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**WO 2014/165258 A1**

(54) Title: COMPOSITIONS AND METHODS FOR LOWERING THE AMOUNT OF UREA IN SOIL

(57) Abstract: The present disclosure relates to compositions, methods and equipment that are effective in removing or reducing the urea content of soil and the ammonia by-product of such removal. The disclosed compositions encompass the use of an enzyme and an ammonia removal system. The ammonia removal system comprises an organic acid, a pH buffer and a surfactant, all in an aqueous carrier.

**COMPOSITIONS AND METHODS FOR LOWERING THE AMOUNT OF UREA IN SOIL**

**CROSS-REFERENCES TO RELATED APPLICATIONS**

[0001] This Application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 61/778,197 filed March 12, 2013 which is incorporated herein by reference in its entirety as if fully set forth herein.

**FIELD OF THE INVENTION**

[0002] The present disclosure relates to compositions, methods and equipment that are effective in removing or reducing the urea content of soil.

**BACKGROUND OF THE INVENTION**

[0003] Urea generally refers to an organic compound typically found in the urine of mammals.

[0004] In order to increase food production, several edible crops are constantly in demand. In order to meet the demands for such products, several fertilizers have been employed. More than 90% of world production of urea is destined for use as a nitrogen-release fertilizer. Urea has the highest nitrogen content of all solid nitrogenous fertilizers in common use and it has the lowest transportation costs per unit of nitrogen nutrient. Therefore, urea based fertilizers are used in large quantities throughout the world.

[0005] Many soil bacteria possess the enzyme, urease, which catalyzes the conversion of the urea molecule to ammonia and carbon dioxide. Urea fertilizers are very rapidly transformed to the ammonium form in soils. Among soil bacteria known to carry urease, there are also some ammonia-oxidizing bacteria, AOB, such as species of nitrosomonas. The carbon dioxide released by the reaction makes biomass that harvest energy by oxidizing ammonia to nitrite, a process called nitrification. The nitrite-oxidizing bacteria oxidize nitrite to nitrate. Ammonia and nitrate are readily absorbed by plants and are the dominant sources of nitrogen for plant growth. Urea is also used in many multi-component solid fertilizer formulations. Urea is highly soluble in water and is, therefore, also very suitable for use in fertilizer solutions such as a 'foliar feed' fertilizers.

[0006] Urea fertilizer has become more popular than its cousin ammonium nitrate. It contains 46 percent nitrogen and involves almost no explosive hazard, making it easier to handle. It is the most inexpensive form of nitrogen per pound, and it lends itself to a variety of applications and blending. Urea can also be dissolved in water as a 50/50 mix to use as a  
5 foliar spray

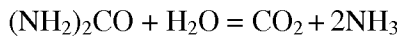
[0007] Urea is a popular solid nitrogen fertilizer because of its high nitrogen content which can be measured at up to be 46%. Most world output is in a solid form, either prills or granules, or crystalline for specialized small-volume uses. For industrialized countries, a liquid form of the product is consumed in the production of nitrogen solution fertilizers. It is  
10 usually applied to the soil at rates of between 40 and 300 kg per hectare but these rates vary. Smaller applications incur lower losses due to leaching. During summer, urea is often spread just before, or during rain to minimize its losses. Urea is not compatible with other fertilizers.

[0008] Because of the high nitrogen concentration in urea, it is imperative that the application be even when applied to the soil. In grain and cotton crops, urea is often applied  
15 at the time of the last cultivation before planting. In high rainfall areas and on sandy soils where nitrogen can be lost through leaching and where good in-season rainfall is expected, urea can be side- or top-dressed during the growing season. Top-dressing is also popular on pasture and forage crops. For irrigated crops, urea can be applied dry to the soil, or dissolved and applied through the irrigation water. Urea will dissolve in its own weight in water. But it  
20 becomes increasingly difficult to dissolve as the concentration increases..

[0009] Urea absorbs moisture from the atmosphere and therefore must be stored either in closed/sealed bags on pallets. In bulk it must be covered and stored in a cool, dry, well-ventilated area.

[00010] The enzyme that breaks down urea is called urease. Urea  
25 amidohydrolase is the urease of choice that is used. This enzyme increases the rate where hydrolysis of the urea occurs, producing carbon dioxide and ammonia. The enzyme, urea amidohydrolase is a nickel metallo-enzyme that catalyzes the degradation of urea to ammonia and carbamine acid which decomposes to generate a second molecule of ammonia and carbon dioxide. This decomposition reaction is expressed as

30 [00011] Urea (NH<sub>2</sub>)<sub>2</sub> CO and the addition of Water (H<sub>2</sub>O) produces → Carbon Dioxide (CO<sub>2</sub>) and Ammonia (NH<sub>3</sub>).



[00012] One of the most commonly cited problems involving increased residue and nitrogen (N) fertilizers is ammonia volatilization. When urea is applied to the soil, it is broken down by chemical reaction with water to form ammonium (NH<sub>4</sub><sup>+</sup>) by the enzyme urease. If conditions are right like poor soil contact and little or no rainfall for several days after the fertilizer application, the ammonium salt, NH<sub>4</sub><sup>+</sup> may be rapidly converted to ammonia NH<sub>3</sub> which can be lost by volatilization, at the soil surface.

#### SUMMARY OF THE INVENTION

10 [00013] The present disclosure relates to compositions, methods and equipment that are effective in removing or reducing the urea content of soil and the ammonia by-product of such removal.

[00014] The disclosed compositions encompass the use of an enzyme, an ammonia removal system and in an aqueous carrier. That composition is mixed in the urea contaminated soil to remove the urea and the byproducts of the decomposition of the urea. The ammonia removal system comprises an organic acid with a pH buffer. The enzyme is an urease product.

[00015] Soil rejuvenation process must be effective in reducing urea and the byproducts of the decomposition of urea with the urease enzyme and then removal or reduction of the ammonia present in the soil. To achieve that goal, the process must achieve the following:

1. The soil must first be exposed to adequate amounts of urease, for a long enough period of time, to allow for full conversion of any urea to its byproducts.
2. Second, an ammonia removal system must be applied in adequate amounts, and for a long enough period of time, to convert the ammonia left after the urease application to a non-detectable odor level.

[00016] Additional advantages will be set forth in part in the description that follows, and in part will be obvious from the description, or may be learned by practice of the aspects described below. The advantages described below will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. It is

to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive.

#### DESCRIPTION OF EXEMPLARY EMBODIMENTS

5           [00017]           In this specification and in the claims that follow, reference will be made to a number of terms that shall be defined to have the following meanings:

          [00018]           Throughout this specification, unless the context requires otherwise, the word “comprise,” or variations such as “comprises” or “comprising,” will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the  
10       exclusion of any other integer or step or group of integers or steps.

          [00019]           It must be noted that, as used in the specification and the appended claims, the singular forms “a,” “an” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a carrier” includes mixtures of two or more such carriers, and the like.

15           [00020]           “Optional” or “optionally” as used herein means that the subsequently described event or circumstance can or cannot occur, and that the description includes instances where the event or circumstance occurs and instances where it does not.

          [00021]           Ranges may be expressed herein as from “about” one particular value, and/or to “about” another particular value. When such a range is expressed, another aspect  
20       includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about,” it will be understood that the particular value forms another aspect. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

25           [00022]           A weight percent of a component, unless specifically stated to the contrary, is based on the total weight of the formulation or composition in which the component is included.

          [00023]           By “contacting” as used herein means an instance of applying a composition to the soil.

[00024] By “sufficient amount” and “sufficient time” as used herein means an amount and time needed to achieve the desired result or results.

[00025] “Admixture” or “blend” as used herein means a physical combination of two or more different components.

5 [00026] “Controlled release” as used herein means the use of a material to regulate the release of another substance.

[00027] “Tilling” as used herein refers to the mechanical or manual process for plowing the soil.

[00028] “Plowing” as used herein refers to the unearthing of the soil as done in  
10 planting of agricultural crops.

[00029] “Enzyme” as used herein refers to any urease suitable to decompose urea.

[00030] “Organic acid” as used herein refers to weak acids that do not dissociate completely in water but are generally soluble in organic solvents and are mostly  
15 carboxylic acids.

[00031] “pH buffer” as used herein refers to a mixture that adjust the pH level in a product.

[00032] “Odor” as used herein refers to any pungent smell or stench.

[00033] “Ammonia removal system” as used here in refers to a system to  
20 remove any ammonia byproduct from the decomposition of the urea present in the soil previously treated.

[00034] The present disclosure addresses several unmet needs as defined below:

- 25 1. Providing compositions effective in removing urea, and the byproducts of the decomposition of urea from the soil, non-limiting examples of which include the use of suitable enzymes such as a urease.

2. Providing a system that is effective in removing ammonia from the soil, a by-product of urea decomposition by a urease, by converting it to a sulfate chloride or chlorite salt.

### Treatment Compositions

5

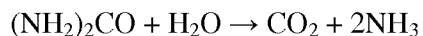
[00035] A first disclosed compositions for rejuvenating the soil by removing urea from the soil and the reduction or removal of the ammonia which is a byproduct of the urea decomposition using the following steps:

1. The addition of an urease enzyme to the soil from about 0.01% to about 25.0%;  
10 and
2. The addition of the Ammonia removal system of about 0.01% to about 20.0 % by weight.

### Urease

[00036] When urea is added to soils as fertilizer or as animal urine is  
15 hydrolyzed enzymatically by soil urease ( $\text{NH}_2\text{CONH}_2 + \text{H}_2\text{O} \rightarrow 2\text{NH}_3 + \text{CO}_2$ ), and the resulting release of ammonia and rise in pH can lead to several problems, including damage to germinating seedlings and young plants, nitrite toxicity and volatilization of urea N as ammonia, which may cause air and water pollution problems. Specifically, highly alkaline soils (pH~8.2 or higher) have proven to increase urea hydrolysis. One study has shown  
20 complete hydrolysis of urea within two days of application on such soils. In acidic soils (pH 5.2) the urea took twice as long to be hydrolyzed. Surface residues, such as thatch and plant stubble exhibit increased urease activity. Soils that have high organic matter content also tend to have higher urease concentrations. More urease results in greater hydrolysis of urea and ammonia volatilization, particularly if urea fails to move into the soil.

25 [00037] The use of an urease enzyme that catalyzes the hydrolysis of urea into carbon dioxide and ammonia. The reaction occurs as follows:



[00038] Urea amidohydrolase is the urease of choice.

30

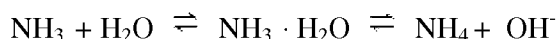
### Ammonia Removal System

[00039] The disclosed compositions comprise the Ammonia removal system. This system comprises an organic acid and a pH buffer.

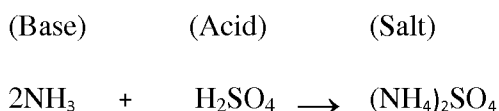
5

#### Organic Acid

[00040] The basic principle action of organic acids on ammonia is that non-dissociated organic acids can react with free ammonia to produce an organic ammonium salt. When the ammonia dissolves in water, it forms the ammonium ions ( $\text{NH}_4^+$ ). This can be  
 10 chemical shown as equilibrium is reached and contains un-ionized ammonia ( $\text{NH}_3$ ), ionized ammonia ( $\text{NH}_4^+$ ), and hydroxide ions ( $\text{OH}^-$ ). The following equation expresses the equilibrium of these chemical species:



[00041] The neutralization using an organic acid occurs when it is combined  
 15 with the above. An acid neutralized all the basic properties of ammonia. Such neutralizing reaction results in the formation of a salt as shown in the following reaction of ammonia and sulfuric acid:



20

[00042] The neutralizing diffusion of organic acids is similar to that of sulfuric acid. The first group of suitable organic acids is Lactic, Acetic, Formic, Fumaric, Citric, Oxalic, Adipic and Uric.

[00043] The second group of suitable organic acids is the carboxylic acids,  
 25 whose acidity is associated with their carboxyl group  $-\text{COOH}$ . Sulfonic acids, containing the group  $-\text{SO}_2\text{OH}$ , are relatively stronger acids. The relative stability of the conjugate base of the acid determines its acidity. In some biological systems more complex organic acids such as L-lactic, citric, and D-glucuronic acids are formed. These use the hydroxyl or carboxyl group.

[00044] The third group of suitable organic acids are Humic, Sebacic, Stearic, Gallic, Palmitic, Caffeic, Glyoxylic, Fulvic, Carnosic, Anthranilic, Ellagic, Lipoic, Chlorogenic, Rosmarinic, Phosphoric, Methacrylic, Oleanic, Nitrohumic, Florocinnamic, Hexafluorosilicic, Hydrofluoric, Hydroxycitric and Silicofluoric.

5 [00045] The fourth group of suitable organic acids is fruit acids. The acids in fruits are chiefly acetic, malic, citric, tartaric, oxalic, and in some instances boric. Malic acid is present in apples, pears, currants, blackberries, raspberries, quince, pineapple, cherries, and rhubarb. Citric acid is found in lemons, oranges, grapefruit, lemons, limes, quince, gooseberry, strawberry, raspberry, currant, and cranberry. Tartaric acid occurs in grapes.  
10 Boric acid is found in many fresh fruits and vegetables. Mandelic acid is present in almonds.

[00046] The fifth group of suitable organic acids is beta hydroxy acids, which is a type of phenolic acid. Salicylic acid is a colorless crystalline organic acid whose main active ingredient obtained from this source is a monohydroxybenzoic acid.

#### **pH Buffer**

15

[00047] A dermal, non-corrosive acid composition that is able to keep the organic acid in the proper pH environment, having a maximum proton count of  $1.5 \times 10^{25}$ , an embodied conductivity range of from 250 mV to 1500mV and a 0.1% solution of the composition having a pH of under 2.0.

20

#### **Surfactant**

[00048] A surfactant component includes ingredients that modify the water in the system making it suitable from use with several types of water such as hard water, soft water, sulfite contaminated water, rain water, pond water, well water or calcium rich water. Quaternary ammonium compounds which are more compatible with anionic surfactants  
25 generally have an inadequate conditioning effect.

[00049] In-order to improve the performance of an aqueous mixture dialkyl diallyl ammonium chloride/acrylic acid-type polymers is added. This method for improving the stickiness properties of the composition encompasses adding an effective amount of a polymer comprising:

- 5 i. about 60 to about 99%, based on total polymer weight, of a quaternary diallyl dialkyl ammonium monomer, wherein alkyl groups are independently selected from alkyl groups of 1 to 18 carbon atoms, preferably C<sub>1-4</sub> alkyl, and wherein said quaternary diallyl dialkyl ammonium monomer's counterion is selected from the group consisting of conjugate bases of acids having an ionization constant greater than 10<sup>-13</sup>, more preferably selected from the group consisting of fluoride, chloride, bromide, hydroxide, nitrate, acetate, hydrogen sulfate, and primary phosphates;
- 10 ii. and about 1 to about 40%, based on total polymer weight, of an anionic monomer selected from the group consisting of acrylic acid and methacrylic acid; wherein the average molecular weight of said polymer ranges from about 50,000 to about 10,000,000, as determined by gel permeation chromatography.

[00050] The polymer base can also be a combination of one or more bases, for example, glycerol in combination with ethoxylated partial glyceride fatty acid esters. These include branched chain esters, ethoxylated partial glyceride fatty acid esters, protein derivatives, lanolin and lanolin derivatives, and fatty alcohol ethoxylates, emollient oils, fatty acids, fatty alcohols and their esters. Other examples of suitable bases include glycerine, sorbitol, aloe, polyglycols, polyethylene glycol, polyoxyethylene and polyethylene oxide.

### Carriers

20 [00051] The balance of the disclosed compositions comprises a carrier. The carrier can be any suitable material that can dissolve the active ingredients and co-ingredients and deliver the ammonia removal system to the soil. Water is a convenient carrier for liquid embodiments of the disclosed composition.

### Formulations

25 [00052] The following are non-limiting examples of the disclosed compositions:

Table 1

Urease enzyme

Ingredients	1	2	3	4	5
Urease Enzyme urea amidohydrolase	1.0	5.0	10.0	15.0	20.0
Carrier	99.0	95.00	90.00	85.00	80.00

Table 2

Ammonia Removal System

Malic Acid	0.10	0.50	1.00	5.00	10.00
pH buffer	2.0	2.0	2.0	2.0	2.0
Surfactant	4.0	4.0	4.0	4.0	4.0
carrier	balance	balance	balance	balance	balance

**Methods of Use**

5

[00053] The disclosed compositions can be used for various applications with the application methods and dosage regimens dictated by the frequency of contamination and infection.

10

1. Spray applications usually consist of a composition that is adequate to cover the entire soil that has been tilled. The ammonia removal system must make contact with all the surfaces.
2. Foam applications are effective where the foam composition can be applied directly to the tilled or unearthen soil in order to insure it is thoroughly coated with the foam.

15

**Test Results**

20

[00054] A Draeger Pump and ammonia detection Draeger tubes were used to determine the presence of any ammonia gas levels. The Draeger pump is a standard bellow style gas sampling pump. It drags the gas a calibrated 100 ml sample through a short-term Draeger tubes. In Table A it shows the results of ammonia expressed as parts per million

(ppm). Any ammonia present is represented as before and after a spray application was done on soil sample. The study times were; less than 1 hour and 5 days after the initial application was done. Table 3 below shows those results:

Table 3

Urine Samples	1 Hour		5 Days	
	Before	After	Before	After
Sample 1	15 ppm	2 ppm	170 ppm	4 ppm
Sample 2	18 ppm	2 ppm	210 ppm	5 ppm
Sample 3	15 ppm	2 ppm	200 ppm	4 ppm
Sample 4	20 ppm	2 ppm	190 ppm	4 ppm
Sample 5	20 ppm	2 ppm	210 ppm	5 ppm

5

[00055] While particular embodiments of the present disclosure have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the disclosure. It is, therefore intended to cover in the appended claims all such changes and  
 10 modifications that are within the scope of this disclosure.

CLAIMS

What is claimed is:

1. A composition for removing or reducing the urea content of soil, comprising:  
5 an enzyme of about 0.01% to 25% by weight; and  
the balance being an aqueous based carrier.
2. The composition according to claim 1, where the urease enzyme is urea  
amidohydrolase.
3. A composition for removing or reducing ammonia from the soil which is  
10 byproduct from claim 1, comprising:  
an ammonia removal system of about 0.01% to about 20.0 % by weight  
comprising:  
from about 0.1% to about 15% by weight of an organic acid;  
at least about 5.0 % by weight of a pH buffer agent; and  
15 from about 0.01% to 5% by weight of a surfactant;  
and the balance being an aqueous based carrier.
4. The composition according to Claim 3, wherein the organic acid is chosen  
from fruit acids such as acetic, malic, citric, tartaric, oxalic, tartaric, mandelic  
and boric acids.
- 20 5. The composition according to Claim 3, wherein the organic acid is chosen  
from several fruit acids such as acetic, malic, citric, tartaric, oxalic, tartaric,  
mandelic and boric acids.
6. The composition according to Claim 3, wherein the organic acid is chosen  
from several organic acids such as Lactic, Acetic, Formic, Fumaric, Adipic,  
25 Citric, Oxalic, or Uric acids.
7. The composition according to Claim 3, wherein the organic acid is chosen  
from several carboxylic and/or Sulfonic containing acids such as Humic,  
Sebacic, Stearic, Gallic, Palmitic, Caffeic, Glyoxylic, Fulvic, Carnosic,

Anthranilic, Ellagic, Oleanic, Lipoic, Chlorogenic, Rosmarinic, Phosphoric, Methacrylic, Nitrohumic, Florocinnamic, Hexaflorosilicic, Hydrofluoric, Hydroxycitric and Silicofluoric.

- 5 8. The composition according to Claim 3, wherein the organic acid is chosen from suitable organic acids that are beta hydroxy acids such Salicylic acid.
9. The composition according to Claim 3, wherein the organic acid is Malic acid.
- 10 10. The composition according to Claim 3, where the pH buffer is a dermal, non-corrosive acid composition, having a maximum proton count of  $1.5 \times 10^{25}$ , an embodied conductivity range of from 250 mV to 1500mV and a 0.1% solution of the composition having a pH of under 2.0.
- 15 11. The composition according to Claim 3, wherein the surfactant is chosen from about 60% to about 99%, based on total polymer weight, of a quaternary diallyl dialkyl ammonium monomer, wherein alkyl groups are independently selected from alkyl groups of 1 to 18 carbon atoms, C<sub>1-4</sub> alkyl, and wherein said quaternary diallyl dialkyl ammonium monomer's counterion is selected from the group consisting of conjugate bases of acids having an ionization constant greater than  $10^{-13}$ , selected from the group consisting of fluoride, chloride, bromide, hydroxide, nitrate, acetate, hydrogen sulfate and primary phosphates.
- 20 12. The composition according to Claim 3, wherein the surfactant is chosen from about 1% to about 40%, based on total polymer weight, of an anionic monomer selected from the group consisting of acrylic acid and methacrylic acid, wherein the average molecular weight of said polymer ranges from about 50,000 to about 10,000,000, as determined by gel permeation chromatography.
- 25 13. The composition according to Claim 3, wherein the surfactant is chosen from a combination of one or more polymer bases, such as glycerol, glycerine, sortibal aloe, polyglycols, polyethylene glycol, polyoxyethylene and polyethylene oxide, in combination with ethoxylated partial glyceride fatty acid esters, branched chain esters, protein derivatives, lanolin and lanolin
- 30

derivatives, and fatty alcohol ethoxylates, emollient oils, fatty acids, fatty alcohols and their esters.

**INTERNATIONAL SEARCH REPORT**

International application No.  
PCT/US2014/024997

<p><b>A. CLASSIFICATION OF SUBJECT MATTER</b>                  IPC(8) - E02D 3/00 (2014.01)                  USPC - 405/302.4                  According to International Patent Classification (IPC) or to both national classification and IPC</p>																	
<p><b>B. FIELDS SEARCHED</b></p> <p>Minimum documentation searched (classification system followed by classification symbols)                  IPC(8) - C09J 11/08, E02D 3/00 (2014.01)                  USPC - 405/302.4, 524/17</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                  CPC - B09C 1/00, C11D 11/00, C12R 1/00 (2014.02)</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)                  Orbit, Google Patents, Google Scholar, PubMed</p>																	
<p><b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b></p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X ----- Y</td> <td>US 7,841,806 B2 (LINDENBAUM) 30 November 2010 (30.11.2010) entire document</td> <td>1, 2 ----- 3-13</td> </tr> <tr> <td>Y</td> <td>WO 2010/142004 A2 (AERTS et al) 16 December 2010 (16.12.2010) entire document</td> <td>3-13</td> </tr> <tr> <td>Y</td> <td>US 2010/0210745 A1 (MCDANIEL et al) 19 August 2010 (19.08.2010) entire document</td> <td>3-13</td> </tr> <tr> <td>Y</td> <td>US 4,276,377 A (GOODHUE) 30 June 1981 (30.06.1981) entire document</td> <td>9</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X ----- Y	US 7,841,806 B2 (LINDENBAUM) 30 November 2010 (30.11.2010) entire document	1, 2 ----- 3-13	Y	WO 2010/142004 A2 (AERTS et al) 16 December 2010 (16.12.2010) entire document	3-13	Y	US 2010/0210745 A1 (MCDANIEL et al) 19 August 2010 (19.08.2010) entire document	3-13	Y	US 4,276,377 A (GOODHUE) 30 June 1981 (30.06.1981) entire document	9
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Y	US 2010/0210745 A1 (MCDANIEL et al) 19 August 2010 (19.08.2010) entire document	3-13															
Y	US 4,276,377 A (GOODHUE) 30 June 1981 (30.06.1981) entire document	9															
<p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/></p>																	
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td style="vertical-align: top;"> <p>“A” document defining the general state of the art which is not considered to be of particular relevance</p> <p>“E” earlier application or patent but published on or after the international filing date</p> <p>“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>“O” document referring to an oral disclosure, use, exhibition or other means</p> <p>“P” document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="vertical-align: top;"> <p>“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>“&amp;” document member of the same patent family</p> </td> </tr> </table>			<p>“A” document defining the general state of the art which is not considered to be of particular relevance</p> <p>“E” earlier application or patent but published on or after the international filing date</p> <p>“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>“O” document referring to an oral disclosure, use, exhibition or other means</p> <p>“P” document published prior to the international filing date but later than the priority date claimed</p>	<p>“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>“&amp;” document member of the same patent family</p>													
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<p>Date of the actual completion of the international search</p> <p>15 June 2014</p>		<p>Date of mailing of the international search report</p> <p style="text-align: center; font-size: 1.2em;"><b>10 JUL 2014</b></p>															
<p>Name and mailing address of the ISA/US</p> <p>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents                  P.O. Box 1450, Alexandria, Virginia 22313-1450                  Facsimile No. 571-273-3201</p>		<p>Authorized officer:</p> <p style="text-align: center;">Blaine R. Copenheaver</p> <p>PCT Helpdesk: 571-272-4300                  PCT OSP: 571-272-7774</p>															