[009] Moreover, under normal operating conditions, cooling towers have substantial evaporative water loss. As a result, large quantities of "make-up" water are introduced into the system that commonly contains ionic species, such as calcium, magnesium, sulphate, and chloride. Increased alkalinity (e.g., carbonate, bicarbonate, and hydroxide ions) may also cause white rust corrosion. Particularly, accumulation of carbonate alkalinity, with a concomitant pH increase, creates an ideal white rust-forming environment. This accumulation is one of the major causes of white rust. The presence of excess anions and/or soft water can aggravate the degree of white rust formation by, for example, reacting with the zinc coating to produce zinc hydroxide.

[0010] As an integral component of cooling water circulation systems biocides are essential is preventing algal, bacterial, and fungal contamination of the systems. Some of these biocides sometimes promote white rust formation as a byproduct because they chemically react with certain white rust inhibitors and/or with the zinc coating. For example, sodium hypochlorite (i.e., bleach) is a common biocide and is highly reactive.

[0011] Because high pH levels are also contributing factor to white rust formation, the addition of a sufficient quantity of free acid, commonly sulfuric acid, to the cooling water helps preclude the formation of white rust. Such free acid addition creates concerns for those handling the free acid and also creates potential for metal corrosion from the acid itself due to overfeed or spillage. None of these passivation or maintenance procedures described above provides a complete solution to the white rust problem. There thus exists a need to provide efficient and improved compositions and methods of inhibiting white rust corrosion.

SUMMARY

[0012] Accordingly, this ~~invention~~disclosure provides a method of preventing corrosion on galvanized metal surfaces. The method includes introducing an effective amount of a corrosion-inhibiting composition having a sulfur-based, preferably sulfide-based, white rust corrosion-inhibiting compound onto a galvanized metal surface to form a barrier on the surface.

[0012a] In one aspect, there is provided a method of inhibiting corrosion on a galvanized metal surface wherein the galvanized metal surface is part of an industrial water system that is at least partially full of water, the method comprising:

(a) adjusting the water in the industrial water system to have a pH from about 6.5 to about 8.2;

(b) introducing an effective amount of a corrosion-inhibiting composition into the water of the industrial water system when said system is either under load or not under load, said corrosion-inhibiting composition including a sulfide-based white rust corrosion-inhibiting compound selected from the group consisting of bismuthiols and dimerized bismuthiols;

(c) circulating the water of the industrial water system for a time interval to contact the sulfide-based white rust corrosion-inhibiting compound with the galvanized metal surface to form a barrier on the galvanized metal surface, if the system was not under load;

(d) operating the system for a time interval to contact the corrosion-inhibiting composition with the galvanized metal surface to form a barrier on the galvanized metal surface, if the system was under load;

(e) overlaying the barrier by:

i) unloading the system, readjusting the pH of the water in the system to be from about 6.5 to about 8.2, reintroducing an effective amount of the corrosion-inhibiting composition into the water of said system, and circulating the water of the system, or

ii) keeping the system under load, readjusting the pH of the water in the system to be from about 6.5 to about 8.2 and reintroducing an effective amount of the corrosion-inhibiting composition into the water of said system; and

(f) operating the industrial water system under load for one or more additional time intervals and repeating step (e) after one or more of the additional time intervals.

[0012b] In one embodiment, the method further includes overlaying the barrier by reintroducing an effective amount of the composition onto the galvanized metal surface after one or more time intervals.

[0013] In an embodiment, the ~~invention~~disclosure provides a method of inhibiting corrosion in an industrial water system that is at least partially full of water and has one or more galvanized metal surfaces. The method includes adjusting the water in the industrial water system to have a pH from about 6.5 to about 8.2 and introducing an effective amount of a corrosion-inhibiting

composition that includes one or more sulfur-based or sulfide-based white rust corrosion-inhibiting compounds into the water of the industrial water system.

[0014] Implementing the method may be accomplished when the system is either under load or not under load. If the system is not under load when introducing the corrosion-inhibiting composition, the water in the system is circulated after such introduction for a time interval to contact the sulfur-based white rust corrosion-inhibiting compound with the galvanized metal surfaces of the system to form the barrier on those surfaces. After a sufficient interval, the unloaded system may be turned on or brought under load at any suitable time. If the system is under load when introducing the corrosion-inhibiting composition, the system is operated under load after such introduction for a time interval to contact the white rust corrosion-inhibiting compound with the galvanized metal surfaces of the system and form the barrier on those surfaces.

[0015] In an ~~aspect~~embodiment, the ~~invention~~disclosure provides a method for overlaying the barrier formed by the sulfide-based white rust-inhibiting compound. This ~~aspect~~embodiment includes overlaying the barrier while the system is under load or not under load. If the barrier is overlaid while the system is under load, the method includes readjusting the pH of the system to be from about 6.5 to about 8.2 and reintroducing an effective amount of the corrosion-inhibiting composition into the water of the system. The system is then operated under load for one or more additional time intervals and the barrier optionally is re-overlaid after one or more of the additional time intervals.

[0016] If the barrier is overlaid while the system is not under load, the method includes readjusting the pH of the system to be from about 6.5 to about 8.2, reintroducing an effective amount of the corrosion-inhibiting composition into the water of the system, and circulating the water of the system for a sufficient interval to contact the sulfide-based compound with the surfaces. After the sufficient interval, the unloaded system may be turned on or brought under load at any suitable time.

[0017] Though the ~~invention~~disclosure is particularly relevant to applications such as basins and heat transfer coils of cooling towers, it should be appreciated that the implementation of the method is not limited to such cooling tower applications. Contemplated applications include any system having galvanized metal surfaces. This ~~invention~~disclosure may also be combined with one or more other corrosion or scale inhibiting compositions, such as silicates, borates, molybdates, tungstates, chromate, zinc salts, orthophosphates, polyphosphates, phosphonate/phosphinate, combinations thereof, or any other suitable corrosion or scale inhibiting compound or composition, with or without one or more fluorescent tracer compounds. Such combinations

would form a comprehensive corrosion and scale inhibition program, discussed in more detail below.

[0018] An advantage of the ~~invention~~disclosure is to provide a method of inhibiting corrosion, especially white rust corrosion, on galvanized metal surfaces.

[0019] Another advantage of the ~~invention~~disclosure is to extend the lifespan of galvanized metal surfaces in various applications including industrial water systems.

[0020] Yet another advantage of the ~~invention~~disclosure is to provide a one-step passivation method for inhibiting white rust corrosion on galvanized surfaces of industrial water systems.

[0021] An additional advantage of the ~~invention~~disclosure is to provide a method for initially pre-passivating with a sulfur-based white rust corrosion-inhibiting composition and post-treating by overlaying the sulfur-based white rust corrosion-inhibiting composition on galvanized surfaces.

[0022] It is another advantage of the ~~invention~~disclosure to provide an approach to inhibiting white rust corrosion on galvanized surfaces in industrial water systems that is effective under a range of pH conditions.

[0023] It is a further advantage of the ~~invention~~disclosure to provide an approach to inhibiting white rust corrosion on galvanized surfaces in industrial water systems that is effective with water having low ionic content, such as soft water.

[0024] It is yet another advantage of the ~~invention~~disclosure to provide a method for inhibiting white rust corrosion on galvanized surfaces in industrial water systems that is effective under elevated carbonate alkalinity.

[0025] It is still another advantage of the ~~invention~~disclosure to provide a composition and method for inhibiting white rust corrosion on galvanized surfaces in industrial water systems, which includes one or more sulfur-based or sulfide-based compounds that adsorb and/or bind to the surfaces and which are effective under a range of pH conditions, a range of alkalinity levels, and a range of water hardness levels.

DETAILED DESCRIPTION

[0026] The invention provides a method of inhibiting corrosion on a galvanized metal surface. The method includes introducing an effective amount of a corrosion-inhibiting composition onto the galvanized metal surface to form a barrier on the surface. The term "barrier" as used herein includes surface modification of the galvanized surface, change of