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Ploetz et al.

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[54] **METHOD OF HEATING PAPER**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 837,879, June 30, 1969, abandoned.

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **21/58**, 21/2, 21/DIG. 4, 117/62, 117/119.6, 117/154

[51] **Int. Cl.** **A61l 13/00**

[58] **Field of Search** 117/62, 119.6, 154; 162/158, 159, 164, 168, 169; 21/DIG. 4, 2, 58

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[57] **ABSTRACT**

Paper and paperboard essentially consisting of cellulosic fibers may be heated to temperatures greatly in excess of 100°C, as during dry sterilization, without becoming brittle or disintegrating, when impregnated with 2 percent to 25 percent of polyethyleneglycol of molecular weight 1,000 to 6,000 or polypropylene glycol. The impregnated paper is sterilized by heating to temperature of at least 180°C for a period of 40 minutes.

4 Claims, No Drawings

METHOD OF HEATING PAPER

This application is a continuation in-part of the copending application Ser. No. 837,879, filed on June 30, 1969, and now abandoned.

The invention relates to a sheet consisting predominantly or entirely of cellulose, such as paper or paperboard, and to its use at high temperature.

Paper or paperboard is known to consist almost exclusively of cellulosic fibers such as groundwood pulp and is used not only as a substrate for printed and written matter, but also is used widely as packaging material. Cellulosic fibers and wood pulp become discolored when heated to temperatures greatly in excess of 100°C., become brittle, and suffer a great decrease of mechanical strength so as to be no longer useful as wrapping material, and, ultimately, completely disintegrate.

Since papers and paperboards, however, are materials capable of inexpensive mass production, there is an urgent demand for a paper or paperboard material that can resist temperatures of 200°C and more without essential loss of strength and flexibility. Such heat resistance is particularly required of so-called sterilization papers. In order to kill all germs and bacteria with certainty, the art has recently moved increasingly from conventional steam sterilization to hot-air sterilization; this means that the material in which surgical instruments, and the like are wrapped must withstand a temperature of about 180°C for at least 40 minutes. Yet, currently available papers exposed to such extreme conditions lose their flexibility and strength. There is a need for heat-resistant paper or paperboard in other technical applications too; for instance, for baking purposes. The tendency is to increase efficiency, to bake the material such as bread and cake directly in the wrapper in which the product is to be sold.

Surprisingly, it has been found that a sheet consisting predominantly or entirely of cellulose, like paper or paperboard, may be heated safely to high temperatures of, for instance, 200°C, if it is, in accordance with the present invention, made to contain 2 to 25 percent by weight of polyalkylene glycols, based on the weight of the untreated paper or paperboard.

Polyalkylene glycols, in the sense of the invention, are understood to be compounds produced by polyaddition of alkylene oxides, in the simplest case ethyleneoxide. This produces a linear polyether carrying terminal hydroxyl groups and having the formula $HO{\cdot}C_aH_{2a}{\cdot}(CH_2OC_aH_{2a})_bCH_2OH$, wherein a is 1 or 2, and b is an integer selected to make the molecular weight of the polyalkylene glycol 1000 to 6000.

In selecting the most suitable polyalkylene glycols, different factors are taken into consideration. These polyalkylene glycols should evaporate as little as possible at the high temperatures to which they are exposed. On the other hand, they must permit easy processing, i.e., they must be capable of impregnating the paper adequately using an aqueous vehicle. This presupposes that they have sufficient solubility in water. All these requirements have been shown to be best satisfied by the polyethylene glycols, but that the polypropylene glycols are also suitable.

The temperature resistance of the polyalkylene glycols, which is particularly important in view of the principal application, is related to their molecular weights. The production of paper or paperboard according to the invention contemplates using polyalkylene glycols

having a molecular weight of from about 1000 to 6000, b in the above formula being about 21 to 135; particularly suitable are polyethylene glycols with molecular weights between 2000 and 4000. Mixtures of polyethylene glycols of different molecular weights, such as, for instance, the commercially available Polyglykol 2000 and 4000 are preferably used.

Even though, in some cases, such small additions of polyalkylene glycol as, for instance, 2 percent by weight, are sufficient to give the paper the required high temperature resistance, the addition of 7 to 15 percent by weight of polyalkylene glycol is preferred. When using an amount of only 2 percent by weight, the tear strength remains good after heating to a temperature of 180°C for 40 minutes, but some paper has a certain brittleness which makes it less suitable as wrapping material. In the preferred range of 7 to 15percent by weight, a sufficiently high pliability of the material is assured. With very high percentages of polyalkylene glycol, some of it may be melted out.

The accompanying table lists the properties of papers with different contents of polyethylene glycol and their properties of mechanical strength such as fracture load and breaking load, before heating and after having them heated to a temperature of 180°C for 40 minutes and a temperature of 200°C, for one hour. An untreated and unheated control was also tested.

The method of the invention is described in the following example.

EXAMPLE

A wood-free untreated paper having a weight of 40 g/m² was, after calendering, passed through an impregnating tank containing a liquid of the following composition:

150 g polyethylene glycol of molecular weight 2000,
150 g polyethylene glycol of molecular weight 4000
dissolved in 700 g of water.

The material, completely impregnated with this solution, was freed of excess solution by being guided between two rolls and subsequently dried in the air. 11 percent by weight of the mixture of polyethylene glycol remaind in the paper.

Non-sterile bandages were wrapped in the heat-resistant paper so produced in such a way as to enclose them with one layer of paper. This sterilization package was sterilized by hot air in a circulating-air drying cabinet for 40 minutes at 180°C. Then, the package was stored under non-sterile conditions for 14 days, and a sterility test was made. This test indicated that the bandage material remained completely sterile.

While the impregnating composition described above produced the desired pick-up of polyalkylene by the paper base employed with the equipment available, those skilled in the art will readily adjust the amount and nature of the diluent if any, to suit specific materials and processing conditions. Similarly the degree of polymerization of the polyalkylene may be chosen according to processing convenience. While all tested types of paper and paperboard could be impregnated satisfactorily with mixtures of polyethylene glycols having respective molecular weights of about 2000 and about 4000, a single fraction, when meeting specific requirements, produces the same results. Polypropylene glycol of similar molecular weight may replace some or all of the polyethylene glycol.

TABLE I

Polyglycol content of the paper, percent by weight	Treatment	Basis weight g./m.²	Porosity (Bendtsen) ml./min.	Fracture load		Breaking load	
				Cross direction	Machine direction	Cross direction	Machine direction
2.5		40	340	3.26	2.64	5,430	4,400
	40 min./180° C.	40	380	2.76	2.2	4,600	3,670
	1 hr./200° C.	40		2.75	2.07	4,580	3,450
5		41	320	3.17	2.41	5,150	3,920
	40 min./180° C.	40.5	370	2.7	2.18	4,450	3,590
	1 hr./200° C.	40.5		2.69	2.04	4,420	3,360
10		43	200	3.22	2.40	4,990	3,720
	40 min./180° C.	42	310	2.39	1.81	3,790	2,870
	1 hr./200° C.	42		2.12	1.78	3,360	2,820
20		47	180	3.02	2.48	4,280	3,520
	40 min./180° C.	44	320	1.56	1.26	2,360	1,910
	1 hr./200° C.	44		1.43	1.26	2,170	1,910
36		53		Very slimy; strong development of vapors irritating the mucous membranes, when heated			
	40 min./180° C.	44					
	1 hr./200° C.	44					
0 (untreated)		39	300	3.92	2.95	6,700	5,040

NOTE.—Porosity according to Bendtsen at 10 cm.²/150 mm. water column. Tension test (fracture load, breaking load): DIN 53112 (test strip 15×100 mm.).

While the invention has been described with particular reference to a specific embodiment, it is to be understood that it is not limited thereto, but is to be construed broadly and restricted solely by the scope of the appended claims.

What is claimed is:

1. A method of sterilizing a sheet-like body of paper or paperboard essentially consisting of cellulosic fibers without essential loss of strength and flexibility which comprises heating said body to a temperature of at least 180°C for a period of 40 minutes while said body is impregnated with 2 to 25 percent of polyethylenes glycol based on the weight of the untreated body, said polyethylene glycol having a molecular weight of 100 to 6000, and said temperature and period being sufficient to cause essential loss of flexibility and strength of said body in the absence of said polyethylene glycol.

2. A method as set forth in claim **1**, wherein said molecular weight is between 2000 and 4000.

3. A method as set forth in claim **1**, wherein said sheet-like body is impregnated with 7 to 15 percent of said polyalkylene glycol.

4. A method as set forth in claim **2**, wherein said temperature is approximately 200°C.

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