SUBSTRATE WASHING DEVICE AND PROCESS

[Continued on nextpage]

A washing device (1) for manual washing of a substrate (9), the washing device (1) comprising a receptacle (5) for containing an aqueous wash liquor (17) with a substrate (9) at least partially immersed therein; a filling and access aperture (11) defined by the upper peripheral edge portions (13) of the washing receptacle (5); and at least one upper portion (7) of the washing device (1) which is transparent or translucent.

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Substrate Washing Device and Process

The present invention concerns a manually operated substrate washing device and also a method of manually washing substrates. The invention relates in particular, but not exclusively, to a device and process for manually washing substrates such as fabrics, hard surface substrates such as culinary and crockery items.

Cleaning substrates at low or ambient temperatures is beneficial to the environment in so far as less energy is consumed in heating the water. However, low temperature cleaning often requires complex formulation arrangements to achieve effective stain removal and this can be costly to produce. One alternative is to use of aggressive or high levels of chemical cleaners, however these also have a negative impact on the environment. In the case of manual or hand wash situations, the additional constraint is that stain removal without assistance from advanced cleaning actives necessitates great manual effort and if one uses aggressive chemicals this can affect the skin of the user carrying out the washing operation. Low temperature active ingredients may also be sensitive to high temperature in storage as is the case in hotter climates and so potential cleaning performance is not realized.

An objective of the invention is to provide an improved fabric hand-washing device and process.

According to a first aspect of the present invention there is provided a washing device for manual washing of a substrate, the washing device comprising:

(a) a receptacle for containing an aqueous wash liquor with a substrate at least partially immersed therein;
(b) a filling and access aperture defined by upper peripheral edge portion/s of the washing receptacle; and
(c) at least one upper portion which is transparent or translucent.

According to a second aspect of the present invention there is provided a method of washing a substrate with a washing device comprising a receptacle, a filling and access
aperture and one or more transparent or translucent upper portions which overlie the receptacle, the method comprising the steps of:
(a) adding water and a washing composition to the receptacle to form a wash liquor therein;
(b) adding a substrate into the washing receptacle;
(c) positioning the receptacle in sunlight.

According to a third aspect of the present invention there is provided a substrate washing system comprising:
(a) a packaged washing composition;
(b) a washing device comprising a receptacle, a filling and access aperture and one or more transparent or translucent upper portions; and
(c) instructions to wash a substrate in the receptacle using the washing composition and water.

The substrates preferably comprises fabric and/or hard surface substrates such as culinary and crockery items.

The arrangement of the invention provides the advantage of a simple, highly cost-effective solar-heated manual washing process, the heat which can be provided throughout the entire washing process. This provides a wash liquor temperature which is elevated and also can be maintained at high levels to provide highly effective cleaning without excessive manual effort, aggressive or high levels of cleaning chemicals or complex and expensive chemical formulations.

A particular advantage arises for consumers undertaking hand washing of fabrics who often feel the need to "top up" the cleaning from their main wash powder or liquid additional chemical cleaners such as laundry bars. The problem with this is that the use of more detergent/chemicals leads to a bigger demand for water during rinses. Typically three to five buckets of water may be needed for rinsing. However, with the invention effective cleaning takes place using the device at elevated temperatures following soaking with no need to "top up" the cleaning using additional chemicals. This results in a reduced demand for water during rinsing typically saving 2 or 3 buckets of water from the
rinse process. Furthermore, the reduced scrubbing action gives rise to less damage to cloths allowing them to appear new for longer. For consumers using prior systems washing can require their participation for many hours. With the present invention less time is spent directly involved in cleaning because soaking does not need attendance and this frees up time. The reduced need for physical effort means less arm and back pains. The device is especially advantageous with large substrates which are also highly absorbent, such as jeans, towels, bedding, or work wear and the like. In prior art methods of cleaning such substrates, these heavy sodden items must be physically dragged in and out of the wash liquor for scrubbing. In the present invention, much of the cleaning can be effected by high temperature soaking with considerably less physical effort and intervention, and therefore the daunting task of cleaning such items is greatly reduced.

Preferably the device is portable when empty so it can be transported to wherever the water supply is situated (a river, water supply pipe). To this end the receptacle and/or translucent / transparent portions comprise a plastic material.

To improve manoeuvrability, when the device is fully loaded with substrates and wash water, the device may comprise one or more glide members. The glide members are preferably located on an external base portion of the receptacle. The glide members may be integral to the device. Such members may comprise an increase thickness of the base wall of the device. Preferably two or more glide members are provided. The or each glide member may comprise an elongate rib or ridge which protrudes as a ground-contacting surface.

The device may further comprise separate glide member or members on which the device is carries, such as a sheet material or sledge structure.

The device may comprise one or more handle members which may be rigid handle section or flexible and may comprise a loop. The handle may comprise a length of rope, tied only at one end. The handle may be integral such that the device is a single moulding or it may be an add-on, attachable to the device e.g. rope loop. There may be attachment means to enable attachment of one or more handle members to the device.
In this way, the system can be easily repositioned in the sun or pulled out of the sun at the end of the soak to complete the wash procedure in comfort in the shade.

The handle members may be attached to the or each glide member/s.

The device may further comprise one or more wheel or roller members. The or each wheel or roller member may be lose or fixed to e.g. the receptacle base.

The device may be provided with friction-reducing fluids e.g. liquids, soft solids for example hydrophilic materials such as water, hydrocolloid structured water, glycerol; amphiphilic material such as surfactants like soaps; hydrophobic materials such as oils, fats, waxes) to grease the bottom of the washing device and any glide member/s.

Preferably the receptacle is rigid. Preferably the receptacle is opaque, and more preferably dark, most preferably it is black.

Preferably said upper portion includes one or more inclined portions. The portions may be flat or curved.

Preferably the receptacle comprises a surface shaped for improved transmission of light into the receptacle at different solar inclinations and directions. The surface shape may be integral e.g. integrally moulded, or modified or attached. The structures may be for example round, oval, square, rectangular or multi-facet lenses or Fresnel lenses or the like. In the case of surface modification, this may be made by embossing or other suitable technique.

Preferably the upper portion comprises a lid portion which may be transparent or translucent. This maintains a humid environment and prevents substrates drying out in the heat generated by sunlight. A further advantage is that this maintains and accumulates the fragrances released by the wash liquor during the washing process. Thus, when the user returns to the washing device after a soaking period, and removes the lid, the fragrances are released to enhance the experience.
Accordingly the washing composition may comprise a fragrance composition for fragrancing or 'refreshing' of fabrics, with or without any cleaning action. Preferably the lid engages with the receptacle peripheral edge portion/rim. Such engagement may comprise sliding, clips, snap-fit, screw-fit, interference fit or any combination thereof. A sliding arrangement preferably comprises mutually engaging peripheral channels and rim portions on the lid and reservoir respectively. Respective channels/peripheral rim portions may be present on the lid or the receptacle. The engagement may be a sealing engagement to reduce or even prevent vapour and/or liquid egress. The lid may be removable by pivoting, sliding, folding/unfolding away from and relative to the receptacle.

Preferably the lid comprises said translucent or transparent portions. More preferably the lid is wholly transparent.

The lid may be flexible, such as plastic sheeting (e.g. transparent polycarbonate) but preferably it is rigid.

Preferably the device further includes an inner membrane. This reduces the time to heat up the contents of the receptacle. This overlies the substrate in the wash liquor. Preferably the inner membrane comprises a lower surface which directly contacts the wash substrates submerged in the wash liquor and an upper surface which contacts air within the receptacle. Importantly, the inner membrane is not underneath/submerged in the wash liquor. When located on top of the wash liquor it prevents the formation of water vapour, and thereby formation of water droplets (condensing) on the transparent cover. This ensures less water is reflected and more sunlight can penetrate the basin, resulting in higher temperatures.

Preferably, the membrane is fitted substantially above the water fill level. Preferably the inner membrane upper surface is above the fill level of the wash liquor and faces the sun.

In practice the membrane needs to be in contact with the wash liquor and substrate but not totally submerged - so minimal and preferably no liquid on top of the membrane which should face the sun and stay dry.
Preferably, the inner membrane is flexible. Preferably the inner membrane is water impermeable. Preferably the inner membrane is opaque and more preferably black. This is advantageous particularly for substrates which are dark/coloured fabrics because it prevents solar bleaching of such fabrics. Particularly preferred is a black plastic foil inner membrane. However, other colours or even transparent membranes can be used for e.g. lighter substrates to allow access to direct sunlight whilst accelerating heat-up times.

The inner membrane may comprise multiple layers, configured such that compartments are provided between adjacent layers. Such compartments can be used to separate wash items for individual treatment, for example if washing different types of items at the same time. For example, items requiring less or no direct sunlight can be placed in a compartment and shielded thus reducing solar bleaching and/or colour transfer and also enabling the use of different washing compositions or different concentrations of washing compositions.

Alternatively, or additionally, the receptacle may have portioning walls or other member, which allow the receptacle to be compartmentalised such that mixed loads (dark coloured articles and light/white loads) can be treated simultaneously with minimal risk of colour transfer. The or each partitioning wall/member may be integral or detachable and may be moveable.

Preferably the device comprises one or more temperature sensors. The temperature sensor/may be in or on a base or side wall of the receptacle. This can be used to record temperature of the water/wash liquor in the receptacle.

The temperature sensor may also be in or on the transparent lid portion to record the overall temperature inside the device or be used as a way to access the amount of solar radiation received. Preferably the fabric washing device comprises a scrubbing portion. The scrubbing portion may comprise a portion of the base and/or a side wall. Preferably the scrubbing portion comprises a scrubbing ramp which preferably comprises an obliquely inclined (or tilted) wall portion. This aids scrubbing of fabrics using the scrubbing portion which the device placed in front of the user, such that pressing against the scrubbing portion urges the device toward rather than away from the user.
Preferably the scrubbing portion comprises one or more raised portions or projections and/or one or more indentations to provide scrubbing ribs, dots, lines, or any other suitable shape and which may be arranged in a pattern. Differential scrubbing may be provided by a scrubbing portion with variable intensity. To this end the scrubbing portion may comprise a mutually opposed, interlocking wedge pattern and/or a variable (e.g. graduating from fine to course) mesh pattern.

Preferably the device comprises a shallow (low depth) box or tray structure. Preferably the transverse cross sectional area of 2000 to 8000, more preferably 3000 - 5000 cm² such as 3000-4000 cm². This allows optimal solar radiation capture and fast heating of an optimum soaking water volume of 3-20 litres. More preferably the device has a cross sectional area (in plan view from above) defined by side lengths of 30 - 120cm, more preferably 80cm. Most preferably this cross sectional area is rectangular and 60cm by 80cm.

Preferably the device comprises a shallow tray with a substantially level base. The base preferably comprises a recess which is preferably adjacent any scrubbing portion. This provides the advantage that clothes to be scrubbed on the scrubbing portion can be substantially immersed during scrubbing, if required even when low wash liquor volumes are used. The device preferably comprises an elevated internal base surface which is elevated relative to the recess and/or the ground when position on a level ground surface.

This elevated base feature insulates the solar heated water from any relatively cold surface on which it is standing. Glide members as described herein may provide an elevated base.

Preferably the solar-soaker gives a soak volume which is shallow, and between 2-20 cm deep in the area of the recess and around 1-10 e.g. 2-3 centimetres above the elevated bottom. This thin layer of water can be relatively rapidly heated by the sun. This feature is particularly advantageous when combined with the lid feature as above described as the laundry will not dry out in such a thin layer of water because the invention can works as a closed system saturated with water vapour.
Preferably the device has a temperature indicator which may receive temperature information from the or each temperature sensor.

The temperature indicator may comprise any suitable device but preferably comprises thermo-sensitive portions or materials in or on the receptacle or the lid such as wax shapes which melt or thermo-chromic inks or materials which react to present visual indicia at specific temperatures or temperature ranges.

Preferably the base comprises at least two base portions mutually inclined at an obtuse internal angle, said mutually inclined base portions located either side of a externally protruding hinge portion. This provides a multi-base system which allows pivoting or rocking of the device on the hinge portion, to effect mixing wash water and get a more even temperature distribution in the system and also agitation of the contained liquor and fabrics thereby enhancing cleaning. This also aids decanting of the used wash liquor from the system more easily.

The or each of the two base portions preferably have comprise a substantially flat external surface such that the device can rest stably on at least one base portion, when positioned on level ground. This affords the advantage that the inclination of the lid portion can be tilted to increase or decrease solar heating.

Preferably the substrate is immersed in the wash liquor. This is especially advantageous for hard surface substrates, such as culinary, crockery and culinary items. Preferably the substrate is substantially immersed in the wash liquor and further preferably the substrate is wholly immersed in the wash liquor.

Preferably the method comprises closing the receptacle with the lid (especially prior to soaking). Preferably the method comprises closing the receptacle by placing the lid to overlie the receptacle aperture. Preferably the method comprises closing the receptacle and engaging a seal to inhibit or prevent moisture loss.

Preferably the wash liquor is formed in step (a) prior to addition of the substrate.
Preferably the method includes the further step, step comprising soaking the substrate in the wash liquor in the closed receptacle e.g. closed by the lid, with lid overlying the access aperture for a soak period in the range 5 minutes to 24 hours. The temperature of the soaking step/s is preferably in the range 25-100 degrees C, 30-100 degrees C, more preferably in the range 40-100 degrees C, more preferably 30-90 degrees C, more preferably in the range 35-80 degrees, most preferably 40-60 degrees C.

For high temperature cleaning systems and washing compositions, the range is preferably be 50-100 degrees C, and most preferably in the range 60-100 degrees C.

Preferably at least part, and more preferably the entire soaking step takes place when the device is positioned in sunlight. Preferably the soak step takes place whilst the device is positioned in sunlight for a soak period in the range of 5 minutes to 24 hours. Longer soaking is preferably at soak temperatures above 30 degrees and may incorporate antimicrobial compositions.

Soaking whilst the device is positioned in sunlight allows the temperature of the wash liquor to be maintained at an elevated level throughout the soaking. A particular advantage of solar soaking is that fatty stains characterised by higher melting points to be deterged more easily and soak times can thus be dramatically reduced relative to other known manual soaking mechanisms. Preferably the method includes the step of adding minimised quantities of water such that substrates e.g. fabrics are wetted only rather than submerged, thereby reducing the amount of wash liquor in the device. This is enabled by the lid portion closing the receptacle and so ensuring a humid environment preventing the fabrics from drying whilst still undergoing the wash process such as stain removal or fragrance treatment or any other wash process. The reduced water usage saves water and speeds up heating of the wash load, and in combination with the high washing composition concentration improve the cleaning performance. The reduced water also reduces the workload by reducing the weight of the device and the weight of the fabrics which feel heavier if they have to be retrieved from a large quantity of water.
The method may include the step of agitating the wash liquor to create a foamy wash liquor and/or agitating the washing liquor and the substrate.

Preferably the method includes the step of scrubbing or rubbing of the substrate, rinsing the substrate, etc., any combination thereof. Preferably this step involves use of the scrubbing portion and further preferably it follows the step of soaking. The scrubbing/rubbing step may be repeated and interspersed with one or more soaking steps.

Agitation and/or scrubbing/rubbing/rinsing etc. steps may be interspersed and alternated with soaking steps as required.

The method may comprise a fabric fragrancing or refreshment method, utilising a fabric fragrance or refreshment composition with or without any cleaning action, the method comprising the step of soaking the substrate in the closed receptacle and then opening the receptacle to provide a concentrated egress of accumulated fragrance.

The method steps may not necessarily be restricted to alphabetical order however preferably the step placing the device in the sunlight precedes soaking step and step of scrubbing/rubbing etc.

The method may comprise placing the inner membrane over fabric substrates.

The device receptacle may be moulded, thermoformed, rotation moulded, blow moulded, injection moulded in whole or in parts which are then assembled.

Preferably the washing composition comprises one or more enzymes. The one or more enzymes may comprise any one or combination of the following enzymes. Enzymes may be from bacterial or fungal origin. Chemically modified or protein engineered mutants are included. As used herein the term "enzyme" includes enzyme variants (produced, for example, by recombinant techniques) are included. Examples of such enzyme variants are disclosed, e.g., in EP 251,446 (Genencor), WO 91/00345 (Novo Nordisk), EP 525,610 (Solvay) and WO 94/02618 (Gist-Brocades NV).
Preferably, the one or more enzymes comprise proteases and/or lipases and/or phospholipases and/or cutinases and/or amylases and/or mannanases and/or cellulases and/or esterases and/or peroxidases/oxidases and/or pectate lyases.


Examples of commercially available alkaline pectate lyases include BIOPREP™ and SCOURZYME™ L from Novozymes A/S, Denmark.

Preferred proteases include serine protease or a metallo protease, preferably an alkaline microbial protease or a trypsin-like protease. Alkaline proteases include subtilisins, especially those derived from *Bacillus*, e.g., subtilisin Novo, subtilisin Carlsberg, subtilisin 309, subtilisin 147 and subtilisin 168. Trypsin-like (i.e. capable of cleaving peptide bonds at the C-terminal side of lysine or arginine.) Such proteases may be of porcine or bovine origin. *Fusarium* derived trypsin proteases are also included.

Commercially available protease enzymes include Alcalase™, Savinase™, Primase™, Duralase™, Dyrazym™, Esperase™, Everlase™, Polarzyme™, and Kannase™, (Novozymes A/S), Maxatase™, Maxacal™, Maxapem™, Properase™, Purafect™, Purafect OxP™, FN2™, and FN3™ (Genencor International Inc.).

Preferred lipases include lipases from *Humicola* (synonym *Thermomyces*), e.g. from *H. lanuginosa* (*T. lanuginosus*) or from *H. insolens*, a *Pseudomonas* lipase, e.g. from *P. alcaligenes* or *P. pseudoalcaligenes*,
P. cepacia, P. stutzeri, P. fluorescens, Pseudomonas sp. strain SD 705 (WO 95/06720 and WO 96/27002), P. wisconsinensis, a Bacillus lipase, e.g. from B. subtilis (Dartois et al. (1993), Biochemica et Biophysica Acta, 1131, 253-360), B. stearothermophilus (JP 64/744992) or B. pumilus (WO 91/16422).

Commercially available lipase enzymes include Lipolase™ and Lipolase Ultra™, Lipex™ (Novozymes A/S).

Preferred Phospholipases (EC 3.1.1.4 and/or EC 3.1.1.32) include enzymes which hydrolyse phospholipids. Phospholipases A1 and A2 which hydrolyze one fatty acyl group (in the sn-1 and sn-2 position, respectively) to form lysophospholipid; and lysophospholipase (or phospholipase B) which can hydrolyze the remaining fatty acyl group in lysophospholipid are included as are Phospholipase C and phospholipase D (phosphodiesterases) which release diacylglycerol or phosphatidic acid respectively.

The term "phospholipase A" used herein in connection with an enzyme of the invention is intended to cover an enzyme with Phospholipase A1 and/or Phospholipase A2 activity. The phospholipase activity may be provided by enzymes having other activities as well, such as, e.g., a lipase with phospholipase activity.

The phospholipase may be of any origin, e.g., of animal origin (such as, e.g., mammalian), e.g. from pancreas (e.g., bovine or porcine pancreas), or snake venom or bee venom. Preferably the phospholipase may be of microbial origin, e.g., from filamentous fungi, yeast or bacteria, such as the genus or species Aspergillus, e.g., A. niger; Dictyostelium, e.g., D. discoideum; Mucor, e.g. M. javanicus, M. mucedo, M. subtilissimus; Neurospora, e.g. N. crassa; Rhizomucor, e.g., R. pusillus; Rhizopus, e.g. R. arrhizus, R. japonicus, R. stolonifer, Sclerotinia, e.g., S. libertiana; Trichophyton, e.g. T. rubrum; Whetzelinia, e.g., W. sclerotiorum; Bacillus, e.g., B. megaterium, B. subtilis; Citrobacter, e.g., C. freundii; Enterobacter, e.g., E. aerogenes, E. cloacae Edwardsiella, E. tarda; Erwinia, e.g., E. herbicola; Escherichia, e.g., E. coli; Klebsiella, e.g., K. pneumoniae; Proteus, e.g., P. vulgaris; Providencia, e.g., P. stuartii; Salmonella, e.g. S. typhimurium; Serratia, e.g., S. liquefaciens, S. marcescens; Shigella, e.g., S. flexneri; Streptomyces, e.g., S. violeceoruber; Yersinia, e.g., Y. enterocolitica. Thus, the
phospholipase may be fungal, e.g., from the class Pyrenomycetes, such as the genus Fusarium, such as a strain of *F. culmorum*, *F. heterosporum*, *F. solani*, or a strain of *F. oxysporum*. The phospholipase may also be from a filamentous fungus strain within the genus Aspergillus, such as a strain of *Aspergillus awamori*, *Aspergillus foetidus*, *Aspergillus japonicus*, *Aspergillus niger* or *Aspergillus oryzae*.

Preferred phospholipases are derived from a strain of *Humicola*, especially *Humicola lanuginosa* or variant; and from strains of *Fusarium*, especially *Fusarium oxysporum*. The phospholipase may be derived from *Fusarium oxysporum* DSM 2672.

Preferably phospholipases comprise a phospholipase A1 (EC. 3.1.1.32) or a phospholipase A2 (EC.3.1.1.4.). Examples of commercial phospholipases include LECITASE™ and LECITASE™ ULTRA, YIELSMAX, or LIPOPAN F (available from Novozymes A/S, Denmark).

Preferred cutinases (EC 3.1.1.74.) are derived from a strain of *Aspergillus*, in particular *Aspergillus oryzae*, a strain of *Alternaria*, in particular *Alternaria brassiciola*, a strain of *Fusarium*, in particular *Fusarium solani*, *Fusarium solani pisi*, *Fusarium roseum culmorum*, or *Fusarium roseum sambucium*, a strain of *Helminthosporum*, in particular *Helminthosporum sativum*, a strain of *Humicola*, in particular *Humicola insolens*, a strain of *Pseudomonas*, in particular *Pseudomonas mendocina*, or *Pseudomonas putida*, a strain of *Rhizoctonia*, in particular *Rhizoctonia solani*, a strain of *Streptomyces*, in particular *Streptomyces scabies*, or a strain of *Ulocladium*, in particular *Ulocladium consortiale*. Most preferably cutinase is derived from a strain of *Humicola insolens*, in particular the strain *Humicola insolens* DSM 1800.

Commercial cutinases include NOVOZYM™ 51032 (available from Novozymes A/S, Denmark).

Preferred amylases (alpha and/or beta) are included for example, alpha-amylases obtained from *Bacillus*, e.g. from strains of *B. licheniformis* NCIB8059, ATCC6634, ATCC6598, ATCC11945, ATCC 8480, ATCC9945a, or the *Bacillus* sp. strains DSM 12649 (AA560 alpha-amylase) or Bacillus sp. DSM 12648 (AA349 alpha-amylase).
Commercially available amylases are Duramyl™, Termamyl™, Termamyl Ultra™, Natalase™, Stainzyme™, Fungamyl™ and BAN™ (Novozymes A/S), Rapidase™ and Purastar™ (from Genencor International Inc.).

Preferred cellulases include cellulases from the genera Bacillus, Pseudomonas, Humicola, Fusarium, Thielavia, and Acremonium, e.g. the fungal cellulases produced from Humicola insolens, Thielavia terrestris, Myceliophthora thermophila, and Fusarium oxysporum.

Especially preferred cellulases are the alkaline or neutral cellulases having color care benefits. Commercially available cellulases include Celluzyme™, Carezyme™, Endolase™, Renozyme™ (Novozymes A/S), Clazinase™ and Puradax HA™ (Genencor International Inc.), and KAC-500(B)™ (Kao Corporation).

Preferred mannanases (EC 3.2.1.78) include derived from a strain of the filamentous fungus genus Aspergillus, preferably Aspergillus niger or Aspergillus aculeatus or Trichoderma resee’ or from the Bacillus microorganism FERM P-8856 which produces beta-mannanase and beta-mannosidase or from alkalophilic Bacillus sp. AM-001 or from Bacillus amyloliquefaciens. The mannanase may comprise alkaline family 5 and 26 mannanases derived from Bacillus agaradhaerens, Bacillus licheniformis, Bacillus halodurans, Bacillus clausii, Bacillus sp., and Humicola insolens.

Examples of commercially available mannanases include Mannaway™ available from Novozymes A/S Denmark.

Preferred peroxidases/oxidases include peroxidases from Coprinus, e.g. from C. cinereus, and variants thereof. Commercially available peroxidases include Guardzyme™ and Novozym™ 51004 (Novozymes A/S).

The enzymes may be the sole fabric treatment agent or other stain removal agents may be incorporated.
Any enzyme present in a composition may be stabilized using conventional stabilizing agents, e.g., a polyol such as propylene glycol or glycerol, a sugar or sugar alcohol, lactic acid, boric acid, or a boric acid derivative, e.g., an aromatic borate ester, or a phenyl boronic acid derivative such as 4-formylphenyl boronic acid.

According to a further aspect of the invention there is provided use of a washing device of the first aspect of the invention in combination with one or more enzymes in the treatment of stains on a fabric in a washing process of the invention.

Other detergent ingredients may be included including surfactants, builders, sequestering agents, hydrotropes, preservatives, complexing agents, polymers, stabilizers, perfumes which may be free oils or encapsulated optical brighteners, or other ingredients such as e.g. fabric conditioners including clays, foam boosters, suds suppressors (anti-foams), anti-corrosion agents, soil-suspending agents, anti-soil re-deposition agents, anti-microbials, tarnish inhibitors, or combinations of one or more thereof, provided that these ingredients are compatible with the enzymes.

The wash compositions may comprise a fabric wash detergent material selected from non-soap anionic surfactant, nonionic surfactants, soap, amphoteric surfactants, zwitterionic surfactants and mixtures thereof. The surfactants may be present in the composition at a level of from 0.1% to 60% by weight. The surfactants and other actives may be reduced to a level of 0.1% to 10% by weight as lower levels of actives can achieve good cleaning due to the acceleration of this process by solar soaking.

The fabric wash composition may comprise any flowable and pourable composition, e.g. liquid, gel, powder, powder-liquid mixture.

Various non-limiting embodiments of the invention will now be more particularly described with reference to the following figures and by way of example only, in which:

Figure 1 shows a perspective view of a device according to the invention;
Figure 2 shows a side view of the device of figure 1;
Figures 3a - 3c show a further embodiment of the invention with a tilting base system; and
Figure 4 shows a further embodiment of the invention with scrubbing portions of varying intensity.
Figures 5a - 5d shows a yet further embodiment of the invention with glide members and a flat base (without recess)

Referring to the drawings, and in particular figures 1 and 2 a washing device 1 for manual washing of a substrate indicated at 9 (shown in figure 2 only), exemplified here as a fabric, comprises:
(a) an opaque black receptacle 5 for containing an aqueous wash liquor 17 with said fabric substrate 9 (but the device is equally advantageous for hard surface substrates such as culinary, crockery or cutlery items) at least partially immersed therein;
(b) a filling and access aperture 11 defined by upper peripheral edge portions 13 comprising the peripheral rim of the washing receptacle 5; and
(c) an upper inclined, transparent lid referenced generally at 7.

The receptacle 5 and lid 7 are made from a rigid plastic material (thermoformed) allowing a relatively lightweight structure for carrying to the water source be it a river, communal water supply point.

The receptacle 5 is closed by the lid 7 to provide a humid environment within the closed device 1 during fabric soaking and prevents substrates drying out in the heat generated by sunlight.

The lid 7 engages with the receptacle upper portions 13 via a sliding arrangement (not shown). The lid 7 comprises extruded channels (not shown) which slide relative to the upper portions 13 of the receptacle 5. However, such engagement may comprise additionally/alternatively comprise multiple clips or snap-fit, screw-fit or other engagements. The engagement here provides sealing engagement to reduce vapour and/or liquid egress. Lid 7 is installed and removed by sliding relative to the receptacle.
Device 1 further includes a flexible, water-impermeable inner membrane 15. This reduces the time to heat up the contents of the receptacle 5 and overlies the substrate in the wash liquor 17. The membrane overlies the substrate and the wash liquor. The inner membrane 15 is opaque, black plastic foil for use with dark/coloured fabrics 9 to protect from solar fading. However, other colours or even transparent membranes can be used for e.g. lighter substrates to allow access to direct sunlight for solar bleaching.

The experimental data in Example 1 shows below how heat-up times are accelerated using the inner membranes.

Also provided (not shown) is an inner membrane of multiple layers, configured such that compartments are provided between adjacent layers. Such compartments can be used to separate wash items to prevent colour transfer or for individual treatment such as with different wash liquors. For example, items requiring less direct sunlight can be placed in a compartment and shielded.

The washing device 1 comprises a scrubbing portion 19. The scrubbing portion 19 may comprise a portion of the base and/or a side wall 21. Preferably the scrubbing portion 19 comprises a scrubbing ramp 19 which preferably comprises an obliquely inclined and inset portion of side wall 21. This positioning aids scrubbing of fabrics 9 using the scrubbing portion 19 which the device 1 placed in front of the user, such that pressing fabrics against the scrubbing portion 19 urges the device toward rather that away from the user.

The scrubbing portion 19 comprises ribs 20. Differential scrubbing may be provided by a scrubbing portion with variable intensity. To this end, further embodiments include mutually opposed, interlocking wedge patterns and/or a variable (e.g. graduating from fine indicated at 41 to course indicated at 43) mesh pattern as shown in Figure 4.

Referring to figure 1, the receptacle 1 can be seen to be shallow (low depth) tray structure. The transverse cross sectional area is 6084cm² (defined by equal side lengths 78cm² x 78cm²). The shallow tray structure allows optimal solar radiation capture and fast heating of an optimum soaking water volume of 3-20 litres. The base is slightly
smaller due to a downward tapering of the walls when viewed from any side - see figure 2.

Preferably the solar-soaker gives a soak volume which is about 10 cm deep in the area of
the recess and around 2-3 centimetres above the elevated bottom. This thin layer of
water can be relatively rapidly heated by the sun. This feature is particularly
advantageous when combined with the lid feature as above described as the laundry will
not dry out in such a thin layer of water because the invention can works as a closed
system saturated with water vapour.

The receptacle 5 has a level base 23 comprising a central recess 25 adjacent scrubbing
portion 19. This provides the advantage that clothes to be scrubbed on the scrubbing
portion can be substantially immersed during scrubbing, if required. The remaining part of
the base 23 has an elevated internal base portion 27 (relative to the recess 25 and/or the
ground (not shown) when the device 1 is positioned on a level ground surface. This
elevated base 27 insulates the solar heated water from any relatively cold surface it is
standing on.

Further embodiments of the device have one or more temperature sensors (not shown) in
a base and/or wall portion. A temperature indicator is also provided indicating when the
wash liquor is at or above a desired temperature. The temperature indicator may
comprise any suitable device but preferably comprises thermo-sensitive portions or
materials in or on the receptacle such as wax shapes which melt or thermo-chromic inks
or materials which react to present visual indicia at specific temperatures or temperature
ranges. In further embodiments (not shown) the device incorporates temperature
sensors in and/or on the lid to record the overall temperature inside the device or be used
as a way to identify the amount of solar radiation received.

Referring now to Figures 3a and 3b, further embodiments are shown schematically
(without detail of base, lid, scrubbing portion etc.) having a dual base comprised of two
base portions 31, 33 mutually inclined at an obtuse internal angle, said mutually inclined
base portions located either side of a externally protruding hinge portion 35. This provides
a multi-base system which allows pivoting or rocking of the device 1 on the hinge 35, to
effect mixing water/wash liquor and so achieve a more even temperature distribution in
the receptacle 5 and also agitation of the contained wash liquor 17 and fabrics thereby
enhancing cleaning. This also provides a pouring mechanism to allow ease of emptying.

5 The two base portions 31, 33 both can be seen to present a substantially flat external
surface such that the device can rest stably on at least either base portion (31 or 33),
when positioned on level ground. This affords the advantage that the inclination of the lid
can be tilted to increase or decrease solar heating.

10 Referring to figure 5 a further embodiment is shown. This has a similar construction to the
previous embodiments but with a rectangular construction, side lengths 60x80cm.
This embodiment also includes a flat bases with no recess 25.

The device of figure 5 includes integral glide members 50. The glides allow the device to
be moved even when fully loaded with wash liquor and substrates. With a handle e.g.
rope attached to the device, it can be pulled, turned etc. so it can be positioned/re-
positioned in or out of the sun during/at the end of/during the soak to complete or add-in
any washing steps in the comfort of the shade.

20 All embodiments are made from plastic and are portable when empty to allow
transportation to the water source (river, water supply pipe) or washing place.

The device is provided as part of a substrate washing system comprising:
(a) a packaged washing composition (not shown);
(b) the device 1; and
(c) instructions to wash a substrate according to the method described below.

An exemplary method of washing a fabric substrate is as follows. The device 1 is
positioned in sunlight. Water and detergent are added to receptacle 5 and mixed to
provide a wash liquor 17. The fabric substrate is added and immersed in this wash liquor
17. The inner membrane may be used to overlie the fabric substrate immersed in the
liquor depending on whether faster heating/and colour/opacity selected depending on
what if any protection from solar fading is required. The device lid 7 is slid into place over
the receptacle and the items left to soak for an extended period of time allowing the user to go about other activities.

The soak period may be in the range 5 minutes to 24 hours.

Most advantageously the entire soaking step takes place when the device is positioned in sunlight. Preferably the soak step takes place whilst the device is positioned in sunlight, with the lid facing the direction of the sun, for a soak period in the range of 5 minutes to 24 hours. Soaking whilst the device positioned in sunlight allows the temperature of the wash liquor to be maintained at an elevated level throughout the soaking.

After or intermittent with the soak periods, the user may:
- carry out the step of agitating the wash liquor to create a foamy wash liquor and/or agitating the washing liquor and the substrate; and/or
- carry out the step of scrubbing or rubbing of the substrate, rinsing the substrate, etc., any combination thereof e.g. using the scrubbing portion 19. Preferably this step follows the or each step of soaking. In such steps the lid is removed.

The method steps may not necessarily be restricted to the above order.

Examples

Example 1: Effect of membrane on heat-up time.

The time required to reach a temperature of e.g. 50°C in the wash load was tested for black and white fabric substrates with various membranes in the receptacle above.

Protocol:

A receptacle - as in figure 1 and 2 - was loaded with 10 standard white or black terry towels (total weight 1.5kg). For reproducibility of the experiments the towels were folded twice and distributed evenly over the bottom of the receptacle. Then 10 litres of tap water was added to the towels. Temperature was monitored using 15 autonomous temperature loggers (Dallas i-Button, type DS1920-F5, www.homechip.com), of which 5 were placed on the bottom of the receptacle, 5 in between the towels, and five on top of the towels. Temperature was recorded over a period of 5 hours. By averaging the temperature data
of these 15 loggers, a reliable average temperature reading of the wash load was obtained over the investigated period. A 1000Watt halogen lamp was placed over the receptacle with transparent lid portion to simulate solar heating (Cosmobeam 1000W, Cosmolight, Rome, Italy). The time required to reach 50°C was tested for the following wash loads following experiments were conducted: A) white towels, B) white towels covered with a transparent plastic inner membrane (LDPE plastic foil, LWH: 80cm*80cm*0.02cm Solar EVA-5 Clear, Rovero, Raamsdonksveer, The Netherlands), C) black towels, and D) black towels covered with a black plastic inner membrane (PVC plastic, LWH: 80cm*80cm*0.05cm, Draka, France). All experiments were performed in duplicate.

Results: In table 1 below it is shown what the effect of different air-wash load interfaces on the time to heat up to 50°C under simulated solar conditions.

Table 1: Time required to reach 50°C under different air-wash load interfaces

<table>
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<tr>
<th>Experiment</th>
<th>Time required to reach 50°C (min)</th>
<th>Standard Deviation</th>
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<tr>
<td>A – white towels</td>
<td>232.5</td>
<td>17.7</td>
</tr>
<tr>
<td>B – white towels + transparent plastic membrane</td>
<td>182.5</td>
<td>10.6</td>
</tr>
<tr>
<td>C – black towels</td>
<td>180.0</td>
<td>7.1</td>
</tr>
<tr>
<td>D – black towels + black (opaque) plastic membrane</td>
<td>137.5</td>
<td>2.5</td>
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</table>

As expected, the time required for the wash load to reach 50°C took longest for the white towels (A) and far less for the black towels (C). Surprisingly however, the white towels covered by a transparent sheet of plastic (B) - still having a white appearance - performed just as well as the black towels (C). Even more surprisingly, towels covered with a black sheet of plastic (D) required even less time than black towels to reach 50°C. It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiments which are described by way of example only.
Claims

1. A washing device for manual washing of a substrate, the washing device comprising:
   (a) a receptacle for containing an aqueous wash liquor with a substrate at least partially
       immersed therein;
   (b) a filling and access aperture defined by upper peripheral edge portion/s of the
       washing receptacle; and
   (c) at least one upper portion of the device which is transparent or translucent.

2. A washing device according to any preceding claim wherein the upper portion is
   inclined.

3. A washing device according to any preceding claim wherein the upper portion
   comprising a lid portion which can be used to close the receptacle.

4. A washing device according to any preceding claim further including an inner
   membrane.

5. A washing device according to any preceding claim wherein the device comprises one
   or more temperature sensors and/or indicators.

6. A washing device according to any preceding claim comprising a scrubbing portion.

7. A washing device according to any preceding claim comprising an elevated base.

8. A washing device according to any previous claim wherein the device comprises one
   or more glide members.

9. A method of washing a substrate with a washing device comprising a receptacle, a
   filling and access aperture and one or more transparent or translucent upper portions,
   which overlie the receptacle, the method comprising the steps of:
   (a) adding water and a washing composition to the receptacle to form a wash liquor
       therein;
(b) adding a substrate into the washing receptacle;
(c) positioning the receptacle in sunlight.

10. A method according to claim 9 wherein the device is the device of any of claims 1-8.

11. A method according to any of claims 9 - 10 comprising the step of closing the receptacle with the lid.

12. A method according to any of claims 9 - 11 comprising the further step comprising soaking the substrate in the wash liquor in the receptacle, closed by the lid, for a soak period in the range 5 minutes to 24 hours.

13. A method according to any of claims 9 - 12 wherein at least part of the soaking step takes place when the device is positioned in sunlight.

14. A method according to any of claims 9 - 13 wherein the soak step takes place whilst the device is positioned in sunlight for a soak period in the range of 5 minutes to 24 hours.

15. A method according to any of claims 9 - 14 wherein said method includes the step (f) of scrubbing or rubbing of the substrate, rinsing the substrate, etc., any combination thereof.

16. A method according to any of claims 9 - 15 wherein the method comprises placing the inner membrane over fabric substrates.

17. A substrate washing system comprising:
(a) a packaged washing composition;
(b) a washing device comprising a receptacle, a filling and access aperture and one or more transparent or translucent upper portions; and
(c) instructions to wash a substrate according to the method of the second aspect of the invention.
18. A substrate washing system according to claim 17 or wherein the device is according to any of claims 1-8.

19. A device according to claims 1-15, and/or a method according to claims 9 - 15 and/or a system according to claims 17 or 18 wherein the substrate comprises fabrics and/or hard surface substrates such as culinary and crockery items.

20. A device according to claims 1-8, and/or a method according to claims 9 - 15 and/or a system according to claims 17 or 18 wherein the washing composition comprises one or more enzymes.

21. A device according to claims 1-8, and/or a method according to claims 9 - 15 and/or a system according to claims 17 or 18 wherein the one or more enzymes comprise proteases and/or lipases and/or phospholipases and/or cutinases and/or amylases and/or mannananses and/or cellulases and/or esterases and/or peroxidases/oxidases and/or pectate lyases.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. D06F1/04

ADD.

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)

D06F

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>EP 0 525 610 A2 (SOLVAY ENZYMES GMBH &amp; CO KG [DE]; BIOTECHNOLOG FORSCHUNG GMBH [DE]) 3 February 1993 (1993-02-03) cited in the application on claims</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"Z" document member of the same patent family

Date of the actual completion of the international search

28 November 2016

Date of mailing of the international search report

19/12/2016

Name and mailing address of the ISA/Authorized officer

European Patent Office, P.B. 5816 Patentaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Clivio, Eugenio

Form PCT/ISA/210 (second sheet) (April 2005)
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