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(54) Title: FREEZER FROST ABATEMENT DEVICE

(57) Abstract: A frost resistant freezer includes a freezer chamber, a door, a cooler, and a desiccant. The freezer chamber has a volume. The door provides access to the freezer chamber. The cooler cools air within the freezer chamber from a first temperature within the chamber immediately following closure of the door to a second, quiescent temperature during a cooling period. The desiccant is disposed within the freezer chamber and is selected to absorb moisture from the freezer chamber at a rate sufficient to reduce the relative humidity within the freezer chamber to a value low enough to prevent the formation of frost within the freezer chamber at the quiescent temperature.

## TITLE

FREEZER FROST ABATEMENT DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority of U.S. Provisional Patent Application No. 60/795,638, entitled Freezer Frost Abatement Device.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to reducing moisture in an enclosed space. More specifically, the invention relates to a method of and apparatus for significantly reducing the formation of frost on the inner surface of and contents contained within a freezer, and for removing frost should it form.

[0003] The build up of freezer frost over time is a known nuisance. As time elapses, more and more frost accumulates on inner surfaces of the freezer and its contents, substantially reducing the usable space within the freezer. Moreover, freezer frost also has a tendency to cause loss of flavoring in food and may discolor some food items. Accordingly, users readily undertake to remove freezer frost from within the freezer, using such techniques as putting hot items in the freezer, chipping ice with an ice pick, and the like. Once the frost is removed, however, the problem is not solved, because over time frost will re-accumulate and the process of removing frost must be repeated.

[0004] In addition to the maladies described above, the presence of freezer frost also may have additional, more detrimental effects on the freezer. Over time, as frost builds up, air ingress vents may become blocked, which puts excess strain on the compressor and mechanics of the freezer as a whole. This leads to excess energy use, inefficiencies, and potential failures. If frost is allowed to build up even more, there then becomes a risk that a vice were frost may actually get into the mechanical components of the freezer, eventually also leading to failures. In each of these scenarios, the final result is at least excessive energy bills, costly repairs, or replacement of the entire freezer.

[0005] Freezer frost is created within the freezer in two general ways. The first way in which freezer frost is formed is caused by opening the freezer. When opened, relatively warm, humid air from the external environment floods the interior of the freezer. Given the drastic temperature difference between the interior of the freezer and ambient air, the moisture present in the outside air rapidly condenses into a fog as the air cools. When the freezer is closed, the fog has no place to go, and slowly deposits itself on any available surface, eventually building up and creating a layer of ice, or frost.

[0006] The second source of freezer frost is sublimation. Typically, when articles are placed in the freezer, including ice cubes and like, moisture may sublime from these articles, and refreeze as frost on other surfaces of or contents within the freezer.

[0007] Frost in freezers is a known problem, and there are currently two standard methods for eliminating freezer frost. However, neither is particularly efficient.

[0008] The first method of removing freezer frost is the traditional method, which includes removing the entire contents of the freezer, turning off the device, and allowing the ice to melt. In this method, melting of the ice may be further facilitated using a warming agent, e.g., warm water, an electric frying pan or the like. This method, of course, is not ideal because it requires the removal of contents of the freezer and relocation of those contents so they do not thaw. Moreover, this method also requires an extensive amount of time.

[0009] The other method of removing freezer frost is commonly built into freezers that are known as "frost-free" freezers. In the method employed by such freezers, the temperature within the freezer is actually elevated at some predetermined time interval to either liquefy or sublimate the frost built up in the freezer. While this method is somewhat effective, it does require additional complex mechanical components be built into the freezer. This can increase the overall cost of purchase and repair of the freezer. This method also requires additional energy, due to the required heating cycles.

[0010] From the foregoing, it should be evident that there is a need in the art for a method of and apparatus for abating freezer frost formation. The method and apparatus should require minimal user interaction. There also is a need in the art for a method of and apparatus for abating freezer

frost formation without additional energy consumption and the costs associated therewith.

#### SUMMARY OF THE INVENTION

[0011] The present invention addresses the foregoing needs in the art by providing a freezer frost abatement device and method of freezer frost abatement using a desiccant.

[0012] In one aspect of the present invention, a frost resistant freezer includes a freezer chamber, a door, a cooler, and a desiccant. The freezer chamber has a volume. The door provides access to the freezer chamber. The cooler cools air within the freezer chamber from a first temperature within the chamber immediately following closure of the door to a second, quiescent temperature during a cooling period. The desiccant is disposed within the freezer chamber and is selected to absorb moisture from the freezer chamber at a rate sufficient to reduce the relative humidity within the freezer chamber to a value low enough to substantially prevent the formation of frost within the freezer chamber at the quiescent temperature.

[0013] In another aspect of the present invention, a method of controlling the buildup of frost in a freezer having a freezer chamber and a cooler for cooling air within the freezer chamber to a quiescent temperature includes cooling the air within the freezer chamber to the quiescent temperature at a first relative humidity, admitting warm air and moisture into the freezer chamber, and re-cooling the air within the freezer chamber

to the quiescent temperature while simultaneously reducing the relative humidity of the air within the freezer chamber.

[0014] An understanding of these and other features of the invention may be had with reference to the attached figures and following description, in which the present invention is illustrated and described.

#### BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0015] Figure 1 is a perspective view of a preferred embodiment of the present invention;

[0016] Figure 2 is a graph illustrating adsorbed moisture over time for various desiccant materials according to preferred embodiments of the invention; and

[0017] Figure 3 is a graph illustrating adsorbed moisture over time for additional desiccant materials according to additional preferred embodiments of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0018] Preferred embodiments of the invention now will be described with reference to the accompanying figures as necessary.

[0019] As described in more detail above, the build-up of frost in freezers is problematic. As illustrated in Figure 1, a freezer 2 generally includes a cavity 4 in which foodstuffs and the like are stored and a cooling

mechanism 6 in communication with the cavity 4 to lower and maintain the temperature of the freezer cavity 4 at a quiescent temperature, substantially at or below freezing. Normally, the cavity is substantially sealed to the exterior. However, when the cavity is accessed, for example, by opening a door 8 of the freezer 2, the seal is broken and relatively warm, moist air rushes into the cavity, displacing a portion of the air previously filling the cavity. This relatively warmer air causes a fog and simultaneously raises the temperature in the cavity 4, such that the cooling mechanism 6 must lower the temperature of the cavity upon resealing. As the temperature within the freezer 2 is so lowered, the relative humidity of the air raises, and if the air becomes saturated, frost forms on inner surfaces of and/or articles contained within the freezer 2.

[0020] The inventors have developed a way of abating freezer frost formation. Specifically, the inventors have found that by placing a desiccant packet 10 inside a freezer, moisture within the freezer can be adsorbed and/or absorbed before depositing as frost. Specifically, the desiccant material preferably maintains the relative humidity in the freezer below 100% during the time it takes for the cooling mechanism to return the temperature in the cavity to the quiescent temperature. A properly selected desiccant also can lower the relative humidity within the freezer to promote sublimation of frost already in the freezer. Ice sublimation generally is caused when the freezer is closed for a short period of time. Once sublimed, the resulting moisture is adsorbed/absorbed by the desiccant composition.

[0021] In a preferred embodiment of the invention, the desiccant is placed in a packet, for example, a bag or pouch. The packet is moisture permeable, such that ambient moisture in the freezer can pass through the packet and be picked up by the desiccant.

[0022] Preferably, a desiccant package according to the present invention includes an adsorbent, which can be any number of adsorbents, including clay, activated clay, wide pore or standard pore size silica gel, a salt, or molecular sieve.

[0023] Tables 1 and 2 show absorbency rates of various compositions over time, as tested by the inventors. In Table 1, formulation 1 is clay, and 1(A) and 1(B) designate two different packets of that formulation; formulation 2 is silica gel, and 2(A) and 2(B) designate two different packets of that formulation; formulation 3 is Transorb<sup>®</sup>, and 3(A) and 3(B) designate two different packets of that formulation; and formulation 4 is molecular sieve, and 4(A) and 4(B) designate two different packets of that formulation. Table 2 is used to illustrate a fifth formulation comprising 16-unit wide-pore silica gel. 5(A) in that table is that fifth formulation, while 5(B) is 16-unit silica gel, provided for comparison.

[0024] In these tests, a standard top unit freezer was used having an average temperature of 0°F. The external environment had an average temperature of 77°F and 50% relative humidity. For each of the tests illustrated, the desiccants were weighed initially and placed in the freezer. They were then weighed periodically, to determine how much moisture had been adsorbed by the desiccant. On "weighing days," i.e., the days on which

the desiccant packets were weighed, the door of the freezer was opened eight times, for three seconds each time. On alternate, non-weighing days, the door was opened three times, for three seconds each time. The inventors estimate that approximately 500 mg of moisture is introduced each time the freezer is opened.

Elapsed Time (days)	Formula Weight (g)							
	1(A)	1(B)	2(A)	2(B)	3(A)	3(B)	4(A)	4(B)
0	548.11	544.32	459.66	461.36	205.3	205.7	480.02	476.31
3	556.21	548.73	467.9	470.22	207.99	208.59	494.78	485.38
5	561.55	553.14	472.27	475.04	209.25	209.77	501.25	491.58
7	566.09	557.14	476.55	477.73	211.09	211.07	507.47	497.53
10	573.05	563.21	484.72	481.08	213.46	212.84	516.33	507.84
12	577.37	566.92	490.02	483.75	215.47	214	521.49	512
14	580.08	569.92	492.65	485.92	217.24	214.81	525.74	517.14
17	585.98	577.12	499.62	490.54	221.29	216.99	534.29	525.44
19	587.83	579.02	500.6	491.82	222.3200	217.53	534.68	528.24
21	591.51	582.88	504.68	494.69	223.76	218.49	541.27	532.39
16	597.66	590.35	513.77	503.4	226.96	220.64	549.15	538.72
18	599.67	593.73	517.73	506.24	227.38	222.23	552.79	543.48
31	604	598.42	521.26	510.99	229.05	224.11	557.08	548.07
33	606.61	601.33	524.95	513.97	231.02	224.66	559.99	552.26
35	610.34	603.43	527.42	517.36	231.8	225.51	561.47	556.33
38	614.37	608.98	532.2	523.39	235.13	227.27	567.86	561.7
40	615.37	613.11	534.6	526.61	236.3	227.83	569.74	564.47
42	618.14	616.54	537.33	529.7	236.68	228.29	571.11	566.34
47	623.27	621.64	542.82	536.53	238.22	231.42	573.03	569.58
49	625.52	624.45	545.92	539.22	239.54	232.38	573.77	570.48
52	630.33	626.6	549.78	543.55	240.56	233.91	574.88	572.04
56	635.35	632.14	552.84	548.79	242.22	235.72	575.27	572.77
61	641.98	635.97	558.92	555.06	244.01	238.02	575.96	573.73
63	643.53	638.21	560.29	557.26	245.62	239.26	575.95	573.83
66	645.72	641.17	563.29	561	247.59	240.85	576.19	574.1
68	647.64	643.77	565.03	563.52	248.67	242.09	576.35	574.35

70	649.49	645.54	567	566.1	249.58	243.26	576	574.51
73	652.5	648	569.3	569.9	252.7	245	576.8	574.9
77	655.48	652	572.54	575.53	257.49	247.25	575.85	574.84
80	657.11	654.37	574.78	578.29	260.4	248.59	575.58	574.87
82	658.69	656.29	576.47	580.62	262.84	249.7	575.62	574.82
84	659.76	657.87	578.28	582.5	264.98	250.64	575.62	574.79
87	661.33	659.69	580.53	585.37	268.4	252.24	575.58	574.87
89	662.07	660.58	582.86	587.19	270.98	253.39	575.7	574.9
91	663.36	661.43	584.94	589.11	273.2	254.5	575.52	574.98
94	664.23	662.34	587.19	590.76	275.87	255.76	575.47	574.67
96	665.12	663.26	588.98	592.17	278.13	256.88	575.43	574.73
101	666.6	664.68	591.78	595.04	282.44	259.01	575.36	574.63
103	667.52	665.19	593.11	596.37	284.48	260.02	575.51	574.67
108	668.9	666.36	595.38	598.87	289.23	262.48	575.56	574.77
110	669.69	666.71	596.24	599.76	291.41	263.6	575.35	574.77
112	670.47	667.41	597.9	601.3	293.81	264.62	575.35	574.77
115	670.68	667.65	598.5	601.78	295.94	265.81	575.35	574.77
117	671.21	668.1	599.43	602.49	298.22	266.92	575.35	574.77
119	676.6	668.4	600.09	603.09	300.15	267.8	575.35	574.77
131	672.71	669.73	602.21	605.03	311.47	273.24	575.35	574.77
136	673.97	670.38	602.86	605.51	314.8	274.92	575.35	574.77
138	674.27	670.61	603.01	605.71	316.65	275.86	575.35	574.77
140	674.62	670.91	603.32	605.87	318.16	276.68	575.35	574.77
143	675.02	671.15	603.14	605.01	320.33	278.16	575.35	574.77
145	675.21	671.39	603.29	606.17	321.49	279.14	575.35	574.77
147	673.35	671.55	603.45	606.47	323.27	280.09	575.35	574.77
167	673.35	671.55	603.45	606.47	324.04	281.69	575.35	574.77
193	673.45	675.99	603.45	606.47	324.04	281.69	575.35	574.77
218	673.35	677.21	603.45	606.47	324.04	281.69	575.35	574.77
249	674.09	678.03	598.63	603.61	362.13	339.87	575.35	574.77

Table 2: Absorptive capacities of regular and wide-pore molecular sieve

Elapsed Time (days)	Formula Weight (g)	
	5(A)	5(B)
0	458.66	459.48
1	462.07	464.52
4	469.23	473.78
8	476.56	484.05
12	483.18	494.29
18	492.12	508.84
20	494.98	513.89

25	500.93	523.19
27	503.24	527.12
29	505.19	530.57
34	511.15	541.5
41	517.05	551.84
48	523.51	563.1
55	528.07	570.66
62	532.92	578.29
69	538.32	586.26
76	542.61	593.03
83	546.4	598.1
90	550.06	603.4
97	555.95	607.86
110	562.08	612.96
117	564.71	614.17
131	569.43	614.92
145	575.12	614.58
152	578.21	614.37
161	580.94	614.22
166	582.17	613.75
173	584.45	613.29
180	587.11	613.17
187	589.43	612.57
191	592.74	612.52
205	594.91	612.74

[0025] Figure 1 is a graphical representation of the data contained in Table 1, and Figure 2 is a graphical representation of the data contained in Table 2. In Figure 1, the plot for each of the formulations 1 through 4 are averages of the (A) and (B) samples of the respective formulation.

[0026] As illustrated in Tables 1 and 2 and Figures 1 and 2, the gel with vermiculite appears to be the most effective at adsorbing moisture under freezer conditions (i.e., between approximately 9°F and -5°F). Moreover, gel with vermiculite lasted, i.e., continued to adsorb moisture, for the longest amount of time. Amongst the standard- and wide-pore silica

gels tested, the standard-pore seems to be more adsorptive, at least over the 77 day test period, represented in Table and Figure 2.

[0027] Table 3 is similar to Table 2, but illustrates the absorption of moisture by a sixth formulation comprising 8-unit wide pore silica gel on potassium chloride. This formulation is represented by 6(A) on Table 3, while 6(B) represents an 8-unit silica gel, provided for comparison.

Table 3: Absorptive capacities of regular and wide-pore molecular sieve		
Elapsed Time (days)	Formula Weight (g)	
	6(A)	6(B)
0	379.09	379.77
2	384.58	385.29
4	389.1	390.83
7	394.03	398.06
10	396.35	402.36
12	396.35	402.36
17	399.47	407.02
19	420.99	408.15
26	426.85	410.52
30	426.91	420.37
37	454.36	427.53
51	470.25	437.38
65	486.91	447.96
72	492.73	451.91
81	499.26	456.93
86	501.37	459.57
93	502.84	463.49
100	504.3	466.84
107	503.69	470.14
119	504.91	475.64
133	504.82	480.56

[0028] Other formulations for use in abating freezer frost formation also may be used according to the present invention. Such alternative

formulations may include humectants salt, for example, calcium chloride. The adsorbent may be mixed or impregnated with such salt. Stabilizers, such as vermiculite or cellulose materials, also may be added to the adsorbent material according to embodiments of the invention. Such stabilizers would keep any excess material that may have converted into solution stable. Any and all combinations of salt and stabilizers may be used.

[0029] Additional additives also may be used to achieve varied results. For example, binder and resins may be added to allow for ease of molding, casting, or otherwise forming the material into a given shape. Odor absorbing or aroma emitting sorbents also may be used. In addition, if the environment must be controlled, oxygen absorbers or carbon dioxide absorbers or emitters also can be added, and not overly interfere with the effectiveness of the invention.

[0030] The inventors also have tested other formulations, some including multiple additives, as described above. Table 4 contains a list of the tested formulations (including formulations 1–5, already described above):

Table 4: Desiccant formulations for use in abating freezer frost	
Formula	Composition
1	Clay
2	Silica gel
3	Transorb (trade name) (vermiculite and calcium chloride)
4	Molecular sieve
5	Wide pore silica gel
6	Potassium chloride dried

7	Solka-Floc (trade name) 20 FCC calcium chloride, 52% ON
8	Solka-Floc 20 FCC and calcium chloride, 2:1
9	Wide pore silica gel and calcium chloride, 2:1
10	Calcium chloride solvent on wide-pore silica gel
11	Potassium Chloride and wide-pore silica gel, 2:1
12	Solka-Floc 900 FCC and calcium chloride, 2:1
13	Formula 8 extrapolate, 52% Solka-Floc and 48% calcium chloride
14	Solka-Floc 900 FCC 20% and calcium chloride 80%
15	Solka-Floc 20 FCC 66% and calcium chloride 33%
16	Solka-Floc 900 FCC 33%, calcium chloride 20%, wide pore silica gel 66%
17	Solka-Floc 900 FCC 20%, calcium chloride 20%, wide pore silica gel 60%
18	Silica gel 80% and calcium chloride 20%
19	Wide pore silica gel 80% and calcium chloride 20%
20	Potassium chloride 20% and wide pore silica gel 80%
21	Calcium chloride 20%, Solka-Floc 20% and silica gel 60%

[0031] Tables 5 and 6 show the results of tests done using the formulations set forth in Table 4. Specifically, those tables show an initial weight (in grams) of a desiccant material and subsequent weights of the same desiccant. From these weights, one of ordinary skill in the art could readily obtain the absorption rate of each formulation. In each of the examples of Tables 5 and 6, a standard top unit freezer was used having an average temperature of 0°F (between -5°F and 9°F). The external environment had an average temperature of 77°F and 50% relative humidity. On days in which the desiccant package was measured, the freezer was opened eight times for three seconds each time. On alternate, non-weighing days, the door was opened three times for three seconds each time. The inventors estimate that approximately 500 mg of moisture is introduced each time the freezer is opened.

Time (days)	Formula Weight (g)							
	7	8	9	11	12	14	15	16
0	354.71	266.82	453.34	454.18	93.94	417.68	458.68	480.24
1		269.06	456	456.88	96.23			483.35
2		271.83	458.99	460.17	99.15			
3						470.28	479.01	488.03
5	363.03					480.77	489.86	
7	365.97	279.76	462.34	467.09	107.93	495.01	504.01	
10						514.78	522.04	
12	373.05							
13								505.77
14		289.63	480.62	473.78	115.95	539.16	548.69	
18	378.98							
21		298.02	490.43	479.25	122.03			
22								540.6
24						592.78	601.06	
35	530.65	307.14	498.17	483.89	127.91			
38						657.91	653.63	
47	547.73	317.53	515.36	490.69	134.6	687.91 (45?)	673.03 (45?)	
61	558.71	326.45	527.04	495.7	139.84			
77						746.13	712.13	589.67
91						776.34	723.42	608.32
117						809.61	760.44	637.89

Time (days)	Formula Weight (g)				
	17	18	19	20	22
0	518.94	520.84	510.92	504.45	515.23
1	526.57		517.62	499.3	
3		560.33			536.89
4	547.05		532.43	507.14	
5		580.02			544.37
6	555.77		547.72	507.03	
7		599.06			551.46
8	563.4		565.04	510.94	
10		620.67			570.93
11	577.02		584.19	512.82	
12		637.89			
14		652.03			559.95
15	591.7		605.58	509.05	
17		668.71			565.19
18	598.77		616.58	510.73	
28		700.46			

[0032] As illustrated in the tables, the different formulations will result in varied amounts of adsorption of moisture in the same freezer. A presently preferred formulation for the desiccant is Formulation 19, which consists of 80% wide-pore silica gel and 20% calcium chloride.

[0033] Preferably, the desiccants according to the invention will continue to adsorb moisture for anywhere between about 30 days and about 180 days. Upon termination of the operative life, which may be indicated on the package or the like, the desiccant is discarded and replaced with a new package. The desiccant's life preferably is some multiple of months, so the user can easily remember when to replace the desiccant.

[0034] The preferred desiccant also preferably will adsorb between about 20% to and about 50% of its weight of moisture at a relative humidity of between about 45% and 55% at a temperature of between  $-5^{\circ}\text{F}$  and  $9^{\circ}\text{F}$ . As illustrated in the tables, above, some of the tested formulations fit within this range.

[0035] The constituents of the desiccant preferably are contained in a packet. The material making up the packet should be easily permeated by ambient water vapor. Some suitable materials would be any permeable, semi-permeable, micro-porous, or porous non-woven material, or other acceptable film. The presently preferred material is a porous non-woven, such as TYVEK<sup>®</sup>. In each of the tests described above, the formulation was placed in a TYVEK<sup>®</sup> bag. As should be readily understood, the porosity of the packet will influence the adsorptive capacity of the desiccant composition. In particular, moisture will be more slowly adsorbed when the packet's pores are relatively smaller than when the pores are relatively larger. Using no packet will provide the greatest adsorptive rate.

[0036] The desiccant package of the invention preferably operates in a range of temperatures from about  $-20^{\circ}\text{F}$  to about  $20^{\circ}\text{F}$ , although the packages described above also will operate in a range of temperatures from about  $-40^{\circ}\text{F}$  to about  $30^{\circ}\text{F}$ . The packages also are operable in environments having varied relative humidity ranging from about 20% to about 99%, but are preferably used between about 45% and about 55% relative humidity. Depending upon the formulation used for the desiccant material, the packet may adsorb moisture for from about 30 days to about 270 days. However,

the preferable operating life of the desiccant preferably is from about 60 days to about 180 days. The life of the desiccant also will vary depending at least on the type of adsorbent or mixture used, the materials used, the relative humidity, and the temperature.

[0037] In a preferred method of using the desiccant packet according to the invention, a user obtains a packet and places the packet in a freezer. The packet maintains the frost-free environment in the freezer for a suggested operating life, and is discarded and replaced at the end of the operating life.

[0038] Several different desiccant formulations are described above. As will be appreciated, different formulations may be used depending upon the desired results. For example, a different formulation may be useful depending upon the desired absorption rate or the desired useful life of the desiccant packet. Characteristics including the equilibrium relative humidity of the desiccant, the temperature within and outside the freezer, and the relative humidity within and outside of the freezer all may be considerations in designing the effective desiccant packet according to the invention. For example, in some embodiments it may be desirable to use a desiccant packet that maintains the relative humidity within the freezer just below 100%, for example, between 90% and 99% relative humidity. In this embodiment, the desiccant does not adsorb any more moisture than necessary to maintain a frost-free environment. Other embodiments also are contemplated in which it is desired that the relative humidity in the freezer be lowered substantially, e.g., to between 40% and 50%, to allow for

quicker and/or more effective sublimation and water vapor adsorption.

Moreover, as described above, the composition of the packing also will have some bearing on the characteristics of the overall desiccant package.

[0039] While the invention has been described heretofore as usable in a freezer environment, the invention also may be used in any environment to aid in abating formation of condensation or frost on surfaces. For example, the device also may be used in air conditioning ducts, and the like.

[0040] The adsorbent material may be in a powdered form in a packet, or it may be in some other form. For example, the material could be formed into a grid structure, placed in a canister, formed into a solid block through a binder, resin, or compression; formed into a sheet by a binder, resin or compression, compressed into any shape, sintered into any shape, molded into any shape, coated onto another substrate, or formed into a corrugated sheet. As will be understood, a desiccant material formed according to some of these methods will not require a packet, bag or sachet.

[0041] The inventors also contemplate that a freezer could be made with a special holder or receptacle for a desiccant packet. In this manner, the desiccant package according to the invention may be shaped or formed for placement in the holder or receptacle.

[0042] In an alternate embodiment of the invention, the desiccant material is formed as a plurality of stacked sheets. Each sheet preferably has a top surface having the exposed desiccant and a bottom surface arranged proximate the top surface of the next sheet in the stack. When a top sheet

reaches the end of its useful life, the sheet is removed, revealing the next sheet in the stack, particularly, the next sheets desiccant. The removed sheet preferably is discarded. In this embodiment, an identifying agent, such as a color changing agent, also may be incorporated in each sheet to indicate to a user that the exposed sheet has come to the end of its useful life, e.g., because the desiccant is saturated. Also in this embodiment, a barrier layer may be provided between sheets and/or over the top sheet, the barrier layer being removable to expose and activate the underlying desiccant. The bottom portion of the bottommost sheet preferably also has a releasable adhesive or the like for affixing the desiccant package to an interior surface of the freezer.

[0043] The foregoing embodiments of the invention are representative embodiments, and are provided for illustrative purposes. The embodiments are not intended to limit the scope of the invention. Variations and modifications are apparent from a reading of the preceding description and are included within the scope of the invention. The invention is intended to be limited only by the scope of the accompanying claims.

We claim:

1. A frost resistant freezer comprising:
  - a freezer chamber having a first volume;
  - a door for providing access to the freezer chamber;
  - a cooler for cooling air within the freezer chamber from a first temperature within the chamber immediately following closure of the door to a second quiescent temperature during a cooling period; and
  - a desiccant disposed within the freezer chamber selected to absorb moisture from the freezer chamber at a rate sufficient to reduce the relative humidity within the freezer chamber to a value low enough to prevent the formation of frost within the freezer chamber at the quiescent temperature.
2. The frost resistant freezer of claim 1 in which the desiccant is selected to maintain the relative humidity within the freezer chamber at the quiescent temperature close to but below 100%.
3. The frost resistant freezer of claim 1 in which the desiccant is selected to reduce the relative humidity within the freezer to below 100% during the time it takes for the cooler to reduce the temperature within that freezer chamber to the quiescent temperature.

4. The frost resistant freezer of claim 2 in which the desiccant is selected to reduce the relative humidity within the freezer at the quiescent temperature to a value that causes sublimation of frost within the freezer to occur area.

5. The frost resistant freezer of claim 1 in which the desiccant is selected to have moisture absorbing capacity sufficient to permit to continue to absorb moisture in amounts sufficient to prevent the formation of frost for a period of at least 60 days.

6. The frost resistant freezer of claim 1 in which the desiccant is selected to have moisture absorbing capacity sufficient to permit to continue to absorb moisture in amounts sufficient to prevent the formation of frost for a period of at least 60 days.

7. The frost resistant freezer of claim 1 in which the desiccant is selected to have moisture absorbing capacity sufficient to permit to continue to absorb moisture in amounts sufficient to prevent the formation of frost for a period of at least 90 days.

8. The frost resistant freezer of claim 1 in which the desiccant is selected to have moisture absorbing capacity sufficient to permit to continue to absorb moisture in amounts sufficient to prevent the formation of frost for a period of at least 120 days.

9. The frost resistant freezer of claim 1 in which the desiccant is selected to have moisture absorbing capacity sufficient to permit to continue to absorb moisture in amounts sufficient to prevent the formation of frost for a period of at least 180 days.

10. The frost resistant freezer of claim one in which the desiccant is selected to absorb between about 20% and about 47% of its weight of moisture at a relative humidity of between about 45 and about 55% at a temperature of between about -5° and plus 9°F.

11. The frost resistant freezer of claim 10 in which the desiccant is selected to provide the absorbing characteristics for between about 60 and 180 days.

12. The frost resistant freezer of claim 10 in which the desiccant comprises silica gel.

13. The frost resistant freezer of claim 11 in which the desiccant comprises a nonwoven polyester package.

14. The frost resistant freezer of claim 13 in which the desiccant comprises approximately 448 g of silica gel.

15. The frost resistant freezer of claim 14 in which the desiccant is selected to have capacity to absorbing at least about 125 g of moisture in about 234 days.

16. The frost resistant freezer of claim 1 in which the desiccant is characterized by an effective relative humidity of more than 50%.

17. The frost resistant freezer of claim 1 in which the desiccant is characterized by an effective relative humidity of more than 75%.

18. The frost resistant freezer of claim 1 in which the desiccant is characterized by an effective relative humidity of more than 85%.

19. A method of controlling the buildup of frost in a freezer having a freezer chamber and a cooler for cooling air within the freezer chamber to a quiescent temperature comprising the steps of:

cooling the air within the freezer chamber to the quiescent temperature at a first relative humidity;

admitting warm air and moisture into the freezer chamber; and

re-cooling the air within the freezer chamber to the quiescent temperature while simultaneously reducing the relative humidity of the air within the freezer chamber.

20. The method of claim 19 wherein the step of reducing the relative humidity of the air within the freezer chamber comprises reducing the relative humidity to a level sufficient to prevent the formation of frost within a freezer chamber.

21. The method of claim 19 wherein the step of reducing the relative humidity of the air within the freezer chamber comprises reducing the relative humidity to a level sufficient to promote sublimation within the freezer chamber.

22. The method of claim 19 wherein the step of reducing the relative humidity of the air within the freezer chamber comprises disposing a desiccant material within the chamber.

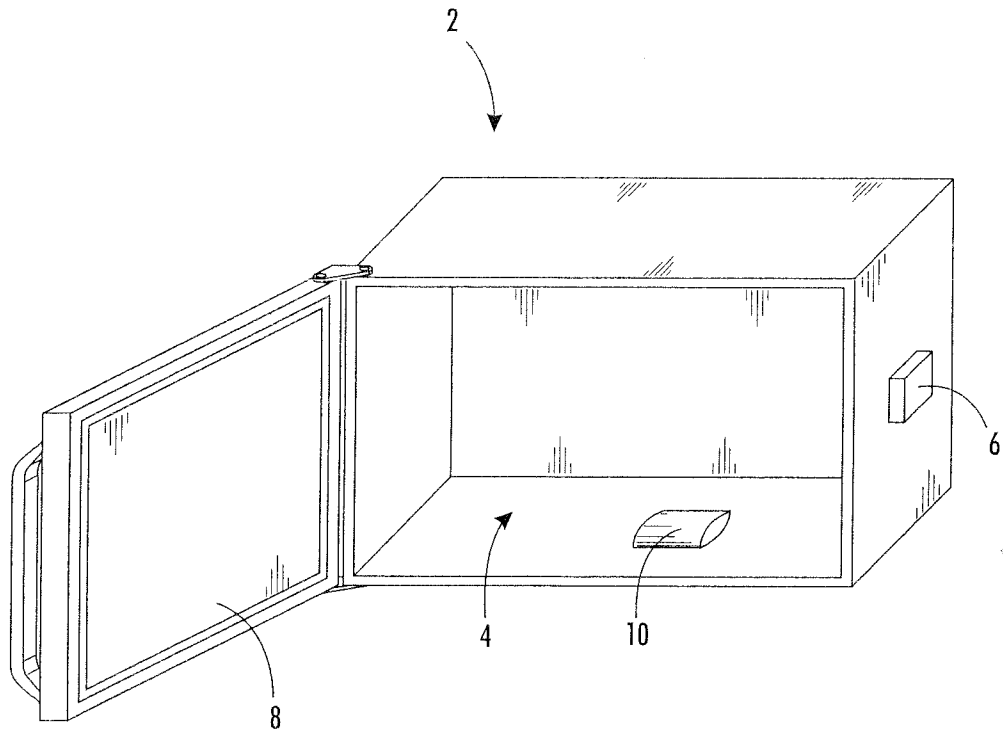
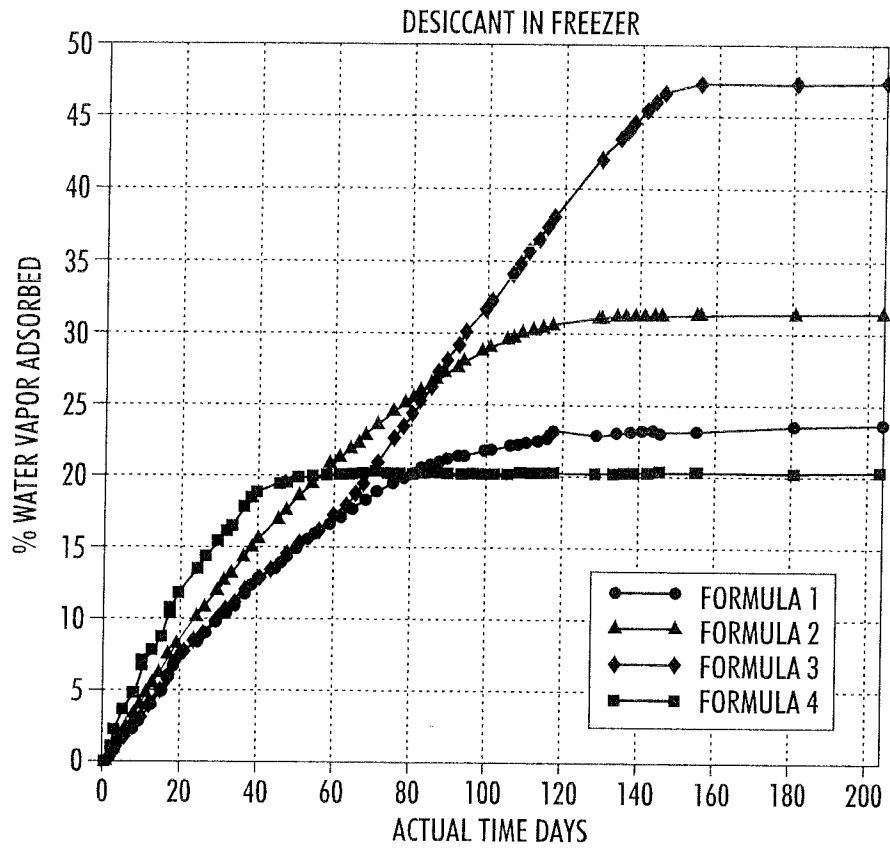
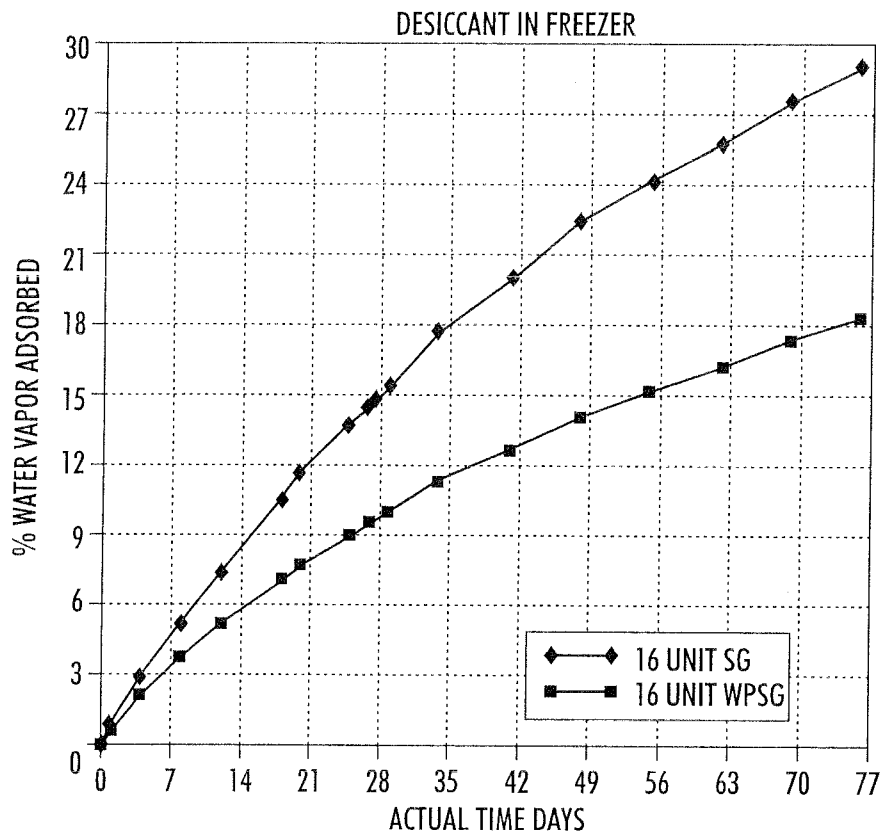


FIG. 1



**FIG. 2**



**FIG. 3**