

Expandable Screen Apparatus and Method

FIELD

The present disclosure relates to a downhole screen apparatus, particularly an
5 expandable screen apparatus for use in a wellbore.

BACKGROUND

Many operations in the oil and gas industry require the use of screens to facilitate certain
operations, for example to provide a filter mechanism during production of fluids from a
10 subterranean reservoir. For example, it is often desirable in certain geologies to deploy
sand screens in a wellbore to prevent or minimise the production of sand (or other
undesired particulates) with produced fluids.

One type of screen that may be used for such operations is an expandable screen,
15 wherein at least part of the filtration mechanism of the screen is an expandable material.
Such screens may be run downhole with the expandable material in a compressed
configuration, and then expanded into contact with the bore wall when they reach their
desired location. This allows for a screen mechanism that may be more straightforward
to run downhole (due to the screen being in its compressed form), and one which may
20 conform to the geometry of the surface of the wellbore when in its expanded state.

SUMMARY

A first aspect of the present disclosure relates to a downhole expandable apparatus for
restricting ingress of solids in a wellbore, comprising:

- 25 a base pipe;
- a fluid permeable expandable foam material mounted on the base pipe
configurable between a non-expanded and an expanded configuration; and
- a degradable sleeve configurable between a first configuration in which the
degradable sleeve retains the expandable foam material in the non-expanded
30 configuration, and a second configuration in which the degradable sleeve has been at
least partially degraded to permit the expandable foam material to radially expand
towards the expanded configuration and into engagement with a surface in the wellbore.

The expandable apparatus may be installed in the wellbore, and degradation of the
35 degradable sleeve initiated, in use. After the degradable sleeve has been at least partially

degraded and the foam material allowed to expand towards its expanded configuration, the foam material may function to provide a filtration effect within the wellbore. That is, the foam material may permit the passage of fluids (e.g., oil, water, gas etc.) therethrough, while preventing or restricting the passage of solids, such as particulate material, for example sand. The expandable apparatus may have various possible uses. For example, the expandable apparatus may be used to prevent the incursion of sand through an aperture in a pipe, tubular, casing, screen or the like during production or injection operations. In another example, the expandable apparatus may prevent the release of debris (e.g. sand, rock, shale or the like) from a formation and into a wellbore.

Use of such a degradable sleeve serves to maintain the expandable foam material in an unexpanded state, while providing an efficient mechanism by which the retaining effect of the sleeve may be removed. This may provide advantages over mechanisms such as mechanically translating the sleeve axially from the expandable foam material, which might otherwise require additional tooling, operational procedures, wellbore intervention, etc. Further, as the sleeve is degradable, the sleeve does not need to be pulled from the apparatus when expansion of the expandable foam material is required. Therefore, frictional forces between the sleeve and the expandable foam material do not need to be overcome to remove the sleeve.

The degradable sleeve may be at least partially degraded, to allow expansion of the expandable foam material, by any appropriate means. For example, at least partial degradation of the sleeve may occur by at least one of corrosion, dissolution, melting, hydrolysis and biodegradation.

In examples wherein the sleeve may be at least partially degraded by corrosion, said corrosion may be at least one of chemical corrosion or atmospheric corrosion. Chemical corrosion may be initiated by at least one of a gas or liquid, not native to the wellbore environment, is provided downhole. Environmental corrosion may be initiated by a gas or liquid native to the wellbore environment. At least partial degradation of the degradable sleeve via corrosion may occur via a combination of chemical and environmental corrosion. Corrosion of the degradable sleeve may only be initiated, or may be accelerated, when at least one of the local wellbore environment, and the substance used to initiate corrosion is at a predefined temperature.

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The degradable sleeve may be at least partially degraded by melting. For example, at least one part of the sleeve may be transformed from a solid to a liquid, thereby removing said at least one part of the sleeve from the apparatus. Melting of the sleeve may be initiated by a predefined wellbore temperature. Melting of the sleeve may be initiated by increasing the atmospheric temperature of the wellbore, for example via a heater disposed downhole. Melting of the sleeve may be initiated by providing a heated fluid downhole, wherein the fluid is heated to a temperature sufficient to melt at least one part of the degradable sleeve.

The degradable sleeve may be at least partially degraded via decomposition by bacteria or other living organisms; thereby making the degradable sleeve biodegradable. The degradable sleeve may be at least partially degraded by bacteria or other living organisms native to the wellbore environment. The degradable sleeve may be at least partially degraded by bacteria or other living organisms provided downhole that are not native to the wellbore environment.

The degradable sleeve may be at least partially degraded via hydrolysis, wherein the sleeve is degraded following interaction with water. The water used to hydrolyse the degradable sleeve may be provided from the wellbore environment. The water used to hydrolyse the degradable sleeve may be transported or pumped downhole from surface.

The degradable sleeve may be at least partially degraded via dissolution. Therefore, the degradable sleeve may be described as being dissolvable.

The degradable sleeve may be at least partially dissolved by a wellbore fluid. The degradable sleeve may be at least partially dissolved by a fluid provided from a source external to the wellbore, for example a fluid transported or pumped downhole from surface. The degradable sleeve may be dissolved by a fluid transported with the apparatus downhole. For example, the apparatus may comprise a fluid volume, configured to release the dissolvent when the apparatus has reached its desired location and the expandable foam material is to be expanded into engagement with the surface of the wellbore. The degradable sleeve may be dissolved by a mixture of any of the aforementioned fluids.

The degradable sleeve may be configured to temporarily expand upon fluid contact (e.g. prior to the degradable sleeve dissolving). The fluid which may cause expansion of the

degradable sleeve may be the same fluid which causes dissolution of the degradable sleeve. The fluid which may cause expansion of the degradable sleeve may be different from the fluid which causes dissolution of the degradable sleeve.

- 5 The degradable sleeve may be dissolved by a fluid at a predetermined temperature. For example, a fluid may need to be at, or heated to, a predetermined temperature to initiate dissolution of the degradable sleeve.

- 10 The degradable sleeve may be dissolved by a fluid with a predetermined acidity or alkalinity. For example, dissolution of the sleeve may be initiated by a fluid with a predetermined pH.

- 15 The products of the degradable sleeve following degradation of the sleeve may be biodegradable.

- 20 The degradable sleeve may need only to be partially degraded to allow expansion of the expandable foam material. Therefore, traces of the degradable sleeve may be present when the expandable foam material has expanded into engagement with the inner surface of the wellbore.

- 25 The degradable sleeve may be configured such that only defined sections of the sleeve are at least partially degraded. Therefore, when the degradable sleeve undergoes degradation, sections of the sleeve may remain intact, maintaining the expandable foam material disposed under the remaining sections of the degradable sleeve in its non-expanded configuration.

- 30 The degradable sleeve may be applied with a fluid to control the rate of degradation of the degradable sleeve. For example, the degradable sleeve may be applied with a fluid prior to, during or after transportation downhole which controls the degradation rate of the sleeve, when the sleeve is to be degraded by any of the aforementioned mechanisms. For example, the degradable sleeve may be applied with a fluid to delay or accelerate degradation of the sleeve via any of the aforementioned mechanisms.

- 35 Such a control fluid may be provided within a fluid volume provided with the apparatus. For example, the fluid volume may be configured to release a fluid held within prior to, during or after transportation of the apparatus downhole to control the degradation rate

of the sleeve; by either helping to delay or accelerate the degradation rate of the degradable sleeve via any of the aforementioned mechanisms.

5 The degradable sleeve may be formed of or comprise a textile material. The degradable sleeve may be formed of or comprise a film material. The material may be a woven material. The material may be a non-woven material. The choice of whether a woven or non-woven material may be used for the degradable sleeve may be determined by the mechanical properties required by the degradable sleeve. For example, the random structure of interlocking materials associated with non-woven fibres may provide a sleeve
10 with the tensile and tear strength sufficient to hold the expandable foam sleeve in its unexpanded state. Further, given the more simplistic process required to create non-woven materials, providing a non-woven material sleeve may provide significant costs benefits over a sleeve formed over of a woven material. Alternatively, a woven material may provide higher tensile and tear strengths than a non-woven material. Therefore, in
15 applications where a high amount of force is required to hold the expandable foam material in its unexpanded state, and/or the expandable foam material is to be held in its unexpanded state for a prolonged period of time, a sleeve formed of a woven material may be required.

20 The degradable sleeve may be formed of or comprise a metallic material. The use of a metallic material for the degradable sleeve may provide a sleeve with high tensile strength, and/or high resistance to heat. Such high tensile strengths may be advantageous when a high amount of force is required to hold the expandable foam material in its unexpanded state and/or the expandable foam material is to be held in its
25 unexpanded state for a prolonged period of time. Further, a material with high heat resistance may be advantageous in high temperature environments wherein premature degradation of the sleeve (via melting, for example) is to be avoided.

30 The degradable sleeve may comprise a coating. Said coating may be disposed on at least one of an inner surface and an outer surface of the degradable sleeve. Said coating may comprise a lubricating fluid or grease. The lubricating fluid or grease may assist in the control of the degradation of the degradable sleeve. For example, the lubricating fluid or grease may delay or accelerate the degradation of the degradable sleeve, when the degradable sleeve is degraded via any of the aforementioned mechanisms. The
35 lubricating fluid or grease may assist with transportation of the apparatus downhole, and/or increase the abrasion resistance of the degradable sleeve.

The apparatus may be defined as a downhole filtration apparatus. The filter of the filtration apparatus may be formed at least partially by the fluid permeable expandable foam material. The expandable foam material may provide filtration capabilities in both
5 its non-expanded and expanded configurations. Alternatively, the expandable foam material may only provide filtration capabilities in its expanded configuration.

The filter of the filtration apparatus may be formed partially by the degradable sleeve. For example, the degradable sleeve may be fluid permeable prior to being exposed to
10 the conditions under which it undergoes at least partial degradation. A non-woven material sleeve may provide increased filtering capabilities in comparison to a woven alternative. Therefore, if the degradable sleeve is also required to provide filtering functionality, a degradable sleeve formed of a non-woven material may be preferred. Alternatively, if it is desirable for wellbore fluids to be substantially prevented from
15 reaching the expandable foam material until the degradation of the degradable sleeve is initiated, a degradable sleeve formed of a woven material may be preferred. Further, given the higher mechanical strength/durability of woven materials to non-woven materials, a degradable sleeve formed of woven material may be preferable when the apparatus is deployed in a wellbore that may have surface features providing a risk of
20 tearing the sleeve.

The degradable sleeve may provide a filtration mechanism for filtering fluids prior to said fluids reaching the expandable foam material of the apparatus. Alternatively, the degradable sleeve may be non-permeable to fluids.
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The degradation rate of the degradable sleeve may be determined by the grade (i.e. grams per square meter (GSM)) of the material forming the degradable sleeve. For example, increasing the GSM of a material may also increase the time taken for the degradable sleeve to degrade to a point at which the expandable foam material may
30 begin to expand. Therefore, varying the material grade of the degradable sleeve may help to customise the time taken for the apparatus to be set in the wellbore (with the expandable foam in engagement with the inner surface of the wellbore) following exposure to conditions which initiate degradation of the degradable sleeve.

Varying the material grade of the sleeve material may also vary the wear resistance of the degradable sleeve. For example, increasing the GSM of the sleeve material may help
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to improve the wear resistance of the degradable sleeve, and help to protect the apparatus during deployment.

5 The degradable sleeve may be formed of or comprise a biodegradable material. The sleeve may be formed of one or more of polylactic acid (PLA), polyglycolic acid (PGA), poly(lactic-glycolic) acid (PLGA), polyvinyl alcohol (PVA), polyhydroxyalkanoate (PHA), polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS), and their derivatives. The material, or combination of materials, used to form the degradable sleeve may be selected dependent upon the rate at which the degradable sleeve is
10 required to undergo at least partial degradation.

In one example, a sleeve formed of or comprising PLA may be used. Use of PLA is advantageous given its ability to degrade under certain conditions, primarily by heat, exposure to an aqueous medium (for example water, a water based solution, or the like)
15 and agitation, with or without the presence of biological organisms. Throughout the process of degradation, the polymeric backbone of a degradable sleeve formed of PLA may be cleaved into two classes of smaller, water-soluble entities that end with carboxyl and hydroxyl terminal groups respectively.

20 Further, PLA fibres may degrade rapidly under the proper conditions, and in doing so form lactic acid or lactic acid oligomers that can be consumed by biological organisms and which are soluble in aqueous environments. Therefore, when the degradable sleeve undergoes degradation, no toxic or non-organic materials are left in the wellbore.

25 The degradation rate of a degradable sleeve formed of PLA may be dependent local conditions (i.e. wellbore conditions), including the temperature of the wellbore, pH of fluids present within the wellbore, or the like.

The crystallinity of a degradable sleeve formed of PLA may determine, at least in part,
30 to the degradation rate of the degradable sleeve. For example, poly-L-lactide is a form of PLA that may degrade slowly in an aqueous solution. As such, a degradable sleeve formed primarily of this form of PLA may be used if slow degradation rate is applicable. Conversely, poly (D,L-lactide) is a form of PLA that may degrade more rapidly in an aqueous solution. For example, a PLA sleeve formed of 13% D-isomer and 87% L-isomer may degrade over several hours in boiling water to form a viscous liquid.
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However, a PLA sleeve formed of 6% of the D-isomer and 94% L-isomer may not degrade under these same conditions.

5 The PLA material for use as a degradable sleeve may have repeating units of the structure $\text{—OC(O)CH(CH}_3\text{)—}$ ("lactic units"). As such, the PLA fibres of the degradable sleeve may each contain at least 90%, such as at least 95% or at least 98%, by weight of these repeating units.

10 The fibres of PLA material used to form the degradable sleeve may contain minor amounts, such as up to 10%, up to 5% and up to 2%, by weight of residues of an initiator compound and/or repeating units derived from other monomers that are copolymerizable with lactide. Suitable such initiators may include, for example, water, alcohols, glycol ethers, and polyhydroxy compounds of various types (such as ethylene glycol, propylene glycol, polyethylene glycol, polypropylene glycol, glycerine, trimethylolpropane, 15 pentaerythritol, hydroxyl-terminated butadiene polymers and the like). Examples of copolymerizable monomers may include glycolic acid, hydroxybutyric acid, other hydroxyacids and their respective dianhydride dimers; alkylene oxides (including ethylene oxide, propylene oxide, butylene oxide, tetramethylene oxide, and the like); cyclic lactones; or cyclic carbonates.

20 The fibres of the degradable sleeve formed of PLA may be capped with a capping agent such as an epoxide, a carbodiimide or oxazoline compound, to reduce and/or increase the amount of carboxyl terminal groups. Similarly, the PLA fibres may be reacted with a compound such as a carboxylic anhydride, to increase the amount of carboxyl terminal groups. Increasing the amount of carboxyl terminal groups may increase degradation rates; therefore the amount of these capping agents can be used in some cases to tailor the degradation rate to a desired value.

30 Lactic acid monomer exists in two enantiomeric forms, the so-called "S-" (or "L-") and "R"- (or "D-") forms. "Lactide" is a cyclic diester made from two lactic acid molecules (with loss of two molecules of water). The chirality of the lactic acid is preserved when lactic acid is formed into lactide. Therefore, lactide exists in several forms: 3S,6S-3,6-dimethyl-1,4-dioxane-2,5-dione (S,S-lactide), 3R,6R-3,6-dimethyl-1,4-dioxane-2,5-dione (R,R-lactide), or 3R,6S-3,6-dimethyl-1,4-dioxane-2,5-dione (R,S-lactide or meso-lactide). 35 When lactide may be polymerized to form PLA, the chirality may again be preserved,

and the PLA so produced may contain S- and R-lactic units in proportions close to the proportion of S- and R-units in the lactide.

Therefore, fibres of a degradable sleeve formed of PLA may contain a mixture of a first
5 polylactide and a second polylactide units. The first polylactide may contain S- and R-
lactic units in the ratio of 8:92 to 92:8. That is, at least 8% of the lactic units in the first
polylactide may be S-units, and at least 8% of the lactic units in the first polylactide may
be R-units. It may be that the ratio of S- and R-units in the first polylactide is from 10:90
to 90:10. A first polylactide may contain S- and R-lactic units in a ratio of 10 to 50% of S-
10 or R-units and from 10 to 50% of the other units. The first polylactide may be described
as a highly amorphous grade that is crystallizable with difficulty, and then only
crystallisable to a small extent.

At least 97% of the lactic units in the second polylactide may be either S-lactic units or
15 R-units, i.e., the ratio of S- and R-units is $\geq 97:3$ or $\leq 3:97$. This ratio may be $\geq 98:2$ or
 $\leq 2:98$, $\geq 98.5:1.5$ or $\leq 1.5:98.5$, and may be as high as 100:0 or as low as 0:100. The
second polylactide is a semicrystalline grade that by itself may crystallize more easily
than the first polylactide.

20 The average molecular weights of each of the first and second polylactides of the PLA
material of the degradable sleeve may be within the range of about 20,000 to 800,000
g/mol, as typically measured by gel permeation chromatography against a polystyrene
standard.

25 At least one of the first polylactide, and both the first and second polylactides, may
contain at least some carboxylic acid end groups. It may be that the blend of polylactides
contains about 15 to 50, and from 20 to 30 milliequivalents of carboxyl end groups per
kilogram of polylactide fibers.

30 The ratio of the first and the second polylactides in the PLA which may form the
degradable sleeve of the invention may be from 20 to 90% of the first polylactide, and
correspondingly from 80 to 10% of the second polylactide, based on total PLA weight. In
some embodiments this ratio may be from 30 to 90% of the first polylactide and
correspondingly from 10 to 70% of the second polylactide.

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The blend of polylactide fibres of the PLA material as a whole may contain a ratio of R-lactic units to D-lactic units in the range of 7:93 to 25:75 or from 75:25 to 93:7. Exemplary ratios ratio may be from 8:92 to 20:80 or from 80:20 to 92:8. An exemplary range may be 8:92 to 15:85 or from 85:15 to 92:8.

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The degradable sleeve may be formed of a plurality of degradable layers. Each of the plurality of layers may be configured identically to one and other. Alternatively, different layers may have differing grades, comprise differing materials, have varying filtration characteristics, and/or be woven or non-woven, for example. Providing multiple layers may be advantageous for a number of reasons. For example, sacrificial layers may be included as the outermost layers of the degradable sleeve, to provide protection to the sleeve when the apparatus is being transported, or deployed downhole. Further, using layers with varying characteristic may allow the degradation rate of the sleeve to be customised, or the conditions under which the sleeve degrades to a point at which the expandable sleeve may expand to its expanded configuration to be better controlled.

The expansion of the foam material may be, at least in part, by virtue of an elastic recovery effect of the foam material, as a result of swelling of the foam material, as a result of decompression of the foam material, or the like, or a combination of any such effects. The foam material may expand into an annulus region between the base pipe and the wall of the wellbore and may, for example, fill at least a part of the annulus such that the expanded foam material is pressed against a surface in the wellbore – for example the rock face of the wellbore itself where the expandable apparatus is installed in an open-hole section of the wellbore, or the surface of a casing, liner, pipe, sand screen or the like where the apparatus is installed in a cased/lined section of the wellbore. As the foam material is permeable to fluids, fluid flow through the foam and towards (and away from) the base pipe is permitted, while solids are restricted from progression towards the base pipe. Where the expandable foam is in contact with the surface of a casing, liner, pipe or the like then any apertures, cracks or other defects therein that are bridged and/or plugged by the foam material will continue to permit the flow of fluids therethrough, while the flow of solid matter is prevented. In this way, the foam effectively excludes any particulate matter from a flow of fluid therethrough.

The expandable apparatus may permit the production and/or injection of a fluid into a wellbore. The expandable apparatus may facilitate the production of hydrocarbons from the wellbore. For example, the base pipe of the expandable apparatus may directly

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transport hydrocarbons from the wellbore. Additionally, or alternatively, the base pipe may transport non-hydrocarbon wellbore fluids (e.g. water) from the wellbore so as to additionally allow hydrocarbons to be produced from the wellbore, although which may not be produced directly in the base pipe.

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The expandable apparatus may be used to remove particulate matter from a wellbore. The expandable apparatus may permit injection of a fluid (e.g. water) into a wellbore for the purpose of creating fractures in the surrounding formation, or to encourage hydrocarbon production in a neighbouring wellbore. The expandable apparatus may permit injection of fluid (e.g. water) into a wellbore for the purpose of particulate removal from the wellbore. For example, the expandable apparatus may permit the injection of a fluid into the exterior of a casing in the wellbore so as to cause turbulent flow inside the wellbore (e.g. the casing). The turbulent flow may disturb particulate matter (e.g. sand) that has settled in the wellbore and/or casing (for example, as a result of particulate ingress through an aperture in the casing) so as to suspend the particulate matter in the injected fluid. Thereafter, the expandable apparatus may be used to circulate out the injected fluid from the wellbore, thereby reducing the volume of particulate matter present in a section of the wellbore. As such, the expandable apparatus may permit the preparation of a section of the wellbore prior to installation of the apparatus in the wellbore.

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The apparatus may comprise a flow channel extending axially along the length of the apparatus. The flow channel may permit a fluid flow therethrough. The flow channel may be defined by the base pipe of the apparatus.

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The base pipe may comprise a single component. Alternatively, the base pipe may comprise a plurality of components that are secured together to form the base pipe. Each of the plurality of components may provide the expandable apparatus with an additional function.

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The base pipe may comprise an aperture in a wall thereof. The base pipe may comprise a plurality of apertures located in a wall thereof. The aperture, or plurality of apertures, may assist in the production and/or injection of a fluid using the expandable apparatus. The aperture, or plurality of apertures, may be located on the base pipe to facilitate production and/or injection through the base pipe. For example, the plurality of apertures may be axially spaced along the base pipe, for example evenly axially spaced, such as

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substantially evenly axially spaced. The plurality of apertures may be circumferentially spaced along the base pipe, for example evenly circumferentially spaced, such as substantially evenly circumferentially spaced. Alternatively, there may be an accumulation of apertures located at a particular location of the base pipe, for example
5 towards an axially central portion of the base pipe, or an axial end of the base pipe, and/or may be restricted to a circumferential segment, such as a single side of the base pipe.

The apertures, or plurality of apertures, may be louvered. Louvered apertures may be
10 desirable to provide additional support to the expandable foam material, by preventing the expandable foam material from extruding into the base pipe through the apertures (into the flow channel) during radial expansion; without compromising on the base pipe's ability to intake filtered wellbore fluids. The base pipe apertures may be louvered in any manner understood by one skilled in the art.

15 If the base pipe comprises a plurality of apertures, the plurality of apertures may comprise a combination of louvered and non-louvered apertures.

The aperture, or at least one of the plurality of apertures, may comprise a valve therein,
20 for example a one-way check valve. In one example, all of the plurality of apertures may comprise a valve therein. Having a plurality of apertures may assist to permit the expandable apparatus to be used efficiently in the injection and/or production of a fluid in the wellbore.

25 The aperture, or at least one of the plurality of apertures, may comprise an inflow control device therein. The inflow control device may be an autonomous inflow control device. The inflow control device in this instance is a passive component installed with the apparatus to help optimise production from the wellbore by equalising reservoir inflow along the length of the wellbore. For example, each inflow control device may be
30 configured to be in an open configuration when hydrocarbons are present within the wellbore, and to be in a closed configuration when an undesirable fluid (e.g. one that is not required to be recovered to surface, such as water) is present.

The aperture, or at least one of the plurality of apertures, may be positioned axially in
35 line with a section of the expandable foam material. The aperture, or at least one of the plurality of apertures may be positioned on a section of the base pipe onto which the

expandable foam material is mounted. In one example, all of the plurality of apertures may be positioned on the section of the base pipe onto which the expandable foam material is mounted. As such, the aperture, or the plurality of apertures, may be positioned on the base pipe, under the expandable foam material. The expandable foam material may extend across at least one (or some or all) of the plurality of apertures (e.g. the expandable foam material may cover one (or some or all) of the plurality of apertures). A fluid may be able to be flowed through the foam material and through at least one of (e.g. each of) the plurality of apertures, and into an interior of the base pipe (e.g. into the flow channel, for example during production of hydrocarbons) such that communication to/from an interior of the base pipe (e.g. the flow channel) is via the expandable foam material. A fluid may be able to be flowed from the interior of the base pipe (e.g. from the flow channel), through the aperture or at least one of (e.g. each of) the plurality of apertures and through the expandable foam material (e.g. from the flow channel, for example during injection) such that communication to/from an interior of the base pipe (e.g. the flow channel) is via the expandable foam material. Such positioning of the plurality of apertures may prevent, or restrict, particulate matter from the formation adjacent the wellbore from flowing through at least one of, or all of, the plurality of apertures in the base pipe.

The expandable apparatus may comprise a flow port for the introduction and/or removal of a fluid from the wellbore. The expandable apparatus may comprise a nozzle or jet. The nozzle or jet may be located in the flow port. The nozzle or jet may assist in causing turbulent flow in the wellbore, e.g. for the purposes of preparing the apparatus for installation therein by removing particulate matter from the wellbore, such as sand. The nozzle or jet may direct a flow of fluid from the flow channel and into the wellbore. For example, a flow of fluid may be injected into the wellbore to suspend particulate matter in the wellbore in the flow of fluid. Subsequently, the flow of fluid may be circulated towards the surface of the wellbore, for example circulated towards the surface of the wellbore via an annulus, such as an annulus between the expandable apparatus and the wellbore.

In one example, a completion string or other downhole apparatus on which the expandable apparatus is mounted may be used to inject a flow of fluid into the wellbore for the purpose of suspending particulate matter therein. As such, a flow port may be located on the completion string/downhole apparatus for this purpose.

The degradable sleeve may facilitate the circulation of a flow of fluid towards the surface of the wellbore. Prior to degradation, the degradable sleeve may prevent or restrict a flow of fluid through the apertures in the base pipe. Therefore, the degradable sleeve may prevent or restrict a flow of fluid through the plurality of apertures in the base pipe when
5 in the first (non-degraded) configuration. In preventing or restricting a flow of fluid through the plurality of apertures, the degradable sleeve may direct the flow of fluid elsewhere for the purpose of circulation of a flow of fluid, for example towards and through the flow port of the expandable apparatus. In restricting or preventing a flow of fluid through the plurality of apertures, the degradable sleeve may assist circulation of a flow of fluid
10 downhole through the flow channel of the expandable apparatus and into the wellbore, and uphole via an annulus between the expandable apparatus and the wellbore. In the first configuration, the degradable sleeve may therefore prevent or restrict flow of a fluid from the annulus and back into the expandable apparatus via the plurality of apertures.

15 Fluid flow through the expandable foam material may be prevented or restricted when the expandable foam material is in the non-expanded configuration. As such, when the degradable sleeve is in the first (non-degraded) configuration and is retaining the expandable foam material in the non-expanded configuration, flow of a fluid through the plurality of apertures may be restricted or prevented by the expandable foam material,
20 which may act to block a flow of fluid therethrough.

The expandable foam material may be mounted on the base pipe so as to fully circumscribe the base pipe (e.g. a section of the base pipe). As such, the expandable foam material may be suitable to cover a large area of the wellbore, casing etc. when
25 installed therein, and may be useable, for example to prevent the ingress of particulates into the wellbore at more than one location. In the expanded configuration, the expanded foam material may contact an entire circumferential section of an external surface, e.g. of a wellbore, casing etc. The expandable foam material may be directly mounted on the base pipe (for example bonded or adhered to the base pipe). The expandable foam
30 material may be mounted in an annular shape around the base pipe. The expandable foam material may be mounted on the base pipe so as to partially circumscribe the base pipe. For example, a section (e.g. a circumferential and/or axial portion) of the base pipe may be absent of the expandable foam material (e.g. may not comprise any expandable foam material). In this example, only the portions of the base pipe that are known to be
35 located in proximity to a known defect downhole may comprise an expandable foam material.

- The expandable foam material may be mounted on the base pipe by any appropriate means, for example by chemical bonding, such as glue, or by mechanical means such as clamping. The expandable foam material may be provided in the form of a sleeve.
- 5 The sleeve may be glued or clamped (e.g. clamped via end rings) to the base pipe. In this way, the foam may be securely attached to the base pipe, while not having any great effect on the fluid permeability of the foam, and without obstructing the plurality of apertures.
- 10 The expandable foam material may be compressible. To configure the expandable foam material to the non-expanded configuration, the expandable foam material may be compressed under the degradable sleeve. The expandable foam material may be provided on the base pipe in an initially compressed configuration. The expandable foam material may be compressed by the installation of the degradable sleeve, to elastically
- 15 deform the expandable foam material. The expandable foam material may be compressed by a vacuum, to elastically deform the expandable foam material. The expandable foam material may be compressed by a vacuum after installation on the apparatus, but prior to installation of the degradable sleeve. The expandable foam material may be compressed by a vacuum following installation of the degradable sleeve
- 20 (the vacuum causing compression of the expandable foam material and the degradable sleeve).
- When the degradable sleeve is in the first configuration, the non-expanded expandable foam material may be held in its compressed state. Once the degradable sleeve has
- 25 been at least partially degraded, the expandable foam material may be configured from the non-expanded configuration to the expanded configuration by virtue of an elastic recovery effect. The material properties of the expandable foam material may assist to configure the expandable foam material from the non-expanded to the expanded configuration. Elastic recovery may be an inherent property of the expandable foam
- 30 material. For example, where the expandable foam material is elastically deformed by the degradable sleeve in the first configuration, at least partial degradation of the degradable sleeve alone may permit expansion of the foam material (e.g. expansion of the free portion of the expandable foam material), as a result of the removal of the cause of the elastic deformation of the expandable foam material. In this scenario, the
- 35 expandable foam material may expand without any further external stimulant.

- In one example, the expandable foam material may increase in volume when expanded (e.g. when configured from the non-expanded configuration to the expanded configuration). The expandable foam material may increase in volume when configured to the expanded configuration to the extent that the expandable foam material comes into contact with an external surface in the wellbore. The expansion of the expandable foam material in the expanded configuration may be limited by an external surface in the wellbore (e.g. a surface of a sand screen, or a surface of an open or unlined wellbore). The expandable foam material may be expanded (e.g. configured to the expanded configuration) so as to be compliant with an external surface (e.g. a surface of a sand screen, or a surface of a wellbore). For example, various portions of the wellbore may expand by differing amounts depending on the geometry of an external surface. In doing so, the area of contact between the expandable foam material and the wellbore may be maximised.
- 15 The expandable foam material may require a stimulant to be configured between the non-expanded configuration and the expanded configuration, e.g. from the non-expanded configuration to the expanded configuration. The stimulant may be a fluid. For example, the expandable foam material may require interaction with said stimulant fluid (e.g. water) in order to be configured between the non-expanded configuration and the expanded configuration. In one example, the expandable foam material may be mounted on the base pipe in a non-expanded configuration, and stimulated in a wellbore such that it is in the expanded configuration. In such a configuration, a user may have increased control of the expansion of the expandable foam material in the wellbore.
- 20
- 25 The stimulant fluid which causes expansion of the expandable foam material may be the same fluid used to at least partially degrade the degradable sleeve. The stimulant fluid which causes expansion of the expandable foam material may be different from that required to at least partially degrade the degradable sleeve.
- 30 In one example, the expandable foam material may comprise a swellable material. A swellable material may be integrated into the expandable foam material. The expandable foam material may comprise a layer of swellable material integrated therein. The swellable material may swell upon contact with a stimulant. For example, the swellable material may swell upon contact with water and/or hydrocarbons (such as oil). The swellable material may assist to expand the expandable foam material. For example, the
- 35

swellable material may swell upon contact with a stimulant, so as to cause the expandable foam material to expand.

5 The expandable foam material may be or comprise an open-cell foam material. Such an open cell foam material may assist to permit the flow of a fluid therethrough, while preventing the flow of particulate matter suspended in said fluid flow, thereby assisting the filtration effect of the foam.

10 The expandable foam material may comprise a swellable material in a cell of the open-cell foam material (e.g. some or all cells of the open-cell foam material).

15 The expandable foam material may be made from any appropriate type of foam. For example, the expandable foam material may be made from polyurethane foam, for example polyurethane reticulated foam such as polyurethane reticulated foam 60 PPI (pores per inch).

20 The coarseness of the expandable foam material may be selected depending on the size of particulates the expandable foam material is intended to exclude from a flow of fluid. The coarseness of the expandable foam material may be in pores per inch (PPI) or pores per millimetre, with a coarser foam material having fewer pores per inch than a finer foam material. The expandable foam material may be of a uniform, or substantially uniform coarseness throughout its entirety.

25 The expandable foam material may have a varying coarseness. For example, the expandable foam material may comprise a section or portion of reduced coarseness, for example a section of the expandable foam material may be finer than the surrounding expandable foam material. A finer expandable foam material may be that having cells of a smaller volume than a coarser expandable foam material, or in other words a higher number of pores per millimetre or PPI. Having an expandable foam material of varying coarseness may assist the expandable foam material to provide more efficient filtration of particulates from a fluid.

35 The expandable foam material may have a graduated coarseness. For example, one portion of the expandable foam material may be relatively coarse, while another portion of the expandable foam material may be relatively fine. The expandable foam material intermediate the relatively coarse portion and relatively fine portion may be of graduated

coarseness, e.g. may be finer closer to the relatively finer portion and gradually increase in coarseness towards the relatively coarser portion. The coarseness of the expandable foam material may vary in the radial direction.

- 5 The expandable foam material may be constructed as a single piece of expandable foam material. Alternatively, the expandable foam material may be constructed of more than once piece of expandable foam material, which may be attached together, for example by bonding.
- 10 The expandable foam material may be provided in a single layer, for example having a single coarseness or varying coarseness. Alternatively, the expandable foam material may be provided in a plurality of layers of expandable foam material (which may be bonded and/or secured together, for example). The expandable foam material may be provided as a plurality of sleeves, or parts thereof. For example, the expandable foam
- 15 material may be provided as a plurality of concentric sleeves, which may be arranged to form a plurality of cylindrical layers. Each of the plurality of layers may have a similar (e.g. the same) coarseness, or may have differing degrees of coarseness (e.g. a varying coarseness). At least one (or some or all) of the plurality of layers may have a graduated coarseness. The variation in coarseness may be radial, circumferential, or both. The
- 20 variation in coarseness may be axial.

- The expandable foam material may comprise a radially inner portion which is finer than a radially outer portion of the expandable foam material. For example, the entire inner annular surface of the expandable foam material may be of a finer foam material than a
- 25 radially outer portion of the expandable foam material. The expandable foam material may comprise a radially outer portion which is finer than a radially inner portion of the expandable foam material. For example, the entire outer surface of the expandable foam material may be of a finer foam material than a radially inner portion of the expandable foam material. The expandable foam material may comprise a radially inner portion and
- 30 a radially outer portion, both of which are finer than an intermediate portion of the expandable foam material. For example, the entire inner and outer surfaces (e.g. a portion of the expandable material forming the inner surface and outer surface) of the expandable foam material may be of a finer expandable foam material than an intermediate portion of the expandable foam material, which may be of a coarser foam
- 35 material.

The coarseness of the expandable foam material may be selected depending on the specific requirements of the expandable foam material. For example, it may be desirable that the expandable foam material provides a graded filtration effect.

5 Where the expandable foam material comprises a finer expandable foam material and a coarser expandable foam material, the transition between the coarser and finer material may be abrupt (i.e. a sudden change from the finer to the coarser expandable foam material). In some examples, the transition between the finer and coarser expandable foam material may be gradual.

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The axial length of the expandable foam material may be selected by a user, prior to installation of the expandable apparatus in the wellbore.

15 The expandable apparatus may comprise an anchor. The anchor may assist to position the expandable foam material downhole. The anchor may be in the form of a conventional slip arrangement. The anchor may be radially expandable. The anchor may comprise a retracted position and an expanded position. In the retracted position, the anchor may be radially aligned with an outer surface of the expandable apparatus. As such, the expandable apparatus may be able to be run into the wellbore without
20 interference from the anchor. In the expanded position, the anchor may radially expand, such that it protrudes from an outer surface of the expandable apparatus. In the expanded position, the anchor may engage an exterior surface, for example a surface of a sand screen, casing, pipe, rock or formation surface, or any other surface of the wellbore. In the expanded position, the anchor may provide a reaction point for the
25 expandable apparatus, so as to hold the expandable apparatus in place upon the application of a force on the expandable apparatus.

30 The anchor may have a bias towards the expanded position. Where the anchor is biased towards the expanded position, a retaining member (e.g. a degradable sleeve) may retain the anchor in the retracted position until anchoring of the expandable apparatus is required. Once anchoring of the expandable apparatus is required, the retaining member may be removed, such that the anchor moves to the expanded position, and engages a surface in the wellbore to anchor the expandable apparatus in the wellbore. Such an anchor may permit the apparatus to be operated simply, and with a degradable sleeve,
35 the movement of which may additionally facilitate other functions of the apparatus.

The anchor may be moved between the retracted position and the expanded position by an external actuator. For example, an actuator such as a ball, a dart or the like may be dropped and/or flowed into the expandable apparatus to move the apparatus between the retracted position and the expanded position. The expandable apparatus may
5 comprise a catcher for catching the actuator. The catcher may move (e.g. move axially) when the actuator is caught in the apparatus. Axial movement of the catcher may configure the anchor between the retracted configuration and the expanded configuration. Axial movement of the catcher may cause a compressive force to act on the anchor, thereby configuring the anchor between the expanded and the retracted
10 configuration.

The anchor may comprise an engagement surface or portion for engagement of a surface external to the expandable apparatus. The engagement surface or portion may comprise a toothed profile to facilitate engagement with a surface.

15 The anchor may comprise a non-return mechanism. The non-return mechanism may be in the form of a ratchet. The non-return mechanism may prevent movement of the anchor from the expanded position to the retracted position.

20 The expandable apparatus may comprise a centraliser. The centraliser may be located on the expandable apparatus axially uphole of the expandable foam material. Alternatively, or additionally, the expandable apparatus may comprise a centraliser located axially downhole of the expandable apparatus. The centraliser may assist to centre the apparatus once the apparatus has the desired position in the wellbore. The
25 centraliser may be configurable between a retracted position, in which it does not provide a centralising effect, and an extended position, in which a centralising effect is provided.

The centraliser may be located radially inwards (e.g. underneath) of the degradable sleeve, prior to at least partial degradation of the degradable sleeve. At least partial
30 degradation of the degradable sleeve may enable configuration of the centraliser from the retracted position to the extended position. The centraliser may comprise a bow spring. The bow spring may be compressed under the degradable sleeve, prior to at least partial degradation of the degradable sleeve, when the centraliser is in the retracted position. Upon at least partially degrading the degradable sleeve, the bow spring may
35 naturally move to the extended position. In the extended position, the bow spring of the centraliser may radially extend from an outer surface of the expandable apparatus, so

as to contact and/or engage a surface of the wellbore, thereby centralising the expandable apparatus in the wellbore.

A plurality of the expandable apparatuses may be stackable in a wellbore.

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The expandable apparatus may comprise a connection profile at an upper and/or lower end thereof, to facilitate the stacking of a first apparatus with a second apparatus. A plurality of apparatuses may be able to be stacked in a wellbore, for example, two, three, four, five etc. apparatuses.

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The stacked apparatuses may be identical. Alternatively, at least one of the stacked apparatuses may comprise at least one different component to another of the stacked apparatuses. For example, only one stacked apparatus may require to have an inlet and outlet port for the introduction and removal of a fluid from a wellbore (e.g. only the apparatus located furthest downhole may require an inlet and outlet port). In such a situation, the remainder of the apparatuses may not comprise such a feature.

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The expandable apparatus may be installed as a retrofit apparatus in a wellbore. The apparatus may be for repair of a defect, for example a defect such as a fissure or hole in a casing, sand screen, pipe, or the like in the wellbore. In this case, a retrofit apparatus may be useful, as the location of such defects may be random and unpredictable. In this instance, the apparatus may be installed in the wellbore via a conveyance member such as a slickline conveyance member, or the like.

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The expandable apparatus may be installed to form part of a completion string. The apparatus may comprise a completion string connection profile at an upper and/or lower end thereof, to facilitate installation of the apparatus with a completion string. Having the apparatus installable to form part of a completion string may enable a user greater flexibility in terms of the size the expandable foam material able to be located on the expandable apparatus, than may be possible if the apparatus were to be a retrofit apparatus, for example due to size restrictions when running a retrofit apparatus into a wellbore, e.g. due to a lubricator stack. The apparatus may be installed as part of the completion string.

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The expandable apparatus may comprise or be used in combination with a pump. The pump may assist to flow a fluid through the base pipe of the expandable apparatus. In

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use, the pump may assist to flow a fluid being produced from an adjacent formation through the base pipe. For example, the pump may assist to flow water being produced from an adjacent formation through the base pipe. The pumping of a fluid through the base pipe may encourage production of a gas from an adjacent formation. Such a gas
5 may permeate the expandable foam material of the expandable apparatus, such that the gas occupies an annulus surrounding the base pipe of the expandable apparatus. The pump may encourage the flow of only a liquid (e.g. water) through the base pipe. A gas, for example a produced gas, may remain in an annulus surrounding the expandable apparatus, and be flowed towards surface by other means.

10 The pump may be located at a region of the expandable apparatus downhole of the expandable foam material. As such, a produced fluid (e.g. a produced liquid) may flow through the expandable foam material and in a downhole direction towards the pump. Due to the lower density of a produced gas, the produced gas may naturally flow through
15 the expandable foam material and in an upward direction in an annulus surrounding the base pipe. As a produced fluid flows through the expandable foam material, it may naturally separate into a lighter gas fraction and a denser liquid fraction, while solid particulate matter that is held in the liquid is held in the expandable foam material. As such, a gas may emerge from the uphole end (or the end which is oriented to have a
20 higher elevation) of the expandable foam material, whereas a liquid may emerge from the downhole end (or the end which is oriented to have a lower elevation) of the expandable foam material. As such, having the pump located below the expandable foam material may encourage a separation of a produced liquid from a produced gas, as the produced liquid will naturally flow towards the pump under gravity, whereas the
25 produced gas will naturally flow away from the pump.

The expandable apparatus may be for use in correcting a defect in a sand screen. The expandable apparatus may be for use in plugging a fracture in a sand screen. In use, the expandable foam material may make direct contact with a sand screen, when the
30 expandable foam material is in the expanded configuration.

The expandable apparatus may be for use in preventing ingress of shale into a wellbore. The expandable apparatus may be for use in preventing ingress of shale into a wellbore during methane production, for example methane contained in a seam of coal (coal bed methane). In use, the expandable foam material may make direct contact with a
35 subsurface formation when the expandable foam material is in the expanded

configuration. The expandable foam material may make direct contact with a layer of shale. Alternatively, the expandable foam material may make direct contact with a casing or liner that runs through a subsurface formation. The expandable foam material may assist to prevent ingress of shale into a wellbore, while permitting the flow of a liquid (e.g. water) and/or a gas (e.g. methane) into the wellbore. The expandable foam material may have a stabilising effect of a subsurface formation. For example, the direct contact between the expandable foam material and a subsurface formation may have a stabilising effect on the subsurface formation. The expandable foam material may have a stabilising effect on a layer of shale in a subsurface formation. The expandable foam material may stabilise a subsurface formation by limiting the volume of particulate matter being produced by the subsurface formation (e.g. the volume of particulate matter exiting the subsurface formation in a flow of fluid such as production fluid).

A second aspect of the present disclosure relates to a method of assembling a downhole expandable apparatus, comprising:

- providing a base pipe;
- mounting a fluid permeable expandable foam material on the base pipe, wherein the fluid permeable expandable foam material is configurable between a non-expanded and an expanded configuration; and,
- at least partially covering the fluid permeable expandable foam material with a degradable sleeve, wherein in a first configuration the degradable sleeve retains the expandable foam material in the non-expanded configuration, and in a second configuration the expandable foam material is permitted to radially expand towards the expanded configuration and into engagement with the surface of a wellbore, following at least partial degradation of the degradable sleeve.

The degradable sleeve may be formed of or comprise a degradable textile material. The degradable sleeve may be formed of or comprise a degradable film material. Said degradable material may be a woven or non-woven material. Said degradable material may be formed of or comprise a biodegradable material. The degradable material may be formed of or comprise at least one of polylactic acid (PLA), polyglycolic acid (PGA), poly(lactic-glycolic) acid (PLGA), polyvinyl alcohol (PVA), polyhydroxyalkanoate (PHA), polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS), and their derivatives. The material, or combination of materials, used to form the degradable sleeve may be selected dependent upon the rate at which the degradable sleeve is required to at least partially degrade.

The degradable sleeve may be formed of or comprise a degradable metallic material.

5 At least partially covering the fluid permeable expandable foam material with a degradable sleeve may involve wrapping the degradable material around the expandable foam material to form a sleeve circumscribing the expandable foam material. Wrapping the degradable material around the expandable foam material may configure the expandable foam material in its unexpanded state (e.g. wrapping the degradable material around the expandable foam material may bring the expandable foam material
10 into a compressed state).

Wrapping the degradable material around the expandable foam material to form a sleeve may comprise wrapping a single layer of degradable material around the expandable foam material. Alternatively, wrapping the degradable material around the expandable
15 foam material to form a sleeve may comprise wrapping multiple layers of degradable material around the expandable foam material. In the example wherein multiple layers of degradable material are wrapped around the expandable foam material, at least one of the layers may be configured differently. For example, at least one layer may have a different material grade (in terms of grams per square meter (GSM)), and/or be woven
20 or non-woven, and/or have a different chemical composition from the others. At least one layer may be configured differently from the others to provide a desired characteristic, such as configuring the rate at which the sleeve degrades, which fluid may degrade the sleeve, if the sleeve is required to have a filtration function, etc.

25 The degradable material may have a length that is substantially the same as, or greater than, the length of the expandable foam material of the downhole expandable apparatus. Therefore, a single length of degradable textile material may simply be provided around the expandable foam material to form the degradable sleeve.

30 Alternatively, the degradable material may have a length that is shorter than the length of the expandable foam material of the expandable downhole apparatus. Therefore, the degradable material may have to be wound around the expandable foam material numerous times to form the degradable sleeve along the length of the expandable foam material; for example resembling how a grip may be wound the handle of a tennis racket.
35 If the sleeve is to comprise multiple layers, at least one layers of the sleeve may be

wrapped on to the downhole apparatus in a different manner to the other. Alternatively, all layers of the sleeve may be wrapped to the apparatus in the same manner.

5 The wrapping technique used to provide the degradable sleeve on the downhole apparatus may vary dependent if the sleeve is required to perform an additional function, such as compressing the expandable foam material.

10 Wrapping of the degradable sleeve may help to avoid the frictional forces involved in pulling a sleeve over the apparatus during assembly. This may be especially beneficial during manufacture of apparatus with greater axially length, wherein large frictional forces may be required to pull a sleeve over the apparatus during manufacture.

15 Alternatively, the degradable material may be formed in to a sock-like structure. Said sock-like structure may be pulled over the expandable foam material to provide the degradable sleeve of the downhole apparatus.

20 The degradable sleeve may be chemically bonded (e.g. glued) to the expandable foam material, thus holding the degradable sleeve in place. Alternatively, the degradable sleeve may be secured to the base pipe of the expandable downhole apparatus at at least one end of the degradable sleeve by the use of one or more straps or bands. Said straps or bands may also be degradable. The degradable sleeve may be secured to the expandable apparatus by a combination of bonding and straps or bands. Alternatively, the degradable sleeve may be attached to the expandable downhole apparatus by any appropriate means within the understanding of the skilled person.

25 The method may further comprise assembly of a fluid volume to the apparatus, wherein the fluid provided within the fluid volume may be a fluid to initiate at least partial degradation of the degradable sleeve. The fluid provided within the fluid volume may be a fluid to control the degradation rate of the degradable sleeve.

30 The method may comprise applying a coating to the degradable sleeve. Said coating may be applied to at least one of an inner surface and an outer surface of the degradable sleeve. Said coating may comprise a lubricating fluid or grease. The lubricating fluid or grease may assist in the control of the degradation of the degradable sleeve. For example, the lubricating fluid or grease may delay or accelerate the degradation of the degradable sleeve, when the degradable sleeve is degraded via any of the

aforementioned mechanisms. The lubricating fluid or grease may assist with transportation of the apparatus downhole, and/or increase the abrasion resistance of the degradable sleeve.

5 An aspect of the present disclosure relates to a method for restricting ingress of solids in a wellbore, comprising:

positioning a downhole expandable apparatus in a wellbore;

at least partially degrading a degradable sleeve of the downhole expandable apparatus to allow the expandable foam material, mounted on the downhole expandable
10 apparatus, to radially expand towards an expanded configuration and into engagement with a surface in the wellbore.

The method may comprise anchoring the expandable apparatus in a wellbore. The method may comprise anchoring the expandable apparatus to a casing, sand screen,
15 pipe, or the like within a wellbore.

The method may comprise pumping a fluid downhole to at least partially degrade the degradable sleeve, and thereby allow expansion of the expandable foam. Alternatively, the degradable sleeve may at least partially degrade in response to contact with a fluid
20 present within the wellbore. Alternatively, the downhole expandable apparatus may be provided with a fluid volume. Said fluid volume may be provided with a fluid configured to initiate degradation of the degradable sleeve. The fluid volume may release the fluid held within when it is required for the expandable foam to be configured to its expanded configuration.

25 The method may comprise anchoring the expandable apparatus in a wellbore before at least partially degrading the degradable sleeve.

30 An aspect of the present disclosure relates to a method for repairing/plugging a defect in a sand screen or tubular, comprising:

positioning a downhole expandable apparatus in a wellbore adjacent a defect, the expandable apparatus comprising a base pipe and an expandable foam material mounted thereon, the expandable foam material being retained in a non-expanded configuration by a degradable sleeve;

at least partially degrading the degradable sleeve of the downhole expandable apparatus to configure the expandable foam material to an expanded configuration, in which the expandable foam material is expanded so as to contact the defect.

5 An aspect of the present disclosure relates to a method for stabilising a subsurface formation, comprising:

positioning a downhole expandable downhole apparatus in a wellbore adjacent a subsurface formation, the expandable apparatus comprising a base pipe and an expandable foam material mounted thereon, the expandable foam material being
10 retained in a non-expanded configuration by a degradable sleeve;

at least partially degrading the degradable sleeve of the downhole apparatus to configure the expandable foam material to an expanded configuration, in which the expandable foam material is expanded so as to contact the subsurface formation.

15 An aspect of the present disclosure relates to a downhole filtration apparatus for restricting ingress of solids in a wellbore, comprising:

a base pipe;

a filtration assembly comprising a fluid permeable expandable foam material mounted on the base pipe, said foam material being configurable between a non-
20 expanded and an expanded configuration; and

a degradable sleeve configurable between a first configuration in which the degradable sleeve retains the expandable foam material in the non-expanded configuration, and a second configuration in which the degradable sleeve is at least partially degraded to permit the expandable foam material to radially expand towards the
25 expanded configuration and into engagement with a surface in the wellbore.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A is a cross-sectional view of an expandable apparatus.

30 Figure 1B is first example of a configuration of the degradable sleeve of the expandable apparatus.

Figure 1C is a second example of a configuration of the degradable sleeve of the expandable apparatus.

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Figure 1D is a third example of a configuration of the degradable sleeve of the expandable apparatus.

5 Figure 2 is a diagram of the structural formula of an exemplary degradable sleeve combined with water, and the resulting by-products.

Figure 3 is an enlarged view of the centraliser region of Figure 1.

10 Figure 4A is an enlarged view of the expandable foam material region Figure 1.

Figures 4B and 4C are alternative configurations of the base pipe of the expandable apparatus.

15 Figure 5 is an enlarged view of the anchor region of Figure 1.

Figure 6 illustrates the expanded configuration of the apparatus of Figure 1.

Figures 7 to 10 show a sequence of steps of an installation of the apparatus of Figure 1.

20 Figures 11 and 12 show detail of a further example of the expandable apparatus.

Figure 13 is a schematic illustration of an exemplary expandable apparatus installed downhole.

25 Figure 14 is a schematic illustration of a further exemplary expandable apparatus installed downhole.

DETAILED DESCRIPTION

30 The present disclosure relates to an expandable apparatus in which an expandable foam material may be caused to expand so as to restrict the ingress of solids in a wellbore. The expandable apparatus may be defined as a filtration apparatus. The expandable apparatus may have multiple exemplary uses, some of which are described below.

35 An example of an expandable apparatus 10 is shown in Figure 1. The expandable apparatus 10 is constructed of a plurality of parts, described below, that together define

a base pipe. The expandable apparatus 10 defines a flow channel 12 that extends axially along the length of the expandable apparatus 10.

5 The expandable apparatus 10 is shown surrounded by a degradable sleeve 14, which in this example completely circumscribes the expandable apparatus 10. The degradable sleeve 14 terminates at an uphole end of the expandable apparatus 10.

10 Figures 1B, 1C and 1D demonstrate different arrangements of the degradable sleeve 14 on the expandable apparatus. Figure 1B shows a length of degradable material that is substantially the same length of the section of the apparatus 10 that is required to be covered by the degradable sleeve 14. The length of material has been wrapped around the expandable apparatus 10 in a single wrap, and affixed in place.

15 Figure 1C shows the degradable sleeve 14 formed as a sock like structure. The sock has been formed by joining two ends of a piece of degradable textile material at a seam 14a. The sock is then slid over the tool to provide the degradable sleeve 14 of the expandable apparatus 10, covering the sections of the apparatus required to be covered by the degradable sleeve 14. The sock may then be affixed in place, or may be held in place by friction forces between the expandable foam material 28 of the apparatus 10,
20 or a combination of both.

In the example of Figure 1D, the degradable sleeve 14 has been installed on the expandable apparatus by wrapping a strip/length of degradable material around the apparatus 10 numerous times, in the same manner as a tennis racket grip may be
25 formed, for example; thus providing the degradable sleeve 14 of the downhole apparatus 10. The sleeve is then affixed in place.

30 Although the sleeve 14 of each apparatus 10 shown within Figures 1B, 1C and 1D is provided as a single layer, it will be appreciated that the sleeve 14 may be provided as a plurality of layers, which may all be wrapped on the apparatus 10 in the same manner, or at least one layer may be wrapped to the apparatus 10 in a different manner to the rest.

35 It will be appreciated that affixing the degradable sleeve 14 in place may be done so by any suitable means within the understanding of the skilled person, for example bonding or the like. In an example not shown, the degradable sleeve may be affixed to the base

pipe 26 of the apparatus 10 via straps or bands. Said straps or band may or may not be degradable. It will also be appreciated that a combination of methods may be used to affix the degradable sleeve 14 to the apparatus 10, such as combining the bonding and the use of strapping/banding the degradable wrap to the base pipe 26 of the apparatus.

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In any of these examples, providing the degradable sleeve 14 on the apparatus 10 may bring the expandable foam material 28 into compression. The degradable sleeve 14 may then hold the expandable foam material 28 in compression until the degradable sleeve 14 starts to at least partially degrade. Alternatively, the degradable sleeve 14 may simply

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circumscribe the expandable foam material 28, without providing any compressive forces.

Figure 2 provides demonstrates the chemical reaction between a degradable material (in this example, PLA) and water. As shown, when PLA is combined with water, the organic compounds of carboxylic acid and alcohol being produced. Therefore, when the degradable sleeve is degraded (in this example, dissolved), as only organic compounds are produced, the degradable sleeve is shown as being biodegradable, leaving no toxic/non-organic product in the wellbore.

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As shown within Figure 3, axially downhole, the apparatus 10 further comprises a centraliser 24, further detail of which can be seen in Figure 3. The centraliser comprises a bow spring 24a which, in the example of Figure 1, is held in a retracted position under the degradable sleeve 14. In the retracted position, the centraliser 24 is prevented from any engagement with an external surface by the degradable sleeve 14.

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The apparatus further comprises a base pipe 26 having an expandable foam material 28 mounted thereon, more detail of which can be seen in Figure 4a. In this example, the base pipe 26 comprises a plurality of apertures 30, axially and circumferentially spaced along the base pipe 26 such that, in use, a fluid is able to flow into or out of the plurality of apertures 30. The expandable foam material 28 is mounted on an outer surface 32 of the base pipe 26. Although it is not shown in detail in Figure 4A, the skilled person will appreciate that the expandable foam material 28 may be mounted on the base pipe 26 by any suitable means, for example by chemical bonding e.g. through application of an adhesive. The expandable foam material 28 is contained within an annulus formed between the degradable sleeve 14 and the base pipe 26, and in the example of Figures 1 and 3, the expandable foam material 28 is compressed under the degradable sleeve

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14, with the degradable sleeve 14 functioning to hold the expandable foam material 28 in the non-expanded configuration. It should be noted that the expandable foam material 28 is mounted on the base pipe 26 such that it traverses each of the plurality of apertures 30 therein. As such, were a fluid containing particulate matter to be flowed through the expandable foam material 28, then the particulate matter would be prevented from entering the interior of the base pipe 26 by the expandable foam material 28, while the fluid portion (which may be a liquid, or a gas, or both) would be permitted to flow through the expandable foam material 28 and the plurality of apertures 30, and into the interior of the base pipe 26. In the example shown, the expandable foam material 28 is shown as a single sleeve surrounding the base pipe 26. It should, however, be noted that the expandable foam material 28 may be provided as multiple concentric sleeves. For example, the expandable foam material 28 may be provided as a first sleeve mounted on the base pipe, and a concentric second sleeve mounted on the first sleeve, the second sleeve being of greater diameter than the first sleeve. As such, the expandable foam material 28 may be provided on the base pipe 26 in the form of multiple cylindrical layers.

With the centraliser 24 in the retracted position and the expandable foam material 28 in the non-expanded configuration, Figures 1 to 3 illustrate the expandable apparatus 10 configured so as to enable running and positioning of the expandable apparatus 10 downhole.

Figures 4B and 4C show alternative configurations of base pipes 26a, 26b that may be used with the present invention. Both of the shown base pipes 26a, 26b include louvered apertures 31a, 31b. Louvered apertures may be beneficial in preventing the extrusion of expandable foam material into the flow path of the base pipe 30a, 30b, while maintaining the ability of the base pipe 26a, 26b to intake filtered wellbore fluid. Within the example of Figure 4B, the base pipe comprises a combination of both substantially circular apertures 30a and louvered apertures 31a; with the base pipe of Figure 4C only comprising louvered apertures 31b. It will be appreciated that any combination of substantially circular apertures and louvered apertures may be used with the base pipe 26 of the present invention. As with all other examples, it will also be appreciated that the apertures of any base pipe 26 may comprise a flow control device, such as a valve or the like.

Forming part of the expandable apparatus 10 is an anchor 36, more detail of which can be seen in Figure 5. Shown in Figures 1 and 5, the anchor 36 is in a retracted position to facilitate running of the expandable apparatus 10 into a wellbore (not shown). The anchor 36 is configurable to an expanded position, shown in the following figures, which may permit the expandable apparatus 10 to engage an external surface (e.g. the inner surface of a casing, sand screen, pipe, or the like, in which the expandable apparatus 10 is positioned). To better grip an exterior surface, the anchor 36 is provided with a toothed profile 36a, as can be seen in Figure 5. In the example shown in Figures 1 and 5, the anchor 36 is formed from a plurality of elongate members, arranged in pairs 38a, 38b. A view of one such pair 38a, 38b is shown most clearly in Figure 5. As shown, each of the elongate members 38a, 38b is connected by a pin member 39, enabling rotation of a first elongate member 38a relative to a second elongate member 38b. In the retracted position, as shown in Figure 5, the pair of elongate members 38a, 38b lie flat, such that their radially outer surface is generally in line with the radial outer surface of the surrounding expandable apparatus 10, and each of the axes of the elongate members 38a, 38b is generally aligned with that of the expandable apparatus 10.

It should be noted that the degradable sleeve 14 does not axially extend as far as the anchor 36, such that the anchor 36 is able to be operated regardless of the state of the degradable sleeve 14.

Axially adjacent and uphole of the anchor 36 is a sliding sleeve mechanism 40, which can be used to operate the anchor 36. The sliding sleeve mechanism 40 comprises an inner sleeve 42 and an outer sleeve 44, with a chamber 46 being located there between. A port 48 in the inner sleeve 42 allows fluid communication between the chamber 46 and the flow channel 12 in the interior of the expandable apparatus 10. The anchor 36 is positioned on an outer surface of the inner sleeve 42, while an end portion of the outer sleeve 44 abuts an axially uphole end of the elongate member 38a of the anchor 36.

In use, the port 48 may be exposed to a higher fluid pressure, the pressure communication between the port 48 and the chamber 46 also causing the pressure in the chamber 46 to rise. Such an increased pressure may be as a result of an increase in pressure in the flow channel 12 itself, or as a result of a pressure containing tool (e.g. the actuator tool 20) being positioned in pressure communication with the port 48.

A rise in pressure in the chamber 46 will cause a force to act on seal members 50a, 50b, positioned between the inner and outer sleeves 42, 44, thereby urging the inner and outer sleeves 42, 44 in opposing directions. In this example, the outer sleeve 44 is permitted to move in an axially downhole direction, relative to the inner sleeve 42. As the
5 outer sleeve 44 is urged in a downhole direction, an axially directed force acts on the anchor 36. This causes rotation of the elongate members 38a, 38b relative to the pin 39, such that the elongate members form a V-shape that protrudes radially from the surface of the expandable apparatus 10 (best shown in Figures 8, 9 and 10).

10 In Figure 6 is shown an elevation view of an uphole section of the expandable apparatus 10, with the degradable sleeve (not shown) removed. As shown, with the degradable sleeve 14 completely degraded, the bow spring 24a of the centraliser 24 has sprung radially outwardly, such that, when positioned in a wellbore (not shown), the centraliser
15 24 would contact a surface of the wellbore to centre the expandable apparatus 10 therein. It will be appreciated that the degradable sleeve 14 may not need to be completely degraded (i.e. it may only be partially degraded) for the centraliser to be sprung radially outwardly.

Similarly, following the at least partial degradation of the degradable sleeve 14, the
20 expandable foam material 28 has expanded radially. Again, it will be appreciated that the degradable sleeve 14 may not need to be entirely degraded to allow the expandable foam 28 to expand radially. In situ, the expandable foam material 28 would continue to expand until coming into contact with a surface in a wellbore. The expansion may be by a variety of mechanisms, for example by an elastic recovery effect of the foam material,
25 following removal of radially inwardly directed compressive force applied by the degradable sleeve 14 on the expandable foam material 28, or as a result of the exposed expandable foam material 28 interacting with wellbore fluids, thereby expanding the foam material 28.

30 Figures 7 to 10 illustrate one example of the installation of the expandable apparatus 10 of Figure 1 in a wellbore 50.

In this example, a sand screen 52 has been installed in the wellbore 50, and the sand screen has developed a number of faults 54 therein, leading to the ingress of sand 56
35 into the interior of the sand screen 52. The faults 54 may have been caused by, for example, a hot spot on the sand screen 52, or by erosion of the sand screen 52.

The expandable apparatus 10 is run inside the sand screen 52, and lowered (e.g. on a completion string 58) to the location of the faults 54 in the sand screen. Once at the location of the faults 54, a flow of fluid (water, for example) can be flowed through the flow channel 12 of the apparatus. Although not shown, then apparatus may comprise a nozzle arrangement, such that the fluid exits the flow channel 12 of the expandable apparatus 10 as a jet, thereby assisting to cause rapid and turbulent flow inside the sand screen. Such flow may assist to entrain the sand that has been deposited inside the sand screen in the fluid. As the fluid is flowed into the sand screen, the tool may be moved in a downhole direction, as can be seen in Figures 7 and 8, entraining sand within the fluid flow as it is moved.

As can be seen in Figures 7 and 8, the degradable sleeve 14 is in the first configuration, whereby the expandable foam material 28 (not visible in Figures 7 and 8) is held thereunder. In this configuration, the degradable sleeve 14 is configured to provide filtering capabilities for wellbore fluids trying to enter the flow path 12 via the apertures 30 of the base pipe 26 of the apparatus 10. It will be appreciated that in an alternative example, the degradable sleeve 14 may be configured to prevent fluid flow through the apertures 30 in the base pipe 26.

Flow of a fluid through the flow channel 12 exits through the nozzle arrangement (not shown) and into an annulus 15 between the apparatus 10 and the sand screen 52. Once in the annulus, the flow of fluid can be used to suspend particulate matter therein, and be circulated to the surface via the annulus 15.

Once the sand has been cleared from the interior of the sand screen, the expandable apparatus 10 is positioned such that the expandable foam material 28 is positioned radially adjacent the faults 54 in the sand screen 52. Initially, the expandable foam material is contained beneath the degradable sleeve 14, and is not in contact with the sand screen 52. Degradation of the degradable sleeve 14 is initiated to at least partially remove degradable sleeve 14 from the tool (as shown in Figures 8 and 9) to expose the expandable foam material 28.

In this example, before the degradable sleeve 14 is at least partially degraded, the expandable apparatus 10 has been secured in position in the wellbore. To secure the apparatus 10 in the wellbore, an anchor 36 is moved from a retracted position to an

expanded position, as described previously. In the expanded position, the anchor 36 protrudes radially so as to engage the sand screen 52. Once engaged with the sand screen 52, the anchor prevents axial movement of the expandable apparatus 12 in the wellbore 50.

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As can be best seen in Figures 9, the degradable sleeve 14 has started to degrade. In this example, the degradation of the sleeve 14 has been initiated by a fluid present in the wellbore. In other examples using degradable sleeves wherein the degradation mechanism is dissolution, dissolution of the degradable sleeve 14 may be initiated by a fluid pumped downhole from surface, or a fluid released from a fluid volume (not shown) disposed on the tool 10. Alternatively, dissolution may be initiated by a fluid pumped downhole, or released from the fluid volume, combining with the fluid present within the wellbore. The degradable sleeve 14 may also be configured to start to degrade when the dissolvent fluid is at a predetermined temperature, when the wellbore is at a predetermined temperature, or both. Further, and as described above, degradation of the sleeve may also be dependent on the acidity or alkalinity (i.e. the pH) of the dissolvent fluid.

Once the degradable sleeve 14 has degraded sufficiently, the expandable foam material 28 begins to regularly expand. Therefore, it should be understood that the degradable sleeve 14 does not need to have entirely dissolved to allow radial expansion of the expandable foam material 28.

As outlined above, expansion of the expandable foam material 28 may be initiated by any suitable means. For example, a fluid present within the wellbore, a fluid pumped downhole, a fluid released from the fluid volume of the apparatus 10, or a combination thereof may cause the expandable foam material 28 to swell, causing radial expansion of the expandable foam material. Alternatively, any of said fluids or combinations thereof may initiate a chemical reaction with the expandable foam material 28, causing radial expansion. Alternatively, the expandable foam material 28 may be held in compression underneath the degradable sleeve 14, prior to degradation of the degradable sleeve 14. Once the degradable sleeve 14 has degraded sufficiently, it may not be able to provide the compression force required to hold the expandable foam material 28 in compression, thereby allowing for radial expansion of the expandable foam material 28.

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As shown within Figure 10, once the degradable sleeve 14 has degraded sufficiently from the expandable apparatus 10, the expandable foam material 28 expands radially into contact with the sand screen 52 so as to bridge the faults 54 therein. Similarly, a centraliser 24, located on a section of the expandable apparatus 10 that is uphole of the expandable foam material 28, radially expands from a retracted position to an extended position, contacting an interior surface of the sand screen 52 and providing a centralising effect on the expandable apparatus 10.

Once in place the expandable foam material 28 of the expandable apparatus 10 bridges the faults 54 in the sand screen 52 so as to prevent ingress of sand therein, while continuing to permit the flow of a fluid therethrough. Once installed, the expandable apparatus 10 may remain in position for as long as production of a fluid into the sand screen is desired.

Figures 11 and 12 illustrate a further example of an expandable apparatus 10, having a valve incorporated into the apertures 30 of the base pipe 26.

For the sake of conciseness, a description of identical parts of the expandable apparatus 10 to those in Figures 1 to 6 will not be repeated. In this example, the expandable apparatus 10 comprises a base pipe 26 comprising a plurality of apertures 30, with an expandable foam material 28 mounted thereon so as to fill an annulus between the base pipe 26 and a degradable sleeve 14. Each of the plurality of apertures comprises a check valve 31, which permits the flow of a fluid in a radially outward direction. As with the example of Figures 1 to 6, the expandable foam material 28 bridges each of the plurality of apertures 30.

In this example, a fluid may be flowed through a fluid channel 12 of the expandable apparatus, and through the check valves 31 provided in the base pipe 26. The flow of fluid may then pass through the expandable foam material 28 and into a wellbore. As such, in this example, the expandable apparatus may be used to inject fluid into a wellbore, whilst simultaneously providing a plugging effect of a crack, aperture, fissure, or the like in a sand screen, tubing, pipeline etc. in a wellbore, so as to prevent ingress of particulate material therein (for example, during breaks in the injection of a fluid into a wellbore).

Figure 13 is a schematic diagram of through-tubing 362 with an expandable apparatus 310 installed in a sand screen 352 in a wellbore 350. Schematically illustrated, the apparatus 310 essentially comprises a base pipe 326 having a plurality of apertures therein 330. An expandable foam material 328 is mounted on the base pipe 326, and bridges each of the plurality of apertures 330. An anchor 336 is positioned below the expandable foam material 328, and is used to hold the expandable apparatus 310 in place relative to the sand screen 352, as in previous examples. Similarly, a centraliser 324 is provided uphole of the expandable foam material 328 to centralise the expandable apparatus 310 in the wellbore 350. In this example, the expandable foam material 328 bridges a large defect 354 in the sand screen 352. Uphole of the expandable apparatus 310 is a through-tubing 362, held in position by packers 364, which may be used for receiving a fluid produced in through the sand screen 352 in the wellbore, or may be used to provide an injection fluid to the expandable apparatus 310.

In this example, when the degradable sleeve (not shown) has not yet been at least partially degraded and is retaining the expandable foam material 328 in the unexpanded configuration, the expandable apparatus 310 is of a diameter that it is able to be installed via through-tubing 362, and subsequently expanded and installed against the sand screen 352.

Figure 14 illustrates a further use of an example of an expandable apparatus 410. In this example, the expandable apparatus 410 is positioned in an open hole wellbore 450, radially adjacent a shale formation containing seams of coal 468, the seams of coal being impregnated with methane gas. The example shown in Figure 14 contains some similarities to that described in Figures 1 to 6. As such similar reference numerals have been used for similar parts, augmented by 400.

In contrast to the previous examples, wherein the expandable apparatus is run in to a wellbore having an existing sand screen in place, in this example the expandable apparatus 410 may form part of a completion string that is run into and installed in an open-hole section of wellbore, for example before initial production operations in the wellbore begin. In this example the expandable apparatus 410 may be run into a wellbore on a tooling string, and maintain a connection with said tooling string throughout production in the wellbore.

As can be seen in Figure 14, and as was the case with previous examples, the apparatus 410 comprises a base pipe 426, having an expandable material 428 mounted thereon. It should be noted that, in this example, the base pipe is simply a blank pipe, and does not comprise any apertures, as was the case with the previous examples. In this case,
5 the length of the expandable material is selected so as to be approximately the same depth as the shale formation, adjacent to which the expandable apparatus 410 is positioned. As such, when the expandable foam material 428 is in the expanded configuration as shown, it expands so as to be in contact with the surrounding shale formation 450 along substantially the entire depth of the shale formation 450.

10 In a further example, it may be possible to stack multiple apparatuses in a wellbore, so as to provide expandable foam material 428 along the entire depth of the shale formation 450. Further, although in the example of Figure 14 contact between the expandable foam material 428 is shown along the entire depth of the shale formation 450, examples where
15 there are gaps in the contact between the expandable foam material and the shale formation 450 are equally possible. For example, as long as expandable foam material is present at the top and bottom of the shale formation 450, so as to contain particulate matter in the shale formation 450, the apparatus may be able to function.

20 While, in this example, it may be possible to secure the expandable apparatus 410 in place with an anchor (not shown), as in the previous examples, as the expandable apparatus 410 maintains a connection with the tooling string, an anchor may not be necessary. Instead, the expandable apparatus 410 may be held in place by the tooling string, the tooling string being held in place by any appropriate means, for example by
25 packers.

In this example, the expandable apparatus 410 comprises a pump 470 located axially downhole of the expandable foam material 428.

30 In use, the expandable apparatus 410 is positioned adjacent the shale formation with a degradable sleeve (not shown in this example) positioned over the expandable foam material 428, with the expandable foam material 428 being in the non-expanded configuration. As with previous examples, once in the desired position, the degradable sleeve is at least partially degraded by any suitable means, and the expandable foam
35 material 428 expanded to be in contact with the surrounding shale formation 450.

After the degradable sleeve has been at least partially degraded, the pump 470 can be operated to pump any fluid in the wellbore through an inlet 472, and through a flow channel in the base pipe (not shown) towards the surface of the wellbore. Typically, shale formations may produce large volumes of fluid, e.g. water. Where seams of coal are included in the shale formation, methane gas may also be produced, along with large quantities of shale rock. Having the expandable foam material 428 of the expandable apparatus 410 in contact with the shale formation may prevent or reduce the production of shale from the formation, while permitting the production of fluids, for example water and/or methane. As such, the expandable foam material 428 may assist to stabilise subsurface formations, such as shale formations, which may otherwise release particulate matter into the wellbore.

Reducing the production of particulate matter (e.g. shale) from the formation may be beneficial for the operation of pump 472. In particular, where there is intermittent operation of pump 472, particulate matter (such as shale) may settle on the pump while it is not in use. Such large volumes of shale can make it difficult to restart the pump 472 without cause significant damage. Therefore, the apparatus may prolong the lifespan of the pump 472, as it may reduce the choking of the pump by produced particulate matter.

With the pump 472 in operation, liquids (e.g. water) from the formation 450 may flow through the expandable foam material 428 and proceed in a downhole direction, towards pump 472 in the direction of arrows 480, through the flow channel of the expandable apparatus 410 and towards the surface of the wellbore. As the liquids are produced, gas (e.g. methane) may also be produced. By virtue of its lighter density, the produced gas will tend to flow upwards in the direction of arrows 482, and will remain in an annulus between the expandable apparatus 410 and the wellbore 450. For illustrative purposes, the produced gas is shown exiting the expandable foam material 428 in the form of bubbles 453 exiting from the upwardly located surface of the expandable foam material 428.

Up hole of the expandable apparatus 410 is located a section of casing 484, which can be used to collect the produced gas in the annulus.

CLAIMS:

1. A downhole expandable apparatus for restricting ingress of solids in a wellbore, comprising:
 - 5 a base pipe;
 - a fluid permeable expandable foam material mounted on the base pipe configurable between a non-expanded and an expanded configuration; and
 - a degradable sleeve configurable between a first configuration in which the degradable sleeve retains the expandable foam material in the non-expanded configuration, and a second configuration in which the degradable sleeve has been at least partially degraded to permit the expandable foam material to radially expand towards the expanded configuration and into engagement with a surface in the wellbore.
- 15 2. The downhole expandable apparatus of claim 1, wherein the degradable sleeve is configured to at least partially degrade by at least one of corrosion, melting, biodegradation, hydrolysis and dissolution of the degradable sleeve.
- 20 3. The downhole expandable apparatus of claim 1 or 2, wherein the at least partial degradation of the degradable sleeve is initiated by at least one of a wellbore fluid and a fluid provided from a source external to wellbore.
- 25 4. The downhole expandable apparatus of any preceding claim, wherein the apparatus is provided with a fluid volume configured to hold a fluid configured to at least partially degrade the degradable sleeve.
5. The downhole expandable apparatus of any preceding claim, wherein the degradable sleeve is formed of or comprises a textile material.
- 30 6. The downhole expandable apparatus of any one of claims 1 to 4, wherein the degradable sleeve is formed of or comprises a film material.
7. The downhole expandable apparatus of claim 5 or 6, wherein the material is a woven material.
- 35 8. The downhole expandable apparatus of claim 5 or 6, wherein the material is a non-woven material.

9. The downhole expandable apparatus of any one of claims 5 to 8, wherein the material comprises at least one of polylactic acid (PLA), polyglycolic acid (PGA), poly(lactic-glycolic) acid (PLGA), polyvinyl alcohol (PVA), polyhydroxyalkanoate (PHA),
5 polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS), and their derivatives, or a combination thereof.
10. The downhole expandable apparatus of any preceding claim, wherein the degradable sleeve is formed of or comprises a metallic material.
10
11. The downhole expandable apparatus of any preceding claim, wherein the degradable sleeve is formed of or comprises a plurality of layers.
12. The downhole expandable apparatus of any preceding claim, wherein the base
15 pipe comprises at least one aperture in a wall thereof.
13. The downhole expandable apparatus according to claim 11, wherein the base pipe comprises a plurality of apertures in a wall thereof, and the plurality of apertures are substantially evenly spaced along the base pipe.
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14. The downhole expandable apparatus of claim 13, wherein at least one of the plurality of apertures is a louvered aperture.
15. The downhole expandable apparatus of any one of claims 12 to 14, wherein the
25 at least one aperture comprises an inflow control device.
16. The downhole flow control device of claim 15, wherein the inflow control device is an autonomous inflow control device.
17. The downhole expandable apparatus of any preceding claim, wherein the
30 degradable sleeve is fluid permeable.
18. The downhole expandable apparatus of any one of claims 1 to 16, wherein the degradable sleeve is non-permeable to fluids.
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19. The downhole expandable apparatus of any preceding claim, configured to form part of a completion string.
20. A method for restricting ingress of solids in a wellbore, comprising:
5 positioning a downhole expandable apparatus in a wellbore;
at least partially degrading a degradable sleeve of the downhole expandable apparatus to allow the expandable foam material, mounted on the downhole expandable apparatus, to radially expand towards an expanded configuration and into engagement with a surface in the wellbore.
- 10 21. The method of claim 20, further comprising providing a fluid downhole to at least partially degrade the degradable sleeve, and thereby allow expansion of the expandable foam.
- 15 22. The method of claim 21, comprising providing a fluid downhole to at least partially degrade the degradable sleeve by releasing a fluid from a fluid volume provided on the downhole expandable apparatus.
- 20 23. The method of any one of claims 20 to 22, comprising degrading the degradable sleeve with a fluid present within the wellbore.
24. A method for repairing/plugging a defect in a sand screen or tubular, comprising:
positioning a downhole expandable apparatus in a wellbore adjacent a defect, the expandable apparatus comprising a base pipe and an expandable foam material
25 mounted thereon, the expandable foam material being retained in a non-expanded configuration by a degradable sleeve;
at least partially degrading the degradable sleeve of the downhole expandable apparatus to configure the expandable foam material to an expanded configuration, in which the expandable foam material is expanded so as to contact the defect.
- 30 25. A method for stabilising a subsurface formation, comprising:
positioning a downhole expandable downhole apparatus in a wellbore adjacent a subsurface formation, the expandable apparatus comprising a base pipe and an expandable foam material mounted thereon, the expandable foam material being
35 retained in a non-expanded configuration by a degradable sleeve;

at least partially degrading a degradable sleeve of the downhole apparatus to configure the expandable foam material to an expanded configuration, in which the expandable foam material is expanded so as to contact the subsurface formation.