Title: DRAINING NETWORK FOR PRODUCING OIL

Abstract: The process regarding "The Exploitation of Oil Deposits Through an Underground Well and Drain Network" represents a new method of oil deposit exploitation, consisting of: the fluids in a deposit (1) are directed to flow by their own energy, through a convergent and/or overlaid closed (4) and opened (5) underground drain network towards the draining area (3) of a field development well (2), through which they are extracted to the surface. The construction and operation of the underground drain (4-5) and of the development well (2) is achieved by the common technologies as required by the concrete technical-geological conditions. The opened drains also have a technological purpose: measurements, special operations, injections. The process will be applied mainly to the exploitation of some deposits located in inaccessible areas or requiring a special environment protection (swamps, populated areas, Alaska, Siberia) because the infrastructure simplification provides a more ecological operation.
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
DRAINING NETWORK FOR PRODUCING OIL

This invention refers to a practice regarding the exploitation of oil deposits through a network of underground wells and drains via which there is formed a common hydrodynamic system that will allow fluids to be extracted by a minimal number of field development wells, making sure of an intensive, more ecological and efficient exploitation; the manner of achievement through its practice is also introduced.

The invention is about to be tested on some oil deposit exploitation, seen in various stages, mainly located in areas which would profit by a particular protection of the environment. The oil deposits cumulate the following conditions: there is no cap gas of large dimensions, the rock container is thick (over 50 m), being litho-logically made up of limes stones, sandstones or consolidated sand, a large area (minimum 500 m in plain diameter) and the main issue is whether the reserve to be retrieved justifies the financial effort.
The common practice shows that the oil deposits exploitation is achieved by descendent vertical field development wells or diverted wells which along the thickness of the crossed deposit show perforations through which the fluids flow into the well from where they are evacuated to the surface, using natural energy (eruption) or supplementary energy (gas-lift, injection, etc.) by using some adequate special equipments and then by pipes they are directed to collecting, separation, processing and storage places.

The number of wells by which the exploitation is achieved is mainly determined by: the size (plain surface) of the deposit, the location and distances between them has in view the fact that each well drains the fluids from a segment of the cylinder-shaped deposit, with a diameter of approximately 100–200 m and a height equivalent with its thickness, named the draining area; therefore the result is that on one deposit the exploitation will be made with one or more wells function of how many different draining areas can be achieved without their interaction.

The inflow of fluids is achieved because of the pressure difference which is created between the deposit and the borehole, as well as an effect of the gravity; it is also affected by the aperture degree (namely by the perforations present in the well column) as well as by a series of parameters of the deposit (the rock pores, the existence of some cracks, the inclination of the header, the fluid viscosity, saturation, etc.), this inflow decreases according as the pressure in the deposit decreases reaching uneconomical flows. Design 1

The disadvantages of this practice are very many and they reside in: the exploitation is achieved by a large number of wells which require large expenses costs for construction, equipment and collecting the extracted fluids; they take large areas of land, require large maintenance and repair expenses both for the wells and for the collecting system affected by a large
wear through the corrosion and abrasion in time; it is energy consuming and polluting; it leads to a diminished factor (coefficient) of the reserve retrieval; a decreased work productivity and its continuous decrease in time as well as the economic efficiency; it also uses insufficiently the natural energy of the deposit, and so on, only to enumerate the most important ones.

The process, according to the invention, eliminates to a great extent the above mentioned disadvantages namely by a substantial reduction of the number of field development wells because for each and every one of them there will be made a (convergent) network of (closed and open) underground drains, similar to an open umbrella with its top down, through which there is insured the interconnection of their draining areas with the draining area of the field development well, which will be located on the most favoured position on the structure, towards which there is made the discharge of the fluids, from where they are evacuated to the surface. The discharge of the fluids in the underground draining network is achieved by using the natural energy of the deposit, the underground drains having the role of some large sized cracks in point of section and length. In order that the drain network should be very efficient it will be built on different levels and (or) in concentric circles given the field development well so that the draining area of each underground drain should interfere as little as possible with the neighboring ones. The building of the drains will be achieved by the adequate current technology, specifying that the crossing of the deposit will be made with anhydrous fluids and that within each drain there will be made at least two well shootings towards its terminal area. The drains will cross the deposit somehow diagonally (inclined) but they will be convergent towards the field development well, they will be liner-cased (3^{1/2}–4 in), thick walled, provided with slits and not cemented, so that the aperture degree should be as large as possible and should insure the free circulation of fluids.
As regards the underground drains open above the deposit, the drilled hole will be cased with casing joint columns (ϕ 4–5 in) on the extension of the liner identical with the one from the closed underground drains, which will be basket (umbrella) cemented and then the cement plug and the floor will be drilled out, thus making possible technological interventions within the underground drain; the temporary closure of the underground drain will be made with retrievable packer. These open drains can be used temporarily in the first stage of the exploitation for extraction via natural eruption. Because they have a multifunctional character the open (technological) underground drains will be dug intertwined among the other closed underground drains on a ratio of 1 to 2 – 4 and through these there can be done measurements and special operations, injection, etc. Outside the first string of underground drains the large sized deposits can take another string of underground drains with the same design as shown above, but which will be directed towards the draining area of the ones situated in the first row, thus increasing the hydrodynamic basin of the field development well or for the very thick deposits there can be achieved overlapped drain networks. The field development well is achieved by large diameter drilling, with installations and adequate current technologies, usually vertically up to under the deposit or inclined up to 20 degrees but without crests (knuckle-joints), its crossing will be done with anhydrous fluids and in different points 3–5 well shootings will be made in order to create large cracks in the rock container saturated with oil, being compulsory made in front of the underground drains. Thus achieved the hole will be cased with a casing joint column ϕ 7–8\( ^{5/8} \) in, thick walled, along the thickness of the deposit and it will be cemented fully, then it will be perforated along the thickness of the deposit, with the recommendation that in case of a cap gas or active bottom water there should be made no perforations about 10 m to the two extremities. The well thus
built will be equipped accordingly with adequate bottom and surface equipment, respectively with tubing and tapping cap, possibly with two lining tubing and packers if two overlaid deposits are being exploited simultaneously or if the discharge is very high. Considering the fact that the field development well will be the only production unit on the deposit or on a section of a large deposit, inside its perimeter from the surface there will be deployed installations of separation, storage maybe processing and transportation that will function in a closed system. Through the underground draining network the fluids flow towards field development wells from where they are evacuated to the surface, the flow taking place under the influence of the hydrodynamic push, of the elastic expansion of the fluids and of the gravity, being favored by the fact that the underground drains have a very good aperture degree, that in the rocks there were made large and small sized cracks by well shootings and as a result the expansion within the field development well is spread alongside all its hydrodynamic system, therefore within the whole deposit and in this way the fluids are concentrated into and towards the field development well by using the deposit energy. The underground drains have a double role, on the one hand to drain the fluids from its own draining area and on the other hand to direct the fluids towards the draining area of the field development well, which will be exploited by using current known technologies. **Design 2 and 5**

The technical problem that the invention solves consists in the exploitation of the deposits function of their size, it can be done through one or several field exploitation wells (production units), thus simplifying to the minimum the fluid collection and transportation system from the surface, which is energy consuming, polluting and very expensive. The fluids in the deposit are concentrated through the underground draining system into the draining area of the field development well by which they are dug out to the
surface, this concentration being made by using the natural energy of the deposit and the gravitational flow, the flow of the fluids being considerably enriched as a result of the intercommunication achieved by the underground draining system. Also there is achieved an uniform evacuation of the deposit, the bottom water flooding of the development wells is delayed.

The facts above show that the author of the invention suggests a new view (thinking) about the oil deposit exploitation materialized in its process and its achievement, which in fact constitutes the inventive, absolutely new activity.

As a result there are given two examples of achieving the process:

**Example 1** Sink type boulder approximately 800m long and 500m wide, approximately 80m thick which is part of a platform type deposit located inside the sandstones which is about to be set for exploitation. **Design 3**

The process according to the invention will be achieved as it follows: boring a development well 2, in the most favored position on the deposit 1 usually vertically or inclined up to 20 degrees but without crests, with a large diameter up to under the base, by using the current adequate technologies, the crossing will be made with anhydrous fluids and on its h thickness there will be made 3-5 well shootings in different points, but being compulsory to be made in front of the underground drains in order to create large size cracks in the rock container, the g borehole thus achieved will be cased with a c casing joint column of r diameter (7-8\(\text{5/8 in}\)) \(\delta\) thick walled (8–10 mm) inside the deposit 1, which will be cemented from its base up to the surface, then it will be perforated alongside the h thickness or 10 m less at its base or roof. If there is active bottom water, respectively sufficient cap gas the borehole will be equipped with t tubing with the k diameter (2\(\text{3/8}-3\text{1/2 in}\)) and E flow head, and in case of dual exploitation retrievable packers will be used. Within the perimeter of the well from the surface there
will be also located separation, storage possibly processing and transportation installations that will function within a closed system. Around the development well 2 there will be achieved several successive strings arrayed concentrically of one or more underground draining networks closed 4 and open 5 that will be made according to the current adequate technologies through small diameter drillings (4–5 in) mainly vertically up to the deposit 1 from where they will be dug diverted (inclined 30–70 degrees) crossing the deposit 1 alongside a diagonally curved trajectory up to the draining area with a d diameter (approximately 100–200 m) of the development well 2 in an imaginary place situated at 30–50 m distance from the base and the column of the well. This crossing will be made with anhydrous fluids and within this segment a there will be made 3–4 well shootings in different points in order to create small and large sized cracks into the rock container; the g’ borehole will be l’ liner cased made up of casing joints in r’ diameter (3½–4 in) thick walled δ’ (6–8 mm) provided with slits with f slots (0.3–0.5 mm) which will not be cemented, in order to obtain a maximum aperture degree, the segment above b will be cemented up to the surface. From the borehole g’ there can be achieved several underground drains closed 4 or open 5 at various depths and directions, taking care that the draining areas 3’ with d’ diameter (maximum 100 m) should not overlap on larger areas. The open underground drains 5 which also have a technological purpose, alongside the b’ segment of the g’ borehole will be cased with a c’ column made up of casing joints in r’ diameter (4–5 in) that will be basket (umbrella) cemented after which the cement plug and the floor will be drilled out in order to open the underground drain 5 from below; because they are also useful for technological interventions the drains will be equipped with tubing t’ in k’ diameter (2¾–2¾/8 in) and flow head E’ and for the closure there will be used retrievable packers p’. In the example taken,
the hydrodynamic system of the development well 2 on the deposit boulder 1 is completed by a network of concentrically storeyed and convergent drains made up of T1 and T2 open underground drains 5 and D1*D9 closed underground drains, specifying the fact that D1 and D2 will be diverted towards the draining areas 3' of the open underground drain 5 neighboring T1 through which the fluids will discharge towards and into the development well 2 from where they will be extracted to the surface, unlike the present practice which might have required 12 development wells with their adequate bottom and surface equipment, as well as a collecting, separation, transportation surface system which is energy consuming, polluting and very expensive.

Example 2 Exploitation deposit stratigraphic trap type with 4 development wells, inclined to 10 degrees, 100 m thick, rock container inside the consolidated sand, retrieval coefficient of the reserve 18%, 600 m plan diameter. Design 4

In order to intensify the extraction on such a deposit the achievement of the process, according to the invention, supposes a complex analysis and research of each well, mainly of the technical status of the columns, of the aperture degree and of the draining area as well as the reserves recalculation, possibly a computer simulation. After this stage is fulfilled well A is picked as the development well 2 inside of which there will be made 2 acid cracks on different timings or a larger acid crack, after which it is attempted the achievement of the underground draining network 4 and 5 in order to retrieve the necessary hydrodynamic system; to this purpose wells B and D will be used out of which there will be accomplished 2 open underground drains 5, respectively T1 and T2 that will be directed towards the draining area 3 of the A well and the column segments from under the drains will be cemented. Outside the draining area 3 of the C well
2 open underground drains will be made 5, respectively T3 and T4, which will also be directed to the draining area 3 of the A well. Out of the C well there will be made 2 closed underground drains 4, overlapped respectively D4 and D5 directed as opposed to the draining areas 3' of the open underground drains 5 neighboring T3 and T4 and under the last drain the column will be cemented. In between A, B and D wells there will be dug the closed underground drains 4 directed to the draining area 3 of the A well. The building of the underground drains 4 and 5 will be made identically as in example 1 specifying that for the achievement of some T1, T2, D4 and D5 windows will be inserted inside the columns of the existent wells (B, C and D) at a convenient depth regarding their trajectory, respectively in one point above the deposit. The example results in the deposit 1 being exploited through a single production unit, the development well 2, respectively well A, whose hydrodynamic system was developed through the drain network made up of: 4 open underground drains 5 respectively T1+T4 and 5 closed underground drains 4, respectively D1+D5 through which the liquids flow to the A well from where they will be extracted to the surface unlike the present practice which might have required the digging of at least 5 development wells with the adequate bottom and surface equipment as well as the completion of the surface collecting system.

The process and its accomplishment according to the invention show the following advantages:

1. a more efficient use of the energy inside the deposit as well as the gravity, through which there will be insured the flow of the fluids towards the development wells from where they are evacuated to the surface,

2. the uniform decompression of the deposit alongside the exploitation period with the expansion of the natural eruption period,
3. the increase of the efficiency of the gravitational flow throughout the exploitation period,

4. simplifying the fluid collection and transportation system to the surface,

5. important diminishing of the land areas taken temporarily or permanently by oil installations,

6. important cuts on energy consumption,

7. important diminishing of the environment pollution,

8. significant decreases of the influence of the natural factors (surveillance and geographic, atmospheric) as well as the operation errors upon the exploitation intensity,

9. the increase of the work productivity and enriching the management as a result of the concentration of the extraction in a few development places,

10. significant expense cuts on building the development wells and the separation and collecting system of the extracted fluids as well as their functioning maintenance.

The materialization of the process according to the invention can be achieved through the present installations and technologies, as required by the concrete geological and technical conditions. According to a sketchy calculus the achievement of the process shown above may insure overall expense cuts by 25-50 % as compared with the process applied up to the moment.
CLAIMS

1. The process referring to the exploitation of deposits through an underground well and draining system is about to be used for the exploitation of some deposits as well as for an intensifying exploitation on old deposits out of which the contained fluids will be intensively exploited, more ecologically and efficiently, via a minor number of development wells provided with common bottom and surface equipment but without a surface collecting system, no longer necessary and defined by the fact that it changes fundamentally the conception about designing and achieving the exploitation of oil deposits, meaning that the extraction is done by a minimum number of production units which will be achieved as follows: around every development well, which will be located in the most favored site there will be made a concentric or overlapped network of open/closed underground draining system that will be convergent to its draining area, thus being made a common hydrodynamic basin through which the fluids inside the deposit flow by their own energy (deposit and gravitational energy) inside the development well from where they are evacuated to the surface. The drains work in a similar way with the development wells inside their own draining area as well as similar with the flowing lines, thus making sure of the fluid discharge inside the whole deposit or inside a part of a larger deposit.
2. An underground well and draining network characterized by its achieving of a hydrodynamic system common with that of the development well (2) through which the fluids inside the deposit (1) are discharged by their own energy towards the draining area (3) of the development well (2) around which there is made a concentric or overlapped and convergent network of closed underground drains (4) and open (5), these having a multifunctional role, that is to drain the fluids inside their own draining area (3) and to direct the fluids just like some "lines", thus achieving their discharge from the whole deposit (1) towards the development well (2) from where they are being evacuated to the surface; the open drains (5) also have a technological role being used for measurements in order to follow the exploitation, to make some operations in order to stimulate the inflow as well as to initiate or achieve some fluid injection processes (CO2, CH4, steam, etc.); the underground well and draining network makes the number of development wells (2) be minimum and the surface lining collection system being no longer necessary.

3. Underground drain characterized by its simultaneous achievement of roles as a development well as well as a fluid leading line towards the draining area (3) of the development well (2). The underground drains may be closed (4) and open (5) and they will be executed via current adequate technologies, through small diameter drillings (3 1/2 – 5 in) mainly vertically up to the deposit (1) from where they will be dug out divertedly (inclined 30-70 degrees) crossing the deposit (1) on a diagonally curved trajectory up to the draining area (3) with approximately 100 – 200 m diameter in the development well (2) in an imaginary point situated 30 – 50 m distance from the basis and the well column (2), this crossing being made with anhydrous fluids and in this segment (a) there will be made 2 – 4 well shootings in different points in order to make small and large sized
cracks into the rock container; the \((g')\) borehole will be lined \((l')\) with casing joints in \((r)\) diameter \((3^{\frac{3}{8}} - 4\text{ in})\) thick walled \((d)\) \((6 - 8\text{ mm})\) provided with \(0.3 - 0.5\text{ mm}\) slits with slots \((f)\) that will not be cemented in order to obtain a maximum aperture degree; the segment on top \((b)\) will be cemented up to the surface.

More opened \((4)\) or closed \((5)\) underground drains may be achieved from borehole \((g')\) at different depths and directions, taking care that the draining areas \((3)\) with \((d')\) diameter (approx. \(100\text{ m}\)) should not interfere on large areas. The open underground drains \((5)\) who also have a technological purpose on segment \((b')\) of the borehole \((g')\) will be lined with a column \((c')\) out of casing joints in \((r')\) diameter \((4 - 5\text{ in})\) that will be basket (umbrella) cemented after which the cement plug and the platform will be drilled out to open the underground drain \((5)\) below; because they are also useful for technological operations, they will be provided with tubing \((t')\) in \((k')\) diameter \((2^{\frac{3}{8}} - 2^{\frac{7}{8}}\text{ in})\) and flowing head \((E')\) and for closure there will be used retrievable packers \((p')\); through this there can be made measurements and special operations, injection, etc.
The conventional method of exploitation

Design no. 1 - Cross section into the deposit
The suggested exploitation process

Design no. 2 – Cross section into the deposit
Section T4 – A

Horizontal view

Design no. 4 – Example 2
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

| IPC | E21B43/30 |

According to International Patent Classification (IPC) or to both national classification and IPC.

**B. FIELDS SEARCHED**

Minimum documentation searched (classification systems followed by classification symbols): IPC 7 E21B

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

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

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Date of the actual completion of the international search: 12 February 2002

Date of mailing of the international search report: 20/02/2002

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