way known per se, e.g. by mechanically providing cotton or cellulosic staple fibers that can be worked into a yarn.

[0013] In particular with a pre-consumer material consisting in garments or fabrics, the said garments or fabrics may be de-colorized to a greige status (undyed) and recycled by subsequent dyeing or printing, or both, of the treated garment.

[0014] The problem is solved by means of the process according to claim 1 and by a plant according to claim 10.

[0015] According to a first aspect of the present invention, there is provided a process for removing dyes from waste textile ,said waste textile containing or consisting in dyed polyester fibers comprising disperse dyes for said polyester fibers, or said waste textile comprising or consisting in dyed cotton fibers comprising indigo or indigoid dyes, characterized in comprising the following steps:

a) providing an amount of said waste textile in an extraction chamber and heating said chamber,

b) circulating through said extraction chamber and said waste textile a solvent suitable to remove from the waste textile said dyes;

c) feeding the solvent exiting said extraction chamber back to the extraction chamber to increase the amount of dyes removed from said waste textile;

d) evaporating at least part of the solvent obtained in step c) in an evaporation chamber;

e) condensing the evaporated solvent in at least one condensation chamber.

[0016] According to an aspect of the invention the process further comprises the steps of: f) feeding at least part of the condensed solvent directly or indirectly to said extraction chamber and g) repeating steps b) – f) until removal of dyes.

[0017] According to an embodiment of the invention, it is provided a process for recycling waste textile containing polyester fibers and dyes, namely disperse dyes, which comprises the step of removing from said waste textile the disperse dyes by means of a solvent that is selected from dimethylformamide (DMF) and dimethylacetamide (DMAC), by circulating (i.e. flowing) the said solvent through the waste textile in an extraction chamber until dyes are removed. Advantageously, polyurethanic material, if present, is removed from the waste textile.

[0018] According to an embodiment of the invention, it is provided a process for recycling waste textile containing cotton and/or cellulosic fibers and dyes, namely indigo or indigoid dyes, which comprises the step of removing from said waste textile the

[0032] According to a preferred aspect of the invention, the solvent exiting the extraction chamber is filtered. The filtering of the solvent maximises the quantity of the waste textile that remains in the extraction chamber while maintaining the solvent free from solid bodies that would jeopardize the final product's quality.

[0033] According to a possible embodiment, the solvent is filtered by a filtering basket housing the waste textile in the extraction chamber. Advantageously the filter basket may be a rigid structure, e.g. a metal structure, provided with filtering openings along its surface to enable the solvent flow. Housing the waste textile in a filter basket allows to constrain the flow of solvent through the waste textile in a closed volume without stirring the fabric/textile pieces.

[0034] According to a possible embodiment, at least part of the process, e.g. steps d) and e), is carried out under reduced pressure, i.e. the evaporation and condensation parts of the plant are connected to a source of reduced pressure. Because steps d) and e) are carried out under reduced pressure it is possible to decrease the temperature needed to evaporate the solvent in the evaporation chamber. A lower evaporation temperature results in preventing degradation, or in a negligible degradation, of the solvent in the plant, so that the same solvent may be used for several processes.

[0035] In an embodiment, a suitable pressure value in the evaporation chamber (and possibly in other parts of the plant connected with the evaporation chamber) is in the range of 20 to 100 mbar, preferably 35 to 100 mbar, most preferably 40 to 80 mbar.

[0036] According to a possible embodiment, the process comprises the step of heating the extraction chamber, thereby heating the solvent that flows through said chamber (and the waste textile). Advantageously, the extraction chamber is heated to a temperature that results in increasing the temperature of the solvent inside the extraction chamber to a value that does not result in degradation of the solvent. The increase of temperature of the waste textile and solvent is preferably such as to decrease the time required to dissolve and remove the dyes and any PU material that may be present in the waste textile.

[0037] In an embodiment, the solvent is re-circulated by means of a pump. Advantageously the recirculation of the solvent by means of a pump allows to increase the number of times that a same portion of waste textile is contacted by a volume of solvent in which the waste textile is subject to the action of the solvent

which would therefore speed up the removal of dyes (and PU material if present) from the waste textile.

[0038] Furthermore, differently from processes known in the art, the waste textile is kept in the extraction chamber in a still (i.e. static) position e.g. the waste textile is not subject to stirring by means of, for example, stirring rotors. Similarly, in a preferred embodiment the extraction chamber and the filtering basket housing the waste textile may be configured to be in a still and static condition, e.g. the basket is not rotated. In an embodiment, the textiles completely fill the basket in the extraction chamber, so that they remain in a static condition when the solvent is circulated, i.e. pumped into and out of the extraction chamber.

[0039] In an embodiment the waste textile is compressed in the basket to use the basket volume to the maximum; advantageously the compression of the waste textile increases productivity of the process.

[0040] Advantageously, having the textile material, e.g. the fabrics, in a static condition dramatically reduces the amount of possibly present staple fibers, e.g. cotton and cellulosic fibers, that are loosened or broken and become detached from the textile material during the process.

[0041] According to a possible embodiment, steps d) and e) are carried out under reduced pressure and the solvent is heated to a temperature value that is below the boiling point of the solvent at the selected pressure in the evaporation chamber, preferably below 100°C to prevent degradation of the solvent.

[0042] Suitable solvents are dimethyformamide (DMF) and dimethylacetamide (DMAC). DMF and DMAC are polar solvents that were surprisingly found to be suitable to remove disperse dyes at the process temperature conditions. DMF and DMAC are also able to dissolve PU and elastomeric materials that might be present in or on the waste textile.

[0043] Advantageously, the claimed solvents can remove dyes with no or extremely reduced degradation of the polyester or cotton fibers in the textile under the claimed process conditions. In fact the following results were observed for polyester: decrease of IV (Intrinsic viscosity) around 3% (measured according to BS EN ISO 1628-5 : 2015) and decrease of Tensile Strength around 5% (measured according to ASTM D5034-21).

[0044] According to a possible embodiment, the extraction chamber is under reduced pressure and the solvent temperature, in the extraction chamber is above 80°C,

preferably 85 to 100 °C, most preferably 85 to 95°C.

[0045] Another embodiment of the invention is a plant to carry out the above discussed process for recycling waste textile containing polyester fibers by removal of dyes, namely disperse dyes, or for recycling a waste textile containing cellulosic fibers by removal of indigo and indigoid dyes, Advantageously, a PU material possibly present in the fabric is removed.

[0046] According to a second aspect of the present invention, there is provided a plant to carry out the above discussed process. The plant comprises an extraction chamber configured to contain a waste textile that includes disperse dyes and/or indigo or indigoid dyes, and possibly also PU material, and a solvent selected from DMF and DMAC.

[0047] The extraction chamber preferably comprises at least a heater. The plant further comprises a container for storing a solvent suitable to remove said dyes from said waste textile, circulation means to circulate the solvent, preferably at least once, through said textile and said extraction chamber, an evaporating chamber configured to collect the solvent containing dissolved dyes and to evaporate at least part of the solvent to be resent to the extraction chamber, and at least one condensation chamber comprising a cooling system configured to condensate the solvent evaporated in said evaporation chamber and feed said condensed solvent directly or indirectly to the extraction chamber.

[0048] In a possible embodiment the recovered solvent may be fed to a solvent reservoir, e.g. when the process is not operated.

[0049] According to a preferred embodiment, the extraction chamber of the plant comprises filtering means, preferably a mesh filter basket to contain the waste textile. As previously mentioned, filtering means in the extraction chamber allows to contain the waste textile and small fibers possibly detached from the textile, in the extraction chamber.

[0050] According to an embodiment of the invention, the plant is connected to a reduced pressure circuit. Preferably said circuit includes a vacuum pump. Preferably the extraction chamber and the condensation chamber are connected or connectable with said reduced pressure circuit.

[0051] According to a possible embodiment the reduced pressure circuit of the plant is connected to said at least one condensation chamber. Preferably there are two condensation chambers connected in series to prevent solvent vapours to leave the plant.

[0052] According to a possible embodiment the solvent collection tank, i.e. the solvent

reservoir, is connected by suitable pipes, or conduits, to the extraction chamber and to the condensation chamber. Advantageously the solvent collection tank could contain the solvent which is removed from the evaporation chamber.

[0053] Alternatively, the solvent contained in the solvent collection tank can be fed to the extraction chamber before step b) in which the solvent is circulating through the extraction chamber and the waste textile to dissolve and remove the elastomeric material from the waste textile. Advantageously, the solvent contained in the solvent collection tank and fed back to the extraction chamber can therefore provide solvent which can be recirculated through said extraction chamber and said waste textile to dissolve and remove the elastomeric material from the waste textile after a step of condensation in at least one condensation chamber.

[0054] According to a possible embodiment, the solvent collecting tank is connectable to the condensation chamber to selectively receive the condensate solvent.

[0055] According to a possible aspect the evaporating chamber comprises a mixer, or stirrer, to improve the evaporation of at least part of the solvent from the solution of elastomeric material present in the evaporation chamber so as to increase the amount of solvent distilled from the evaporation chamber.

[0055a] According to a third aspect of the present invention, there is provided the use of the above discussed plant in a process of removing disperse dyes from a polyester dyed textile.

[0055b] According to a fourth aspect of the present invention, there is provided a process of recycling garments comprising or consisting in fabrics containing polyester yarns dyed with disperse dyes or fabrics containing cotton yarns with indigo or indigoid dyes, wherein said dyes are removed from said garments with above discussed processes and said garments are treated to provide pre-consumer garments.

[0056] Further aspects and advantages in accordance with the present disclosure will be discussed more in detail with reference to the enclosed drawings, given by way of non-limiting example, wherein:

- Fig.1 shows a schematic representation of a plant according to a possible embodiment of the present invention;
- Fig. 2 is a flow chart illustrating an extraction process according to the invention and

- Fig.3 shows 15 samples of polyster fabrics dyed or printed before and after the treatment according to the invention.

[0057] With reference to the exemplary embodiment of fig. 1, a textile recycling plant 100 comprises an extraction chamber 4 configured to contain a waste textile 2 that is a textile comprising polyester fibers 1 dyed with disperse dyes. In an embodiment, the textile comprises cellulosic fibers, particularly cotton fibers, dyed with indigo and indigoid dyes. Extraction chamber 4 is configured to receive and contain a solvent 3 (DMF or DMAC) suitable to remove the dyes 1 and dissolve a PU material possibly present. The extraction chamber 4 is connected to a re-circulating circuit 42 in which the solvent 3 exiting the extraction chamber from chamber outlet conduit 43 can be

CLAIMS

1. A process for removing dyes from waste textile, said waste textile containing or consisting in dyed polyester fibers comprising disperse dyes for said polyester fibers, or said waste textile comprising or consisting in dyed cotton fibers comprising indigo or indigoid dyes, characterized in comprising the following steps:

a) providing an amount of said waste textile in an extraction chamber and heating said chamber,

b) circulating through said extraction chamber and said waste textile a solvent (3) suitable to remove from the waste textile said dyes;

c) feeding the solvent exiting said extraction chamber back to the extraction chamber to increase the amount of dyes removed from said waste textile;

d) evaporating at least part of the solvent obtained in step c) in an evaporation chamber;

e) condensing the evaporated solvent in at least one condensation chamber (7).

2. A process according to claim 1, wherein said solvent is selected from dimethylformamide (DMF) and dimethylacetamide (DMAC).

3. A process according to claim 1 to 3, wherein said waste textile further comprises polyurethane material selected from filaments and layers.

4. A process according to any claim 1 to 4, wherein said textiles and said extraction chamber are in a static condition during said extraction step.

5. A process according to any previous claim, further comprising the steps of:

f) feeding at least part of the condensed solvent directly or indirectly to said extraction chamber;

g) optionally repeating steps b) – f) until removal of dyes, wherein at least said evaporation and condensation steps (d, e) are carried out under reduced pressure.

6. A process according to any previous claim wherein at least in step c) said solvent is circulated through the waste textile and extraction chamber and is fed back to said chamber by means of a pump.

7. A process according to any previous claim, wherein the removed dyes are recovered.

8. A process according to any previous claim, wherein the pressure in said evaporation chamber is in the range of 20 to 85 mbar, preferably 40 to 80 mbar and the temperature of the solvent in said evaporation chamber is in the range of 75 to 95 °C, preferably 80 to 90 °C.

9. A process according to claim 8, wherein the solvent temperature in said extraction chamber is in the range of 80 to 100 °C, preferably 80 to 95°C, more preferably about 85°C.

10. A process according to any previous claim, further comprising a step of recovering solvent from said treated waste textile, preferably said solvent recovering step being selected from pressing, squeezing, spinning or centrifuging said waste textile.

11. A plant to carry out a process for removing dyes from a waste fabric according to any previous claim, characterized in that it comprises an extraction chamber configured to contain a waste textile, said extraction chamber preferably comprising at least a heater; a container for storing a solvent suitable to remove said dyes from said waste textile; circulation means to circulate said solvent at least once through said textile and said extraction chamber ; an evaporation chamber configured to collect the solvent containing dyes and to evaporate at least part of said solvent; at least one condensation chamber comprising a cooling system configured to condensate said solvent evaporated in said evaporation chamber and means to store said condensed solvent.

12. A plant according to claim 11, wherein the extraction chamber comprises filtering means, preferably a filtering basket to house said waste textile.

13. A plant according to claim 11 or 12, wherein at least part of said plant is connected or connectable to a reduced pressure circuit, said circuit preferably including a vacuum pump configured to generate a reduced pressure of 35 to 100 mbar, wherein said reduced pressure circuit is connected or connectable to said evaporation chamber, preferably also to at least one condensation chamber that is connected or connectable to said evaporation chamber.

14. A plant according to any claim 11 to 13, wherein said circulation means comprises a circuit and a pump for circulating solvent in and out of said extraction chamber.

15. A plant according to any claim 11 to 14, further comprising a solvent collecting tank to contain said solvent, said solvent collecting tank being connected or connectable to said extraction chamber and to said condensation chamber.

16. A plant according to claim 15, wherein said condensation chamber is connectable to said solvent collecting tank.

17. The use of a plant according to any claim 11 to 16 in a process of removing disperse dyes from a polyester dyed textile.

18. A process of recycling garments comprising or consisting in fabrics containing polyester yarns dyed with disperse dyes or fabrics containing cotton yarns with indigo or indigoid dyes, wherein said dyes are removed from said garments with a process according to any claim 1 to 10 and said garments are treated to provide pre-consumer garments.