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(54) Title: A COATED STEEL SHEET, STORAGE TANK AND METHODS THEREOF

(57) Abstract: The present disclosure relates to a galvannealed (GA) steel sheet coated with a coating composition, a method of obtaining such coated sheet and a storage tank made thereof. The present disclosure also relates to a composition, a method of obtaining such composition and a method of determining resistance thereof.

"A COATED STEEL SHEET, STORAGE TANK AND METHODS THEREOF"

TECHNICAL FIELD

The present disclosure relates to material science particularly it relates to metal sheet, more particularly it relates to a galvannealed (GA) steel sheet coated with a coating composition, a method of obtaining such coated sheet and a storage tank made thereof. The present disclosure also relates to a composition, a method of obtaining such composition and a method of determining resistance thereof.

BACKGROUND OF DISCLOSURE

In recent years, various coatings have been developed for automobile fuel tanks. In order to have better durability, it is necessary to use coated sheets with high fuel and corrosion resistance. Hence specific coatings are required to be developed to improve the fuel resistance and corrosion resistance. Internal corrosion produces rust particles that can clog the fuel injectors resulting in their failure and also leading to huge warranty complaints.

Bare steel sheets for fuel tank applications were reported to have rust issues from field. As a corrosion prevention measure, the option of coated sheets was explored. Conventionally Zn-Ni sheet with chrome (Cr) free barrier coating is used for all gasoline and high end diesel applications. It is corrosion and fuel resistant, however it is costly. The instant disclosure explores Galvannealed (GA) steel sheets with modified resin based chrome (Cr) free and titanate (Ti) free barrier coating as a cost effective, corrosion and fuel resistant solution.

BRIEF DESCRIPTION OF THE ACCOMPANYING FIGURES

In order that the disclosure may be readily understood and put into practical effect, reference will now be made to exemplary embodiments as illustrated with reference to the accompanying figures. However, the figures are purely for the purpose of exemplifying and are non-limiting in nature. The figures together with the detailed description below,

are incorporated in and form part of the specification, and serve to further illustrate the embodiments and explain various principles and advantages, in accordance with the present disclosure where:

Figure 1 illustrates the test setup.

Figure 2 illustrates the graphical representation of the test cycle.

Figure 3 illustrates the initial condition of subject samples i.e. Zn-Ni+Cr free barrier coat (a), GA+modified resin barrier coat (b) and GA (c).

Figure 4 illustrates the condition of subject samples, i.e. Zn-Ni+Cr free barrier coat (a), GA+modified resin barrier coat (b) and GA (c); after exposure to test solution for about 50 days.

OBJECTIVES OF THE DISCLOSURE

- An object of this disclosure is to obtain a galvannealed (GA) steel sheet coated with a modified resin based barrier coating composition.
- Another object of the disclosure is the usage of GA steel sheet with modified resin based barrier coating for storage tank applications.
- Yet another object of the disclosure is to vary the thickness of the modified resin based barrier coating composition's layer for storage tank applications so as to provide high corrosion and fuel resistance.
- Still another object of the disclosure is to arrive at a composition for determining corrosion resistance or fuel compatibility or dissolution of any metal.
- Still another object of the disclosure is to determine the fuel compatibility of a subject fuel material.

SUMMARY OF THE DISCLOSURE

The shortcomings of the prior art are overcome and additional advantages are provided through the provision as claimed in the present disclosure. Additional features and advantages are realized through the techniques of the present disclosure. Other

embodiments and aspects of the disclosure are described in detail herein and are considered a part of the claimed disclosure.

The present disclosure relates to a coated galvannealed (GA) steel sheet with coating composition comprising modified resin and corrosion inhibitor optionally along with component selected from group comprising hardener, coupling agent, wetting agent, leveling agent, wax and solvent or any combinations thereof.

The present disclosure further relates to a method for obtaining coated galvannealed (GA) steel sheet, said method comprising acts of:

a. subjecting steel sheet to hot dip galvanizing and annealing to obtain the galvannealed (GA) steel sheet; and
b. coating the galvannealed (GA) steel sheet with coating composition comprising modified resin and corrosion inhibitor optionally along with component selected from group comprising hardener, coupling agent, wetting agent, leveling agent, wax and solvent or any combinations thereof.

The present disclosure further relates to a storage tank comprising coated galvannealed (GA) steel sheet as above.

In an embodiment of the present disclosure, the modified resin is selected from group comprising acrylic modified polyolefine, polyurethane, alkyd resin, silicate resin and silicon resin or any combinations thereof; the corrosion inhibitor is selected from group comprising amorphous silica, amorphous silane, and siloxane phosphate or any combinations thereof; the hardener is selected from group comprising melamine, epoxy and isocyanate or any combinations thereof; the coupling agent is silane; the wetting agent is siloxane phosphate; the leveling agent is silicon polymer; the wax is PTFE wax; and the solvent is selected from group comprising water, alcohol based solvent and ether or any combinations thereof.

In another embodiment of the present disclosure, the coating composition is free of chromium or titanium and compounds thereof; or any combinations thereof.

In yet another embodiment of the present disclosure, the coating on the coated galvannealed steel sheet has thickness ranging from about 0.4 gsm to about 1.1 gsm; preferably from about 0.7 gsm to about 0.8 gsm.

In still another embodiment of the present disclosure, the coated galvannealed steel sheet is resistant to fuel or corrosion or combination thereof.

The present disclosure further relates to a composition comprising iso-octane, toluene, ethanol, water, salt, acetic acid and inorganic acid, optionally along with excipient.

The present disclosure further relates to a method for obtaining composition as claimed in claim 8, said method comprising act of combining iso-octane, toluene, ethanol, water, salt, acetic acid and inorganic acid, optionally along with excipient to obtain the composition.

The present disclosure further relates to a method of determining resistance of a sheet, said method comprising act of contacting the sheet with composition as claimed in claim 10 and incubating to determine the resistance of the sheet.

In an embodiment of the present disclosure, the iso-octane is at volume ranging from about 410 ml to about 440 ml, preferably about 425 ml; the toluene is at volume ranging from about 410 ml to about 440 ml, preferably about 425 ml; the ethanol is at volume ranging from about 110 ml to about 130 ml, preferably about 120 ml; the water is at volume ranging from about 1 ml to about 1.5 ml, preferably about 1.2 ml; the salt is sodium chloride at an amount ranging from about 0.0002 g to about 0.001 g, preferably about 0.0006 g; the acetic acid is glacial acetic acid and is at volume ranging from about 0.008 ml to about 0.011 ml, preferably about 0.0092 ml; the inorganic acid is selected from group comprising sulfuric acid at volume ranging from about 0.0025 ml to about

0.004 ml, preferably about 0.032 ml; and hydrochloric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml, or combination thereof; and the excipient is selected from group comprising formic acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml; and nitric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml, or combination thereof.

In another embodiment of the present disclosure, the composition is used to determine corrosion resistance or fuel compatibility or dissolution of any metal.

In yet another embodiment of the present disclosure, the sheet is coated with a coating composition at specified thickness; and wherein the sheet is made into desired shape.

In still another embodiment of the present disclosure, the incubating is by placing in water bath or by subjecting to temperature cycle or a combination thereof; and the determining of resistance is by observing specks of red dust.

In still another embodiment of the present disclosure, the resistance is corrosion resistance or fuel resistance or resistance to dissolution of any metal.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

DETAILED DESCRIPTION

The foregoing has broadly outlined the features and technical advantages of the present disclosure in order that the detailed description of the disclosure that follows may be better understood. Additional features and advantages of the disclosure will be described hereinafter which form the subject of the claims of the disclosure. It should be appreciated

by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other aspects/structures for carrying out the same purposes of the present disclosure. It should also be realized by those skilled in the art that such equivalent aspects/constructions do not depart from the spirit and scope of the disclosure as set forth in the appended claims. The novel features which are believed to be characteristic of the disclosure together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present disclosure. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this disclosure.

The present disclosure relates to usage of galvannealed (GA) steel sheet with modified resin based barrier coating composition for fuel tank applications. The galvannealed steel sheet coated with modified resin based barrier coating composition are resistant to fuel and corrosion.

The instant disclosure uses the phrases 'Cr free barrier', 'instant composition', 'instant composition's coating', 'coating composition', 'barrier coating composition', 'modified resin based barrier composition coating', 'modified resin based barrier coating composition', 'modified resin based barrier composition', 'modified resin barrier coat', 'modified resin based chrome (Cr) free and titanate (Ti) free barrier coating', 'modified resin barrier coat' interchangeably. The aforementioned composition comprises resin and corrosion inhibitor, optionally along with hardener, coupling agent, wetting agent, wax, leveling agent and solvent.

In an embodiment of the present disclosure, the modified resin based barrier coating composition is chrome (Cr) free and consists of a modified resin and at least one corrosion

inhibitor. The modified resin could be selected from group comprising acrylic modified polyolefine, polyurethane, alkyd resin, silicate resin, silicon resin, or any combinations thereof. The corrosion inhibitor could be selected from group comprising siloxane phosphate, amorphous silica and silane or any combinations thereof. Further, the modified resin based barrier coating composition does not contain titanate (Ti), *i.e.* the barrier coating composition is free from titanium-containing anion/titanium oxides, and is cost effective. The barrier coating composition is non-toxic as it does not comprise of any form of chromium and titanium.

In an embodiment of the present disclosure, the modified resin based barrier coating composition further comprises hardener, coupling agent, wetting agent, wax, leveling agent and solvent. Without limitation, the hardener is selected from a group comprising melamine, epoxy and isocyanate or any combinations thereof. The coupling agent is silane, the wetting agent is siloxane phosphate, the leveling agent is silicon polymer, the wax is PTFE wax and the solvent is selected from group comprising water, alcohol based solvent and ether or any combinations thereof.

In an embodiment of the disclosure, the thickness of the Chrome free layer/barrier or the instant coating composition coated on the GA steel sheet ranges from about 0.4 gsm to about 1.1 gsm.

In another embodiment, various iterations are carried out with varying thickness of the instant coating composition (such as 0.2gsm, 0.4gsm, 0.7gsm). If thickness is lower than 0.4 gsm, low fuel resistance is observed. If thickness is greater than 1.1 gsm, poor weld quality is observed. Specks of red rust are observed at various stages and thus thickness of the chrome free barrier layer or the instant coating composition coated on the GA steel sheet is determined to be in the range of about 0.4 gsm to about 1.1 gsm based upon these iterations, as it gives an optimum strike between fuel resistance, corrosion resistance, welding quality and cost.

In another embodiment, the galvannealed steel sheet is obtained by hot dip galvanizing the steel sheet followed by annealing. Thereafter, the said sheet is subjected to coating by the modified resin based barrier coating composition at specific thickness to obtain the modified resin based barrier composition coated GA steel sheet.

Without any limitation, galvannealing of the steel sheet is done using ASTM international (American Society for Testing and Materials) standards ASTM A653/A653M-13: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process. Further, without any limitation, the coating of the coating composition at the specific thickness on the GA steel sheets is done using roll coating or any other coating protocol.

In an embodiment, the GA steel sheet with modified resin based barrier composition coating is tested for fuel tank applications by the process comprising the acts of:

a) Identification of the subject sheet to be coated for fuel tank applications.
b) Selection of modified resin based barrier composition's coating thickness for fuel tank applications.
c) Freezing upon the thickness of Cr free barrier or the instant composition's coating for fuel tank applications.
d) Forming deep drawn cups from the sheet coated with the instant composition.
e) Preparing test solution by mixing reagents in suitable proportion, as given further in the instant disclosure.
f) Placing test specimens of step d) in said solution of step e) under specific temperature conditions.
g) Topping the test solution as and when required (at start of the day).
h) Taking out the test specimens from the test chamber after every 24 hours for observation.
i) Repeating said steps f) to h) till failure in terms of observance of specks of red dust.

In an embodiment of the disclosure, the test composition is a corrosive/aggressive composition/fuel comprising iso-octane, toluene, ethanol, water, salt, acetic acid and inorganic acid, optionally along with excipients or any combinations thereof. Without limitation, the salt is a chloride. Without limitation, the inorganic acid is selected from a group comprising sulfuric acid, hydrochloric acid and nitric acid or any combinations thereof. Without limitation, the excipients are selected from a group comprising nitric acid and formic acid or a combination thereof.

In an embodiment of the disclosure, the test composition comprises iso-octane at volume ranging from about 410 ml to about 440 ml, preferably about 425 ml; the toluene is at volume ranging from about 410 ml to about 440 ml, preferably about 425 ml; the ethanol is at volume ranging from about 110 ml to about 130 ml, preferably about 120 ml; the deionized water is at volume ranging from about 1 ml to about 1.2 ml, preferably about 1.2 ml; the salt is sodium chloride at an amount ranging from about 0.0002 g to about 0.001 g, preferably about 0.0006 g; the acetic acid is glacial acetic acid and is at volume ranging from about 0.008 ml to about 0.011 ml, preferably about 0.0092 ml; the inorganic acid is selected from group comprising sulfuric acid at volume ranging from about 0.0025 ml to about 0.004 ml, preferably about 0.032 ml; hydrochloric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml; and nitric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml, or any combinations thereof; optionally along with formic acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml or any combinations thereof; and nitric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml, or combination thereof . All the reagents are of laboratory grade and the acids are concentrated acids.

In an embodiment of the present disclosure, the GA steel sheets coated with the instant coating composition without limitation has application in storage tanks such as liquid, solid or gas tanks; oil sumps, air tanks, etc.

The invention is further elaborated with the help of following examples. However, these examples should not be construed to limit the scope of the invention.

EXAMPLES:

Example 1: Corrosion Test

The GA steel sheet coated with modified resin based barrier coating composition of the instant disclosure at a thickness of about 0.7-0.8 gsm is tested for corrosion resistance to fuels. The instant composition or the modified resin based barrier coating composition is obtained by mixing about 5 w/v % to about 15 w/v % of acrylic modified polyolefine, about 2 w/v % to about 10 w/v % of hardener, < about 5 w/v % of siloxane phosphate, < about 2 w/v % of PTFE wax, < about 1 w/v % of silicon polymer, and about 80 v/v % to about 90 v/v % of water.

As an exemplification, the GA steel sheet is coated with coating composition comprising about 12 w/v % of acrylic modified polyolefine, about 4 w/v % of melamine (hardener), about 2 w/v % of siloxane phosphate, about 0.5 w/v % of PTFE wax, about 0.4 w/v % of silicon polymer and about 80 v/v % of water at a thickness of about 0.7-0.8 gsm.

Experiments are carried out to test and compare fuel resistance of coated sheets like Zn-Ni sheet obtained by electro-galvanizing and coated with Cr free barrier sheet consisting of polyurethane resin and titanate chelate corrosion inhibitor (Zn-Ni + Cr free barrier coat) at a thickness of about 1.3 gsm, GA steel sheet with Cr free modified resin based barrier composition coat of the instant disclosure (GA + modified resin based barrier coat) and GA steel sheet (GA).

Initially, deep drawn cups are formed from the respective coated sheet and subjected to the following steps for carrying out the internal corrosion test on the deep drawn cups:

1. The test facilities required for the instant experiment consist of a metal tray, watch glasses, glass rod for mixing the solution and an oven with air circulating facility. The test set up is illustrated in Figure 1.

2. The deep drawn cup specimen is drawn out of a blank of diameter of about 98 mm from the respective coated sheet of thickness of about 1 to about 1.2 mm. The drawn cup has a diameter of about 50 mm with about 30 mm draw depth. The initial conditions of subject samples *i.e.* Zn-Ni + Cr free barrier coat, GA + instant modified resin based barrier composition coat and GA are illustrated in Figures 3a-c respectively.
3. The composition of test solution (an aggressive/corrosive fuel composition) is prepared by mixing reagents tabulated in Table 1 below.

Table 1: Composition

S.No	Reagents	Quantity
1	Iso-octane	about 425ml
2	Toluene	about 425ml
3	Ethanol	about 120ml
4	DI water	about 1.2ml
5	NaCl	about 0.0006gm
6	Sulfuric acid	about 0.0032ml
7	Glacial acetic acid	about 0.0092ml
8	Hydrochloric acid	about 0.0084ml
9	Nitric acid	about 0.0084ml

The test solution may optionally comprise about 0.0084ml of formic acid.

4. The test solution is filled in each cup till the neck such that it does not over flow and the cups are closed with watch glasses.
5. The fuel cup samples are placed in a water bath to ensure uniform heating.
6. The samples are subjected to a temperature cycle over about 24 hours; split as about 8 hours at about 45°C followed by about 16 hours at room temperature of about 23°C-30°C (Figure 2).
7. The extent of corrosion is evaluated everyday by recording the extent and location of corrosion on the samples. Red rust after test period of about 30 days should not exceed about 5% of total surface area exposed to the test solution.

8. The cups are topped with fresh solution at the start of each day.
9. The test is carried out continuously for about 60 days. The time for unavoidable interruptions is minimized by maximizing the efforts to transfer the specimen cup or for inspection.

The table 2 provided below depicts the samples that are tested *vis-à-vis* the status of each of them in terms of the experimental results observed.

Table 2: Experimental results

S.No	Sample	Status
1	Zn-Ni + Cr free barrier coat	Specks of red rust < about 1% observed at the bottom of the cup after about 50 days (Figure 4a).
2	GA + instant composition/Cr-free modified resin based barrier coat	Specks of red rust < about 1% observed on the neck area after about 43 days (Figure 4b).
3	GA	Red rust observed within 8 days of commencement of the test. Heavy rusting observed subsequently and test discontinued (Figure 4c).

It is observed that GA steel sheet coated with instant composition/modified resin based barrier composition coating withstands about 43 days of aggressive fuel resistance test and is about 86% comparable with Zn-Ni coated sheet with Cr-free barrier coating.

The results indicated nearly similar corrosion resistance of GA steel sheet with instant composition/modified resin based barrier coating as observed in Zn-Ni steel sheet coated with Cr free barrier. However the instant GA steel sheet with modified resin based barrier coating is more cost effective in comparison with Zn-Ni steel sheet with Cr free barrier coating, as the latter employs Ni which is not easily available and hence costly. Further,

the corrosion resistance of Zn-Ni sheets is mainly from the Zn-Ni, whereas in case of instant disclosure, the corrosion resistance is from the barrier coating over the GA steel sheets.

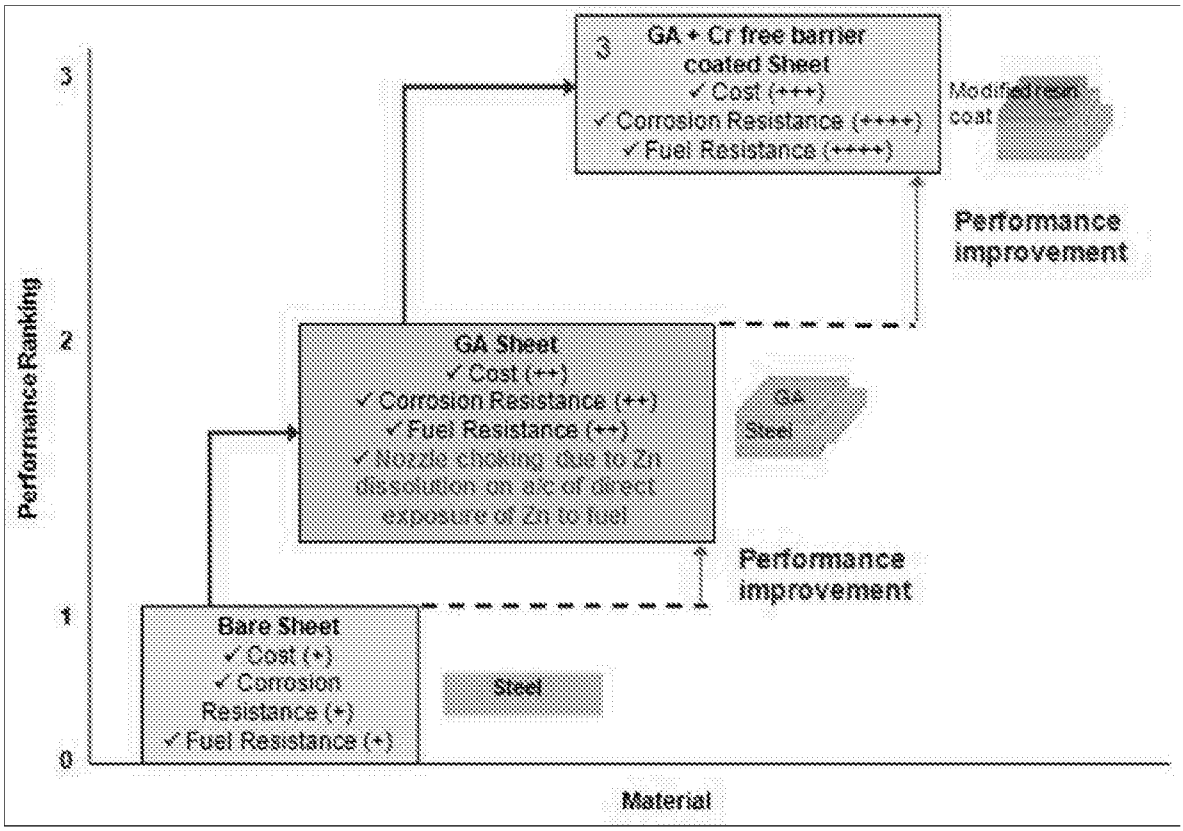
Nozzle choking due to Zn dissolution on account of direct exposure of Zn to fuel is associated with GA steel sheets. GA steel sheet with modified barrier coating overcomes this problem. The modified resin barrier coat prevents the direct contact of fuel with the underneath GA layer. Hence, zinc dissolution test is done to determine if zinc particles are found in the filtrate of the cups drawn from GA sheet and GA sheet coated with instant composition.

Zinc dissolution test is done by analyzing the filtrate in the above test setup using a filtration method using a Whatman Grade 42: 2.5 μm filter paper (the standard for critical gravimetric analysis with the finest particle retention of all Whatman cellulose filter papers). The particles are then observed under Scanning Electron Microscope (SEM) and an Energy-dispersive X-ray spectroscopy (EDS) analysis is carried out for detecting the Zn particles.

Red rust on GA steel sheet indicates depletion of zinc in the sheet, hence resulting in zinc dissolution. The uncoated GA steel sheets show dissolution of zinc. No dissolution of zinc is observed in the filtrate of the test solution from the test cup for the galvannealed steel sheet coated with modified resin based barrier coating, indicating that the said steel sheet drawn herein is resistant to corrosion and compatible with aggressive fuel which in turn indicates that it is compatible with other fuels.

The enhanced performance of the instant disclosure is depicted in the below flow chart represented as table 3.

Table 3: Options explored in sequence



Example 2: Optimization of Coating Thickness

Various iterations are carried out for galvannealed steel sheet coated with varying thickness of Cr free modified resin based barrier coating composition of the instant disclosure ranging from about 0.2 gsm to about 1.1 gsm, by testing them with composition disclosed in table 1 and employing the set up described in Example 1.

The table 4 provided below depicts the status of samples of the cups drawn from the galvannealed steel sheet coated with the barrier coating composition at a thickness of about 0.2gsm, 0.4 gsm and 0.7 gsm in terms of the experimental results observed.

Table 4: Experimental results of the various thickness iterations

S.No	Thickness of the coating composition	Status
1	0.2gsm	Specks of red rust < about 5% is observed at the bottom of the cup after about 29 days.
2	0.4gsm	Specks of red rust < about 2% is observed at the bottom of the cup after about 40 days.
3	0.7gsm	Specks of red rust < about 1% is observed at the bottom of the cup after about 43 days.

The experiment results indicate that if the thickness of the coating composition applied on the galvannealed steel sheet is lower than about 0.4 gsm, low fuel resistance is observed. If the thickness is greater than about 1.1 gsm, poor weld quality is observed. Specks of red rust are observed at various stages. Accordingly, in order to meet the performance requirement with the mentioned specification, the thickness of the coating composition coated on the GA steel sheet is determined to be in the range of about 0.4 gsm to about 1.1 gsm based upon these iterations.

Example 3: Slosh & Pressure-vacuum cycle test

Further, fuel tank made out of the GA steel sheet coated with modified resin based barrier coating composition of the instant disclosure at a thickness of about 0.7-0.8 gsm meets the Slosh & Pressure-vacuum cycle test requirements. This is observed by way of the below experiments.

- **SLOSH ENDURANCE TEST:**

Test at half volume:

Test Conditions: Fill the tank half to its specified filling capacity with water.

Duration: about 50 h

Test at full volume:

Test conditions: Fill the tank to its specified nominal capacity with water. Conduct pressure test on the tank at about 0.3 bar internal pressure for about 5 min. for leakage checking. There should be no leakage. Mount the whole shell floor with tank or fixture with tank on the slosh test rig. Fill the tank to its filling capacity with water. Conduct slosh test under following test conditions:

Duration	: about 80 h.
Frequency	: about 85 cpm.
Acceleration measured on the platform of the rig	: not to exceed about 15 m/s^2 in longitudinal and vertical directions.
Stroke of the mounting platform of the rig	: about 160±5mm.

Level of acceptance: Throughout the 130 hours of test as per above procedure, there shall be no leakage from the following:

1. Weld joints of the tank.
2. Valves fitted on the tank.
3. Tank unit/feed pump flange and flange joints.
4. Tank shell.
5. All blocked ports such as that going to canister in case of petrol tanks.
6. No failure at the tank mounting points throughout the test of about 130 h (80h + 50h), if the test is done on the actual vehicle shell floor.
7. No failure of baffles.
8. Extend the above test till it fails or terminate the testing at about 260 h.

- **VACUUM HOLDING CAPACITY TEST:**

Test conditions: Tank assembly to be connected to a vacuum source with all the outlets in blocked conditions and evacuated gradually till the collapse.

Level of acceptance:

1. For passenger cars, the tank shall not collapse till about 250 mm of Hg vacuum (about 0.32bar).
2. For SUVs and all commercial vehicles, the tank shall not collapse till about 300 mm of Hg vacuum (about 0.39 bar).
3. There shall be no leakage in pressure leakage test at about 0.3 bar pressure.

No structural failure (crack), leakage or seepage is observed in the fuel tank of the present disclosure after slosh and pressure-vacuum tests.

EQUIVALENTS

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite

articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation *is* explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean *at least* the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means *at least* two recitations, or *two or more* recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

We Claim:

1) A coated galvannealed (GA) steel sheet with coating composition comprising modified resin and corrosion inhibitor optionally along with component selected from group comprising hardener, coupling agent, wetting agent, leveling agent, wax and solvent or any combinations thereof.

2) A method for obtaining coated galvannealed (GA) steel sheet, said method comprising acts of:
   a) subjecting steel sheet to hot dip galvanizing and annealing to obtain the galvannealed (GA) steel sheet; and
   b) coating the galvannealed (GA) steel sheet with coating composition comprising modified resin and corrosion inhibitor optionally along with component selected from group comprising hardener, coupling agent, wetting agent, leveling agent, wax and solvent or any combinations thereof.

3) A storage tank comprising coated galvannealed (GA) steel sheet as claimed in claim 1.

4) The coated galvannealed steel sheet and method as claimed in claims 1 and 2, wherein the modified resin is selected from group comprising acrylic modified polyolefine, polyurethane, alkyd resin, silicate resin and silicon resin or any combinations thereof; the corrosion inhibitor is selected from group comprising amorphous silica, amorphous silane, and siloxane phosphate or any combinations thereof; the hardener is selected from group comprising melamine, epoxy and isocyanate or any combinations thereof; the coupling agent is silane; the wetting agent is siloxane phosphate; the leveling agent is silicon polymer; the wax is PTFE wax; and the solvent is selected from group comprising water, alcohol based solvent, and ether; or any combinations thereof.

5) The coated galvannealed steel sheet, method and storage tank as claimed in claims 1-3, wherein the coating composition is free of chromium or titanium and compounds thereof; or any combinations thereof.

6) The coated galvannealed steel sheet, method and storage tank as claimed in claims 1-3, wherein the coating on the coated galvannealed steel sheet has thickness ranging from about 0.4 gsm to about 1.1 gsm; preferably from about 0.7 gsm to about 0.8 gsm.

7) The coated galvannealed steel sheet, method and storage tank as claimed in claims 1-3, wherein the coated galvannealed steel sheet is resistant to fuel or corrosion or combination thereof.

8) A composition comprising iso-octane, toluene, ethanol, water, salt, acetic acid and inorganic acid, optionally along with excipient.

9) A method for obtaining composition as claimed in claim 8, said method comprising act of combining iso-octane, toluene, ethanol, water, salt, acetic acid and inorganic acid, optionally along with excipient to obtain the composition.

10) A method of determining resistance of a sheet, said method comprising act of contacting the sheet with composition as claimed in claim 10 and incubating to determine the resistance of the sheet.

11) The composition and methods as claimed in claims 8-10, wherein the iso-octane is at volume ranging from about 410 ml to about 440 ml, preferably about 425 ml; the toluene is at volume ranging from about 410 ml to about 440 ml, preferably about 425 ml; the ethanol is at volume ranging from about 110 ml to about 130 ml, preferably about 120 ml; the water is at volume ranging from about 1 ml to about 1.5 ml, preferably about 1.2 ml; the salt is sodium chloride at an amount ranging

from about 0.0002 g to about 0.001 g, preferably about 0.0006 g; the acetic acid is glacial acetic acid and is at volume ranging from about 0.008 ml to about 0.011 ml, preferably about 0.0092 ml; the inorganic acid is selected from group comprising sulfuric acid at volume ranging from about 0.0025 ml to about 0.004 ml, preferably about 0.032 ml; and hydrochloric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml, or combination thereof; and the excipient is selected from group comprising formic acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml; and nitric acid at volume ranging from about 0.008 ml to about 0.009 ml, preferably about 0.0084 ml, or combination thereof.

12) The composition as claimed in claim 8, wherein the composition is used to determine corrosion resistance or fuel compatibility or dissolution of any metal.

13) The method as claimed in claim 10, wherein the sheet is coated with a coating composition at specified thickness; and wherein the sheet is made into desired shape.

14) The method as claimed in claim 10, wherein the incubating is by placing in water bath or by subjecting to temperature cycle or a combination thereof; and the determining of resistance is by observing specks of red dust.

15) The method as claimed in claim 10, wherein the resistance is corrosion resistance or fuel resistance or resistance to dissolution of any metal.

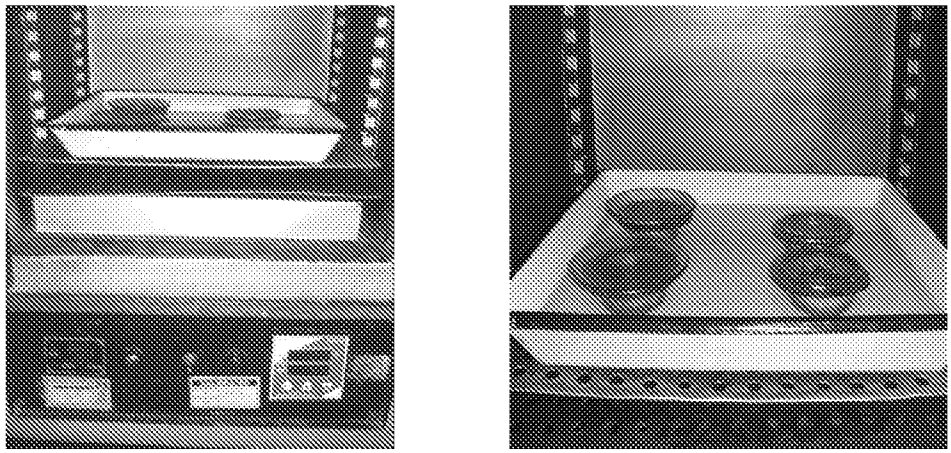


FIGURE 1

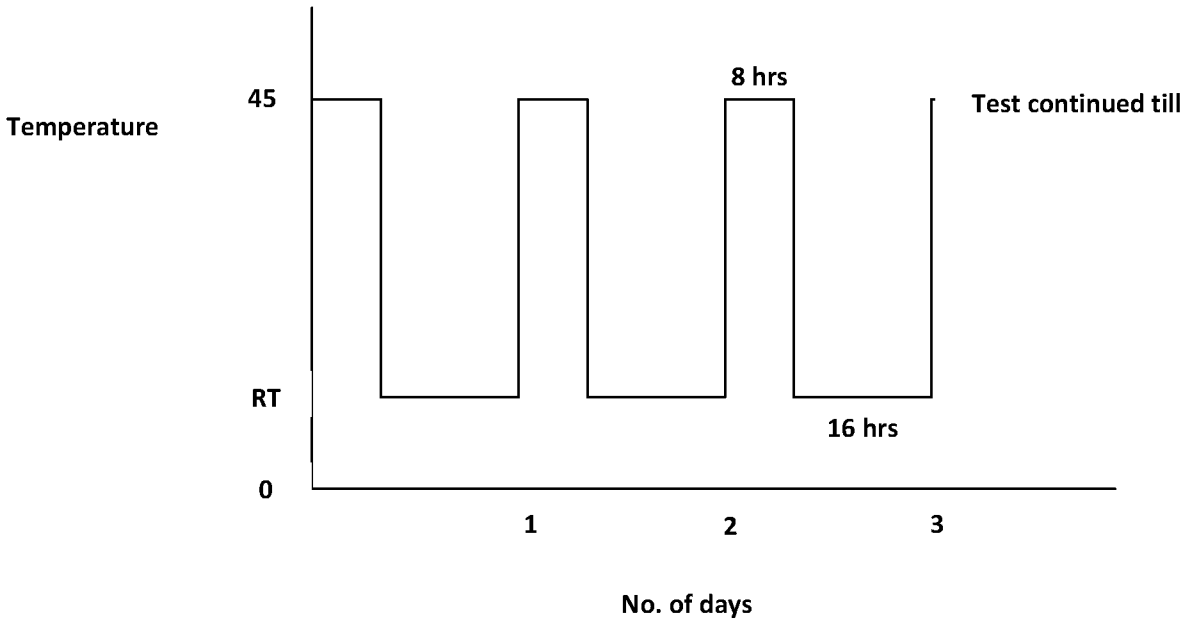


FIGURE 2

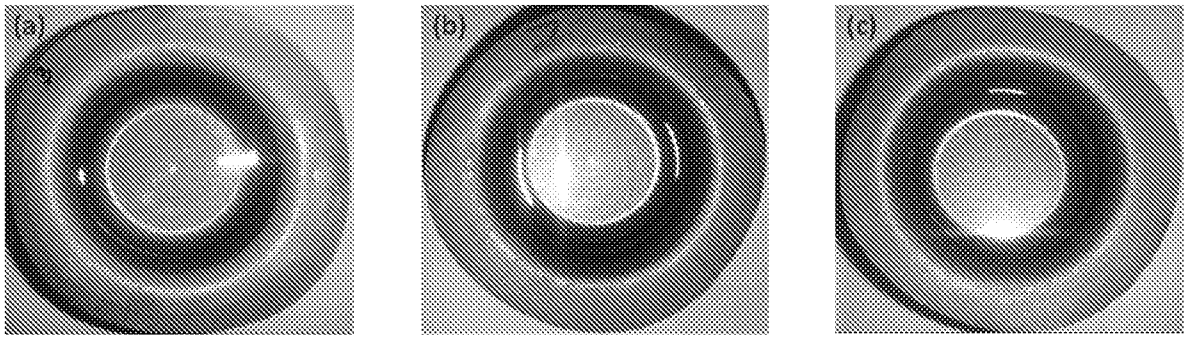


FIGURE 3

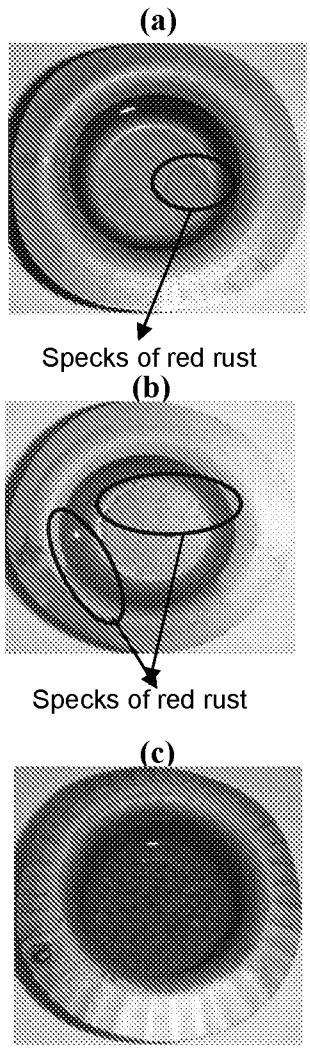


FIGURE 4