Preparation of High Efficient (Epoxy/plants coal/Alumina) Primers Applied to Concrete Petroleum Tanks

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Abstract

Very little work has been reported on the influence of exposure to petroleum products on the chemical resistance of concrete. The work presented in this paper deals with the fundamental aspects of this problem. Therefore different chemical solutions are used to study the chemical effect on this type of tanks that used in petroleum storage.

The effect of different additive fillers are used in prepared primer and are studied for different exposure media (moisture, 10% H_2SO_4, Oil) during 28 day residue time at 50 ^oc, and measure the penetration and chemical resistance of these samples.

Two types of filler are used organic (charcoal 30 m particle size), and in organic (alumina 100 m particle size) to improve the chemical resistance of the prepared epoxy primer at different mixing ratio (st.s, $Ch_{1.2,\ 2.4,\ 3.6}$, $A_{\ 1.2,\ 2.4,\ 3.6}$) respectively.

A comparative analysis shows that high chemical resistance appeared for alumina samples than charcoal especially for optimum mixing ratio (2.4 Ep. / additives).

Less effect of thickness on chemical properties appeared for standard sample and large effect of thickness for charcoal and alumina samples with preference for alumina especially at optimum thickness (2mm) for alumina and (3 mm) for charcoal samples with 2% comparison effect of thickness.

Also less effect of both moisture and oil compared to high effect of acidic solution (10% H_2SO_4) on the prepared samples with clear appearance to charcoal at 3 mm thickness and 1 mm for alumina.

Keywords: epoxy, primer, plants coal and alumina additive, application to petroleum.

تحضير طلاء عالي الكفاءة من الايبوكسي /الفحم النباتي/الومينا لتطبيقة في الخزانات الكونكريتية للمشتقات النفطية.

الخلاصة

هناك العديد من الدراسات المعدة في مجال تعرض المكونات والمواد للمشتقات النفطية وتأثيرها على مقاومة الخزانات الكونكريتية لهذه المشتقات .والعمل الحالي في هذا البحث لـــه علاقة بهذه المشكلة ، لذلك تم استخدام المحاليل الكيمياوية المختلفة لدراسة تأثيرها على هـــذه الانواع من الخزانات والمستخدم في خزن المشتقات النفطية لحين تسويقها او نقلها .

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ان تأثير الحشوات المختلفة والمضافة لتحضير طلاء محسن عالي الكفاءة ثم دراستة لمختلف الاوساط المؤثرة مثل (الرطوبة ، 10% محلول حامض الكبريتيك ، الزيت الخفيف) خـــلال زمن بقاء لا يقل عن 28 يوم عند درجة حرارة 50 ^{o}م ثم قياس كل مـــن النفاذيـــة والمقاومـــة الكيمياوية لهذه النماذج من الطلاء .وهناك نوعين من الحشوات المضافة للتحسين تم استخدامها وهي (عضوية مثل الفحم االنباتي ذو حجم حبيبي 3 مايكرون ، وغير عضوي مثل الالومينا ذو الحجم الحبيبي 100 مايكرون) لتحسين المقاومة الكيمياوية لطلاء الايبوكسي المحضـــر عنـــد نسب خلط مختلفة تبدأ من (القياسية ، المحسنة بالفحم النباتي عند نسب خلـــط 1.2 ، 2.4 ، و 3.6 ، والمحسنة بالالومينا عند نسب خلط 1.2 ، و 2.4 , 3.6) على التوالي .
ان مقارنة التحاليل للنماذج المحضرة اثبت مقاومة كيمياوية عاليـــة اظهرتهـــا نمـــاذج طـــلاء الايبوكسي / الومينا عن الايبوكسي / فحم نباتي وخصوصا عند نسب الخلط المثاليـــة (2.4 ايبوكسي / المضاف) .ان السمك المطبق للطلاء المحسن المحضر اظهر اقـــل تـــأثير عـــن الخصائص الكيمياوية مقارنة بالطلاء القياسي وافضل تأثير لهذا المتغير كان لمضاف االفحـــم النباتي ثم الالومينا عند سمك 3 ملم على التوالي مع فرق بالتأثير مقدارة 2% فقط .اضافة الى التأثير القليل لكل من الزيت والرطوبة مقارنة بالمحلول الحامضي للمحاليل المطبقة مع تـــأثير واضح للعينات ذات سمك 3 ملم فحم نباتي و 1 ملم الومينا .

Introduction

It is widely known that use of epoxy primer for many applications is promoted by the deformation resistance of such primers, when cured are subjected to compressive forces and / or elevated temperatures. Epoxy primer compositions that are heat cured exhibit great resistance to and stand up well under abrasive environments as well [1,2].

Such epoxy compositions utilizing particulate fillers such as silica, alumina, black carbon, have been sold for the surface coating of metal pipes and cement floor, for securing equipment to solid coated floors. Concrete tanked used for petroleum storage [2-6].

The use of alumina particles in transparent coating is much more limited even though alumina is significantly hardener than silica-based materials and as a scratch and abrasion-resistance filler higher performance at lower loading is often observed for alumina particle sizes greater than 100 nm the high refractive index (1.72) result in significant light scattering and a hazy appearance in most clear coating. Carbon black called flaky morphology due to its impervious laminar structure is an effective coating additive. When properly dispersed, overlapping graphite lamella form a tough, impervious coating that is lubricious, inert and both electrically and thermally conductive so it will not be bleached or affected by ultraviolet radiation, it is a variable in size ranging from 0.5 mm to 3- micron powder [7].

These additives are used to improve the following properties

1. Enhanced barrier properties to moisture solvents, chemical vapors, gas such as O_2, and flavors, there by enhancement corrosion protection and performance of the coated part [8].
2. Enhanced physical properties of the coating such as modulus and tensile and heat deflection temperatures due to the reinforcing nature of coating.

3. Enhanced dimensional stability and reduced shrinkage of the composite coating.
4. System is able to bridge gaps and seem surviving expansion and contraction of substrate (i.e. concrete expansion seems that thermally cycle through winter and summer). While the final material may be used as a coating component of the composite, also find industrial utility a cast-able elastomeric, caulk, sealant, membrane, sponge, foam, adherence, other rubber-fabricate materials, such as chemically resistance coating, adhesives, bond lines, reaction injection molding (RIM) [8].
5. To improve chemical resistance of concrete, prevent the concrete from sweating, impart a non-skid surface to seal the surface from moisture and reduce dust for appearance sake [9].

Many studied found in this field as patent. The U.S.pat.No.3, 234,159 where in acidic resistance cements improved tensile strength and very electrical resistivity comprise silica sand contain a minor amount of epoxy up to 10% [8]. The U.S pat. No. 3, 328, 339 where in a reinforced polymeric composition is improved in its physical properties such as increased flexural strength and modulus by reacting an organosilane coupling agent with the saline monomer prior to polymerization and there after chemically binding the resulting polymer to a siliceous mineral reinforcing agent[9]. US pat. No. 3,390,120 where in the modulus and tear resistance of polyurethane polymer compositions are said to be enhanced by a kaolin clay modified by from 1 to 3 % amino organsilane[10]. US pat. Application ser.No. 333,675 fields Dec.23, 1981 of common assignee it is taught that amino saline treated siliceous aggregate can be utilized as an additive to epoxy compositions to markedly increase its chemical and temperature resistance while retaining the useful work ability and abrasion resistance [11].

Generally then in addition to the silica aggregate various types of inert pigments and filler may also be in corporate in to aggregate compositions such as fillers may be mentioned blank fixe, talc, pyrophyllite, diatomaceous earth, silica, aerogel, and other like inert material [12].Others author studied the addition of color materials the coloring materials include organic and inorganic coloring materials such as titanium dioxide and carbon black, they should be selected as to be non-reactive with the epoxy pigment and other ingredients at atmospheric temperature as other wise might cause poor strong stability and also effect retention of adhesiveness and abrasion resistance [13].

In this work

To provide an epoxy primer composition of enhanced resistance to creep deformation.

Retaining its resistance to adverse chemical and/or elevated temperature days ,50 ^{o}C). environments aging. Retaining its resistance to abrasion.

Optimization and selection of best additive (alumina, charcoal) give best application resistance.

Optimization the effect of concentration and thickness of improved prepared primer on application properties (creep, chemical resistance, abrasion) for along time aging (28

Experimental Materials

1. Ultra guard epoxy primer is a high performance epoxy primer used for preparing interior concrete floors and other interior concrete surfaces table (1) shows the characterization properties of this primer.
2. Alumina (Al_2O_3) particles of partial size > 10µ m , high refractive index (1.72) and 45 m^2/g surface area 60 wt% dispersion level from geological scanning office.
3. Flaky carbon black charcoal of particle size from 0.5 to 3 micron powder. Purity 80-90% carbon, and specific gravity (2.2-2.3) black color visible Mohs hardness of (1-2).
4. Portland salt resistance cement of 15 MPa. ts_1= 45 min, ts_2=10 hrs.
5. Natural sand used in concrete density (1.6 gm/cm^3).
6. Natural coarse aggregate or stones.
7. Drinking water (tap water).
8. Concentration H_2SO_4 (99.9%) from BDH company.
9. Kerosene used in test.

Procedures

1. preparation of concrete mix

In order to form the samples required in this work the following steps were under taken.

1.1- Metallic molds in which the samples were formed (cubic shape (100*100*100) mm^3) were prepared tighten.

1.2- Concrete of standard composition (1 part cement + 2parts sand+ 4 parts stone) were made and cast in the prepared and oiled molds.

1.3- To prepare concrete mixtures, water was added to mixed solid materials in about 50% of cement content by good mixing with water uniform mixture was poured in the mold to for the samples , in two stages with (30 sec) vibration after each stage on the vibration plate in the of getting sound samples.

1.4- Formed samples were left inside the mold (24hrs) and then open the molds to have samples prepared with exposure them to moisture to give soiled stability one.

1.5-

2. Preparation of epoxy / additive coating:

3 parts of a primer resin A was added to 1 part of B activator. Due to the high viscosity of the product manual mixing is not recommended. All mixing should be performed with 400-600 rpm power drill and the mixing attachment provident. Low speed was used and keep mixing blade down in the product to avoid entrapping air in the mixture. Then premixing a component primer resin to compensate for any settling which may have occurred. Then emptied the entire content of component B primer activator in to component a primer resin and mixed for a minimum of 15 min after a uniform appearance is first obtained. Then different types and concentration of additives are used as (active carbon charcoal , Ch 1.2, 2.4, 3.6 g/g) and (alumina A 1.2, 2.4, 3.6 g/g) were added respectively with continuous mixing for 10 min then these standard and improved primer are applied at prepared concrete mix samples above.

3. Application of prepared primer (standard and improved) on concrete samples:

3.1-Prepared primer was applied by spreading with a notched squeegee and immediately black rolling with a short nap paint roller to insure uniform coverage and absence of pin holes. The products would self level to a smooth surface filling minor defects, fissures and dings.

3.2- This coating was lift on concrete for 1.5 hrs at 24 ^oC or 30 min at 33 ^oC in order to give chemical curing mixed.

3.3- Multiple coats of primer were recommended over high porosity concrete or severely air entrained concrete to insure complete sealing of the surface and absence of any pin holes, also to give a required thickness (1-3 mm), also for best adhesion and service, subsequent coats should be applied with in 5-12 hrs of application of underlying coat.

3.4- the primer surface would cured enough for coating in 5-12 hrs then left it under typical conditions,. Before tests stage.

4. Testing chemical activity for preparing samples:

4.1- Chemical activity under moisture: three container of tap water were prepared to check the chemical activity of samples (Ch, A, S) to moisture for 28 day at 50 ^oC.

4.2- Chemical activity under oil: three containers of oils were prepared to check the chemical resistance of prepared samples (S, Ch, A) to oils 28 days at 50 ^oC.

4.3- Chemical activity under acidic solution (10% H_2SO_4): three glass container of 10 % H_2SO_4 solution were prepared by adding 10 ml of concentrated H_2SO_4 (99.9 %) to 90 ml of distilled water leaving for 15 min, then immersed prepared coated samples to this solution for 28 day under 50 ^oC then check its appearance and weight each 7 days.

Results and Discussion

1. Activity to moisture exposure

Figures (1, 2) show the chemical activity of samples under moisture every 7 day at 50 ^oC for (standard and improved samples) meaning standard and improved primers). Where high chemical activity and resistance are appeared to primer improved by alumina additive than charcoal and standard one according to high resistance of alumina to moisture than charcoal, and inorganic structure of it yield stable coating in solvents, such as water and alcohol, polar and non polar hydrocarbons, plasticizers, and even directly in acrylate monomers with the appropriate surface – treatment process. And the prepared surface maintains a sufficiently low viscosity for each blending [2].

And figures (3,4) show the chemical activity of samples under moisture every 7 days at 50 ^oC for (standard and improved samples) at different application thickness (1,2,3) mm , where high activity appeared to samples improved by alumina additives due to its structure and chemical nature against solvents hydrocarbons and moisture [2].

1. **Activity to oil exposure**

Figures (5,6) show high chemical activity of prepared samples (standard primer , improved primer) to oil at all with excellent resistance at high mixing ratio of charcoal 3.6 g/g and same chemical effect of alumina additive (1.2,2.4,3.6 g/g) . Due to high chemical stability of structure at concentration 3.6 g/g for charcoal and stability nature and structure of alumina effect [2]. And figures (7,8) show the effect of thickness coating prepared (standard , improved) 50 ^{o}c every 7day on the chemical activity of these samples , where linear and constant effect of thickness appears for samples improved by alumina additive and less chemical activity to that improved by charcoal due to its nature and chemical structure [2].

2. Activity to acidic solution 10 % H_2SO_4:

Figures (9, 10) show high chemical stability against acidic solution of charcoal improved coating and excellent result appeared at 2.4 g/g for charcoal and 3.6 g/g for alumina additive due to acidic nature of alumina and inert nature of charcoal [2].And figures (11, 12) show the effect of increasing thickness on chemical activity of prepared primer (standard, improved), where high activity and chemical resistance appeared to high thickness of improved epoxy/charcoal primer and optimum thickness of improved epoxy/alumina samples at 3 mm and 1 mm with improved activity percent 12% for charcoal and 15% for alumina than standard one according to its chemical nature and structure of alumina than organic structure for charcoal [2].

Conclusions

From this word could conclude that:

1. Strength hens substrate provide excellent surface for bonding of coating with preference to alumina additive fillers.
2. Dual chemically crosslinked bonding provides protection against delaminating caused by expansion and contraction penetration provides mechanical bonding advanced polymer chemistry produce chemically crosslinked bonds between dissimilar concrete surface and the epoxy resin in the coating system "creeping resistance".
3. Powder filler additives to primer enhancing barrier properties to moisture solvent and chemical vapors with preference to alumina additives according to its nature and chemical structure.
4. Less effect of thickness applied primer on the activity and chemical resistance for alumina additive fillers mean with optimum thickness at 1 mm give same result for other additives at high thickness 3 mm for charcoal additive – filler/ epoxy primers.
5. Optimum concentration of additive fillers (alumina, and charcoal) produced optimum resistance and activity are (2.4 g/g) for alumina and (3.6 g/g) for charcoal one.
6. This type of primer has successful result in the petroleum field storage for a long time 28 day during holding and manufacturing.

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. **Table (1) characterization properties of epoxy primers[1].**

Typical properties	value
Physical properties	
Sp.gr.comp.A	**1.14**
Sp.gr. activator B	**0.93**
Sp.gr. blended	**1.08**
Unit weight Kg\L comp. A	**1.14**
Unit weight Kg\L activator B	**0.93**
Unit weight Kg\L blended	**1.08**
Drying time at 21 ^{o}C\ days	**7**
Pot life at 33 ^{o}C\hrs	**1.5**
Wet film thickness 1 L\m^{2}	**1**
color	**Light amber**
Oder	**Mild chemical**
Performance properties	
Elongation% 3 mils	**15**
Adhesion PSI(ASTM-D 454)	**2750**
Strong stability	**1 year**
Chemical properties	
Non volatile% wt.(ASTMD-4479,8.2	**100**
Chemical resistance	**excellent**

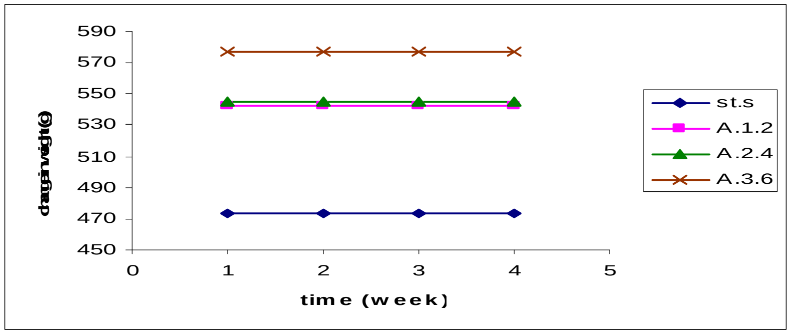

Figure (1) The effect of moisture on the chemical activity of epoxy/ alumina primer at 28 days and 50 ºC.

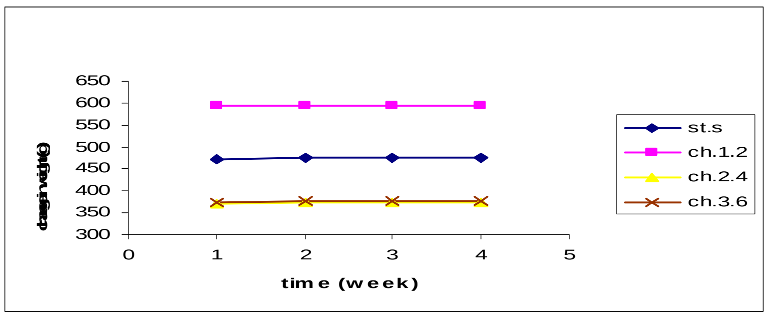

Figure (2) The effect of moisture on chemical activity of epoxy/charcoal primer at 28 days and 50 ºC.

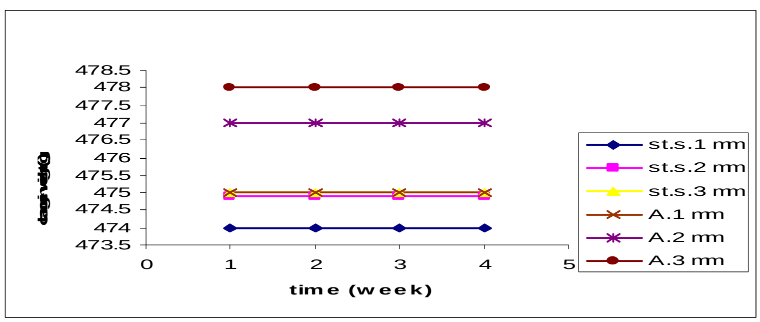

Figure (3) The effect of primer thickness of the chemical activity of epoxy/alumina primer under moisture field at 28 days and 50 ºC.

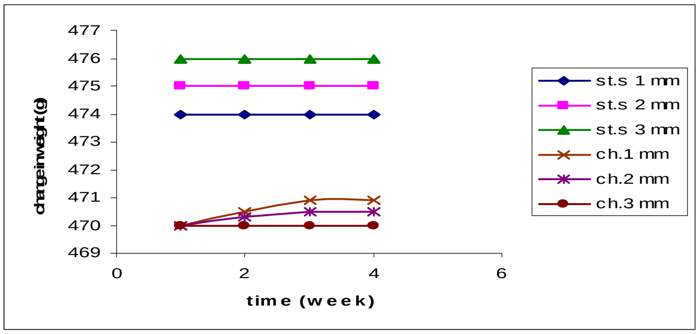

Figure (4) The effect of epoxy/charcoal thickness on chemical activity primer under moisture field at 28 days and 50 ºC.

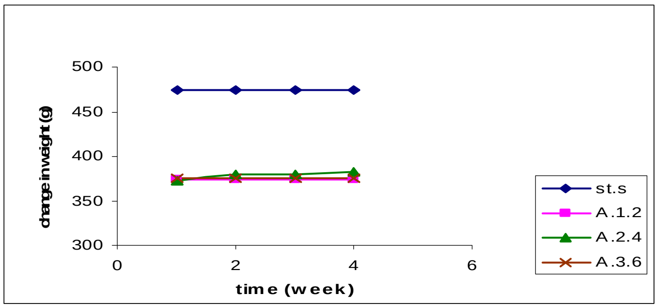

Figure (5) The effect of type and concentration of primer alumina additive on chemical activity of primer under oil field at 28 days and 50 ºC.

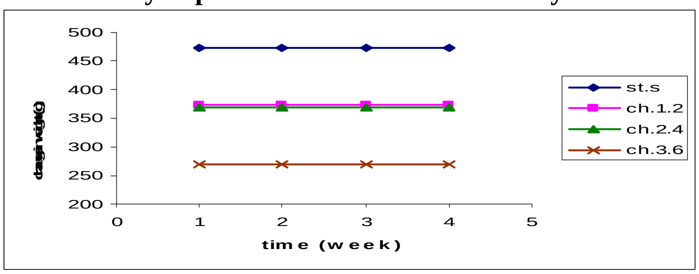

Figure (6) The effect of type and concentration of primer charcoal additive on chemical activity of primer under oil field at 28 days and 50 ºC.

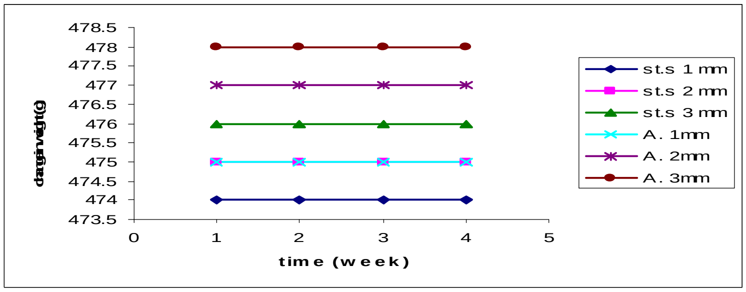

Figure (7) The effect of primer thickness of the chemical activity of epoxy/alumina primer under oil field at 28 days and 50 °C.

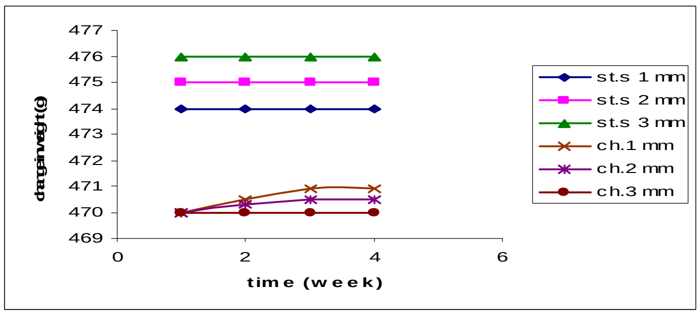

Figure (8) The effect of epoxy/charcoal thickness on chemical activity primer under oil field at 28 days and 50 °C.

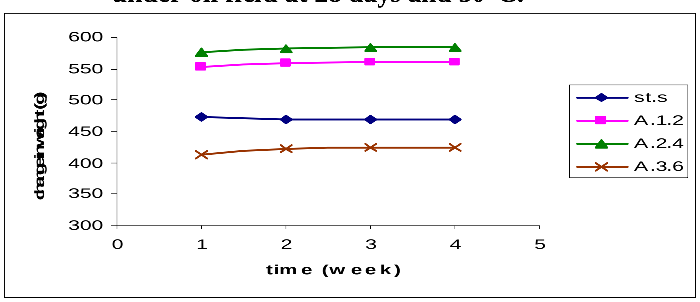

Figure (9) The effect of type and concentration of primer alumina additive on chemical activity of primer under H_2SO_4 solution field at 28 days and 50 °C.

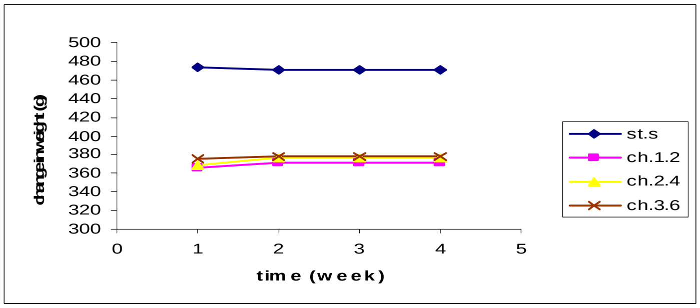

Figure (10) The effect of type and concentration of primer charcoal additive on chemical activity of primer under H_2SO_4 solution field at 28 days and 50°C.

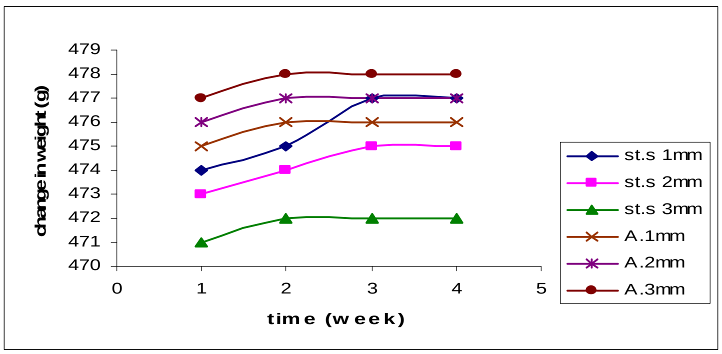

Figure (11) The effect of primer thickness of the chemical activity of epoxy/alumina primer under H_2SO_4 solution field at 28 days and 50°C.

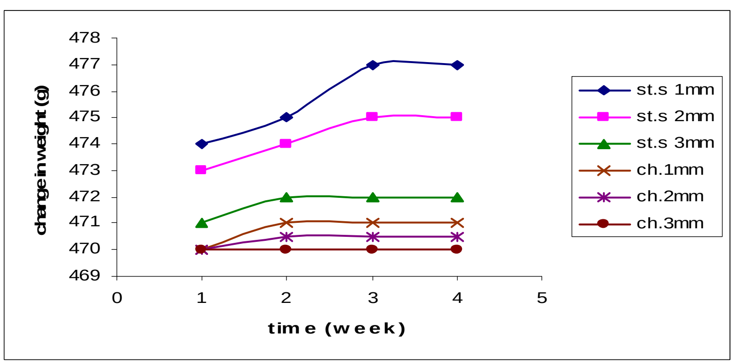

Figure (12) The effect of epoxy/charcoal thickness on chemical activity primer under H_2SO_4 solution field at 28 days and 50°C.