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ABSTRACT

This invention relates to a water-soluble film (WSF) system with embedded/entrapped water-soluble films (WSF). More particularly, the invention relates to a WSF system with actives embedded/entrapped therein such as to
5 provide precise and desired release of actives there from and its method of manufacturing for diverse applications, in which a variety of substances such as detergents, enzymes, softeners, perfumes, pesticides, fungicides, active ingredients, dyes, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings, walls, furniture, fluffs, pulp, etc., and the like can be so
10 embedded/entrapped for such purpose. The invention further discloses novel online and offline process for the manufacture of such multi-layered WSF with or without liners and of desired shapes to selectively entrap interacting/non-interacting materials and their combinations. The process also provides options for the use of a wide range of raw materials, liners such as paper, film, foil, fabric,
15 etc.

METHOD OF MANUFACTURING EMBEDDED WATER SOLUBLE FILM CARRIER

FIELD OF INVENTION

This invention relates to a water soluble film (WSF) system with embedded/entrapped water-soluble films (WSF) and a process of manufacturing the same. More particularly, the invention relates to a WSF system with actives embedded/entrapped therein such as to provide precise and desired release of actives therefrom and its method of manufacturing for diverse applications, in which a variety of substances such as detergents, enzymes, softeners, perfumes, pesticides, fungicides, active ingredients, dyes, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings, walls, furniture, etc., and the like can be so embedded/entrapped for such purpose.

BACKGROUND ART

In various processes/operations and in day-to-day life, a number of substances including hazardous or non-hazardous chemicals are required to be delivered in the precisely measured doses.

Attempts by the packaging industry has been to develop approaches to evolve accurate delivery systems for active materials especially those that are expensive or are environmentally sensitive or have possibilities of reacting with other ingredients in formulations. There have been several attempts in the past to either encase or laminate or package different materials in water-soluble films (WSF).

The objective of delivering precise quantities of products like detergents have been being addressed by the industry for example by packaging detergents in "soluble" and "non-soluble" sachets in dosages ranging from 20 gms/sachet to 50 gms/sachet. In case of non-soluble sachets the detergents tend to adhere to statically charged packaging material surface thereby inhibiting their total transfer to the point of application. Similar problems of particles adhering to statically charged surface are faced when small and precise quantities of pesticides actives are to be packed in non soluble sachets. In the case of soluble sachets problem arising out of chemical reaction of the ingredients to the film cause serious problems in its "smooth

applications. Similarly in the case of pesticide packaging the active ingredients in the package varies from about 2% to about 30% based on the formulation.

5 US Patent No. 4,416,791 discloses a packaging film comprising a base film of at least partially water-soluble plastics material carrying on one surface only a protective layer, in particulate form, of an inert plastics material having a contact angle to water of at least 80.degree, the said layer being effective to protect the base film surface from attack by aqueous media. Such a packaging film has the advantages that, on its unprotected side, it can be dissolved away, or partly
10 dissolved and partly dispersed, by water, whereas on the side carrying the protective layer it is protected from attack by aqueous systems and other aggressive media. It is essential that the inert protective layer be in the form of substantially un-coalesced discrete particles attached firmly to the base film but only loosely or not at all to each other, so that if the base film is dissolved away the protective layer has little or no
15 integrity and is rapidly dispersed. Further it provides a package comprised of the packaging film defined above, having the protective layer on its internal surface(s), so that the layer protects the package from attack by any water present inside the package. It is claimed that such a product can be used to package liquid or solid detergent useful for dosing into domestic or commercial washing machines.

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In one of the methods described in the patent a cold-water-soluble polyvinyl alcohol / polyvinyl acetate film having a thickness of 0.0038 cm was heated to a temperature just above its glass transition temperature to render it slightly tacky. Polytetrafluoroethylene powder is sprinkled onto the upper surface of the heated film.
25 The film is then passed between rollers heated and then allowed to cool.

The limitation of US Patent No. 4,416,791 is that it requires a pre formed WSF substrate and the extent of coating of the Polytetrafluoroethylene powder would be restricted to the surface of the WSF. By this process it wouyld not be possible to
30 control the depth to which the Polytetrafluoroethylene powder can be embedded. The enduse of this invention would be limited to the water repelancy and the release properties of Polytetrafluoroethylene powder on the surface of the pre formed WSF.

US Patent No. 4,176,079 discloses an invention for dispersing an enzyme into water soluble resin and forming the resin by casting or extruding into a sheet. The sheet is then dried, if necessary, and, if required, cut into "ribbons" for incorporation
5 into the detergent product. The ribbons of enzyme-dispersed resin may be admixed with a detergent composition in granular, viscous liquid, paste or gel form. The resulting mixture may be used directly in the washing process, particularly in an automatic dishwasher, or it may be incorporated within a water-soluble packet, for easy and convenient dispensing. In this case the water soluble resin is being used
10 as a means to bind the enzyme to its matrix. This method of preparing the ribbons also suffers from the shortcoming that two or more reacting substances cannot be dispersed in the same film as they would interact with each other and degrade.

US Patent No. 6,378,274 discloses a process for producing a thermoformed
15 package of the type comprising the steps of placing a first sheet of formable film over a forming die having a cavity, moulding the film into the cavity thereby forming a recess in the film, placing a composition in the thus formed recess, and sealing a second sheet of film across the recess to close the package. In particular, the prior art relates to such a process for producing a water-soluble package containing a
20 detergent composition. The disclosure is restricted thermo formed packages formed out of a combination of soluble and insoluble films. It also needs pre formed films to be operated on offline equipment for packaging applications thereby making the process of incorporating the materials within the films very complex and requiring expensive equipment.

25 Patent No. EP 0493553 relates to a containerization system and to containers which are particularly suitable for storing, packaging and transporting toxic or hazardous products, such as agricultural chemicals. The containerization system comprises the chemical in the form of a gel, which is contained within a water soluble or water-
30 dispersible bag. This EP '553 has limitations as it is restricted to toxic products that can be converted into gels and then packaging of gel into a WSF bag.

Patent No. EP 0347220B1 relates to a package comprising e.g. a liquid chemical or a chemical dissolved or dispersed in an organic liquid contained in an envelope of water-soluble or water dispersible material and having a water-soluble or water dispersible seal. The patent also provides a process for the preparation of a package according to the invention which comprises heat sealing the envelope material to obtain a water dispersible or, preferably, a water soluble heat seal. This prior art specifically discusses packaging of pesticides by means of an efficient heat seal system into a container.

Patent GB 2244258B relates to a package comprising hazardous chemical dissolved or dispersed in a liquid or gel which is contained in an envelope of water-soluble or water-dispersable material. The patent seeks to provide a new container system for agrochemicals which is safe to handle. This patent also provides a package which comprises a hazardous chemical dissolved or dispersed in a liquid or gel contained in a water-soluble or water-dispersible laminated film. There is also discussed the delivery of toxic and hazardous materials by means of plain and laminated soluble sachets.

It would be evident from the above state of the art that none of the prior art teach or provide for delivery of the encased, laminated or packaged material in precise quantities. It is therefore the long-standing need of industry to develop efficient and cost effective stable embedded WSFs for controlled dosing in diverse applications and especially to embed a wide variety of substances avoiding interaction with each other within films. Further the need for carriers that can selectively carry combination of materials with dissimilar properties such as miscible/in-miscible, hydrophobic/hydrophilic ingredients continues to elude the industry.

OBJECT OF THE INVENTION

The main object of the present invention is to provide a stable water soluble film and film system having embedded/entrapped actives for diverse applications, in which a variety of substances such as detergents, enzymes, softeners, perfumes, pesticides, fungicides, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings, walls, furniture etc., and the like are

embedded/entrapped singly or in combination for delivering them in precise and desired dosages.

Another preferred object of the present invention is to provide an offline process for the manufacture of stable water soluble films for diverse applications, in which a variety of substances such as detergents, enzymes, softeners, perfumes, pesticides, fungicides, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings, walls, furniture etc., and the like are embedded/entrapped singly or in combination for delivering them in precise and desired dosages.

Another preferred object of the invention is to provide a process of entrapping absorbent materials such as fluff, pulp and the like within WSFs.

It is yet another preferred object of the invention to disperse diverse non-water-soluble materials on the surface and within WSFs.

Yet another preferred object of the present invention is to provide a process for manufacture of multi-layered WSF to selectively entrap interacting / non-interacting materials.

Yet another preferred object of the present invention is to provide a process for manufacture of multi-layered WSF to selectively entrap combination of materials with similar and / or dissimilar properties.

It is yet another preferred object of the invention to provide a process of manufacturing of WSFs with materials embedded in selective areas of the WSFs in desired shapes.

It is yet another preferred object of the invention to provide WSFs for diverse applications, in which a variety of substances such as detergents, enzymes, softeners, perfumes, pesticides, fungicides, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings, walls, furniture etc., and the like are embedded for delivering them in precise and desired quantities.

It is yet another object of the invention to provide a process for the manufacture of WSFs exploiting the various embodiments of the invention using a wide range of raw materials including polyvinyl alcohol copolymer ionomers, polyvinyl alcohol homopolymer, non ionomeric poly vinyl alcohol polymer, polymethacrylate, polyvinyl alcohol, polyacrylamide, polymethacrylamide, polyacrylic acid, polymethacrylic acid, polyethyleneglycol, polyvinylpyrrolidone, proteinaceous binders such as gelatin modified gelatins such as phthaloyl gelatin, polysaccharides, such as starch, gum arabic and dextrin and water-soluble cellulose derivatives.

It is yet another object of the invention to provide a process for the manufacture of WSFs with the options to use a range of liners such as paper, film, foil or fabric, preferably of film, more preferably of polyester film. The film liners may be plain, metallised, embossed, gloss or matte depending upon the desired end product parameters. Paper liner can be plain, embossed, gloss, matte, extrusion coated laminated or release coated.

Fabrics made of cotton or synthetic yarns, solution coated, plain, embossed, gloss, matte, extrusion coated or laminated may be used as liner dependant dependent upon the desired end product properties. Foils made of steel, aluminium, copper or mixture thereof, more preferably aluminium foil, plain, embossed, gloss, matte, extrusion coated laminated or release coated. A liner may be made of a combination of any or all of the above materials. A liner may be used for single use or may be used for multiple uses.

SUMMARY OF THE INVENTION

Thus according to one aspect of the present invention there is provided a process for the manufacture of a water soluble film with at least one embedded active material, the method comprising the steps of:

- i) providing a liner upon which to cast a water soluble film;
- ii) providing a formulation for the water soluble film of step (i);
- iii) providing the formulation of step (ii) with at least one active material;

iv) casting the formulation with said at least one active material from step (iii) on the liner to form a water soluble film with said at least one active material embedded therein;

and

- v) drying the cast water soluble film with said at least one embedded active material on said liner by the application of heat at a temperature in the range of 50°C to 250°C.

Preferably the liner material is selected from the group comprising paper, film, foil or fabric.

In another preferred embodiment the liner is selected from plain, embossed, metallised, gloss, matte, extrusion coated, laminated, or release coated materials.

In another preferred embodiment the cast water soluble film from step (v) is detached from the liner of step (i).

In another preferred embodiment the process is characterized by the step of casting at least one further water soluble film on the embedded water soluble film from step (v) at a subsequent casting head and drying the multi-layer water soluble film to produce a multi-layer water soluble substrate.

Preferably at least one active material is provided in a formulation for casting said at least one further water soluble film.

The multi-layer water soluble film preferably comprises combinations of water soluble films which dissolve at different temperatures in any desired sequence.

According to an embodiment of the present invention, the process for the manufacture of embedded water-soluble film (WSF) system using a casting liner comprises:

- i) Mixing of the formulation of WSF;
- ii) casting of at least one WSF at least one casting head;
- iii) metering of the cast film at the respective casting head, wherein said active material to be embedded is added with the WSF prior to casting and/or at least during casting;
- iv) smoothening of the at least one film thus formed; and
- v) drying of the WSF.

According to yet another embodiment of the present invention, the process of Casting WSF on a liner comprises:

- i) providing a liner for the formation of WSF with or without treating/coating;
- ii) casting of WSF with embedded material, the temperature range of the batch solution maintained from 10°C to 95°C, preferably from 13°C to 90°C, more preferably from 15°C to 85°C;
- iii) metering of the cast film at casting head;
- iv) smoothening of the film embedded material at primary station, the percentage of solid content maintained in the range of 3% to 85%, preferably in the range of 4% to 70%, more preferably in the range of 5% to 65%;

- v) drying of the WSF, the temperature range in the dryers maintained from 50°C to 250°C, preferably from 60°C to 200°C, more preferably 55°C to 170°C;
- vi) casting of WSF, with or without the material to be embedded at secondary/tertiary subsequent casting head (s);
- vii) drying of the WSF, the temperature range in the second dryers maintained from 50°C to 200°C, preferably 60°C to 160°C, more preferably 55°C to 140°C;
- viii) guiding the multi-layered WSF through hot/chill device for rewinding or splitting.

According to a further preferred feature of the present invention, the process uses a spraying method that comprises:

- i) unwinding of the liner for the formation of WSF;
- ii) optional coating of the liner via a primer coating station;
- iii) casting of WSF with material to be embedded at a primary casting head, the temperature range of the batch solution maintained from to 95°C, preferably 13°C to 90°C, more preferably 15°C to 85°C;
- iv) metering of the cast film at a casting head;
- v) executing a controlled dosing by spraying of pre-measured material to be embedded by primary sprayer;
- vi) smoothening of the film with the embedded material at a primary station;
- vii) drying of the WSF at a dryer, the temperature range in the dryers maintained in the range of 50°C to 250°C, preferably from 60°C to 200°C, more preferably 55°C to 170°C;
- viii) casting of WSF with or without the material to be embedded at secondary/tertiary subsequent casting head(s);
- ix) drying of the WSF, the temperature range in the second dryer maintained 50°C to 200°C, preferably 60°C to 160°C, more preferably 55°C to 140°C; and
- x) guiding the multilayered WSF through hot chill cylinder for rewinding or splitting.

According to another preferred feature of the present invention, the process uses a Secondary application on partially formed film that comprises:

- i) unwinding of the liner for the formation of WSF;
- ii) optional coating of the liner via a primer coating station;
- iii) casting of WSF with material to be embedded at primary casting head, the temperature range of the batch maintained in the range of to 95°C, preferably 13°C to 90°C, more preferably 15°C to 85°C;
- iv) metering of the cast film at casting head;
- v) smoothening of the film with the embedded material at primary station drying of the WSF, the temperature range in the dryers maintained in the range of 50°C to 250°C, preferably from 60°C to 200°C, more preferably 55°C to 170°C;

- vi) executing a controlled dosing by spraying of pre-measured material to be embedded by secondary disperser;
- vii) smoothening of the film with the embedded material at secondary station;
- viii) casting of WSF with or without the material to be embedded at secondary/tertiary subsequent casting head(s);
- ix) drying of the WSF, the temperature range in the second dryers maintained in the range of 50°C to 200°C, preferably 60°C to 160°C, more preferably 55°C to 140°C
- xi) guiding the multilayered WSF through hot chill cylinder for rewinding or splitting. Optionally offline or online splitting between the WSF film and the liner.

According to another preferred feature of the present invention, the process uses online entrapment comprising:

- i) unwinding of the liner for the formation of WSF and/or providing a conveyor;
- ii) optional coating of the liner via a primer coating station;
- iii) casting of WSF with material to be embedded at primary casting head, the temperature range maintained 10°C to 95°C, preferably 13°C to 90°C, more preferably 15°C to 85°C;
- iv) metering of the cast film at casting head;
- v) smoothening of the film with the embedded material at primary station
- vi) drying of the WSF, the temperature range in the dryers maintained in the range of 50°C to 250°C, preferably from 60°C to 200°C, more preferably from 55°C to 170°C;
- vii) casting of WSF with or without the material to be embedded at secondary/tertiary subsequent casting head(s);
- viii) drying of the WSF, the temperature range in the second dryers maintained from 50°C to 200°C, preferably 60°C to 160°C, more preferably 55°C to 140°C;
- ix) unwinding of a pre-formed WSF from an unwinder and guiding it through the guide rolls to meet the WSF, with embedded material for entrapping of materials embedded.

Preferably, in the above process of the invention, the materials of the WSF formulation is taken in a batch reactor and mixed intimately to ensure complete dissolution in the desired solvent. As would be evident from the above various possible embodiments of the process can be followed.

In one of the embodiments of this invention the materials to be embedded in the WSF are added to the batch solution and mixed thoroughly before feeding it to the casting head for further processing. The materials that can be taken into the batch mixing are selected from those that are water-soluble, sheer insensitive, temperature resistant, like certain agrochemicals, pesticides,

insecticides, softeners, surfactants, perfumes for detergent and laundry industry, disinfectants, deodorizing liquids, etc.

In another embodiment of this invention the materials to be embedded in the WSF may optionally be introduced in the process at the primary, secondary, tertiary and subsequent sprayers and or at the second or subsequent casting heads fed from second and/or subsequent batch mixers.

According to another aspect of the invention there is provided a process for the manufacture of a multi-layer water soluble film with at least one embedded active material, the method comprising the steps of:

- i) casting a water soluble film at a primary casting head;
- ii) drying the cast film;
- iii) casting a water soluble film on the water soluble film from step (ii) at a secondary casting head to form a multi-layer water soluble film;
- iv) drying the cast film from step (iii)

characterised by providing at least one active material in a formulation for casting at least one of the water soluble films cast at the primary and secondary casting heads such that the active material is embedded in the cast film.

Preferably steps (iii) and (iv) are repeated at subsequent casting heads.

According to another aspect of the invention there is provided a process for the manufacture of a multi-layer water soluble film with at least one entrapped active material, the method comprising the steps of:

- i) providing a first water soluble film;
- ii) providing a second water soluble film
- iii) providing at least one active material between the first and second water soluble films
- iv) affixing the water soluble films so that the at least one active material is entrapped between the first and second water soluble films.

Preferably steps (i) to (iv) are repeated to entrap active material between successive water soluble films.

Preferably the entrapped active material is provided in selective areas of the water soluble film in desired shapes.

In another preferred embodiment of any one of the above mentioned processes the at least one active material is selected from the group comprising detergents, enzymes, softeners, perfumes, pesticides, fungicides, active ingredients, dyes, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings and walls singly or in combination.

In another preferred embodiment of any one of the above mentioned processes the water soluble film raw materials are selected from the group comprising polyvinyl alcohol copolymer ionomers, polyvinyl alcohol homopolymer, non-ionomeric polyvinyl alcohol polymer, polymethacrylate, polyvinyl alcohol, polyacrylamide, polymethacrylamide, polyacrylic acid, and polymethacrylic acid.

In another preferred embodiment of any one of the above mentioned processes the water soluble film raw materials are selected from the group comprising polyethyleneglycols, polyvinylpyrrolidone, proteinaceous binders such as gelatine, modified gelatins such as phthaloyl gelatine, polysaccharides such as starch, gum Arabic and dextrin, and water soluble cellulose derivatives or combinations thereof.

DETAILED DESCRIPTION IN RELATION TO ACCOMPANYING FIGURES

The details of the invention its objects and advantages are explained hereunder in greater details in relation to non-limiting exemplary illustrations given in figs 1-4.

The explanation to the part numbers in figure 1 is given below:

1 Conveyor; 2 Guide Roll; 3 Batch Mix; 4 Primary Casting Head; 5 Primary Sprayer; 6 Smoothing Rolls; 7 Dryer; 8 Secondary Sprayer; 9 Secondary Casting Head; 10 Dryer; 11 Tertiary Sprayer; 12 Disperser for Entrapment; 13 Guide Roll; 14 Chilling Cylinder; 15 Rewinder 16 Guide Rolls; 17 Unwinder; 18 Smoothing Rolls; 19 Batch Mix; 20 Nip Roll;

Accordingly as illustrated in Figure 1 the process comprises of the following steps:

1. Batch Mixing of the formulation of WSF and optionally the material to be embedded;
2. Casting of WSF with or without the material to be embedded at primary casting head;
3. Metering of the cast film at casting head;
4. Optionally dispersing of material to be embedded by primary sprayer;
5. Smoothing of the film with or without the embedded materials at the primary station;
6. Drying of the WSF from step 2;

DETAILED DESCRIPTION IN RELATION TO ACCOMPANYING FIGURES

5 The details of the invention its objects and advantages are explained hereunder in greater details in relation to non-limiting exemplary illustrations given in figs 1-4. Water soluble films and film systems may be made in accordance with the non-limiting examples.

The explanation to the part numbers in figure 1 is given below:

10 1 Conveyor; 2 Guide Roll; 3 Batch Mix; 4 Primary Casting Head; 5 Primary Sprayer; 6 Smoothing Rolls; 7 Dryer; 8 Secondary Sprayer; 9 Secondary Casting Head; 10 Dryer; 11 Tertiary Sprayer; 12 Disperser for Entrapment; 13 Guide Roll; 14 Chilling Cylinder; 15 Rewinder; 16 Guide Rolls; 17 Unwinder; 18 Smoothing Rolls; 19 Batch Mix; 20 Nip Roll;

15 Accordingly as illustrated in Figure 1 the process comprises of the following steps:

1. Batch Mixing of the formulation of WSF and optionally the material to be embedded;
- 20 2. Casting of WSF with or without the material to be embedded at primary casting head;
3. Metering of the cast film at casting head;
4. Optionally dispersing of material to be embedded by primary sprayer;
5. Smoothing of the film with or without the embedded materials at the primary station;
- 25 6. Drying of the WSF from step 2;

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7. Optional spraying of material to be embedded using a secondary sprayer ;
8. Smoothing of the film with or without the embedded materials at the secondary station ;
9. Drying of the WSF from step 7 ;
- 5 10. Casting of WSF with or without the material to be embedded at secondary casting head ;
11. Optional spraying of material to be embedded by a tertiary disperser ;
12. Rewinding of the WSF ;
- 10 13. Optionally as a post-step 11 step unwind a pre-formed WSF from an unwinder and guiding it through the guide rolls to meet the WSF from step 11 for entrapping of materials to be embedded ;
14. Guide the multilayered WSF of step 13 through hot / chill cylinder for rewinding or splitting ;
- 15 Optionally the steps 1 to 14 may also be carried out on a casting liner (Figure 1) or a conveyor (Figure 2).

The invention and the various embodiments are further explained hereunder in relation to the accompanying figures :

20

Casting Conveyor without Liner [Figure 1]

This process comprises of the following:

1. Casting of WSF on (1) at (4) with embedded material in the batch mix. The temperature range of the batch solution is in between may vary from around 25 10°C to around 95°C, preferably around 13°C to around 90°C, preferably around 15°C to around 85°C.
2. Metering of the cast film at casting head.
3. Smoothing of the film with the embedded materials at the primary station (6).
- 30 4. Drying of the WSF from step 1 at (7). The temperature range in the dryers may vary from around 50°C to around 250°C, preferably between around

60°C to around 200°C, more preferably between around 55°C to around 170°C. Rewinding of the WSF at (15).

Casting WSF on a liner (Figure 2)

5

The explanation to the part numbers in figure 2 is given below:

10 25 Unwinder of "Carrier Web"; 26 Primer Coating; 27 Batch Mix; 28 Primary Casting Head; 29 Primary Sprayer; 30 Smoothing Roll; 31 Dryer; 32 Secondary Sprayer; 33 Secondary Casting Head; 34 Dryer; 35 Tertiary Sprayer; 36 Disperser for Entrapment; 37 Guide Roll; 38 Chilling Cylinder; 39 Rewinder; 40 Guide Rolls; 41 Unwinder; 42 Smoothing Rollers; 43 Batch Mix; 44 Nip Roll;

15 This process comprises of the following:

1. Unwinding of the liner at (25) for the formation of WSF which can be optionally treated or untreated and coated or uncoated. Liners can be of paper, film, foil or fabric, preferably of film, more preferably of polyester film. The films can be in the range of 2 microns to 500 microns, preferably in the range of 10
20 microns – 300 microns, more preferably in the range of 12 microns – 250 microns. The film liner may be plain, metallised, embossed, gloss, matte, extrusion coated laminated or release coated depending on the desired characteristics of the end product. Paper Liner are also used for production of WSF film. Paper liners that accept temperatures needed for production of
25 WSF, GSM(Grams per sq meter – the standard for measuring weight of paper) may be in the range of around 7 gms to around 500 gms, preferably a range of around 20 gm to around 300 gms, more preferably in the range of around 60 gm to around 180 gms. The paper liner may be plain, embossed, gloss, matte, extrusion coated laminated or release coated depending on the
30 desired characteristics of the end product. Fabrics made of cotton or synthetic yarns, solution coated, plain, embossed, gloss, matte, extrusion coated or laminated may be used as liner based on the desired end product properties.

2. Optional coating of the liner via a primer coating station (26).
3. Casting of WSF on (25) at (28) with embedded material in the batch mix. The temperature range of the batch solution may be around 10°C to around 95°C, preferably around 13°C to around 90°C, more preferably around 15°C to around 85°C.
4. Metering of the cast film at casting head.
5. Smoothing of the film by (30) with the embedded material at primary station.
The percentage of solid content may be in the range of around 3% to around 85%, preferably in the range of around 4 % to around 70%, more preferably in the range of around 5% to around 65%
6. .Drying of the WSF from step 3 at (31). The temperature range in the dryers may be set from around 50°C to around 250°C, preferably from around 60°C to around 200°C, more preferably around 55°C to around 170°C. The temperature range of the batch solution may vary from around 10°C to around 95°C, preferably around 13°C to around 90°C, more preferably around 15°C to around 85°C..
7. Casting of WSF with or without the material to be embedded at secondary/tertiary subsequent casting head(s) (33).
8. Drying of the WSF from step 7 at (34). The temperature range in the second dryers (34) may be from around 50°C to around 200°C, preferably around 60°C to around 160°C, more preferably around 55°C to around 140°C.
9. The multi-layered WSF of step 8 is guided through hot / chill cylinder(38) for rewinding or splitting at (39).

Spraying Method (Figure 2)

This process comprises of the following

1. Unwinding of the liner at 25 for the formation of WSF. Optionally a conveyor can be used.
2. Optional coating of the liner via a primer coating station (26).

3. Casting of WSF with material to be embedded at primary casting head (28).
The temperature range of the batch solution may vary from around 10°C to around 95°C, preferably around 13°C to around 90°C, more preferably around 15°C to around 85°C.
- 5 4. Metering of the cast film at casting head.
5. Spraying of pre-measured material to be embedded by primary sprayer (29).
6. Smoothing of the film with the embedded material at primary station (30).
7. Drying of the WSF from step 5 at dryer (31). The temperature range in the
dryers may be set from 50°C to around 250°C, preferably from around 60°C to
10 around 200°C, more preferably around 55°C to around 170°C.
8. Casting of WSF with or without the material to be embedded at
secondary/tertiary subsequent casting head(s) (33).
9. Drying of the WSF from step 8 at dryer (34). The temperature range in the
second dryer (34) may be from around 50°C to around 200°C, preferably
15 around 60°C to around 160°C, more preferably around 55°C to around 140°C.
10. The multilayered WSF of step 8 is guided through hot / chill cylinder (38) for
rewinding or splitting at (39).

Secondary application on partially formed film [Figure 2]

- 20 This process comprises of
 1. Unwinding of the liner at (25) for the formation of WSF. Optionally a conveyor
can be used.
 2. Optional coating of the liner via a primer coating station (26).
 3. Casting of WSF with material to be embedded at primary casting head (28).
 - 25 The temperature range of the batch solution may vary from around 10°C to
around 95°C, preferably around 13°C to around 90°C, more preferably around
15°C to around 85°C.
 4. Metering of the cast film at casting head.
 5. Smoothing of the film with the embedded material at primary station (30).

6. Drying of the WSF from step 5 at dryer (31). The temperature range in the dryers may be set from 50°C to around 250°C, preferably from around 60°C to around 200°C, more preferably around 55°C to around 170°C.
- 5 7. Spraying of pre-measured material to be embedded by secondary disperser (32).
8. Smoothing of the film with the embedded material at secondary station (42).
9. Casting of WSF with or without the material to be embedded at secondary/tertiary subsequent casting head(s) (33).
- 10 10. Drying of the WSF from step 9 at dryer (34). The temperature range in the second dryers (34) may be from around 50°C to around 200°C, preferably around 60°C to around 160°C, more preferably around 55°C to around 140°C.
11. The multilayered WSF of step 9 is guided through hot / chill cylinder (38) for rewinding or splitting at (39). Optionally offline or online splitting between the
15 WSF film and the liner can be done.

Online Entrapment Method [Figure 2]

The process comprises of the following:

- 20 1. Unwinding of the liner at (25) for the formation of WSF, optionally a conveyor can be used.
2. Optional coating of the liner via a primer coating station (26).
3. Casting of WSF with material to be embedded at primary casting head (28).
The temperature range of the batch solution may vary from around 10°C to
25 around 95°C, preferably around 13°C to around 90°C, more preferably around 15°C to around 85°C.
4. Metering of the cast film at casting head.
5. Smoothing of the film with the embedded material at primary station (30).
6. Drying of the WSF from step 5 at dryer (31) The temperature range in the
30 dryers may vary from around 50°C to around 250°C, preferably from around 60°C to around 200°C, more preferably from around 55°C to around 170°C.

- 7. Casting of WSF with or without the material to be embedded at secondary/tertiary subsequent casting head(s) (33).
- 8. Drying of the WSF from step 7 at dryer (34). The temperature range in the second dryers (7) may be from around 50°C to around 200°C, preferably around 60°C to around 160°C, more preferably around 55°C to around 140°C.
- 9. Unwinding of a pre-formed WSF from an unwinder (41) and guiding it through the guide rolls (40) to meet the WSF from step 8 for entrapping of materials to be embedded. Both the liners along with WSF film, which may be semi-cured WSF and the entrapments, may remain in the roll form or sheet form in its original construction, stripping from casting liner can be done immediately or after an self-curing ageing period ranging from around 1 hrs. to around 720 hrs., prior to splitting the liners so as to deliver the final WSF product with entrapped materials.
- 10. If desired the multi-layered WSF of step 9 may be guided through hot / chill cylinder (38) for rewinding or splitting at (39). Optionally offline or online splitting between the WSF film and the liner can be done

The process described above offers various possibilities for the manufacture of WSFs with entrapped materials either on a liner or a conveyor. Some of the product options the may be exercised are as follows:

- H / E / H
- H / E / C
- H / E / H / E / H n times
- C / E / C / E / n times
- C / E / C / E / C n times
- C / E / C n times
- L / UC / E / UH / E ... n times
- L / UH / E / UH / E ... n times
- L / UC / E / UC / E ... n times
- L / UC / E / H / L / E ... n times
- L / UH / E / H / L / E ... n times

L/UC/E/C/L/E ... n times

Where

U = Uncured; H = Hot Water Soluble Film; C = Cold Water Soluble Film

5 E = Embedded Material; L = Liner

and the value of "n" is decided based on the application of the final multilayered embedded WSF.

10 The above sequence may be repeated in multiple layers as per the requirements of the end use of the multiply embedded WSFs. Further this process also allows the manufacture of multilayered embedded WSF using combinations of Cold WSFs and Hot WSFs in various sequences. It also provides the options of using cured/uncured films of CWSFs and HWSFs in any desired sequences

15

Dimples or other embossed or patterned designs can be created during entrapment by using such designed male/female rollers (46,51 Sheet No. 3) or rollers (60,61 Sheet No. 4). In case of casting on liner method both the liners along with WSF film, semi-cured WSF and the entrapments may remain in roll form or sheet form in its
20 original construction, stripping from casting liner can be done immediately or after an self curing aging period ranging from around 1 hrs to around 720 hrs., prior to splitting the liners so as to deliver the final WSF film with entrapped materials.

25 Certain materials such as highly alkaline or highly acidic materials may react adversely if added in the batch mix process or if sprayed before the gelling process or before the film forming process and may therefore necessitate the use of entrapment method for incorporating such materials. Certain liquids like oil based perfumes, aromas, softening agents, cleaning agents etc or solvent based aromas, softening agents, cleaning agents etc may be entrapped more efficiently with
30 entrapment method disclosed in this invention.

Offline Entrapment Method

The process to incorporate such sensitive materials described above comprises of the following:

5 Vertical Entrapment Method (Figure 3).

The explanation to the part numbers in figure 3 is given below:

45 Unwinder; 46 Affixing Roller; 47 Guide Roll; 48 Dispenser for Vertical
10 Entrapment; 49 Guide Roll; 50 Unwinder; 51 Affixing Roller; 52 Rewinder;

1. Unwinding of the WSF films (45) and (50) with or without liner.
2. Dispensing of the embodiment at (48) in between two affixing guide rollers (47 & 49).
- 15 3. Affixing of the WSF films from step 2 at the affixing rollers (46 & 51).
4. Rewinding in roll form or sheet form or fan-fold form. Optionally the film can be with or without casting liners. The casting liners can be stripped immediately or after aging period of around 1 to around 720 hrs. or can be
20 supplied all together and the end user may be informed to strip the casting liner before use. The entrapped film can also be slit in ribbons, tapes, perforated sheets, perforated tapes, perforated ribbons or cut sheets of any size.

Such a process offers various process and product options such as :

- 25 1. Entrapped material in WSF With or without carrier.
2. Entrapped material in WSF in Roll form or pouch form
3. Entrapped material in WSF in Roll form with perforates
4. Entrapped material in WSF in Sheet form with multiple pouches
5. All above Entrapped material in WSF with casting liner for the consumer to
30 remove immediately or after aging period of around 1 hr to around 720 hrs.

Some of the product options the may be exercised are as follows:

- H/E/H
- H/E/C
- H/E/H/E/H n times
- 5 C/E/C/E/ n times
- C/E/C/E/C n times
- C/E/C n times
- L/UC/E/UH/E ... n times
- L/UH/E/UH/E ... n times
- 10 L/UC/E/UC/E ... n times
- L/UC/E/H/L/E ... n times
- L/UH/E/H/L/E ... n times
- L/UC/E/C/L/E ... n times

15 Where
 U = Uncured; H = Hot Water Soluble Film; C = Cold Water Soluble Film
 E = Embedded Material; L = Liner

20 and the value of "n" is decided based on the application of the final multilayered embedded WSF.

The above sequence may be repeated in multiple layers as per the requirements of the end use of the multiply embedded WSFs. Further this process also allows the manufacture of multilayered embedded WSF using combinations of Cold WSFs and
 25 Hot WSFs in various sequences. It also provides the options of using cured/uncured films of CWSFs and HWSFs in any desired sequences

Horizontal Entrapment Method (Figure 4).

30 The explanation to the part numbers in figure 4 is given below:

55 Unwinder; 56 Guide Roll; 57 Dispenser for Horizontal Entrapment; 58 Guide Roll; 59 Unwinder; 60 Affixing Roller; 61 Affixing Roller; 62 Rewinder; 63 Spillage Controller Knife;

- 5 1. Unwinding of the WSF films (59) and (55) with or without liner.
2. Dispensing of the embodiment at (57) in between two affixing guide rollers (58 & 56).
3. Affixing of the WSF films from step 2 at the affixing rollers (60 & 61).
- 10 4. Rewinding in roll form or sheet form or fan-fold form. Optionally the film can be with or without casting liners. The casting liners can be stripped immediately or after aging period of around 1 hr to around 720 hrs. or can be supplied all together and the end user may be informed to strip the casting liner before use. The entrapped film can also be slit in ribbons, tapes, perforated sheets, perforated tapes, perforated ribbons or cut sheets of any size.

15

Such a process offers various process and product options such as :

1. Embedded/entrapped material in WSF With or without carrier.
2. Embedded/Entrapped material in WSF in Roll form or pouch form
3. Embedded/Entrapped material in WSF in Roll form with perforates
- 20 4. Embedde/Entrapped material in WSF in Sheet form with multiple pouches
5. All above Embedded/Entrapped materials in WSF with casting liner for the enduser to remove after aging period of around 1 hr to around 720 hrs.

25 In the above options the WSF film may be pre-embedded and used for the manufacture of the above product options.

In yet other embodiment of the invention, materials that are stable in hot water conditions may be introduced into Hot Water Soluble Films(HWSF) and those that are sensitive to cold conditions can be incorporated in Hot or Cold Water Soluble
30 Films(CWSF).

Applications of the process options

The invention with various embodiments are now further illustrated with a few non – limiting Examples :

5

Example I

Embedding of Actives such as Piiian Liquid in WSF

10 Piiian is a water dispersable deodorizer which is commercially available from Piiian Systems, USA . Piiian was added to the pre-mixed WSF formulation batch and stirred for 6 hours. This was followed by a period of another 6 hours with continuous slow stirring of the solution. The solution was then casted on a continuous casting line. It was then dried and spilt. Several samples of varying compositions were made
15 to incorporate 10% Piiian to 90% in WSFs.

The Grammage per Square Meter (GSM) for the Piiian incorporated WSF measured as per IS1060 is represented as (A).

20 A reference WSF without the incorporation of Piiian was prepared under identical conditions. The GSM of this reference sample is represented as (B). The Piiian loaded in the WSF is therefore $A - B = C$.

Strips of 10 x 10 cms were cut from the material WSF loaded with Piiian.

25

Following are the characteristics of the WSF strips loaded with Piiian.:

Piiian Loaded film	=	30.5 GSM ($\pm \frac{1}{2}$ Gm)
30 Loading of Piiian	=	5 GSM
Film thickness of Piiian loaded WSF	=	28 microns

GSM of the Reference film without Piian = 26 gms.(± 1 gm)

Following are test results of reference WSF and Piian loaded WSF

5

Tensile Strength of the reference film

(kg/cm²)Dir-I = 380.74 Test Method – ASTM D-883

Dir-II = 382.67 Test Method – ASTM D-883

Young Modulus

10 (kg/mm²)Dir-I = 13.19 Test Method – ASTM D-882

Dir-II = 8.14 Test Method – ASTM D-882

Elongation(%)

(kg/cm²)Dir-I = 259.27 Test Method – ASTM D-882

Dir-II = 252.90 Test Method – ASTM D-882

15 Puncture Resistance

(Ozs. Inches/Tear Inch) = 270.00 Test Method – IS-1060

Tensile Strength of the Piian Load WSF

20 (kg/cm²)Dir-I = 329.5 Test Method – ASTM D-883

Dir-II = 381.1 Test Method – ASTM D-883

Young Modulus

(kg/mm²)Dir-I = 7.38 Test Method – ASTM D-882

Dir-II = 11.81 Test Method – ASTM D-882

25 Elongation(%)

(kg/cm²)Dir-I = 252.36 Test Method – ASTM D-882

Dir-II = 291.50 Test Method – ASTM D-882

Puncture Resistance

(Ozs. Inches/Tear Inch) = 225.00 Test Method – IS-1060

30

Dissolution in seconds = 86 secs at 30C

Breaking of the film = 3.14 secs at 30 C

5 The film properties of the Piiian loaded WSF, together with the uniform dispersion of the Piiian in the WSF illustrates that Piiian can be delivered in precise quantities by incorporating it in the WSF using the process disclosed in the invention.

10 In one of the variants of the process described in this invention, pre-dissolved enzymes may be mixed in a WSF formulation and a controlled casting on a preformed substrate/liner based WSF film is possible. Alternatively two pre-formed substrate based WSF films may be used. A water-based enzyme may be loaded to precisely fill the center of the two films. The water based enzyme helps to affix the two films substrates so that the enzymes are sandwiched in between the films thereby resulting in an enzyme loaded WSF. The two substrates can then be stripped off after appropriate ageing.

15

Enzymes in precise quantities can be incorporated in singly or multi-layered WSFs by the process described in this invention so that the processor or the user does no inhalation of the enzyme. The enzyme embedded WSF can be incorporated into detergent formulations or added to washing medium in a machine or a washing vessel such as a bucket to ensure that the precise dosage of enzymes are added at the point of application.

20

Example II

25 Incorporation of large particles in WSFs

30 Non-soluble Acrylic resins (72 – 75 microns) were dispersed into cold water-based solutions to form a high viscous dispersion. The liquid dispersion was dropped in between two films through a motorized valve controlled slot nozzle to have a margin at the end of the webs, thereby not allowing the dispersion to ooze out from the sides. Cold water was used as the solvent. Both the WSFs used were Hot Water Soluble formulations. In this process the Hot Water Soluble Films. Do not get

affected by cold-water dispersion and therefore remain entrapped till the acrylic entrapped film passes through the dried and reaches the rewinder. Typically the film is split from its casting liner after an appropriate aging period.

5 The properties of the acrylic incorporated films were:

	Acrylic Loaded GSM	=	60 GSM ($\pm \frac{1}{2}$ Gm)
	Microns of Acrylic loaded film	=	140 microns
10	Base films GSM	=	58 GSM (± 1 gm)
	Weight of Acrylic Entrapping	=	2 GSM

15 Similarly following are test results of reference WSF and Acrylic resin loaded WSF

	Tensile Base film		
	(kg/cm ²)Dir-I	=	380.74 Test Method – ASTM D-883
	Dir-II	=	382.67 Test Method – ASTM D-883
20	Young Modulus		
	(kg/mm ²)Dir-I	=	13.19 Test Method – ASTM D-882
	Dir-II	=	8.14 Test Method – ASTM D-882
	Elongation(%)		
	(kg/cm ²) Dir-I	=	259.27 Test Method – ASTM D-882
25	Dir-II	=	252.90 Test Method – ASTM D-882
	Puncture Resistance		
	(Ozs. Inches/Tear Inch)	=	270.00 Test Method – IS-1060
	Tensile Acrylic Entrapped film		
30	(kg/cm ²)Dir-I	=	80.69 Test Method – ASTM D-883
	Dir-II	=	83.46 Test Method – ASTM D-883
	Young Modulus		

	(kg/mm ²)Dir-I	=	2.79	Test Method – ASTM D-882
	Dir-II	=	3.25	Test Method – ASTM D-882
	Elongation(%)			
	(kg/cm ²)Dir-I	=	229.5	Test Method – ASTM D-882
5	Dir-II	=	206.7	Test Method – ASTM D-882
	Puncture Resistance			
	(Ozs. Inches/Tear Inch)	=	180.0	Test Method – IS-1060
	Dissolution of film in seconds	=	47 secs at 30C	
10	Breaking of the film	=	3.75 secs at 30 C	

The WSF characteristic with the hydrophobic polymer indicates that the process disclosed in the invention can be effectively used to embed any hydrophobic materials of diverse shapes and sizes within a WSF matrix.

Also this application shows the possibility of using two hot water soluble films or a combination thereof, taking advantage of the hydrophilic properties. This application also shows the advantage of using casting liners.

20

Example III

Films incorporating water insoluble fine particles

25

The performance of the films based on water insoluble fine particles were prepared by the process described in this invention. Fine particle sized iron oxide (5-10 Microns) was dispersed in water based formulations to form a high viscous dispersion. The liquid dispersion thus obtained was precisely dropped in between two films through a motorized valve controlled slot nozzle in such a manner that a margin was available at the end of the webs, so as not to allow the dispersion to

30

ooze out from the sides. In this case warm water at around 40°C was used to deliver the dispersion to between two Cold WSF webs. .

The properties of the ferric oxide incorporated films were:

5	GSM of Iron Oxide Loaded WSF	=	73 GSM ($\pm \frac{1}{2}$ Gm)	
	Thickness of Iron Oxide Loaded WSF	=	55 microns	
10	GSM of reference WSF	=	58 GSM (± 1 gm)	
	Weight of Iron Oxide Entrapping	=	15 GSM	
	Tensile Strength of Entrapped film			
15	(kg/cm ²)Dir-I	=	325.87	Test Method – ASTM D-883
	Dir-II	=	327.77	Test Method – ASTM D-883
	Young Modulus			
	(kg/mm ²)Dir-I	=	7.18	Test Method – ASTM D-882
	Dir-II	=	8.26	Test Method – ASTM D-882
20	Elongation(%)			
	(kg/cm ²)Dir-I	=	341.9	Test Method – ASTM D-882
	Dir-II	=	324.27	Test Method – ASTM D-882
	Puncture Resistance			
	(Ozs. Inches/Tear Inch)	=	600	Test Method – IS-1060
25	Dissolution in seconds	=	37 secs at 60C	
	Breaking of the film	=	19 secs at 60 C	

30 As illustrated in the earlier examples the material embedded films have favorable film properties and can be used for diverse application. This application provides possibilities of embedding environmentally sensitive materials, wastes and toxic

of diverse shapes, sizes and reactivities within an appropriate WSF Matrix in precise quantities for storage, transportation or disposal. This method may also be used to embed powdered or granular materials of any shapes or sizes such as pesticides, solid deodorants, disinfectants, uncoated enzymes, toxic products etc. which are to be delivered to their point of application/action or storage.

These applications also clearly demonstrate the wide number of product and process options using the methods disclosed in this invention.

Comprises/comprising and grammatical variations thereof when used in this specification are to be taken to specify the presence of stated features, integers, steps or components or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

CLAIMS:

1. A process for the manufacture of a water soluble film with at least one embedded active material, the method comprising the steps of:
 - i) providing a liner upon which to cast a water soluble film;
 - ii) providing a formulation for the water soluble film of step (i);
 - iii) providing the formulation of step (ii) with at least one active material;
 - iv) casting the formulation with said at least one active material from step (iii) on the liner to form a water soluble film with said at least one active material embedded therein;and
 - v) drying the cast water soluble film with said at least one embedded active material on said liner by the application of heat at a temperature in the range of 50°C to 250°C.
2. A process according to claim 1 wherein the liner material is selected from the group comprising paper, film, foil or fabric.
3. A process according to claim 2 wherein the liner is selected from plain, embossed, metallised, gloss, matte, extrusion coated, laminated, or release coated materials.
4. A process according to claim 1 wherein the cast water soluble film from step (v) is detached from the liner of step (i).
5. A process according to claim 1 further comprising the step of casting at least one further water soluble film on the embedded water soluble film from step (v) at a subsequent casting head and drying the multi-layer water soluble film to produce a multi-layer water soluble substrate.
6. A process according to claim 5 further comprising the step of providing at least one active material in a formulation for casting said at least one further water soluble film.

7. A process according to claim 5 or claim 6 wherein the multilayer water soluble film comprises combinations of water soluble films which dissolve at different temperatures in any desired sequence.

8. A process according to any one of the preceding claims wherein the at least one active material is selected from the group comprising detergents, enzymes, softeners, perfumes, pesticides, fungicides, actives ingredients, dyes, pigments, hazardous chemicals, active agents for cleaning laundry, dishes, floorings and walls singly or in combination.

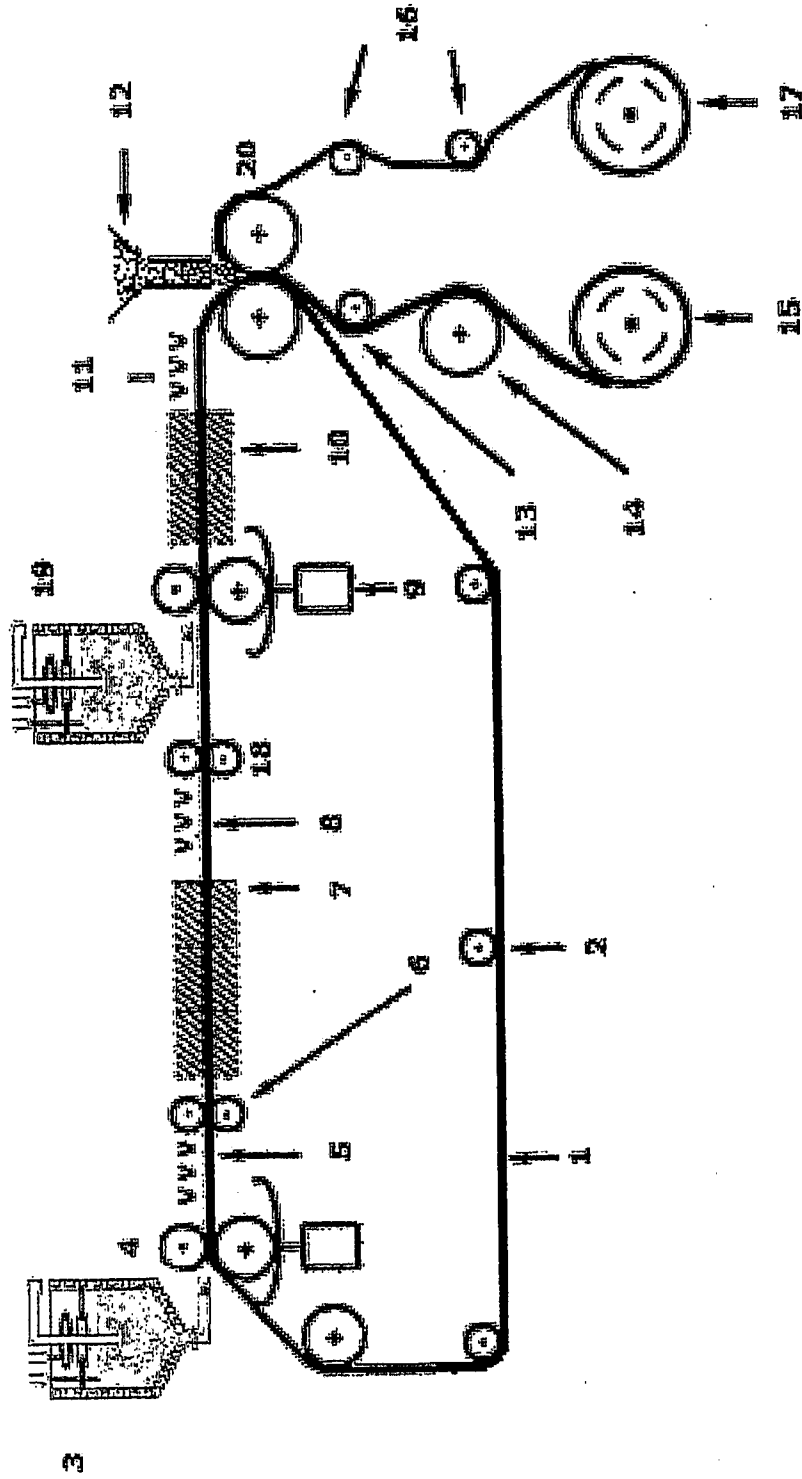
9. A process according to any one of the preceding claims wherein the water soluble film raw materials are selected from the group comprising polyvinyl alcohol copolymer ionomers, polyvinyl alcohol homopolymer, non-ionomeric polyvinyl alcohol polymer, polymethacrylate, polyvinyl alcohol, polyacrylamide, polymethacrylamide, polyacrylic acid, and polymethacrylic acid.

10. A process according to any one of claims 1 to 8 wherein the water soluble film raw materials are selected from the group comprising polyethyleneglycols, polyvinylpyrrolidone, proteinaceous binders such as gelatine, modified gelatins such as phthaloyl gelatine, polysaccharides such as starch, gum Arabic and dextrin, and water soluble cellulose derivatives or combinations thereof.

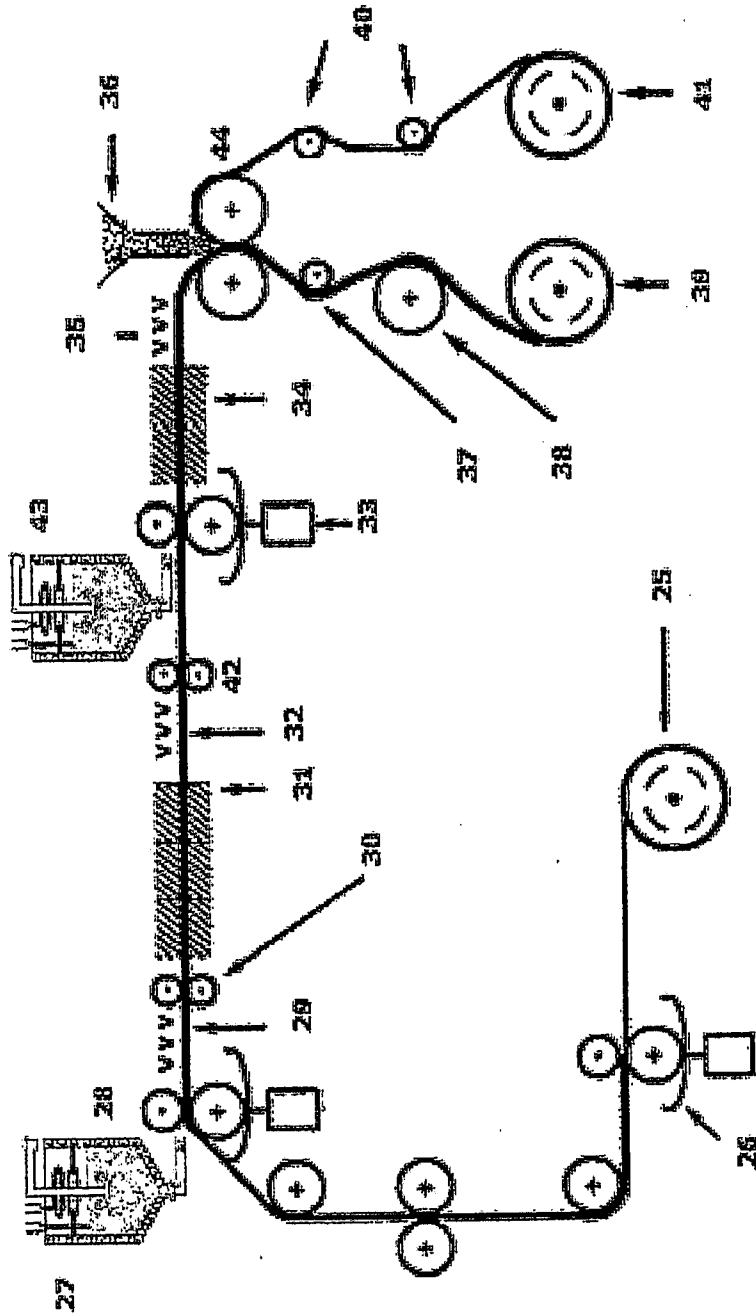
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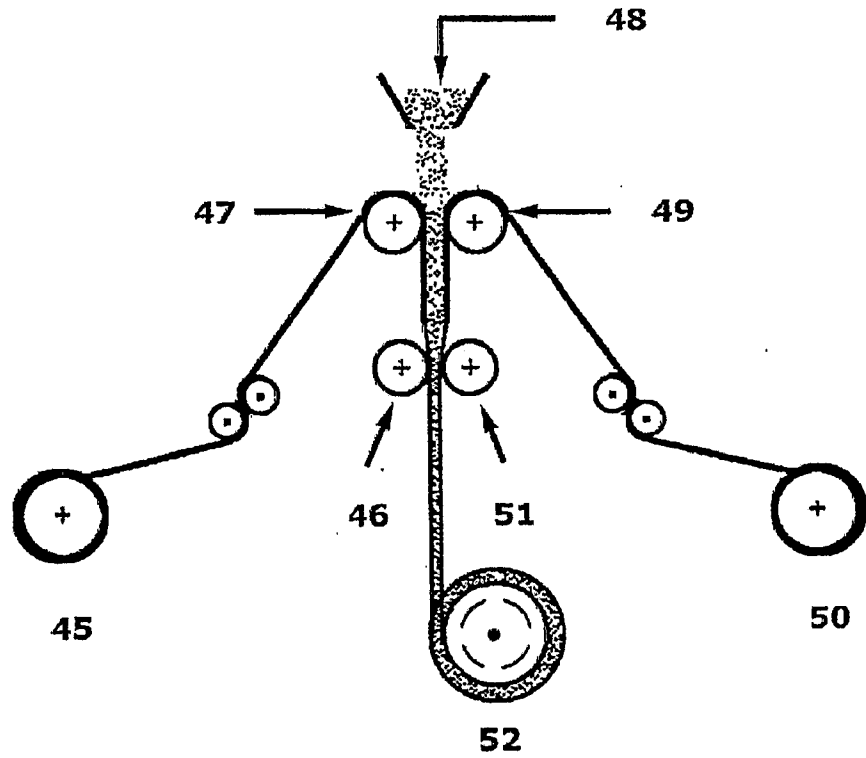


Full Diagram - All Methods
(Casting on Conveyor)

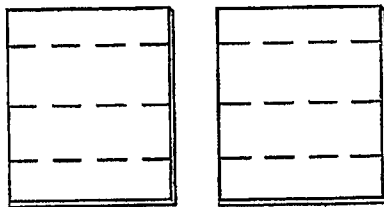


Full Diagram - All Methods
(Casting on Liner)

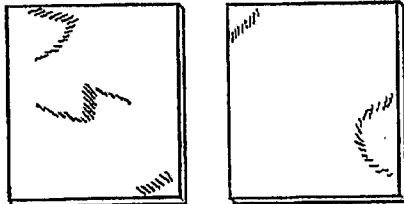
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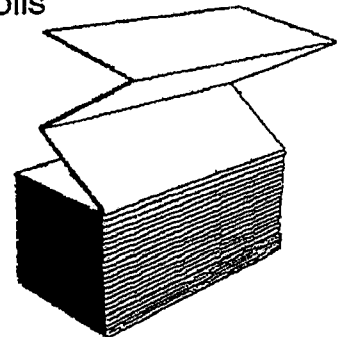
Vertical Method



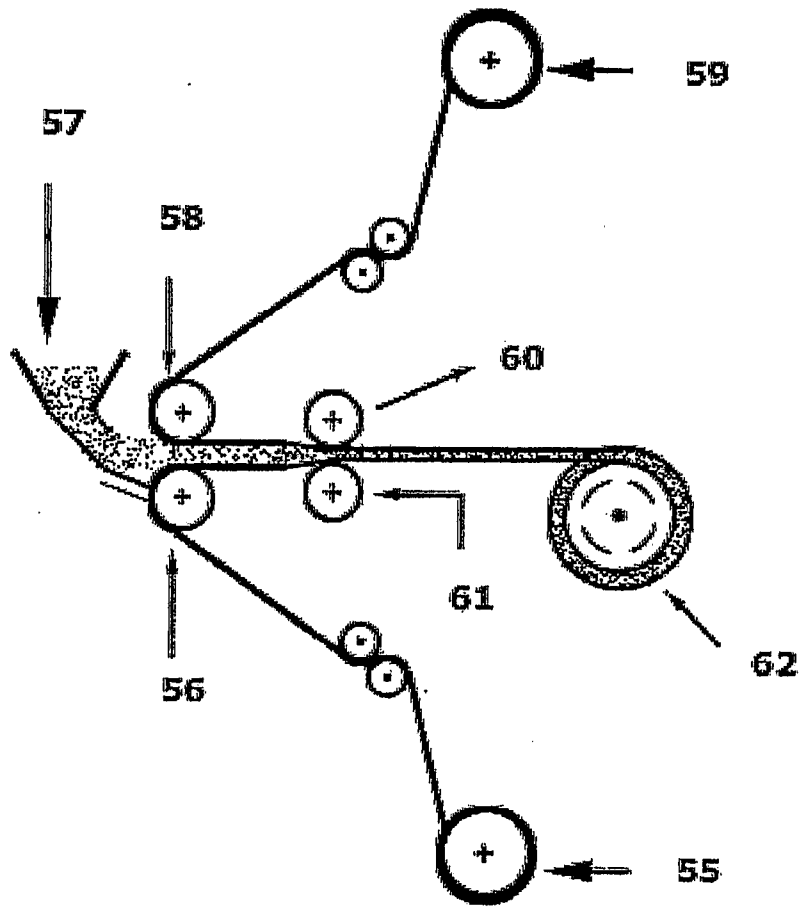
Perforated Sheets or Rolls



Cut Sheet



Fanfold



Horizontal Method