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ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: CARBON DIOXIDE DRY CLEANING

(57) Abstract: The invention is related to a method for cleaning objects in a cleaning fluid comprising a dense phase gas and water, wherein at least part of said water is filtered out of said cleaning fluid.



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Specification

Carbon Dioxide Dry Cleaning

The invention relates to a method for cleaning objects in a cleaning fluid comprising a dense phase gas and water. Further the invention relates to an apparatus for cleaning
5 objects in a cleaning chamber.

Filtration of dense phase gas, such as liquid carbon dioxide, is carried out in commercial dry cleaning machines in order to avoid accumulation of particulate dirt such as detached fibers in the distillation / recovery part of the dry cleaning machine.
10

In dry cleaning systems, water is useful as additive in order to assist the removal of hydrophilic stains. Also, certain useful surfactants exhibit higher solubility in the presence of water than in pure carbon dioxide. It has been speculated that water and surfactants exist in condensed carbon dioxide in the form of reverse micelles, and that
15 these reverse micelles contribute greatly to the observed cleaning effect. However, it is found in practice that water has a high affinity to many materials, such as garments, and is therefore difficult to remove from those. Following a dry cleaning cycle, garments are often wet which requires costly measures for drying.

20 Among people skilled in the art of dry cleaning with carbon dioxide, sometimes the belief is held that garments following a carbon dioxide dry cleaning process either are clean – in which case they are wet of water -, or they are dry – but in this case they are unlikely to be clean. Therefore, water is added in the practice of dry cleaning because of its beneficial aspects, e.g. in the form of aqueous-based pre-spotters, or surfactants
25 dissolved in water which are introduced directly into the washing drum, and said water is removed later by time-consuming drying.

It is therefore an object of the invention to develop a method for dry cleaning of objects which allows the presence of water during the washing cycle, but which avoids the
30 above described problems that the objects are wet after the washing cycle.

This object is achieved by a method for cleaning objects in a cleaning fluid comprising a dense phase gas and water, wherein at least part of said water is filtered out of said cleaning fluid.

- 5 According to the invention the objects are at least temporarily cleaned in a cleaning fluid comprising a dense phase gas and water. Preferably towards the end of the cleaning procedure, at least a fraction of the water is filtered out of the cleaning fluid. It is advantageous to remove essentially all water by filtration. Thus, after the cleaning procedure is finished it is no more necessary to dry the objects. At least, the time
10 needed for drying the objects is minimized.

- According to a preferred embodiment said objects are placed in a cleaning chamber and washed with a cleaning fluid comprising a dense phase gas and water. At least a fraction of said cleaning fluid is withdrawn from said cleaning chamber and water is
15 filtered out of said fraction of said cleaning fluid. After the filtration step the filtered cleaning fluid is transferred back to said cleaning chamber.

- In one preferred embodiment, the filtration device is placed in a pipe, and the cleaning fluid is pumped through the pipe continuously during the cleaning process whereby
20 water is removed from the cleaning fluid. Said pipe may be the pipe which is used for emptying the cleaning fluid into the recovery and distillation vessel. Optionally, the flow through the pipe is supported by pumping. The complete cleaning fluid is pumped through the pipe during the cycle at least once, optionally two, five, fifty or more times.

- 25 Preferably the cleaning method comprises at least a step of cleaning the objects in a dense phase gas and water and a step of cleaning the objects in dense phase gas only. Between these two steps the water is filtered out of the cleaning fluid according to the invention.

- 30 The filtration of water out of the cleaning fluid is preferably carried out by passing the cleaning fluid through a filtration device which comprises a hygroscopic material, especially a silica gel or a molecular sieve. In particular it is preferred to use a molecular sieve with a pore size between 3 Å and 4 Å.

According to a preferred embodiment the objects are cleaned in a cleaning chamber in a cleaning fluid comprising a dense phase gas and water. At least part of the water is filtered out of said cleaning fluid inside said cleaning chamber. This is preferably achieved by placing a filtration device inside the cleaning chamber.

5

According to a preferred embodiment the cleaning procedure is started with a cleaning fluid comprising a mixture of a dense phase gas, such as carbon dioxide, with a relative high content of water. The cleaning fluid is continuously passed through the filtration device and thus the water fraction continuously decreases. Towards the end of the cleaning procedure the objects are cleaned essentially in dense phase gas only.

10

Preferably the filtration device comprises a mechanical filter. The mechanical filter removes fibers, dirt, and other particulate material from the cleaning fluid and protects the hygroscopic material, such as a molecular sieve or a silica gel. In one embodiment, the cleaning chamber comprises a rotating drum. Simple net filters, for example made of steel wire, are arranged on the rotating drum to collect loose fibers during a garment cleaning cycle. The hygroscopic material may be provided on the exterior surface of the rotating drum or in a pipe connected to the cleaning chamber.

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The filtration device is ideally constructed in such a manner that it can easily be changed or replaced.

20

The cleaning fluid preferably comprises dense phase carbon dioxide in liquid or super-critical state. The cleaning result may be further improved by adding additives, in particular water-soluble additives, to the cleaning fluid.

25

The invention allows carbon dioxide-dry cleaning in the presence of water, but solves the problem caused by water which is present on carbon dioxide-dry-cleaned garments after the cleaning process. Equally, passing the cleaning fluid many times during the treatment process through a mechanical filter, effectively removes all solid particles, such as loose fibers, mites, and other particulate material, as it were, from the distribution equilibrium. In addition, certain surfactants used for detaching particulates from the substrate to be cleaned, e.g. of cationic type, are removed as well as they are strongly bound to the particulate material.

30

Claims

1. Method for cleaning objects in a cleaning fluid comprising a dense phase gas and water, **characterized**, in that at least part of said water is filtered out of said cleaning fluid.
5
2. Method according to claim 1, characterized in that said objects are cleaned in a cleaning chamber comprising the steps of:
 - withdrawing part of said cleaning fluid from said cleaning chamber,
 - filtering water out of said part of said cleaning fluid, and
10
 - transferring said filtered cleaning fluid back to said cleaning chamber.
3. Method according to claim 1, characterized in that said objects are cleaned in a cleaning chamber and wherein at least part of said water is filtered out of said cleaning fluid inside said cleaning chamber.
15
4. Method according to any of claims 1 to 3, characterized in that said cleaning fluid is passed through a filtration device wherein said filtration device comprises a hygroscopic material, especially a silica gel or a molecular sieve.
- 20 5. Method according to claim 4, characterized in that said molecular sieve has a pore size between 3 Å and 4 Å.
6. Method according to claim 4 or 5, characterized in that said filtration device comprises a mechanical filter.
25
7. Method according to any of claims 1 to 6, characterized in that said cleaning fluid comprises additives, in particular water-soluble additives.
- 30 8. Apparatus for cleaning objects in a cleaning chamber, **characterized** in that a filtration device comprising a hygroscopic material, especially a silica gel or a molecular sieve, is provided.

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	WO 02/086223 A (DAMASO, GENE, R; SCHULTE, JAMES, E; RACETTE, TIMOTHY, L) 31 October 2002 (2002-10-31) page 22, line 28 - page 23, line 12 figure 2	1-8
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Patent family members are listed in annex.

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