]	Putty 2 [PY-2]	Putty 3 [PY-3]	Putty 4 [PY-4]	Std. Putty from Market-SPY
1	Mixing Ratio Putty:Water	4:1	4:1	3:1	6:1	3:1
2	Specific Gravity	1.56	1.58	1.40	1.52	1.80
3	% Solids	80 %	81 %	67 %	65 %	78 %
4	Viscosity By Brookfield [Spindle 7]	432 Poise	436 Poise	1145 Poise	400 Poise	452 Poise
5	Consistency & Finish	Smooth & Matt	Smooth & Matt	Smooth & Matt	Smooth & Matt	Smooth & Matt

Table.2 Film Properties of Putty

Sr. No	Testing	Putty 1 [PY-1]	Putty 2 [PY-2]	Putty 3 [PY-3]	Putty 4 [PY-4]	SPY
1	Drying time a. Touch Dry b. Tack free c. Hard Dry	 18 Minutes 30 Minutes 1.45 Hrs	 16 Minutes 28 Minutes 1.38 Hrs	 10 Minutes 18 Minutes Overnight	 30 Minutes 1:30 Hr 3 Hrs	 18 Minutes 1 Hr&40 minutes 2Hrs
2	Chalking after 500 Hrs	Poor	Not observed	Not observed	Not observed	Not observed
3	Cracking after 500 Hrs	Slight Cracking	Not observed	Not observed	Not observed	Not observed
4	Flaking after 1000 Hrs	Observed	Not observed	Not observed	Not observed	Not observed
5	Pencil Hardness	5 H Passes	6 H Passes	HB, H Pass, 2H Fail	HB, H Pass, 2H Fail	HB, H Pass, 2H Fail
6	Dry Scrub Resistance	Excellent	Excellent	Excellent	Excellent	Moderate
7	Wet Scrub Resistance	160 Double rub test pass	175 Double rub test pass	800 Double rub test pass	1100 Double rub test pass	440 Double rub test pass
8	Water Vapor Transmission (After 7 days)	Test could not completed because of fragile nature of Putty sample	25 %	30 %	29 %	Cracks observed so test could not completed

Table.3 Physical Properties of the Powder Paint

Sr No	Testings	PT-2	PT-3	PT-4	PT-4(D1)	PT-4(D2)	Premium Quality Emulsion Paint from Market (PQP)
1	Mixing Ratio Putty: Water	1:1	1:1	1:1	1:1	1:1	1:0.65
2	Specific Gravity	1.08 gms/cc	0.956 gms/cc	1.31 gms/cc	1.33 gms/cc	1.36 gms/cc	1.22 gms/cc
3	% Solids	51 %	50%	44 %	43 %	44 %	35 %
4	Viscosity By Brookfield [Spindle 7]	31 sec @ $27^{O}C$	37 Sec @ $27^{O}C$	40 Sec @ $27^{O}C$	25 Sec @ $27^{O}C$	46 Sec @ $27^{O}C$	41 Sec @ $27^{O}C$
5	Hiding Power	5.74 m^2/lit	6.37 m^2/lit.	5.04 m^2/lit	8.40 m^2/lit	8.60 m^2/lit	4.54 m^2/lit
6	Consistency & Finish	Smooth & Matt	Smooth & Matt	Smooth & Matt	Smooth & Matt	Smooth & Matt	Smooth & Matt

Table.4 Film Properties of Paint

Sr No	Testings	PT-2	PT-3	PT-4	PT-4(D1)	PT-4(D2)	PQP
1	Drying time a. Touch Dry b. Tack free c. Hard Dry	7 Minutes 18 Minutes 1 Hr,48 minutes	10 Minutes 20 Minutes Overnight	15 Minutes 35 Minutes Overnight	25 Minutes 45 Minutes Overnight	30 Minutes 50 Minutes Overnight	1: 30 Hrs 2: 30Minutes Overnight
2	Chalking after 500 Hr	Not observed	Not observed	Not observed	Not observed	Not observed	Not observed
3	Cracking after 500 Hrs	Not observed	Not observed	Not observed	Not observed	Not observed	Not observed
4	Flaking after 1000 Hrs	Not observed	Not observed	Not observed	Not observed	Not observed	Not observed
5	Pencil Hardness	2 H Passes	3H Pass, 4H fail	HB Pass, H Pass	H Pass, 2H Passes	3H Passes	4 H Passes
6	Dry Scrub Resistance	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
7	Wet Scrub Resistance	55 Double rub test pass	25 Double rub test pass	330 Double rub test pass	560 Double rub test pass	745 Double rub test pass	600 Double rub test pass
8	Water Vapor Transmission (After 7 Days)	7.66 %	7.05 %	6.9 %	5.35 %	3.33 %	1.83 %

Table.5 Chemical Resistance Properties for Putty Film

Sr. No	Testing	PY-1	PY-2	PY-3	PY-4	SPY
1	2% Acid Resistance after 24 Hrs	Failed after 2 Minutes	Failed after 5 Minutes	Color Changes and cracking/ flaking observed	Passes; color changes to dark	Failed after 3 minutes; film washed out
2	2 % Alkali Resistance after 24 Hrs	Failed after 2.45 Hrs	Failed after 3 Hrs	Passes, Slight puffing observed	Slight color change and fine cracks observed	Failed after 2 Hrs and 35 minutes; film washed out
3	Humidity Resistance	Puffing Observed after 448 Hrs	550 Hrs Pass	Puffing Observed after 240 Hrs	Excellent passes 650 Hrs	Puffing observed after 268 Hrs.

Table.6 Chemical Resistance Properties for Paint Film

Sr. No	Testing	PT-2	PT-3	PT-4	PT-4(D1)	PT-4(D2)	PQP
1	2% Acid Resistance after 24 Hrs	Failed after 2 Minutes	Color change to yellowish, Film is Intact	Film intact but color change occurs	Film Intact but blackens	Film Intact: Color Changes to dark black	Color Change to yellowish, Film is Intact
2	2 % Alkali Resistance after 24 Hrs	Slight puffing observed after 3 Hrs	Pass, flaking, chalking observed	Excellent no change in color, film is intact	Excellent no change in color, film is intact	Excellent no change in color, film is intact	Excellent no change in color, film is intact
3	Humidity Resistance	Excellent 500 Hrs Pass	Excellent 500 Hrs Pass	Excellent 500 Hrs Pass	Excellent 524 Hrs Pass	Excellent 542 Hrs Pass	Only 224 Hrs Pass; puffing observed

Fig.1 Schematic Diagram of Oven Used for Testing of Heat Insulation Properties of Dispersible Powder Paint System

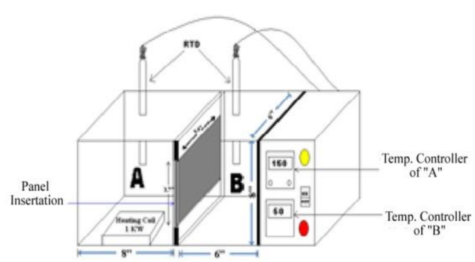


Fig.2 Wet Scrub Resistance of Putty

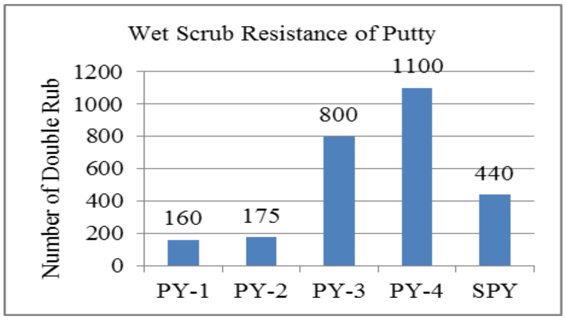


Fig.3 Wet Scrub Resistance of Paint

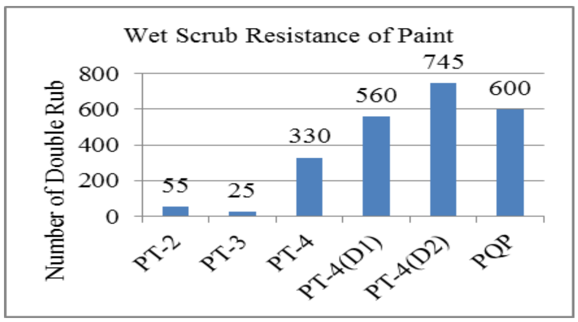


Figure.4 Test Panels of Wet Scrub Resistance and Humidity Resistance Test of Powder Paint

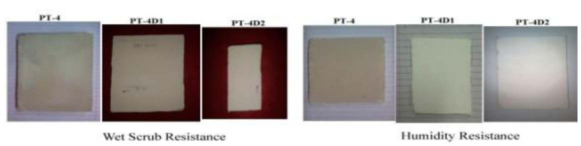


Fig.5 Humidity Resistance of Putty

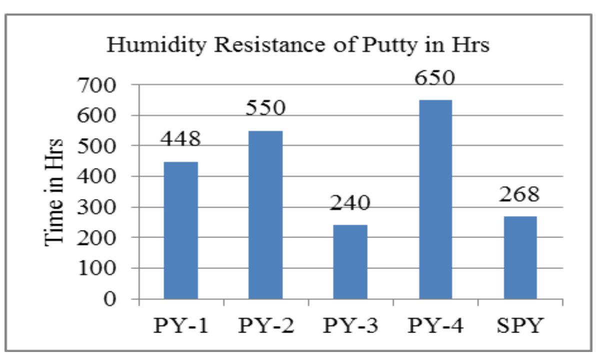


Fig.6 Humidity Resistance of Paint

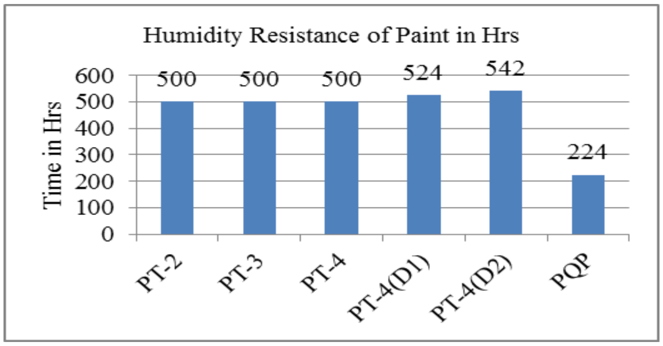


Fig.7 Test Panels of Acid and Alkali Resistance Test of Powder Putty and Powder Paint

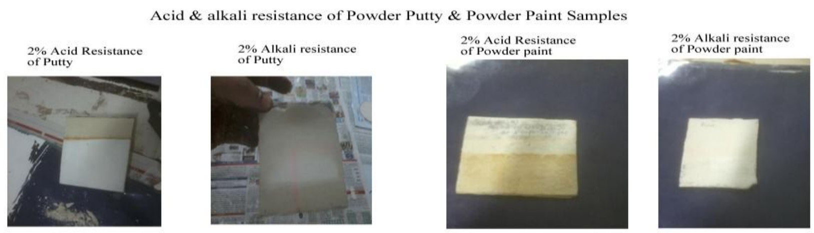


Figure.8 Heat Insulation for Pt-3 Samples with 1% & 2% Glass Microspheres Loading

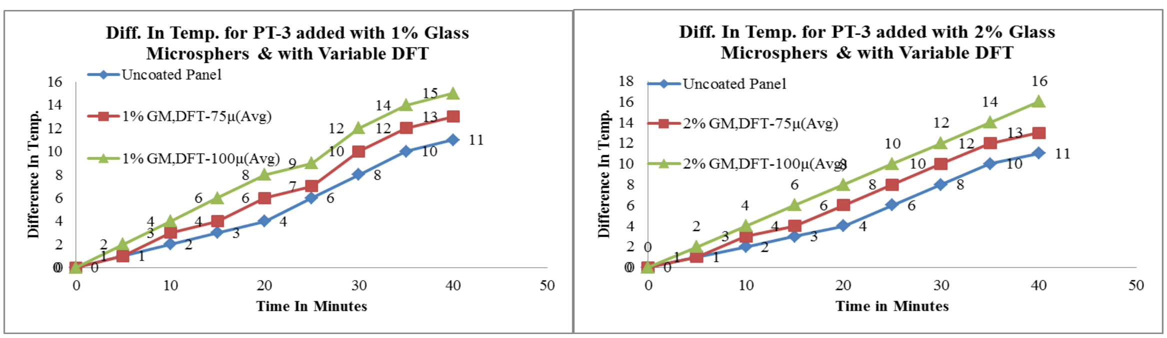
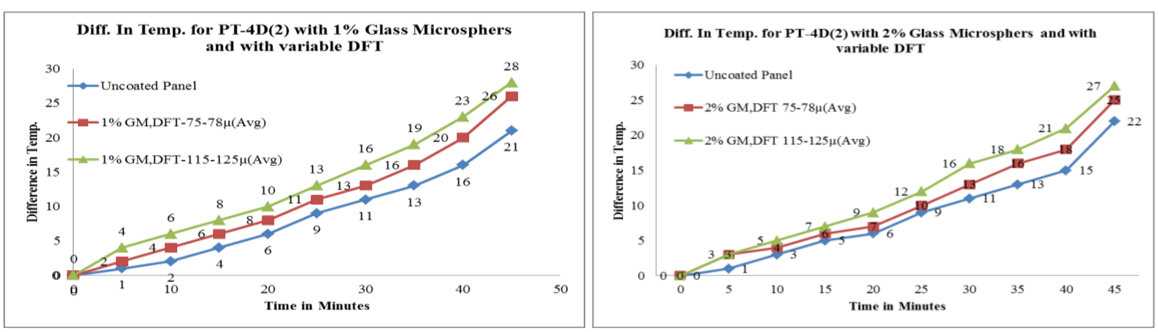


Figure.9 Heat Insulation for Pt-4d (2) Samples with 1% & 2% Glass Microspheres Loading



Heat Insulation for PT-4(D2) Samples with 1% and 2% Glass Microspheres Loading

In the paint formulation PT-4(D2); 1% and 2 % glass microspheres added for the varying degree of film thickness. It is observed that for 1% glass loading, heat insulation properties is found to increase at 2.5 to 3.5 %at average DFT of 75-78 μ. It is also observed that with increase in film thickness of 110-115 μ; for the same degree of loading of glass microspheres (1%); heat insulation effect is found to increase to the tune of 7 to 8 %.The results are shown in the figure no 9.

With 2% loading of glass microspheres in PT-4D2 formulation; heat insulation is found to increase to the tune of 4 to 5%at average DFT of 90-100 microns. However with the same degree of loading (2%) and with increase in film thickness (140 -160 μ) heat Insulation is found to increase at the rate of 6 to 8 %.The results are shown in figure no 9. Thus developed powder paint samples containing 1 to 2% glass microspheres; average heat insulation effect to the tune of 6 to 8% with respect to surrounding and coatings is observed.

Conclusion

These developed formulations are based on very simple natural raw materials. Products are convenient for manufacturing, packing and transportation. Since no extra addition of water is required there is direct cost reduction in terms of packing & transportation. The existing manufacturing machines and equipment (like Pebble Mill) can be used for processing. The developed powder putty and powder paint products are readily reducible in water, contain no any harmful chemicals, & are environment friendly and no health hazards are associated with it. Both powder putty and powder paint contains sodium silicate as one of the ingredient, which is alkaline in nature and is best suitable to strong alkaline surfaces like cement/concrete. Moreover the formulated products after application to cement surface dries to forms strong crystals having good to excellent adhesion on the cement surfaces. The results have been verified by different physical tests in this experimental work. As proven by water vapor transmission test and humidity resistance test, the developed powder putty and powder paint samples are found to have excellent Breathing tendency and Humidity resistance than the existing standard putty and emulsion paint samples in the market. The powder paint formulations PT-3 and PT-4(D2); were tested for heat insulation properties by incorporating 1% and 2% glass microspheres at variable dry film thickness. The average heat insulation effect in this case is found to the tune of 6 to 8%. In the Indian continent during summer season 50^0C temperature is very common. Formulating coating system based on easily available natural raw materials will open new gate to the development of durable, environment friendly coatings.

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