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Señor

SUPERINTENDENTE DE INDUSTRIA Y CC
DIVISION DE NUEVAS CREACIONES

SUPERINDUSTRIA Y COMERCIO

Radicacion : 01009827 00000002

Folios: 28

Fecha (HH): 2001-05-31 16:32:40

Tramite : 002 PATENTES D 1 REGISTRADO/ 229 COMPLETADO

Recomendacion: PARA DISTRIBUCION DE INFORMACION

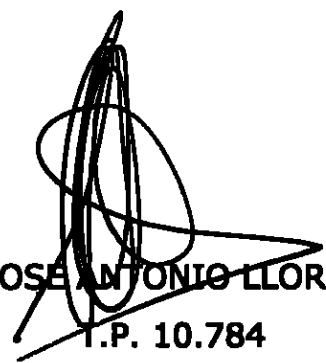
E. S D.

Re: P1.-DEN NORSKE STATS OLJESELSKAP A.S y
CHAMPION TECHNOLOGIES, INC.- Solicitud de Patente
de Invención para "PROCEDIMIENTO DE TRATAMIENTO
DE LA ZONA DE YACIMIENTOS DE POZOS
PRODUCTORES DE HIDROCARBUROS PARA INHIBIR
LOS PROBLEMAS DE PRODUCCIÓN DE AGUA".- Clase C.
10.-Expediente número 01-009.827.-

1. Me refiero a mi solicitud de patente de fecha 9 de Febrero de 2001.
2. Anexos me permito presentar a usted:
 - (1) Copia autentica, debidamente certificada de la solicitud de patente presentada para el invento arriba nombrado **respecto de la cual reclamo prioridad**, a saber la solicitud británica número 0003214.4 de 11 de Febrero de 2000, junto con su traducción correspondiente a las legalizaciones y reivindicaciones de dicho documento; y
 - (2) Copia debidamente autenticada por el Notario Sexto del Circulo de Bogotá, de los documentos que acreditan la calidad de Traductor Oficial del señor Gabriel Rueda Chadid quien elaboró la traducción de la legalizaciones de la solicitud británica número 0003214.4 de 11 de Febrero de 2000.

3. Ruego a usted tomar atenta nota de lo anterior y proceder de conformidad.

Señor Superintendente,



JOSE ANTONIO LLOREDA
I.P. 10.784
Código 231

59 61

EL SUSCRITO JEFE DEL AREA DE
LEGALIZACIONES DE MINISTERIO DE
RELACIONES EXTERIORES.

HACE CONSTAR

COLOMBIA NOTARIO SEXTO DE
SANTAFE DE BOGOTA
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIERDE CON LA FOTOCOPIA
AUTENTICA QUE ME TENGO A LA VISTA
SANTAFE DE BOGOTA 13 DIC 2000
NOTARIO

Que el señor Gabriel Rueda, se encuentra debidamente
registrado ante este Ministerio, como traductor e
intérprete oficial para los idiomas INGLES -ESPAÑOL,
ESPAÑOL - INGLES.

Para efectos de ésta certificación el interesado presenta
copia autenticada de la certificación del Ministerio de
Justicia acerca de la validez de la certificación de 1982.

COLOMBIA NOTARIO SEXTO ENCARGADO DEL CIRCULO
DE SANTAFE DE BOGOTA
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIERDE CON LA FOTOCOPIA
AUTENTICA QUE ME TENGO A LA VISTA
SANTAFE DE BOGOTA 21 FEB 2001
PAOLO MENDOZ BARAJAS

Dada en Santafé de Bogotá los días nueve días
(19) del mes de diciembre del año 1982.

Neibón Sánchez Torres
Jefe Area de Legalizaciones

COLOMBIA NOTARIO SEXTO ENCARGADO DEL CIRCULO
DE SANTAFE DE BOGOTA, HAGO CONSTAR QUE
ESTA COPIA FOTOSTATICA CONCIERDE CON EL ORIGINAL QUE ME TENGO A LA VISTA
01 JUL 1998
PAOLO MENDOZ BARAJAS

COLOMBIA NOTARIO SEXTO DE
SANTAFE DE BOGOTA
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIERDE CON LA FOTOCOPIA
AUTENTICA QUE ME TENGO A LA VISTA
01 SEPT 2000
NOTARIO



Ministerio de Justicia y del Derecho

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EL SECRETARIO GENERAL DEL MINISTERIO DE JUSTICIA Y DEL DERECHO

CERTIFICA:

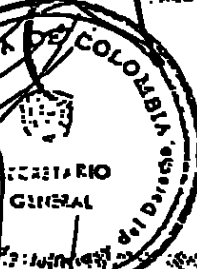
Que por Resolución 5996 del 29 de noviembre de 1982, le fue expedida licencia para ejercer funciones de Traductor e Intérprete Oficial en los idiomas INGLES-ESPAÑOL, ESPAÑOL-INGLES a GABRIEL RUEDA CHADID, identificado con la cédula de ciudadanía No. 17.124.145 expedida en Bogotá. Que dicha resolución es aún vigente en la fecha.

A solicitud del interesado, en Santa Fe de Bogotá D.C. el 14 de noviembre de 1994.

JORGE LUIS BAROGAL

COMO NOTARIO SEXTO DE SANTIAGO DE BOGOTA
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIDE CON LA FOTOCOPIA
AUTENTICA QUE HE TENIDO A LA VISTA
13 JUL 2000

COMO NOTARIO SEXTO DE SANTIAGO DE BOGOTA
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIDE CON LA FOTOCOPIA
AUTENTICA QUE HE TENIDO A LA VISTA
14 AGO 1998



SECRETARIO GENERAL
MINISTERIO DE JUSTICIA Y DEL DERECHO
BOGOTA, D.C.
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIDE CON LA FOTOCOPIA
AUTENTICA QUE HE TENIDO A LA VISTA

COMO NOTARIO SEXTO DE SANTIAGO DE BOGOTA
HAGO CONSTAR
QUE LA FOTOCOPIA CONCIDE CON LA FOTOCOPIA
AUTENTICA QUE HE TENIDO A LA VISTA
01 SET 1991

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COMO NOTARIO SEXTO DE
SANTAFÉ DE BOGOTÁ
HAGO CONSTAR
QUE LA FOTOCOPIA COINCIDE CON LA FOTOCOPIA
AUTÉNTICA QUE HE TENDIDO A VISTA
EN LA OFICINA
13 DIC 2000
NOTARIO

COMO NOTARIO LEVITO ENCARGADO
DE SANFAM DE BOGOTÁ.
HAGO CONSTAR
QUE LA FOTOCOPIA CONCORDA CON LA FOTOCOPIA
AUTÉNTICA QUE HE TENIDO A LA VISTA
CHADID. 07 SET. 2000
Bogotá
ESPANOL. 27 AGO. 1998
2001

COMO NOTARIO SEITO ENCARGADO
DE SANTAFE DE BOGOTA
HAGO CONSTAR
QUE APLICATA CONIENE CONSENTIMIENTO
AUTENTICA QUE HE TENIDO A LA VISTA
SANTAFE DE BOGOTA
A FIANZA EN UNO DE PARANAL

[illegible]

COMO NOTAR...
 EL SANTAFE DE BOGOTA
 HAGO CONSTAR
 QUE LA FOTOCOPIA CORRESPONDE A LA FOTOCOPIA
 AUTENTICA QUE ME MOSTRO LA VISITA
 SANTAFE DE BOGOTA 02 SET-1998
 POR CLAVIER GARCIA

CRM. /

62 64

Den N rake Stats oljeselskap a.s. C-P22028 CO
REF: LLC-0028-2001. La presente es Traducción Oficial de un
documento presentado originalmente en inglés. Esta
traducción es elaborada por Gabriel Rueda Chadid
(Traductor Oficial).

OFICINA DE PATENTES

The Patent Office

**The Patent Office
Cardiff Road
Newport
South Wales
NP10 8QQ**

El suscrito en su condición de funcionario debidamente
autorizado al tenor de lo dispuesto en el Artículo 74(1) y
(4) de la Ley de Desregulación y Contratación de 1994, para
firmar y expedir certificados a nombre del Contralor General,
certifico mediante el presente instrumento que anexo se
encuentra fiel copia de los documentos según fueron
presentados originalmente en relación con la solicitud de
patente que se identifica en dichos documentos.

De acuerdo con las Reglas sobre patentes (Nuevos Registros de
Compañías) de 1982, si una compañía cuyo nombre aparece en el
presente certificado y en los demás documentos que le
acompañan se ha registrado nuevamente al amparo de la Ley de
Sociedades de 1980, con el mismo nombre con el cual se había
registrado inmediatamente antes del nuevo registro, con

excepción de la sustitución o inclusión de la última parte del nombre en las palabras "Sociedad Pública Limitada." o sus equivalentes en Inglés, y las referencias al nombre de la sociedad en el presente certificado y en los demás documentos que le acompañan se considerarán como referencias al nombre con la cual se encuentran nuevamente registrada.

De acuerdo con las normas, las palabras Sociedad pública Limitada pueden ser reemplazadas por p.l.c., plc, P.L.C. o PLC.

El nuevo registro según lo dispone la Ley de Sociedades no constituye una nueva persona jurídica, sino tan solo somete a la sociedad a determinadas normas jurídicas adicionales aplicables a las compañías.

Firmado: (Hay firma)

Fecha: Febrero 1, 2001

Entidad Ejecutiva del Departamento de Comercio e Industria

GABRIEL RUEDA CHADAY
 TRADUCTOR OFICIAL
 RESOLUCION 5196 DE NOV. 29-83
 MINISTERIO DE JUSTICIA

64 66

Oficina de Patentes

1/77

Solicitud de otorgamiento de patente Oficina de Patentes
Cardiff Road
Newport
Gwent NP9 1RH

Nota: Hay sello de la Oficina de Patentes de Fecha Febrero 11. 2000.

1. Referencia	DCR/P22026	FEBRERO 11, 2000
2. Número de Solicitud de patente (La Oficina de Patentes diligenciará esta sección)	0003214.4	
3. Nombre completo, dirección y código postal del solicitante.	Den norske stats oljeselskap a.s. N-4035 Stavanger NORWAY Champion Technologies, Inc. PO Box 27727 Houston Texas 77227-7727 UNITED STATES OF AMERICA	
Número de Patentes ADP (si se conoce)	405845006 Y	
Si el solicitante es persona jurídica, indicar el país o estado de su constitución.	7832546001	
4. Título del Invento	Método para el Tratamiento de Pozo Productor de Hidrocarburos para Inhibir problemas de Producción de Agua	

GABRIEL RUEDA CHADIN
TRADUCTOR OFICIAL
RESOLUCION 5996 DE NOV. 29-83
MINISTERIO DE JUSTICIA

5. Nombre del Representante (en caso de tenerlo)

"Dirección para envío de correspondencia" en el Reino Unido al cual debe enviarse toda la correspondencia (se incluye el código postal).

KILBURN & STRODE
20 RED LION STREET
LONDON
WC1R 4PJ

Número ABP de patentes (si se conoce)

125001

6. Si usted esta declarando prioridad a partir de una o más solicitudes de patentes anteriores, suministre el nombre del país y la fecha de presentación de cada una de estas solicitudes anteriores y (en caso de tener dicha información) el número de cada uno de los solicitantes.

País	No. Prioritario de Solicitud (si lo conoce)	Fecha de Presentación (día/mes/año)
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7. Si la presente solicitud está dividida o se deriva de una solicitud anterior en el Reino Unido, suministre el número y fecha de presentación de la solicitud anterior.

No. de Solicitud anterior	Fecha de Presentación (día/mes/año)
---------------------------	-------------------------------------

8. Existe declaración de invención y derecho de otorgamiento de una patente como requisitos de apoyo de esta solicitud? (Responder afirmativamente si:

- a. Uno de los solicitantes cuyo nombre aparece en la sección 3 no es el inventor, o
- b. existe un inventor cuyo nombre no aparece como solicitante, o
- c. el solicitante cuyo nombre aparece es persona jurídica. Ver Nota (d)

GABRIEL RUEDA CHADIE
TRADUCTOR OFICIAL
RESOLUCION 5996 DE NOV. 29-82
MINISTERIO DE JUSTICIA

9. Ingresar el número de hojas para cada uno de los siguientes ítems que se radican junto con el presente formato. No contar copias correspondientes al mismo documento.

Hojas de continuación del presente formato

Descripción	21
Reivindicaciones	2
Resumen	1
Diseños	-

10 Si usted también esta presentando algunos de los siguientes documentos, indique el número de cada uno de ellos:

Documentos prioritarios

Traducciones de documentos prioritarios

Declaraciones de invención y derechos para otorgamiento de una patente (Formato de Patentes 7/77)

Solicitud de Examen preliminar e investigación
(Formato de Patentes 9/77) 1

Solicitud de examen sustantivo
(Formato de Patente 10/77)

Otros documentos (Favor especificar)

11. El suscrito solo solicita el otorgamiento de patente con base en la presente solicitud.

Firma:
Kilburn & Strode

Fecha:
Febrero 11 del 2000

12 Nombre y número telefónico en horario hábil de la persona con la cual se deba establecer contacto en el Reino Unido.

D C Ress
Tel: 0171-539 4200

GABRIEL RUEDA CHADIN *[Signature]*
TRADUCTOR OFICIAL
RESOLUCION 5996 DE NOV. 39-83
MINISTERIO DE JUSTICIA

REIVINDICACIONES

1. Un método para el tratamiento de un pozo de hidrocarburos durante la fase de completamiento, para inhibir problemas relacionados con producción de agua, donde el método comprende: el despliegue hacia el interior de la región cercana a la perforación de un pozo, durante la fase de completamiento, de un agente para el tratamiento compatible con hidrocarburos en una fase hidrocarburos, permitiendo que el componente activo del agente del tratamiento penetre irreversiblemente en el agua que se encuentra en la región del pozo, y permitiéndole también al componente activo ser retenido para la matriz de roca en la región del pozo, donde el componente activo del agente de tratamiento inhibe activamente el respectivo problema, si y cuando el agua se produzca finalmente a partir del pozo.

2. Un método según se describió en la Reivindicación 1, donde el agente de tratamiento es un material soluble d hidrocarburo, un sistema micelle surfactante o una emulsión.

3. Un método según se describió en la Reivindicación 2, donde el componente activo se hidroliza al hacer contacto con el agua.

4. Un método según se describió en la Reivindicación 3, donde la hidrólisis es un proceso irreversible.

5. Un método según se describió en una de las Reivindicaciones anteriores, donde la hidrólisis hace que el

agente de tratamiento sea hidrosoluble.

6. Un método según se describió en una de las Reivindicaciones anteriores, donde el agente de tratamiento se ubica al final del programa de completamiento.

7. Un método según se describió en una de las Reivindicaciones anteriores, donde el agente de tratamiento es un inhibidor de escamas soluble en aceite o una combinación de inhibidores de escama solubles en aceite.

8. Un método según se describió en una de las reivindicaciones anteriores, donde la concentración del agente de tratamiento en la fase hídrica es superior a la concentración en la fase de hidrocarburo como resultado de la transferencia irreversible de masa entre las fases.

9. Un método según se describió en una de las Reivindicaciones anteriores, donde la concentración del agente de tratamiento en el material de hidrocarburo tal y como se le suministró a la formación es de >2% por peso.

10. Un método según se describió en una de las Reivindicaciones anteriores, donde la concentración del agente de tratamiento en el material de hidrocarburo después de la entrega a la formación es de <1% por peso.

11. Un método según se describió en una de las Reivindicaciones anteriores, donde la concentración del agente de tratamiento en el agua inherente después del

suministro del material de hidrocarburo que porta el agente de tratamiento es >2% por peso.

12. Un método según se describió en una de las Reivindicaciones anteriores, donde la fase de hidrocarburo se selecciona a partir de kerosene, aceite lampante, aceite diesel y petróleo crudo.

La anterior es Traducción Oficial de un documento presentado originalmente en inglés. Esta traducción fue realizada por GABRIEL RUEDA CHADID (Traductor Oficial). Resolución 5896 del Minjusticia, por lo cual estampo mi Sello y Firmo.

Bogotá D.C., Marzo 2, 2001.

GABRIEL RUEDA CHADID
TRADUCTOR OFICIAL
RESOLUCION 5896 DE NOV. 28-83
MINISTERIO DE JUSTICIA



Den Norske Stats
P 22026/CO
INVESTOR IN PEOPLE
72
70

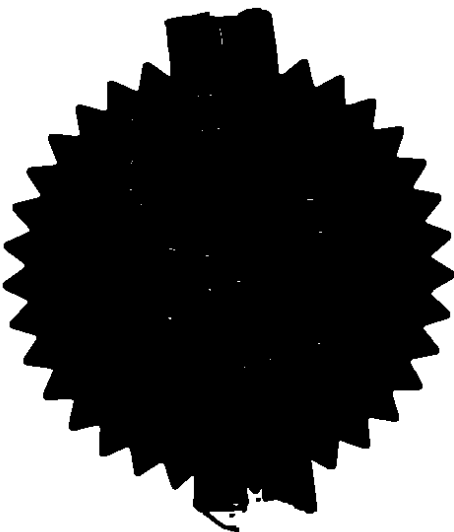
The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.



Signed

Dated 1 February 2001

An Executive Agency of the Department of Trade and Industry

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office
Cardiff Road
Newport
Gwent NP23 5RH

1.	Your reference	DCR/P22026	11 FEB 2000
2.	Patent application number (The Patent Office will fill in this part)	0003214.4	14FEB00 E512864-1 D00056 P01/7700 0.00-0003214.4
3.	Full name, address and postcode of the or of each patent applicant (underline all surnames)	Den norske stats oljeselskap a.s. N-4035 Stavanger NORWAY Champion Technologies, Inc PO Box 27727 Houston Texas 77227-7727 UNITED STATES OF AMERICA	
	Patents ADP number (if you know it)	405845006 + 7832546001	
	If the applicant is a corporate body, give the country/state of its incorporation		
4.	Title of the invention	Method of Treating Hydrocarbon Producing Well to Inhibit Water Production Problems	
5.	Name of your agent (if you have one)		
	"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	KILBURN & STRODE 20 RED LION STREET LONDON WC1R 4PJ	
	Patents ADP number (if you know it)	125001 ✓	
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)
			Date of filing (day / month / year)
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application number	Date of filing (day / month / year)
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer "Yes" if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))		

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form :
 Description : 21
 Claim(s) : 2
 Abstract : 1
 Drawing(s) :

10. If you are also filing any of the following, state how many against each item.

Priority documents :
 Translations of priority documents :
 Statement of inventorship and right to grant of a patent (Patents Form 7/77) :
 Request for preliminary examination and search (Patents Form 8/77) : 1
 Request for substantive examination (Patents Form 10/77) :
 Any other documents (please specify) :

11. I/we request the grant of a patent on the basis of this application.

Signature

Date

Kilburn & Stroe



11 February 2000

12. Name and daytime telephone number of person to contact in the United Kingdom

D C Rees
 Tel: 0171-539 4200

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

Method of Treating Hydrocarbon Producing Well to Inhibit Water Production Problems

5 The present invention is concerned with a method of treating a hydrocarbon producing well to inhibit problems associated with water production. It is particularly but not exclusively applicable to a preventive scale treatment in oil, gas and condensate fields, using an oil soluble scale inhibitor (OSI).

10 An increasing number of complex and expensive wells are being installed, e.g. multilateral, multi-zones, sidetrack and horizontal completions. The infrastructures which are in place, such as flow lines and platforms, also enable us to target and drain the additional reserves found near the exiting fields. Very often these additional oil and/or gas are produced via tieback and satellite facilities. Successful scale squeeze treatments in these wells can no
15 longer rely on the traditional method of bullheading the chemicals into the reservoir. Special tools such as coil tubing will be needed to place the chemicals accurately. Intervention in these wells will be prohibitively expensive due to tools hire, personnel and extended period of deferred oil production. It is important to realise that for certain types of completions, well re-entry is almost
20 impossible despite accepting the financial penalty. There is clearly a need to develop the systems with as low an intervention frequency as possible for these wells, i.e. with the chemicals pre-delivered downhole.

Preventive rather than remedial treatments against scale, hydrate and other tubing deposits represent the first step towards achieving such goal. For
25 example, in the case of scale inhibition, preventive treatment means the delivery and deposition downhole of an appropriate scale inhibitor package at an early stage, i.e. before the well starts producing scaling water. A number of options

on scale preventive treatment have emerged recently. These include water soluble scale inhibitors, proppant/gravel pack based solid scale inhibitors, oil soluble scale inhibitors (OSI), emulsified scale inhibitors and micro particle systems for deep matrix placement.

5 Traditionally, scale deposition has been considered to be a water related problem, i.e. if no water is produced no scale forms. As such, almost all scale inhibitor chemicals are water soluble and are typically deployed as an aqueous based product. For preventive treatment in a 'dry' or 'modestly dry' well, the use of a conventional water based scale inhibitor may cause a significant, 10 though usually temporary, reduction in its productivity. One of the main concerns and a frequently observed problem when carrying out a water based squeeze is the length of the necessary clean up period. It is often found that the well might take weeks or months to regain its pre-squeezed level of oil production. In most cases, the loss of oil production is the direct result of a 15 decrease in the oil relative permeability caused by the change in water saturation near the wellbore region which creates emulsions. These problems are not experienced with oil soluble squeezes. How fast the well can recover will depend on the wettability of the rock which is a specific property for a given crude/produced brine/formation matrix system. For those wells with weak 20 bottom hole pressure and/or a lack of artificial lift, the excessive water injected during the squeeze treatment will pose a risk of killing the well. The ingress of water means a much higher draw down is needed to induce the well to flow back.

25 The lost or deferred oil production is often based on the well shut-in time during the squeeze treatment. This can be misleading especially if the well requires a significant clean up period to regain its pre-squeeze level of oil production. Together with the other commonly observed problems when using a

water base scale inhibitor, e.g. process upset and poor water quality (discharged), operators are often reluctant to be proactive. As a result the squeeze treatment is usually postponed to avoid upsetting the oil production and is only carried out when the production decline starts, i.e. after damage has been done.

It is an object of the present invention to provide a method of treating a hydrocarbon producing well to prevent scale deposition and build up which does not suffer from these various drawbacks.

According to the invention, there is provided a method of treating a hydrocarbon well during the completion phase to inhibit problems associated with water production, the method comprising: deploying into the near wellbore region of a well during the completion phase a hydrocarbon-compatible treatment agent in a hydrocarbon phase; allowing the active component of the treatment agent to enter irreversibly the connate water in the well region; and allowing the active component to be retained by the rock matrix in the well region, whereby the active component of the treatment agent inhibits the respective problem if and when water is finally produced from the well.

The hydrocarbon well may be for example an oil well or a gas well. The problems associated with water production include corrosion and hydrate formation, and in particular, scale formation. The term "hydrocarbon-compatible" includes materials which are transportable in or can be carried by a hydrocarbon phase, and particularly includes oil soluble materials. Preferably, therefore, the treatment agent is an oil-soluble scale inhibitor.

The entry of the active component into the connate water phase is irreversible and this may be achieved by any convenient mechanism. Thus water soluble treatment agents can be made hydrocarbon-compatible by means of a surfactant package such as a surfactant-micelle system or by means of an

emulsion. Preferably, however, the treatment agent is an oil soluble material which hydrolyses or decouples on contact with water.

The term "completion phase", when applied to wells, means essentially, the stage before the well is put into planned long term production or the stage before the well is intended to produce uninterruptedly for a significant period of time.

The treatment agent remains in the connate water or is adsorbed on to the mineral surface of the reservoir. The system allows free production of hydrocarbons without eluting any of the treatment agent during pure hydrocarbon production then when water breaks through, the treatment agent will be released in adequate concentrations for protection against scaling.

Preferably, the treatment agent is deployed at the end of the completion phase of the well developed. However, the treatment agent can also be deployed at any time during the completion phase.

Preferably, the treatment agent is an oil soluble scale inhibitor or combinations of oil soluble scale inhibitors, including different soluble inhibitors. Suitable materials can be obtained from Champion Technologies. Products are available which make use of different molecules and active concentrations. Such combinations may take advantage of different absorption isotherms of various inhibitors, playing on both short term and long term dissolution or desorption from the matrix. This could also be combined with mixing of different generic types of inhibitors and also mixing in such a way that for example inhibitors most efficient in protection of carbonate scale could be combined with inhibitors most efficient in protection of sulphate scale. Likewise, combinations of scale, corrosion and hydrate inhibitors could be employed during the same squeeze, or in sequence of the same squeeze to obtain multiple protection.

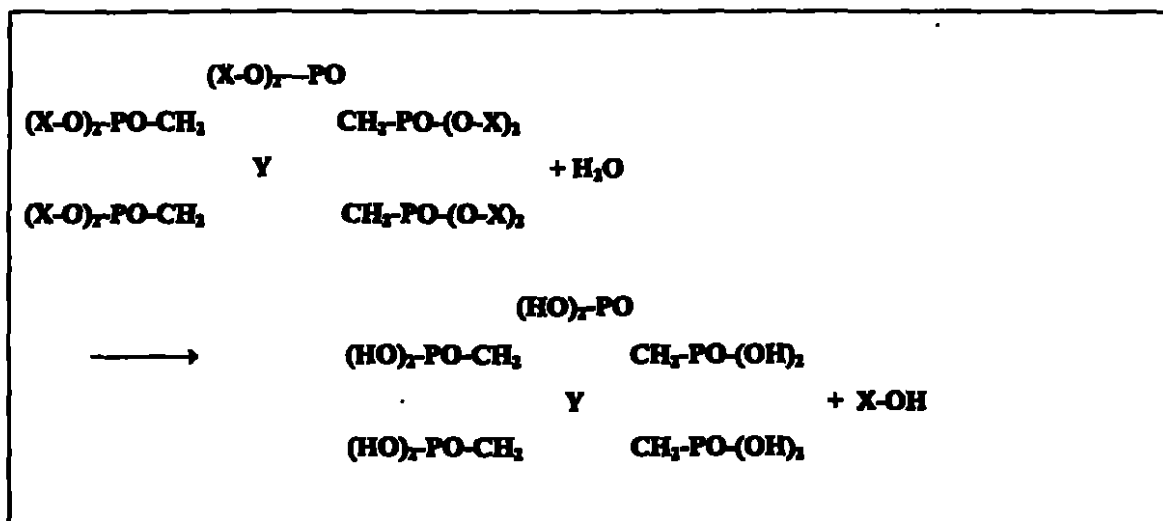
There are clear advantages in using an oil soluble scale inhibitor (OSI), particularly when used in wells during the completion phase and in low energy reservoirs. These exploit the hydrodynamic differences between an oleic and an aqueous phase. To be deployed successfully in the field as a preventive treatment against scale, the OSI preferably behaves like a conventional water based product as and where it is needed. This requires the active agent of the OSI to be present in the produced water when the well starts cutting water, which can be some months or years after it was first deployed. For this reason the OSI package preferably possess properties which enable it to deliver selectively the desired component(s). These properties include a ready transfer process from the oil (carrier) phase into the water phase when in contact. The mass transfer process, including hydrolysis and partitioning of the molecules, is preferably rapid. The hydrolysed molecules, after partitioning in the water phase, must then be able to inhibit scale formation. Furthermore, in order to yield a long squeeze life, the partitioned molecules are preferably strongly adsorbed by the rock matrix.

Preferably, the hydrolysis is an irreversible process and preferably, the hydrolysis renders the treatment agent water soluble. The partition between the hydrocarbon and connate water phases may be followed by or be a consequence of the hydrolysis and both operations may be controlled.

The treatment agent is preferably an oil-soluble penta phosphate derivative which hydrolyses to a penta phosphonate according to the reaction:-

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Preferably, the concentration of the treatment agent in the connate water is higher than the concentration in the hydrocarbon phase as a result of the hydrolysis and the subsequent irreversible mass transfer between phases.

Preferably the concentration of the treatment agent in the hydrocarbon material as delivered to the formation is >2wt%, more preferably 2 to 30 wt%. Preferably, the concentration of the treatment agent in the hydrocarbon material after delivery to the formation is <1wt%. Preferably, the concentration of the treatment agent in the connate water after delivery of the hydrocarbon material carrying the treatment agent is >2wt% more preferably 2 to 50 wt%. The hydrocarbon phase in which the treatment agent is deployed may be any suitable hydrocarbon material, for example, kerosene, lamp oil, diesel oil, crude oil, condensate, synthetic oils etc.

Preferably, the connate water concentration of the treatment chemical is supporting a concentration driven adsorption. Preferably, the adsorption to the matrix from the connate water continues even after the hydrocarbon production is started, giving a shut-in time requirement only for the oil to water process to take place. In the case of partitioning, the shut-in and hydrolysis for most

temperatures may have reached termination at 30 minutes.

Preferably, the OSI will give reduced initial flow-back return of the treatment agent and will be environmentally friendly. Conveniently, it will offer protection time in early and/or unexpected water break through. The OSI can be employed with/or without a preflush, which may consist of a mutual solvent and/or surfactants or other additives. The OSI can be employed also in wet wells with an appropriately sized hydrocarbon preflush to render the water saturation in the treatment region as low as possible.

The OSI chemicals may be truly oil solublised without the addition of any mutual solvent, surfactants or other additives. It is believed that the OSI chemical and treatment procedure will not give adverse relative permeability effects. It can be administrated with or without coil tubing and will be able to withstand significant thermal degradation for a defined period of time.

The present invention can therefore offer the following benefits: a preventative treatment incorporated in a well completion programme; more efficient chemical usage; increased environmental friendliness, with a minimum or no return of treatment chemicals if the well is dry, (since the chemicals will remain in the connate water); no high peak in flow-back return; reduced shut-in time; protection in the case of early/unexpected water break-through; reducing initial scaling; reduced sand production and clay swelling which would normally be expected within a water injection; savings on subsequent costly treatments and interventions related to damage and repair of equipment; and start-up problems are minimised.

The invention may be carried into practice in various ways and some embodiments will now be illustrated in the following examples and experiments and described with reference to the accompanying drawings in which:-

Figure 1 is a graph showing the partitioning of OSI in oil and water

phases:

Figure 2 is a schematic view of the reservoir P-MAC apparatus;

Figure 3 is a graph showing the effect of scaling on the pressure drop along the P-MAC coil;

5 Figure 4 is a graph showing the results of a preventive squeeze with OSI; and

Figures 5 to 10 are graphs representing the results in various experiments.

10 When sea water (SW) and formation water (FW) mix, scaling can occur immediately. Thus, the salts in each of the solutions of SW and FW are soluble, but when mixed, some ions from each solution may form salts that are not soluble.

15 The tests of the Scale inhibitors were carried out by pretreating a sandpack column in various ways to simulate a squeezed reservoir, and then flow the SW through the column. As some oil will be produced before the SW has flowed through, the clock is started when the mix of FW and SW is seen at P1.

20 The comparative tests (no Scale inhibitor) described below were carried out by by-passing the sandpack column, i.e. a stream of SW and FW is mixed, and enters the coil. The time is taken from when the mix of SW and FW is seen at P1, until there is enough scale in the coil that a pre-determined pressure difference is observed between P1 and P2.

25 A set up such as this is necessary, in order to put the preventative chemical into a stream at a stage before any scale is produced, and it is known that scaling conditions will occur at a later stage.

Chapter 1 Field Tests

Some experiments have been carried out under field conditions. Several

squeeze treatments using suitable OSI products have been conducted for example in the North Sea. These are not in accordance with the invention since the wells treated were already producing water.

For the treatments carried out in the North Sea, the reservoir temperatures varied between 110°C to 125°C and the water cuts varied between 1% to 20% . Both diesel and base oil were used as the carrier fluid. The general observations during the flow back period can be summarised as follows. Injectivity was unchanged with WHP remaining high during injection. Clean up is not an issue, in that the wells flow back instantly with an unchanged water/oil cut. Topside process suffered no apparent upset, as often observed with water based squeeze (caused by the return of large volume, high concentration scale inhibitor). As for discharge, no apparent oil-in-water problems were encountered as have often been observed with water based squeezes.

15 Chapter 2 Partitioning of Oil Soluble Scale Inhibitor

In order to study the partitioning of the OSI between the oil and water phases the following laboratory experiment was conducted.

In this test, a 10% OSI solution was made up in crude oil. The sample was then mixed with Statfjord formation water (FW) at 5:1 ratio (cf. 17% S_{wi}). The mixture was shaken briefly and left in an oven overnight at 80°C. The aqueous and the oleic phases were separated in the following day. Together with an original sample (10% in crude) they were analysed using Fourier Transform Infrared Spectrometry (FTIR) which offers a quick and qualitative response. It is particular useful for the phosphonate based OSI since the P=O and P-OH) bonds (stretching vibrations) can be easily identified at the wave numbers of ~1150 and ~970 respectively. It is clear from Figure 1 that upon contact with water, most of the OSI molecules are transferred from the oil phase

into the aqueous phase through a combined hydrolysis and partitioning process. The mass transfer process was achieved very rapidly and the level of transfer was extremely high with little (<0.1%) or no OSI detected in the final oil layer. In contrast, due to the small amount of water present, the final scale inhibitor concentration in the aqueous phase was significantly higher than that in the original OSI mix. Such 'ENHANCED PARTITIONING' will have strong implication in the deployment strategy and utilisation efficiency of the product in the field.

10 Pressure Monitoring and Control (P-MAC)

One piece of equipment which can be used for OSI testing is the Reservoir P-MAC (Pressure Monitoring And Control) as shown in Figure 2. It is based on standard tube blocking apparatus with the addition of a pre-column. In this set-up, a sandpack is inserted into a sea water line and placed upstream of the P-MAC coil. The purpose of this column is to enable a simulated squeeze treatment using OSI to be carried out prior to any test. When the co-injection of the incompatible brine starts, the sea water would elute the adsorbed scale inhibitor. As a result, there would be a time delay for the coil to scale up to the pre-set pressure ($\Delta P = 1$ Bar). Comparison could then be made with the "blank" run in which no prior squeeze treatment had been carried out in the column.

20 Chapter 3 Effect of Hydrocarbon Production on Partitioned OSI

This test was conducted using the P-MAC apparatus. In this test, two separate runs were carried out with a sandpack column pre-treated (squeezed) with OSI. In the first run, sea water was directly injected and the delay in the scale up time was observed. In the second run a volume (50 ml) of kerosene was injected prior to the sea water, i.e. to simulate oil production in a dry well until the first

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water breaks through. The objective of this was to examine if the adsorbed OSI molecules could be removed readily by the passage of hydrocarbon. The results show that the flow of hydrocarbon did not displace the inhibitor and that the presence of the inhibitor delays scaling up the coil, as can be seen from figure 3.

5 The time of scaling up the coil is measured form the time when formation water and sea water mix.

Chapter 4 Preventive Squeeze Study

10 Figure 4 shows an experiment where the OSI was squeezed into a sand pack with subsequent back production of sea water and formation water (curve labelled SA1070(10%)). This gave a protection time in this system of about 23 minutes, or about 20 pore volumes (PV). The same type of squeeze was carried out before the sand pack was back produced with sea water and formation water, it was back produced with 6 PV of the hydrocarbon phase. This was
15 carried out at two different inhibitor concentrations (curves, SA1070(10%) + 6PV-CH and SA1070(2%) + 6PV-CH, respectively). Protection time is just in the same range as when only brine was back produced. This indicates that no OSI is being removed by the hydrocarbon phase. The inhibitor will therefore reside in the connate water or on the formation rock until formation water or sea
20 water is produced.

Experimental Details

Details of the sand packs used are as follows.

25 Sand packs

Omni columns with inner diameter 15mm (minus end pieces), packed with Baskarpsand, were used in the experiments. The column was made of

borosilicate glass, and the frits of each end piece were porous discs of polyethylene with pore size 25 μ m.

The particle size distribution of the Baskarpsand is given in Table 1. Chemical analysis of the sand is given in Table 2.

5 Table 1. Particle size distribution of Baskarpsand.

	Particle diameter [microns]	Del [wt %]
	< 88	0,3
10	88-125	3,9
	125-250	55,5
	250-500	39,8
	>500	0,5

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Table 2. Chemical analysis of Baskarpsand

	Mineral	Del [wt %]
	SiO ₂	90.9 (76.6% free quartz)
20	Al ₂ O ₃	5,1
	Fe ₂ O ₃	0,45
	CaO	0,3
	MgO	0,07
	Na ₂ O	1,02
25	K ₂ O	2,02

Brines

The compositions of the sea water and formation water used in the blocking tests are given in Tables 3 and 4. The composition of the formation of water is taken as an average of more general formation waters, but with an increased concentration of Barium (400ppm Ba²⁺). This is to service two purposes.

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- a) The precipitation in the P-mac coil will occur within reasonable time and repeatable manner.
 - b) In order to resemble Heirun formation water; Barium concentration in Heidrun Fangst is around 190ppm, while Heidrun Åre is reported with values from 100 to 350ppm (A-22 FW) and also as high as 800ppm.
- Thus, a formation water with 400ppm of Barium was chosen.

Table 3 Composition of synthetic sea water

Salt	Concentration [g/l]
NaCl	23,13
CaCl ₂ * 2H ₂ O	1,69
MgCl ₂ * 6H ₂ O	12,21
SrCl ₂ * 6H ₂ O	0,02
KCl	0,82
Na ₂ SO ₄	3,92

Table 4. Composition of synthetic formation water

Salt	Concentration [g/l]
NaCl	21,67
CaCl ₂ * 2H ₂ O	1,1
MgCl ₂ * 6H ₂ O	0,59
SrCl ₂ * 6H ₂ O	0,15
KCl	0,36
NaHCO ₃	1,48
BaCl ₂ * 2H ₂ O	0,71
CH ₃ COOH	0,395 ml/l

Inhibitors

Both the oil soluble inhibitor used in the experiments are pentaphosphonates delivered from Champion Technologies. The commercial name of the oil soluble inhibitor is SA1070. The commercial name of the water soluble

inhibitor is SA1130. These inhibitors will correspond to traditionally DETA pentaphosphonate (DTMP).

Column packing and preparations

- 5 Frits and o-rings were checked eventually changed and one end piece was mounted on the column. About 37g Baskarpsand was poured into the column while vibrating it over a period of 1½ min. The batch of sand was kept in an oven at 80°C. The other end piece (adjustable) was mounted and the column was weighed. The column was evacuated by means of a vacuum pump (vertical position) and filled with distilled water with the vacuum pump still on. The water permeability over the column was found by measuring the differential pressure over the column at different rates (100,200, 300, 400 and 400 ml/h). The column was weighed at 100% water saturation and the length of the sand pack was measured. The dead volume in tubes and end pieces was found by weighing an empty column with and without water and the volume of the empty cylinder was subtracted from this difference.

To make the sand in the columns oil wet, 50 ml Heidrun A46 crude was pumped through the column at a rate of 400 ml/h. This operation was done at 70°C. Before the inhibitor squeeze the column was kept in the oven at 90°C for three days.

Table 5 and Table 6 give the column data for the different experiments.

Table 5 Column data for the experiments with oil soluble scale inhibitor.

Trial	Length [cm]	Dry wt. [g]	Wet wt. [g]	Mass w. [g]	Deadvol. [ml]	Porevol. [ml]	Waterperm. [Darcy]
OSI 2	12.2	329.5	338.3	8.8	1.2	7.6	4.6
OSI 3	12.2	327.1	335.7	8.6	1.2	7.4	4.6
OSI 5	12.4	328.0	336.4	8.4	1.2	7.2	5.2
OSI 6	12.3	327.7	336.5	8.8	1.2	7.6	4.3
OSI 7	12.3	327.4	336.0	8.6	1.2	7.4	3.6
OSI 8	12.1	328.5	336.9	8.4	1.2	7.2	4.5
OSI 9	12.3	327.9	336.6	8.7	1.2	7.5	5.9
OSI 10	22.5	368.5	382.5	14.0	0.7	13.3	5.5
OSI 11	22.5	384.8	399.5	14.7	1.2	13.5	4.9
OSI 12	22.4	385.0	399.5	14.5	1.2	13.3	5.9
OSI 13	12.1	328.3	336.5	8.2	1.2	7.0	4.3
OSI 14	12.1	328.4	336.9	8.5	1.2	7.3	4.0
OSI 15	12.7	312.2	320.4	8.2	0.7	7.5	5.0
OSI 16	12.7	307.7	315.9	8.2	0.7	7.5	5.2
OSI 17	12.2	328.4	336.7	8.3	1.2	7.1	3.4

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5 **Table 6 Column data for the experiments with water soluble scale inhibitor**

Trial	Length [cm]	Dry kol. [g]	Wet kol. [g]	Mass w. [g]	Deadvol. [ml]	Forevol. [ml]	Waterperm. [Darcy]
WSI 1	12.0	329.7	338.5	8.8	1.2	7.6	2.7
WSI 3	12.0	328.0	336.4	8.4	1.2	7.2	4.6

10 **Oil soluble inhibitor squeeze**

The following operations were carried out at 90°C. At startup, the column was 100% saturated with water.

- 15 1. 50 ml kerosene was pumped through the column at 400 ml/h. The water volume that come out was measured and the residual water saturation calculated on the basis of this.
2. A given volume of inhibitor diluted in kerosene was pumped through the column at 400 ml/h. (Inhibitor concentrations in the kerosene are given in Table 4.2).
- 20 3. The column was left at 90°C over night.

Table 7 gives the amount of water that came out of the column during the injection of kerosene, and the calculated residual water saturation before the inhibitor injection.

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Table 7 Residual water saturation before the inhibitor squeeze

Trial	Water out [ml]	Water left [ml]	Water saturation [%]
OSI 2	6,8	2	26
OSI 3	7,0	1,6	22
OSI 5	7,1	1,3	18
OSI 6	7,0	1,8	24
OSI 7	7,0	1,6	22
OSI 8	6,0	2,4	33
OSI 9	7,5	1,2	16
OSI 10	11,6	2,4	18
OSI 11	11,8	2,9	21
OSI 12	11,5	3	23
OSI 13	7,1	1,1	16
OSI 14	7,2	1,3	18
OSI 15	6,4	1,8	24
OSI 16	6,7	1,5	20
OSI 17	7,0	1,3	18

Table 8 P-mac results for the tests with oil soluble inhibitor

Trial	Inhibitor conc. in brine	Inhibitor volume in squeeze	Time to 1 bar sat. only SW-FW	Time to 1 bar with treated column	Comment
OSI 2	10%	100 ml	8 min.	23 min.	
OSI 3	2%	100 ml	8 min.	23 min.	
OSI 5	10%	1/3 PV	10 min.	17 min.	2/3 PV of brine after inh.
OSI 6	10%	1/3 PV	10 min.	16 min.	
OSI 7	3.3%	1 PV	11 min.	19 min.	
OSI 8	3.3%	1 PV	11 min.	14 min.	33% water saturation
OSI 9	3.3%	100 ml	13 min.	31 min.	oil wet sand
OSI 10	10%	1/3 PV	14 min.	21 min.	
OSI 11	10%	1/3 PV	14 min.	23 min.	2/3 PV of brine after inh.
OSI 12	3.3%	1 PV	8 min.	21 min.	
OSI 13	3.3%	100 ml	9 min.	28 min.	oil wet sand
OSI 14	3.3%	100 ml	9 min.	15 min.	no shut-in
OSI 15	3.3%	100 ml	7 min.	14 min.	shut-in 16°C for 136 days
OSI 16	3.3%	100 ml	9 min.	26 min.	shut-in 16°C for 136 days
OSI 17	3.3%	100 ml	8 min.	14 min.	no shut-in

Water soluble inhibitor squeeze

100 ml of 4 wt% SA1130 in sea water was pumped through the column at 400 ml/h at room temperature before the column was left at 90°C over night.

5 **Table 9 P-mac results for the tests with water soluble inhibitor.**

10	Trial	Inhibitor conc. in sea water	Inhibitor volume in squeeze	Time to 1 bar ref. only SW+FW	Time to 1 bar with treated column
	WSI 1	4%	100 ml	11 min.	12 min.
	WSI 3	4%	100 ml	8 min.	12 min.

Reservoir P-mac Operative Conditions

15 The compositions of the sea water and formation water used in the experiments are given in Tables 3 and 4. A general composition formation water with 400ppm Ba^{2+} was used. The brines were degassed before every experiment. The column, and capillary tube were both placed in water baths at 90°C. The two waters were therefore preheated before they were mixed.

20 Before every experiment a reference experiment without inhibitor (the blank) was carried out.

For the experiments with oil soluble scale inhibitor, 50 ml kerosene was pumped through the column in the opposite direction of the inhibitor injection at 400 ml/h. The column was then placed in the sea water line of the P-MAC, with the same flow direction as for kerosene. Some formation water was first
25 flowed through the capillary tubing to ensure that the differential pressure measurement and the printer were working normal before the sea water pump was started. During the experiment, 400 ml/h of both formation water and sea

water were pumped through the capillary tubing until the differential pressure over the capillary tube reached 1000 mbar.

After each experiment, the capillary tubing was rinsed with a 10% scale dissolver solution in distilled water. The rinsing fluid was pumped through the tube in the opposite flow direction for 20 minutes at a rate of 499 ml/h.

Ageing

To test the temperature stability of the inhibitor over time, two squeezed columns were kept at 165°C over an extended time period before they were tested in the P-MAC. The polyethylene frits were replaced with a piece of woven steel because of the high temperature.

The columns were packed, pre treated and squeezed as normal. Caps, fittings and tubes were removed from the columns. The open columns were placed in a piston bottle filled with kerosene on one side of the piston (the side with the columns) and empty on the other side. The piston bottle was placed in an oven and the empty side was connected to a N₂—pressure of 15 bar. The oven was heated to 165°C and the pressure then rose to about 20 bar. The columns were left in the oven for 15 and 136 days, respectively. The heat was turned off and the pressure was reduced and tubes were mounted on the column. The columns were post flushed with 50 ml kerosene before they were tested in the reservoir P-MAC as described above. The results of the various further experiments are summarised in Figures 5 to 10, which show the differential pressure over the capillary tubing during the period of the blocking tests. An average of the results of the reference tests without inhibitor is shown in each Figure. The experimental conditions are given in Tables 8 and 9. A squeeze with the water soluble version of the OSI was tested first in order to estimate the expected protection time of the squeeze. The results are shown in Figure 5.

Different concentrations were tested. Also thermal stability of the OSI is crucial for long term activity. Although certain reservoir temperatures will only vary between 85-98°C, the ageing was carried out at 165°C to accelerate the degradation process.

5 Figure 6 shows oil soluble inhibitor squeeze with different concentrations and ageing. It shows that the protection time of the oil soluble inhibitor squeeze is in the same range for different inhibitor concentrations in kerosene (2-10%). Note that this is when pumping 100 ml of inhibitor solution through the column. Ageing of the squeezed column at 165°C for 15 days does
10 not seem to reduce the efficiency of the inhibitor. When comparing Figures 5 and 6, there are indications that the protection time of the experiments with an oil soluble inhibitor squeeze is almost double that when a water soluble inhibitor was used.

 Figure 7 shows the result of two P-MAC tests with no shut-in time.
15 Compared with Figure 6 it appears that shut-in time had beneficial effect on the oil soluble inhibitor treatment. However, results from the partitioning experiments combined with reservoir P-MAC experiments indicate that there is no benefit from shut-in times longer than 3 hours.

 Figure 8 shows the results from two P-MAC tests with oil wet sand. The
20 oil wet columns had the longest inhibitor treatment lifetime of all the experiments. The reason for this may be that the oil wet columns had a lower initial water saturation than the other columns (see Table 8).

 In an attempt to optimise the squeeze procedures and to investigate the mechanisms of the OSI, different squeeze methods were tested. In one test, a
25 column with much higher water saturation was achieved by lowering the drainage velocity.

Figures 9 and 10 show the results from P-MAC experiments with different squeeze procedures. In all three cases, the same amount of inhibitor was squeezed into the column, but in different ways. The first column was filled with one pore volume of 3.3% inhibitor in kerosene without overflush. The second column was filled with 1/3 pore volume with 10% inhibitor in kerosene followed by 2/3 pore volume of kerosene to displace the inhibitor. These three tests were conducted both with 15cm long columns (Figure 10) and 25 cm long columns (Figure 9). The experiments gave no clear differences between the three squeeze methods.

Figure 10 also shows the treatment lifetime for a squeeze with one pore volume of 3.3% SA1070 in kerosene on a column with 33% water saturation. The water saturation of the other columns varies between 16-26% (see Table 8).

The conclusions to be drawn from the experiments and tests can be summarised as follows:

The scale protection time of the oil soluble inhibitor treatment has been compared with the lifetime of a squeeze with the corresponding water soluble chemical. The lifetime of the experiments with oil soluble inhibitor squeeze was almost double of the protection time of experiments with water soluble inhibitor. Experiments with varying inhibitor concentration in kerosene showed that in the concentration range of 2-10 wt %, the protection time of the oil soluble inhibitor was in the same range for all the inhibitor concentrations in kerosene. This indicates that at 2 wt % one approaches the concentration limit of the corresponding connate water. In these experiments SWI is varying between 22-26%.

Ageing of the squeezed column at 165°C for 15 days does not seem to reduce the effectiveness of the inhibitor. However, after 4 or 5 months (136) days, the protection time is reduced to 50% of the initial. Applying the

Arrhenius relations, indicating that the rate of reaction doubles for each 10°C increase, and knowing the temperature at the Heidrun field to be much lower, the expected protection time will be considerably longer.

5 Two experiments were performed with no shut-in time. The results indicate that shut-in time gives an enhanced lifetime to the oil soluble inhibitor treatment. This implies that the hydrolysis and the absorption with the concentration driven mechanism need some time. These experiments were performed with 22 hours shut-in time. However other mechanistic studies indicate a shut-in of 3 hours should be more than sufficient in practice.

10 Two experiments were performed with columns filled with oil wet sand. These had the longest inhibitor treatment lifetime of all the experiments. These again point to a concentration driven absorption mechanism. The connate water will only obtain a certain saturation concentration, thus, driving/forcing the absorption of the inhibitor to the matrix.

15 In order to investigate the sequence of the squeeze procedure, two series of three P-MAC experiments were performed where the same amount of inhibitor was squeezed into the columns in three different ways. The experiments gave some indications, but no clear differences between the different squeeze methods.

20 The experiments clearly suggest that a preventive squeeze treatment is achievable. This means that the inhibitor will be retained in the near wellbore area until the formation water is produced.

Claims

1. A method of treating a hydrocarbon well during the completion phase to inhibit problems associated with water production, the method comprising:
5 deploying into the near wellbore region of a well during the completion phase a hydrocarbon-compatible treatment agent in a hydrocarbon phase; allowing the active component of the treatment agent to enter irreversibly the connate water in the well region; and allowing the active component to be retained by the rock matrix in the well region, whereby the active component of the treatment agent
10 actively inhibits the respective problem if and when water is finally produced from the well.
2. A method as claimed in Claim 1, in which the treatment agent is a hydrocarbon soluble material, a surfactant-micelle system or an emulsion.
15
3. A method as claimed in Claim 2, in which the active component is one which hydrolyses on contact with water.
4. A method as claimed in Claim 3, in which the hydrolysis is
20 an irreversible process.
5. A method as claimed in any preceding Claim, in which the hydrolysis renders the treatment agent water soluble.
- 25 6. A method as claimed in any preceding Claim, in which the treatment agent is deployed at the end of the completion programme.
7. A method as claimed in any preceding Claim, in which the treatment

agent is an oil soluble scale inhibitor or a combination of oil soluble scale inhibitors.

5 8. A method as claimed in any preceding Claim, in which the concentration of the treatment agent in the water phase is higher than the concentration in the hydrocarbon phase as a result of the irreversible mass transfer between phases.

10 9. A method as claimed in any preceding Claim, in which the concentration of the treatment agent in the hydrocarbon material as delivered to the formation is >2 wt%.

15 10. A method as claimed in any preceding Claim, in which the concentration of the treatment agent in the hydrocarbon material after delivery to the formation is <1 wt%.

11. A method as claimed in any preceding Claim, in which the concentration of the treatment agent in the connate water after delivery of the hydrocarbon material carrying the treatment agent is >2 wt%.

20 12. A method as claimed in any preceding Claim, in which the hydrocarbon phase is selected from kerosene, lamp oil, diesel oil and crude oil.

Abstract

5 **A method of treating an oil well to inhibit scale formation. An oil soluble scale inhibitor is injected into the well during the completion phase. The inhibitor hydrolyses on contact with connate water in the well and the active part enters the water phase. It remains in the water phase while oil is extracted and until the water breaks through. At that stage, the inhibitor becomes active in inhibiting scale formation.**