

SPECIFICATION

A method of cleaning and regenerating filters

- 5 The present invention relates to a method of cleaning and regenerating filters which have become clogged with a layer of deposited microorganisms such as algae which are present in sea water.

Injection of water into an oil bearing structure is today employed partly to increase and partly to maintain the pressure in an oil producing well. By injecting water into the oil bearing layer a better utilization of the oil field can be obtained. The structure into which the water is pumped can vary from field to field. However, in general such a structure can be characterized as being micro-porous.

The pores which are to be permeated by the water will generally have a diameter of approximately 10 μm or less. If the water being forced into the structure contains dispersed particles with a diameter above approximately 10 μm the structure will act as a filter, resulting in the structure becoming blocked or clogged after a certain time.

Hence it is necessary to remove suspended particles above a certain particle size before the water is introduced into the oil bearing structure. As injection water, there can inter alia be used sea-water, water from lakes, rivers, and the like. Water from said sources will usually contain relatively large amounts of microorganisms, usually algae, having a size in the range 1 - 100 μm . The total amount of organic material will for instance in water taken from the optimal depths in the North Sea be in the range 0,1 - 0,5 ppm.. In order that the microorganisms not shall multiply the water must further be sterilized, for instance by means of chlorine.

The filtration degree will be dependent on the structure into which the water is to be injected. However, in most cases particles above 10 μm must be removed.

Filtration of water containing marine microorganisms is particularly difficult as such organisms usually form a slime-like and clogging layer on the active surface of the filters, which in a relatively short time will result in a complete blocking of the filter.

Conventional re-conditioning methods such as back-washing with water or air are very difficult as relatively high pressures are necessary in order to remove the matter being deposited in and on the very fine-pored material which is utilized for such filtration.

As back-washing at best is very ineffective and further represents very high mechanical stress the effective life-span of the filter will be relatively short and consequently the filter units must be replaced with short intervals, which is very costly both with respect to the costs of the material and in labour.

By means of the present invention there is provided a regeneration method for such filters by submitting the same to a chemical treatment resulting in a breakdown or dissolution of the layer of deposited marine biological material.

Algae in general have a high content of proteins and polysaccharides which for instance can be

broken down or brought in solution by the use of concentrated sulphuric acid.

According to the present invention there is provided a method of cleaning and regenerating filters which have become clogged with a layer of deposited microorganisms, which method comprises the steps of contacting the deposited layer with sulphuric acid of at least 65% concentration, which acid is capable of breaking down or dehydrating the microorganisms; and subsequently removing the broken down or dehydrated microorganisms by flushing with water. Such concentrated sulphuric acid will dehydrate the carbo-hydrates and polysaccharides to elementary carbon and water and further dissolve and break down proteins which are present, resulting in the removal of the deposited organic material in substance from the filter material.

From US-patent No. 2,548,440 a process for cleaning filter sand beds is known by contacting the same with sodium bisulphite and sulphuric acid which reacts to give sulphurous acid and sodium bisulphate. The object of the process disclosed in said US-patent is to remove manganese and iron compounds from the filter sand as well as to sterilize the filter. From the specification it appears that sulphuric acid is used in an excess of stoichiometric amount of the added sodium bisulphite and based on the figures given in the specification of said patent the concentration of the sulphuric acid in contact with the sand bed will be approximately 10%. Said concentration of sulphuric acid will not be sufficient to dehydrate any carbohydrate material, which is essential according to the instant invention.

In US-patent No. 3,932,278 a method of cleaning sand or multi-media filters is disclosed which comprises a process for back-washing the filter with water containing a high concentration of chlorine or ozone. Norwegian Patent No. 137.506 to Shell International Research Maatschappij N.V., relates to a process for dissolution of dispersing of cellular microorganism material deposited within a permeable structure such as an oil bearing structure or in an oil well by injecting into the permeable structure a solution containing at least one surface-active agent being effective for dispersing the outer wall layer of the cells of the microorganisms, at least one chelating agent being used to disperse the secondary layer of the cells of the microorganisms and at least one alkali metal hydroxide to promote the above-mentioned dispersing effect. The injection of the above-mentioned active ingredients can optionally be followed by a further injection of a water-miscible liquid in order to displace the liquid first injected. Said Norwegian patent thus relates to the removal of colonies of bacteria which multiply in an oil bearing structure, for instance colonies of desulphovibrio desulphuricans being a sulphate reducing bacteria multiplying in crude oil and water adjacent to such oil.

However, none of the prior art processes are adaptable for the regeneration of the very fine pored filters used for filtration of salt water to be injected to an oil bearing structure.

A condition in order to work the instant invention is that the filter material is inert with respect to the

agent used to remove the biological material deposited on the filter medium.

As indicated above at least 65% sulphuric acid is to be used. This acid is one of the most commonly used and is already used in large amounts within the petrochemical field. Suitable filter materials which are resistant to sulphuric acid are homo- or copolymers of olefins such as ethylene, propylene or butylene, or polymers derived from the corresponding halogenated monomers, for instance polytetrafluoroethylene.

Tests carried out with a filter material of polypropylene have shown that the filter could be fully regenerated by contacting the same with sulphuric acid with a concentration of approximately 98% in 6-10 minutes, whereby the slime-like material deposited on the surface of the filter medium was converted to a black-coloured coating which was easily removed by flushing with water. The thus treated filter medium was regenerated to its original condition. A corresponding filter of a conventional filter material which is regenerated by means of conventional back-washing has an average life-span of 3-4 weeks, whereas in a pilot plant tests have shown that the filters regenerated by means of sulphuric acid will have a useful life of 10-100 times longer. Tests carried out for more than a year with filters of different fineness, for instance with pore sizes in the range of 1.5-8 μm , have shown that the filters can be repeatedly regenerated and brought back to their original condition without any detectable changes in the physical properties of the filter medium.

The instant regeneration method can easily be adapted in an automatic filter process. For example, a filter plant may be provided comprising at least two filter units, which units preferably are identical and each is provided with at least one inlet for introduction of unfiltered water and at least one outlet for filtered water. The filter units can be of conventional type with the only provision that the filter medium is inert with respect to the regeneration medium. Thus, filter medium ought to be of the types previously described and the pipes and other parts of the filter units which are brought in contact with the concentrated sulphuric acid should be made of stainless steel.

Duplex filters are, of course, known within the state of art and are utilized as an integrally installed portion of a continuously operating liquid line so that one element of the filter operates while the other one is idle. The idle element is then available for cleaning and restoration to its original condition. When the operation filter becomes substantially clogged or just prior thereto the liquid flow is switched over to the reconditioned filter unit while the clogged idle filter unit is regenerated. Such a filter is described for instance in US-patent No. 2,681,736.

In order to facilitate automatic control of the new filtering device each of the filter units is provided with a pressure transducer or the filter units are connected to a common pressure transducer for registration of the pressure drop over the filter medium. When the pressure drop, due to the build-

up of organic material on the filter medium reaches a predetermined value the active filter unit is disconnected while the idle filter unit is connected for filtering of incoming sea-water.

In the now idle filter unit to be regenerated the water is drained off as much as possible in order that the concentrated sulphuric acid to be introduced is diluted only to a minor degree. Thus after a suitable drainage time the filter unit is filled with concentrated sulphuric acid in such a way as to cover all the organic material deposited on the surface of the filter medium and is allowed to act on the deposited layer for a predetermined time.

After said predetermined time the sulphuric acid is drained off and returned to a storage tank for subsequent use. In order to ensure a constant concentration of the sulphuric acid in the storage tank make-up acid is supplied from a make-up tank containing suitably concentrated sulphuric acid. The filter medium thus regenerated by means of the sulphuric acid is thoroughly washed to remove adhering sulphuric acid by introduction of purified water from the other filter unit whereafter the regenerated filter unit is ready for a new filtration cycle. Thus by utilizing two filter units which alternately are regenerated and alternately are used in an active filtration cycle it is possible to obtain a substantially continuous filtration of sea-water because one of the filter units always will be in an active filtration phase while the other filter is under a regeneration phase or will stand by in a regenerated condition and thus ready for a new filter cycle. Thus when the pressure drop over the active filter reaches the predetermined value a control unit will bring the idle, regenerated filter into an active phase, whereas the clogged filter unit is regenerated as described above.

For certain purposes where an uninterrupted flow of filtered water is not necessary it is of course possible to use only one filter unit.

The objects of the invention are attained in the preferred embodiment of the invention described in the accompanying description and illustrated in the accompanying drawing.

The filter comprises two identical filter vessels 1 and 2 of which one is used for filtration while the other is regenerated. In each of the filter vessels filter elements of the desired fineness are provided. The water to be filtered is introduced through the pipe-line 3. From the valve 4 the water is introduced via the pipes 5 or 6 to either filter vessel 1 or 2. From each of the filter vessels 1 and 2 the filtered water is exhausted through the tubes 7 and 8 and the valve 9. The filter vessels 1 and 2 are drained via the pipes 10 or 12 and the valves 11 and 13. The regeneration liquid, sulphuric acid of at least 65% concentration, is pumped by means of the pump 18 in and out of the filter vessels 1 and 2 through the valves 14 and 15 and the pipes 16 and 17. The valves are activated by suitable means (remote control). The used regeneration liquid from the filter vessels 1 and 2 is returned to the tank 22 via the tube 21 by means of the pump 18. From the storage tank 23 make-up regeneration liquid is introduced into the system by means of the pump 18 via the check valve 19 and tube 20. The

filter vessels 1 and 2 and tanks 22 and 23 are provided with vents 24. In addition the tank 23 is provided with a device 25 for introduction of new regeneration liquid. The whole procedure is controlled by the control unit 26 via the leads 27.

The functioning of the illustrated device is as follows:

- When the filter vessel 1 is used for filtration the pressure drop over the filter will gradually increase.
- 10 When the pressure drop reaches the predetermined value the pressure transducer 28 will activate the control unit 26. The control unit 26 activates the valves 4 and 9 causing the water to be filtered to pass through filter vessel 2, whereas the filter vessel 15 1 is disconnected. The water in the filter vessel 1 is exhausted by opening of the valve 11 and the filter vessel is drained for a predetermined time. The valve 11 is closed and the valve 14 opened. Regeneration liquid is introduced into the filter vessel 1 via the 20 tubes 21, 16, 10 and the filter is maintained in contact with the regeneration liquid for a predetermined time, whereafter the regeneration liquid is returned to the tank 22 via the pump 18. When the filtration vessel is nearly empty a level sensor 29 closes the 25 valve 14 and the pump 18 will hence withdraw make-up regeneration liquid from the tank 23 via the check valve 19 and introduce the make-up liquid into the tank 22 until the level sensor 31 stops the pump 18. In the filter vessel 2 a level sensor 30 is provided, 30 corresponding to the level sensor 29 in filter vessel 1. Then the valves 11 and 32 are opened and the filter vessel 1 is flushed with filtered water from filter vessel 2 which is active during this stage. After a predetermined flushing time the valves 11 and 32 35 are closed in sequence, and the regeneration process of the filter vessel 1 is terminated. When the pressure drop over filter vessel 2 increases and reaches the predetermined level, due to the deposited organic matter, the filter vessel 1 is activated 40 and filter vessel 2 disengaged and regenerated in the same manner as described for filter vessel 1.

The above described embodiment of the filtration plant represents the most simple embodiment by means of which it is possible to obtain continuous 45 filtering of for instance sea-water. For certain purposes a filter plant can comprise two or more modules of the above-described plant, such modules can be coupled in series or in parallel or combination thereof in order to adapt the filter plant 50 for particular purposes.

CLAIMS

1. A method of cleaning and regenerating filters 55 which have become clogged with a layer of deposited micro-organisms, which method comprises the steps of contacting the deposited layer with sulphuric acid of at least 65% concentration, which acid is capable of breaking down or dehydrating the micro-organisms; and subsequently removing the broken 60 down or dehydrated microorganisms by flushing with water.
2. A method according to claim 1, wherein the filter is made of a homo- or co-polymer of an olefin 65 or of a polymer derived from a corresponding

halogenated monomer.

3. A method according to claim 2, wherein the filter; is made of polyethylene, polypropylene, polybutylene or polytetrafluoroethylene.

- 70 4. A method according to claim 1 and substantially as hereinbefore described with reference to the accompanying drawing.

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