

BIOCIDAL PRINT SYSTEM COMPONENTS

BACKGROUND

[0001] Biocides are routinely added to ink and other marking fluid formulations in order to mitigate growth of bacteria, fungi, mold and other such microbial organisms. However, regulatory or compatibility issues may limit the amount of biocide added to the marking fluid formulation. This may limit the useful shelf life of the marking fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Figure 1 is depiction of a carrier for a slow-release biocide for use with the various embodiments of the disclosure.

[0003] Figure 2 is a cut-away perspective view of a marking fluid reservoir in accordance with one embodiment of the disclosure.

[0004] Figure 3 is a block diagram of an imaging device in accordance with a further embodiment of the disclosure.

DETAILED DESCRIPTION

[0005] In the following detailed description of the present embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific embodiments of the disclosure which may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the subject matter of the disclosure, and it is to be understood that other embodiments may be utilized and that process, chemical, electrical or mechanical changes may be made without departing from the scope of the present disclosure. The following detailed

description is, therefore, not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims and equivalents thereof.

[0006] The various embodiments involve incorporation of a biocide, such as a metal ion biocide, into one or more components of the printing system where ink contact may be found. For one embodiment, the metal ion biocide is a silver ion-containing compound including silver ions bonded to a zeolite carrier. As one example, the AgION™ antimicrobial compound available from AgION Technologies, Inc., Wakefield, Massachusetts, USA, is a compound of silver ions bonded to a ceramic support structure. The structure allows the ions to be released at a slow and steady rate. Ambient moisture in the air can cause low-level release sufficient to provide biocidal effects. The ion exchange is increased in high humidity environments, where bacterial growth is often more prevalent. However, the interstices of the carrier limit the release of the silver ions such that long-term efficacy, perhaps years, can be achieved.

[0007] Figure 1 is a depiction of a carrier for a slow-release biocide for use with the various embodiments of the disclosure. The carrier 105 is depicted as a zeolite structure having silver (Ag) ions 110. As ions 115, such as sodium (Na) ions, potassium (K) ions and/or lithium (Li) ions, present in ambient moisture or a marking fluid approach and contact the carrier 105, a non-reactive ion exchange occurs, releasing one or more of the silver ions 105. The silver ions 105 are an active biocide. Marking fluids generally contain some marking material, such as one or more dyes or pigments, for marking the medium, and some aqueous or solvent-based carrier vehicle to facilitate controlled ejection of the marking material.

[0008] An ink formulation was prepared for testing efficacy of the silver-ion biocide. The ink formulation is an amphoteric system which is positively charged at a pH of about 4-5. As tested, the ink formulation had a pH of approximately 4, making it cationic. The ink formulation contained, approximately, 3.5wt% carbon black dispersion, 8wt% 1,1,1-tris(hydroxymethyl) propane, 4wt% glycerol ethoxylate, and 0.4wt% propylene glycol butyl ether in an aqueous carrier. The biocide was used in the form of pellets containing approximately 20wt% of the AgION™ antimicrobial compound in high-impact polystyrene (HIPS). Differing levels of the biocidal pellets were added to the ink formulations before inoculating the ink formulation with a microbe cocktail containing *Bacillus subtilis*, *Pseudomonas cepacia*, *Candida albicans* and *Aspergillus niger*, and

allowed to incubate for up to two weeks. Aliquots were removed from the test solutions at intervals and plated out on to an Agar dish, which was then placed in an oven to help further organism growth. The colonies on the Agar dish were then counted and compared against a control without a biocidal component added. Table 1 represents data obtained from such a testing procedure.

Table 1

Ink	AgION™ compound added to ink (g/100g of ink)			
	0	8	16	32
0	41500	64000	43000	80000
1	550	460	420	30
3	655	305	83	0
7	350	215	55	0
15	320	11	0	0

[0009] As can be seen from Table 1, significant and rapid reductions in plate counts can be achieved with 16g of the HIPS pellets with 20wt% AgION™ compound per 100g of the tested ink formulation. Although the example of Table 1 corresponds to an acidic marking fluid, i.e., pH < 7, marking fluids with pH ≥ 7 may also be used.

[0010] Print system components are commonly constructed of resins, plastics, elastomers and the like. Some examples include bonded nylon fiber; bonded polyester fiber; Delrin® synthetic resin; terpolymers of ethylene, propylene, and a non-conjugated diene; PET (polyethylene terephthalate); polyimides; polyurethanes; polypropylenes; polyethylenes; polysulfones; polyesters; Santoprene® thermoplastic elastomer; isoprene; Teflon® fluorine-containing resins; and the like. Slow-release biocides of the type described may be incorporated within such resins, plastics and elastomers at levels sufficient to provide efficacy against microbial growth without materially degrading their structural integrity. Alternatively, such slow-release biocides may be coated onto these materials as well as other materials of construction, such as metals, e.g., stainless steel, ceramics, e.g., aluminum oxide, and the like. By incorporating inorganic biocides into the

materials used to form print system components that are likely to contact marking fluid during storage and delivery, or adhering the biocides to such surfaces of the print system components, the inclusion of biocides within the marking fluid formulation may be reduced or eliminated, thus facilitating the development of a wider variety of marking fluid formulations.

[0011] One common form of print system component is a replaceable pen for inkjet printers. These pens commonly provide both storage and delivery of the ink to a substrate. Returning to the testing detailed in Table 1, as the surface area of 16g of the tested HIPS pellets corresponds roughly to an internal surface area of an inkjet pen of dimension 2.5cm x 2.5cm x 4.5cm, it can be seen that a pen body formed of plastics containing the AgION™ compound can be efficacious at controlling microbial growth in the contained ink. Empirically, for one embodiment, an amount of silver ion in resin for formation of a print system component might be expressed as:

$$C(\text{Ag}) \geq 0.01 * [M_{\text{ink}} / M_{\text{resin}}]$$

where $C(\text{Ag})$ is the wt% of silver in resin used to form the print system component;

M_{ink} = mass of the ink in contact with the print system component; and

M_{resin} = mass of the resin used to make the print system component.

Note, however, that such an empirical equation is to be used as guidance only. Efficacy may need to be tested in conditions simulating actual use.

[0012] Figure 2 is a cut-away perspective view of one such pen, or marking fluid reservoir, 220 in accordance with one embodiment of the disclosure. The marking fluid reservoir 220 includes a body 222. A fluid ejection device or printhead 224 is integral to the body 222. The printhead 224 includes marking fluid ejectors 226 for dispensing marking fluid onto a print media or other substrate. The marking fluid ejectors 226 are controlled by various electrical signals received at one or more contacts 228.

[0013] The volume within the body 222 is adapted to contain marking fluid 230, e.g., ink. The cut-away portion of the body 222 represented by dashed lines may represent the cross-section of a one-color marking fluid reservoir or an individual chamber of a multi-color marking fluid reservoir, with each chamber having a different marking fluid formulation. Thus, the various embodiments include one-color and multi-color marking

fluid reservoirs 220. The body 222 includes a biocide adhered to, or incorporated within, an inner surface 232 configured to be in contact with the marking fluid 230. For one embodiment, the biocide is a metal ion-containing material. For a further embodiment, the biocide is a ceramic zeolite structure having silver ions bonded thereto. For an alternate embodiment, a metal ion-containing support structure is added directly to the marking fluid 230.

[0014] In addition to a wall of the body 222 itself, the inner surface 232 may also include structures enclosed within the body 222. For example, back-pressure within a marking fluid reservoir 220 may be controlled using reticulated foam or other filler material of controlled capillary force, or bladders or spring bags may also be used to control flow.

[0015] While such integrated pens for storage and delivery of marking fluid are common in the consumer market, storage and delivery need not be combined. Figure 5 illustrates an imaging device 300, such as a printer, according to another embodiment of the disclosure. Imaging device 300 has a fluid handling system that includes a fluid-ejection device 324, such as an inkjet print head, in flow communication with a stationary marking fluid reservoir 340, e.g., an ink reservoir, by one or more conduits 342. Fluid-ejection device 324 is movably attached to a rail or other support 344. Fluid-ejection device 324 can eject marking fluid droplets 346, such as ink droplets, onto a substrate 348, e.g., paper, as fluid-ejection device 324 moves across substrate 348.

[0016] For one embodiment, fluid reservoir 340 is fixedly attached to printer 300. For another embodiment, each of conduits 342 conveys a different fluid, e.g., a different colored ink, from fluid reservoir 340 to fluid-ejection device 324. For another embodiment, a portion of conduits 342 are fluid delivery lines that respectively convey different fluids to fluid-ejection device 324 and another portion of conduits 342 are fluid return lines for conveying fluids that are not ejected by fluid-ejection device 324 back to fluid reservoir 340.

[0017] For various embodiments, one or more of the fluid-ejection device 324, conduits 342 and fluid reservoir 342 include a biocide adhered to, or incorporated within, an inner surface configured to be in contact with the marking fluid.

[0018] Oftentimes, components for transporting marking fluid in systems such as printer 300 are normally empty and contain marking fluid only intermittently during transport from the reservoir 340 to the fluid-ejection device 324. For example, fluid-ejection device 324 may contain an integral reservoir (not shown) and the conduits 342 may only be in contact with marking fluid when re-filling the integral reservoir of the fluid-ejection device 324 and may be flushed or otherwise emptied of marking fluid upon completion of the re-filling operation. It is noted that the conduits 342 may represent components in addition to mere tubing, such as fittings, filters, check valves and the like. Any or all components of such conduits 342 may include a biocide adhered to, or incorporated within, an inner surface configured to be in intermittent contact with the marking fluid. Including a biocide in such components subject to only intermittent contact with marking fluid may lead to extended efficacy of the biocidal system.

CLAIMS

What is claimed is:

1. A print system component, comprising:
a body (222) for enclosing or transporting a marking fluid (230), the body (222)
having an inner surface (232) for contact with the marking fluid (230);
wherein the inner surface (232) contains a biocide incorporated within or adhered
thereto.
2. The print system component of claim 1, wherein the body (222) is selected from
the group consisting of a marking fluid reservoir (220) having an integrated fluid
ejection device (224), a marking fluid reservoir (220) without an integrated fluid
ejection device (224), a fluid ejection device (324) and a conduit (342) of the print
system.
3. The print system component of claim 1 or 2, wherein the biocide is a metal ion-
containing compound.
4. The print system component of claim 3, wherein the metal ion-containing
compound comprises a zeolite structure (105) containing silver ions (110) bonded
thereto.
5. The print system component of claim 4, wherein the body (222) is formed of a
material having an amount of the zeolite structure (105) efficacious to provide
biocidal activity to the inner surface (232) of the body (222).
6. The print system component of claim 5, wherein the material is selected from a
group consisting of resins, plastics, elastomers, metals and ceramics.

7. A method of controlling microbial growth in marking fluids (230), comprising:
contacting the marking fluid (230) with a surface of a print system component;
wherein the surface of the print system component comprises a material having a
metal ion biocide incorporated within or adhered thereto.
8. The method of claim 7, wherein contacting the marking fluid (230) with a surface
of a print system component further comprises contacting the surface of the print
system component with marking fluid (230) only intermittently.
9. The method of claim 7 or 8, wherein the print system component is selected from
the group consisting of a marking fluid reservoir (220) having an integrated fluid
ejection device (224), a marking fluid reservoir (220) without an integrated fluid
ejection device (224), a fluid ejection device (324) and a conduit (342) of the print
system.
10. The method of any of claims 7, 8 or 9, wherein the metal ion biocide is a silver
ion-containing compound.
11. The method of claim 10, wherein the silver ion-containing compound comprises a
zeolite structure (105) containing silver ions (110) bonded thereto.
12. An imaging device (300), comprising:
a fluid ejection device (324) having an inner surface (232) for contact with a
marking fluid (230);
a marking fluid reservoir (220) and having an inner surface (232) for contact with
the marking fluid (230); and
one or more conduits (342) for transporting marking fluid (230) from the marking
fluid reservoir (220) to the fluid ejection device (324) and having at least
one inner surface (232) for contact with the marking fluid (230);
wherein at least one of the inner surface (232) of the fluid ejection device (324),
the inner surface (232) of the marking fluid reservoir (220) and the at least
one inner surface (232) of the one or more conduits (342) comprises a
metal ion biocide incorporated within or adhered thereto.

13. The imaging device (300) of claim 12, wherein the inner surface (232) of a first conduit (342) is adapted to be normally empty during operation of the imaging device (300).
14. The imaging device (300) of claim 13, wherein the inner surface (232) of the first conduit (342) comprises the metal ion biocide incorporated within or adhered thereto.
15. The imaging device (300) of any of claims 12-14, wherein the metal ion biocide comprises a zeolite structure containing silver ions bonded thereto.