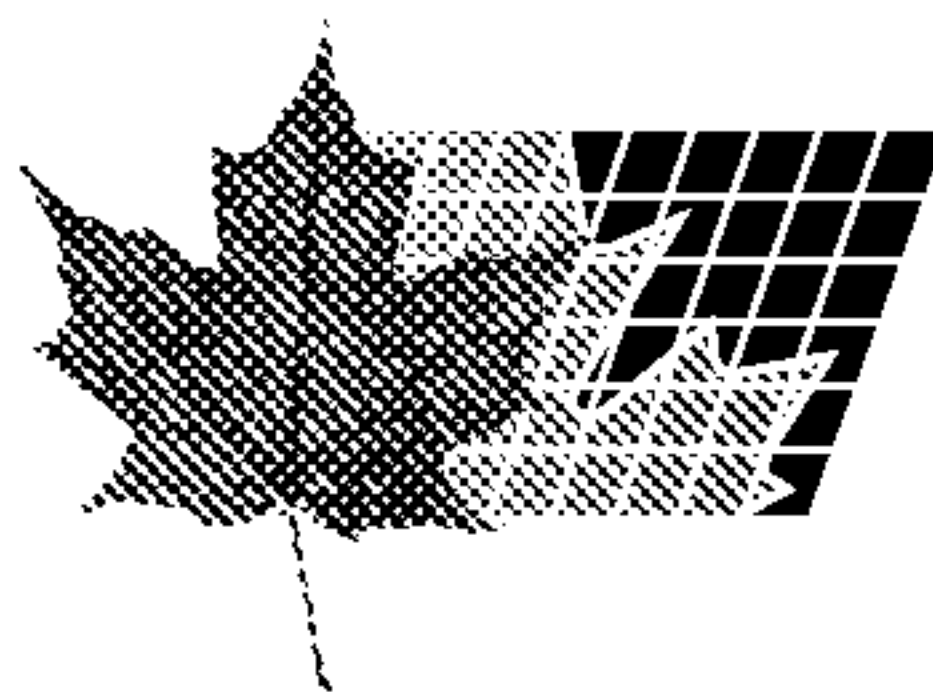




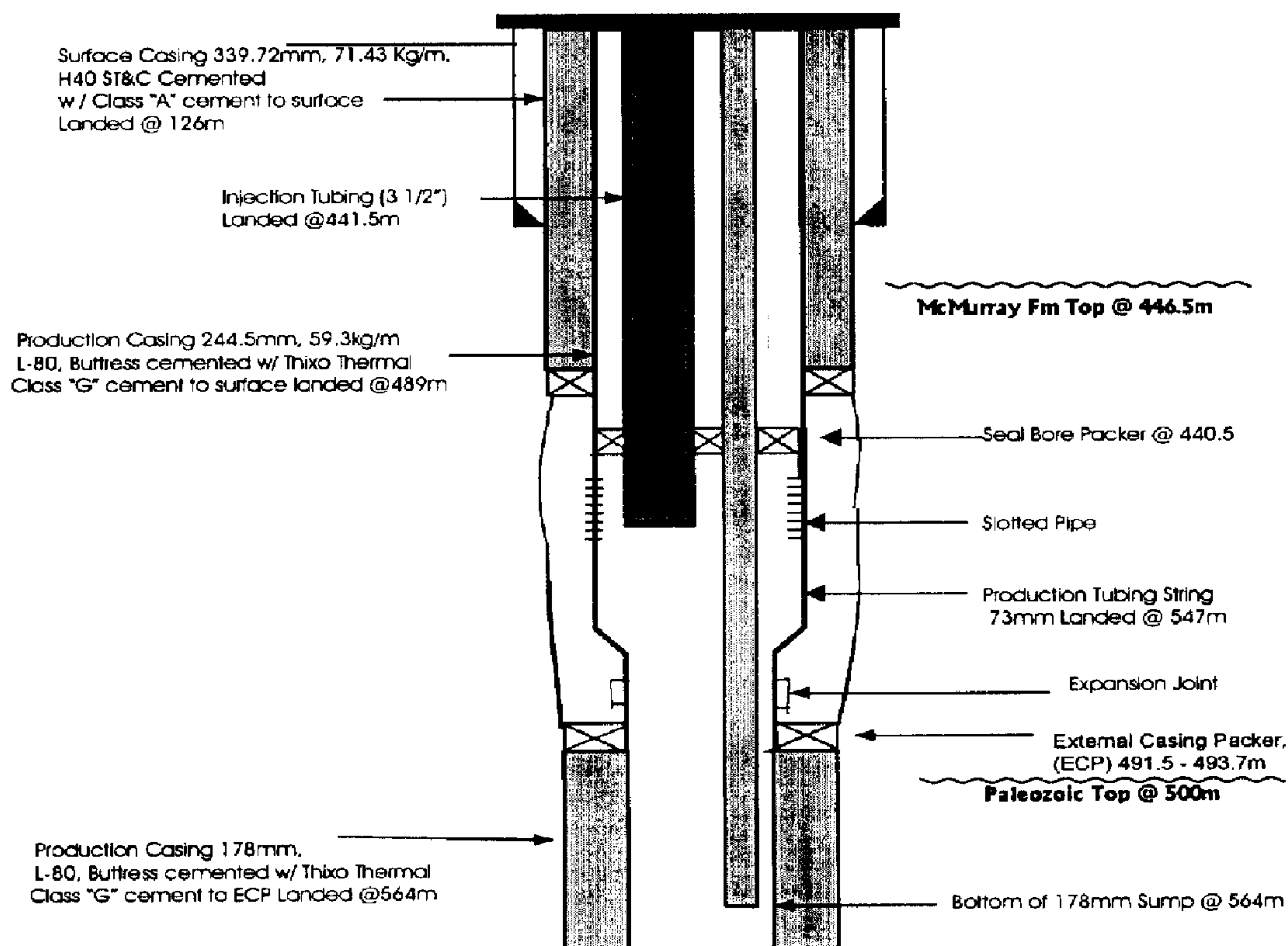
(72) CHHINA, Harbir Singh, CA

(71) ALBERTA ENERGY COMPANY LTD., CA

(51) Int.Cl.⁶ E21B 43/22

(54) **UN PROCEDE NON THERMIQUE D'EXTRACTION EN PHASE
VAPEUR D'HUILE VISQUEUSE PROVENANT D'UN
RESERVOIR D'HYDROCARBURES, A L'AIDE D'UN
SYSTEME EN FORME DE Puits VERTICAL**

(54) **A PROCESS FOR NON-THERMAL VAPOR EXTRACTION OF
VISCOUS OIL FROM A HYDROCARBON RESERVOIR USING
A VERTICAL WELL CONFIGURATION**



K.B. = 674.1m

(57) The invention provides processes and apparatus for the recovery of viscous oil from reservoirs by means of generally vertical wells using unheated hydrocarbon solvents.



ABSTRACT

The invention provides processes and apparatus for the recovery of viscous oil from reservoirs by means of generally vertical wells using unheated hydrocarbon solvents.

**A PROCESS FOR NON-THERMAL VAPOR EXTRACTION OF VISCOUS OIL
FROM A HYDROCARBON RESERVOIR USING A VERTICAL WELL
CONFIGURATION**

5

FIELD OF THE INVENTION

This invention relates to the processes and apparatus for the recovery of hydrocarbons from hydrocarbon deposits, and specifically of viscous oil from viscous oil or bitumen reservoirs, by means of wells drilled into or through the reservoir.

10

BACKGROUND OF THE INVENTION

This invention is concerned with the application of hydrocarbon vapor in a recovery process whose principal flow mechanism is gravity drainage, carried out using vertical wells.

15

Other patents and publications describe a non-thermal recovery process in oil sands and heavy oil reservoirs wherein a hydrocarbon vapor is used to mobilize the bitumen or viscous oil, and the mobilized oil is allowed to drain to a producing point under the influence of gravity. The prior art teaches that such processes should be carried out using horizontal wells because the relatively slow pace of gravity drainage dictates a requirement for a large area of exposure of the hydrocarbon solvent to the reservoir, and this can be best achieved with horizontal wells.

20

For example, a seminal publication by Butler and Mokrys in 1991 (Reference 1) described a process, referred to thereafter in the industry literature as "VAPEX". The process involves utilizing a hydrocarbon solvent, such as propane, in the vapor form, as a means of dissolving the viscous oil in the reservoir. The solvent is introduced into the reservoir at a horizontal injection well, and the mobilized oil drains into an underlying horizontal producing well parallel to the injector. It is important to note that liquid solvents had been proposed prior to the disclosure of the VAPEX process. However, the

30

lower diffusivity of liquid solvents, and the smaller density difference between the liquid solvent and the oil, produce a slower rate of oil recovery using a liquid solvent. In other words, the rate at which oil is mobilized by the solvent, and the rate at which the mobilized oil subsequently drains down to the producer well, are typically very slow with a liquid solvent. Butler and Mokrys proposed the use of a solvent which is introduced in the vapor form, and which is close to its dew point. The introduction of a solvent in the vapor form was proposed to mitigate the abovementioned problems associated with liquid solvents.

One publication disclosing a solvent-based gravity drainage process utilizes vertical wells. However, it includes, as an integral part of the process, pre-heating of the solvent. Specifically, a publication by Duerkson and Eloyan in 1995 (Reference 2) describes a solvent-based process involving vertical wells in which recovery occurs by gravity drainage. However, in their process, the solvent is vaporized by heating.

In summary, the prior art discloses non-thermal solvent-based gravity drainage processes for horizontal wells, and a thermal solvent-based gravity drainage process for vertical wells.

SUMMARY OF THE INVENTION

The present invention provides methods of viscous oil recovery using a solvent in the vapor phase, wherein heating is not required to achieve or maintain the vapor state of the solvent. The solvent vapor contacts the viscous oil and mobilizes it. The oil, thus mobilized, drains downward under the influence of gravity. The invention is applied at one or more vertical, or substantially vertical wells. That is, the solvent is injected into a vertical well, and the mobilized oil is produced either through that same vertically oriented wellbore or through another nearby vertically oriented wellbore.

More specifically, the method involves providing one or more vertical, or substantially vertical, wells which partially or fully penetrate the reservoir. At one or more of the vertical wells, a non-thermal process is initiated whereby a hydrocarbon vapor solvent is

injected so as to bring it into contact with the oil in the reservoir. The hydrocarbon vapor increases the mobility of the oil by means of diffusion or other mixing mechanisms, whereupon the oil is permitted to drain under the influence of gravity to the lower reaches of the wellbore. From there, the oil is lifted to the surface through one or more of the
5 vertical wells.

The process comprises three elements as follows:

1. The utilization of an unheated hydrocarbon solvent in the vapor phase to mobilize the oil.
- 10 2. Gravity drainage of the mobilized oil to a collection point.
3. Application of the process described in points 1. and 2. above by means of one or more vertical wells.

The combination of these elements in appropriate ways, as described herein, provides a process for recovering viscous oils from their reservoir lodgements.

15

EMBODIMENTS OF THE INVENTION

Embodiments Pertaining to Enhancement of the Recovery Mechanism

In many viscous oil reservoirs, the area capable of being exposed to a vertical wellbore is much less than the area which can be exposed to a horizontal wellbore. Thus diffusion
20 and oil mobilization will be slower in the vertical wellbore, as will the rate at which mobilized oil enters the wellbore. Consequently, one might expect the overall recovery process to be slower in a vertical well.

There are, however, some important circumstances that can improve the attractiveness of
25 the vertically oriented process, in addition to the generally lower cost of vertical wells compared to horizontal wells. Three such embodiments are described as follows:

1. If there is a mobile phase, such as gas and/or water, in the form of either distinct zones in contact with the viscous oil reservoir, or in the form of saturations within
30 the pore structure of the oil-bearing zone, or both, the solvent vapor may be injected so as to penetrate further into the reservoir matrix using these mobile fluid phases or

zones as conduits. Thus, by imposing a convection mechanism, and not simply relying on molecular diffusion to disperse a solvent, an effectively large area of contact is generated between the solvent vapor and the viscous oil, even in a vertical well. This accelerates the rate at which viscous oil is mobilized by the solvent. Although these mobile phases might also be available to a horizontal well, the state of the art of horizontal well completions precludes the degree of control of fluid injection and production that is routinely achieved with vertical wells.

2. It may be desirable to inject a precursor fluid prior to injecting the solvent. A typical precursor fluid might be natural gas. The purpose of the precursor fluid would be to either create a higher mobility path ahead of the solvent, or to provide conditions for the solvent to achieve the desired phase behavior characteristics, or both. The state of the art of vertical well completions is such that better control of the injection profile in the vicinity of the well, would be afforded by a vertically oriented well than by a horizontally oriented well.
3. The mechanism described in item 1 above, and enlarged upon in item 2 above, can be further enhanced if the solvent vapor is injected into the vertical well at pressures that exceed the fracturing or parting pressure of the formation. This will expose an even larger area of reservoir matrix to the wellbore, and will permit a greater rate of diffusion of the solvent into the viscous oil. The resulting induced fracture may be intentionally propped open using a suitable propping medium, or may simply be allowed to behave in accordance with the fluid-rock mechanics of a fracture into which no proppant has been intentionally introduced. The presence of a fracture, in addition to facilitating diffusion of the solvent in the viscous oil, will also expedite the rate at which the mobilized oil drains downward to its collection point. Again, the state of the art of horizontal well completions with respect to inducing a fracture and propping it open has not been developed to any degree, and certainly not to the degree to which the technology has been developed for vertical wells.

Embodiments Pertaining to Process Operating Sequence

The steps of the process, involving a) introduction of the solvent so that it contacts the viscous oil, b) mobilization of the oil, c) gravity drainage of the oil to a collection point, and d) production of the mobilized oil, may proceed in such a manner that solvent injection and fluid production are ongoing concurrently. Alternatively, one may wish to inject the solvent in batches rather than continuously. In that instance, production could either proceed continuously, or could be scheduled to occur in discrete production windows.

10

Embodiments Pertaining to the Vaporized Solvent

The solvent vapor can consist of either a pure substance or a mixture of substances. For example, in come circumstances, a pure substance such as ethane may be suitable. Alternatively, one might wish to employ a mixture of, say, methane and butane in appropriate proportions.

20

Embodiments Pertaining to Vertical Well Equipment Configuration

There are many ways in which a vertical well, or an aggregate of vertical wells, can be configured so as to utilize the recovery process described above. The particular choices will depend upon the characteristics of the reservoir, including but not restricted to lithology, fluid properties, fluid distribution, depth, pressure and temperature. Those choices will also depend upon the solvent properties, and upon equipment constraints and cost considerations. Configuration will also depend upon recovery process strategies, such as the use of induced fractures or precursor fluids.

The well can be completed so that only the oil zone is exposed at the wellbore. Or, if there are associated gas and/or water zones, it can be completed so that one or more of

these zones are exposed as well if this is advantageous. The exposure of the reservoir to the wellbore can involve one continuous interval. Alternatively, the exposure may be designed to occur over one or more segments of selected length which do not span the entirety of the target zone(s).

5

The well can be completed so that there is no isolating mechanism, such as a packer, within the wellbore. Or, the well can be completed so that portions of the open interval are isolated, one from another, by an isolating mechanism.

10 Figure 1 attached illustrates one of many possible configurations. It shows schematically one specific embodiment related to vertical well equipment configuration. It should be understood, however, in relation to all of the embodiments herein described, that the present disclosure is to be considered an exemplification of certain principles of the invention and is not intended to limit the invention to any specific embodiment so
15 described.

In the specific example presented in Figure 1, solvent vapor, or any other precedent injection fluid as described previously, is injected down the 3 ½ inch Injection Tubing. The solvent enters the reservoir through the upper portion of slots in the Slotted Pipe,
20 diffusing into and mobilizing the viscous oil. Mobilized oil drains downward and enters the wellbore through the lower portion of slots in the Slotted Pipe. Once in the wellbore, the oil, together with any other reservoir liquids that have entered the wellbore, migrates to the lower reaches of the wellbore, and specifically to the 178 mm Production Casing, which is blanked off. The Production Tubing string is bottomed in the lower reaches of
25 the wellbore, so that any action taken to raise fluids up the Production Tubing, as may be done for example by pumping or gas lifting, will collect the oil and associated liquids and bring them to the surface. Note that in this specific example, a Packer is used to isolate the active process region of the wellbore from the region above.

30

Embodiments Pertaining to Well Groupings

The embodiments described above may be applied on either a single well or a multiple well basis. In the case of multiple wells, those wells may be functioning as an aggregate of isolated wells, or two or more of the wells may be in communication with each other through the reservoir. Where such communication exists, the locations at which solvent is injected and fluids are collected may be configured as desired, both laterally among wells and vertically within each wellbore.

10

REFERENCES CITED:

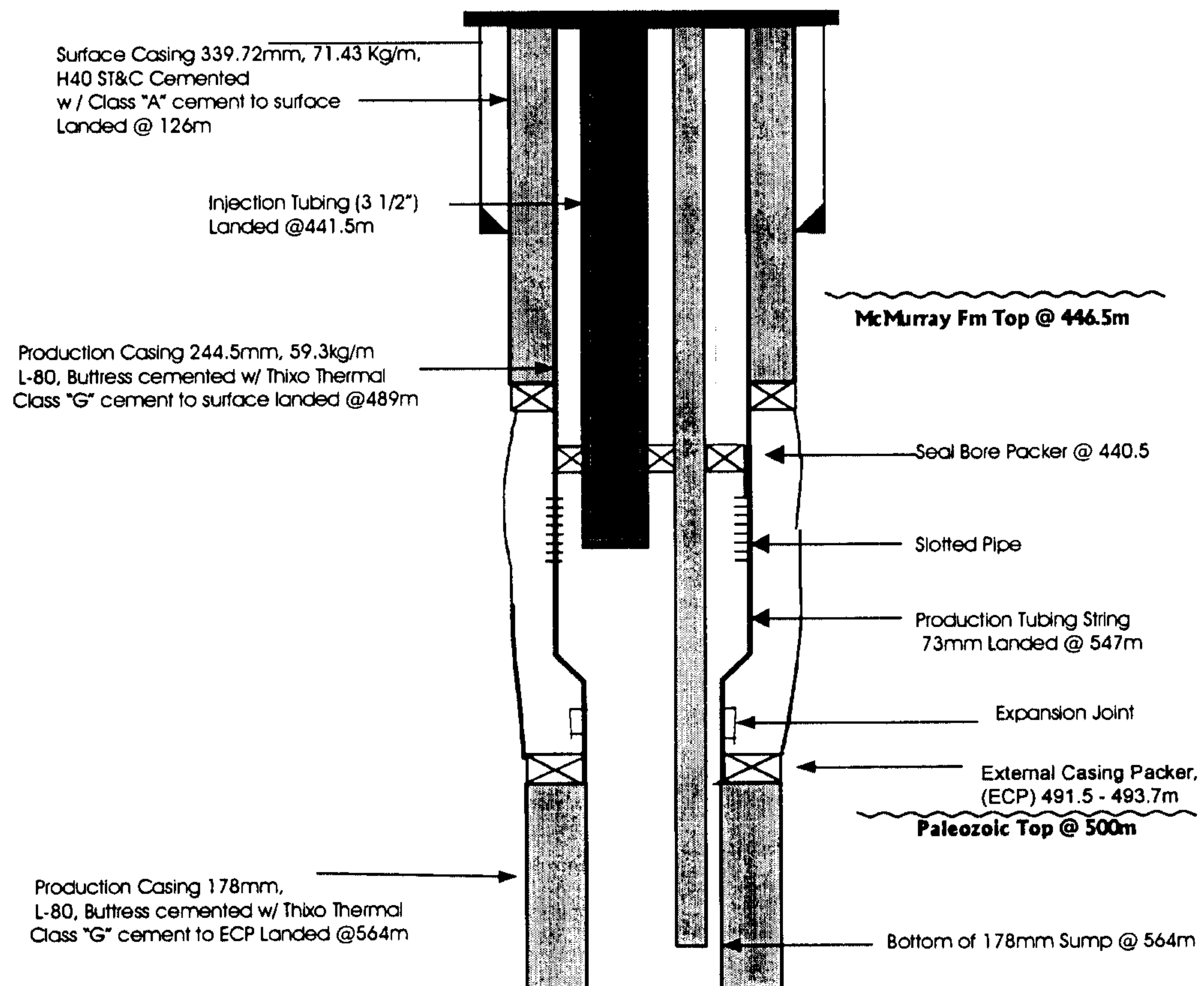
1. BUTLER, R.M., MOKRYS, I.J., A new process (VAPEX) for recovering heavy oils using hot water and hydrocarbon vapour; *Journal of Canadian Petroleum Technology*, Vol. 30, No. 1, pp.97-106, January-February 1991.
2. DUERKSEN, J.H., ELOYAN, A., *Evaluation of Solvent-Based In Situ Processes for Upgrading and Recovery of Heavy Oil and Bitumen*, UNITAR Conference, Houston, Texas, February 12, 1995.

What is claimed is:

1. A process for extraction of viscous oil from a reservoir, comprising:
 - a. providing one or more generally vertical wells in a viscous oil reservoir;
 - 5 b. injecting an unheated hydrocarbon solvent into the reservoir through one or more of the wells, wherein the solvent is in the vapor phase at ambient temperature and pressure in the reservoir;
 - c. allowing the solvent to mobilize the viscous oil, to produce mobilized oil that migrates towards the bottom of one or more of the wells under the
10 influence of gravity;
 - d. extracting the mobilized oil through one or more of the wells.
2. The process of claim 1 further comprising the initial step of injecting a precursor
15 fluid into the reservoir prior to injecting the solvent.
3. The process of claim 1 or 2 wherein the reservoir comprises a mobile fluid zone and at least one of the wells through which solvent is injected into the reservoir is located in fluid communication with the mobile fluid zone.
- 20 4. The method of any one of claims 1, 2 or 3 wherein the solvent is injected at pressures that exceed the fracturing or parting pressure of the reservoir.
5. The method of claim 4 further comprising injecting a propping medium into the
25 reservoir to prop open fractures in the reservoir created by the solvent.

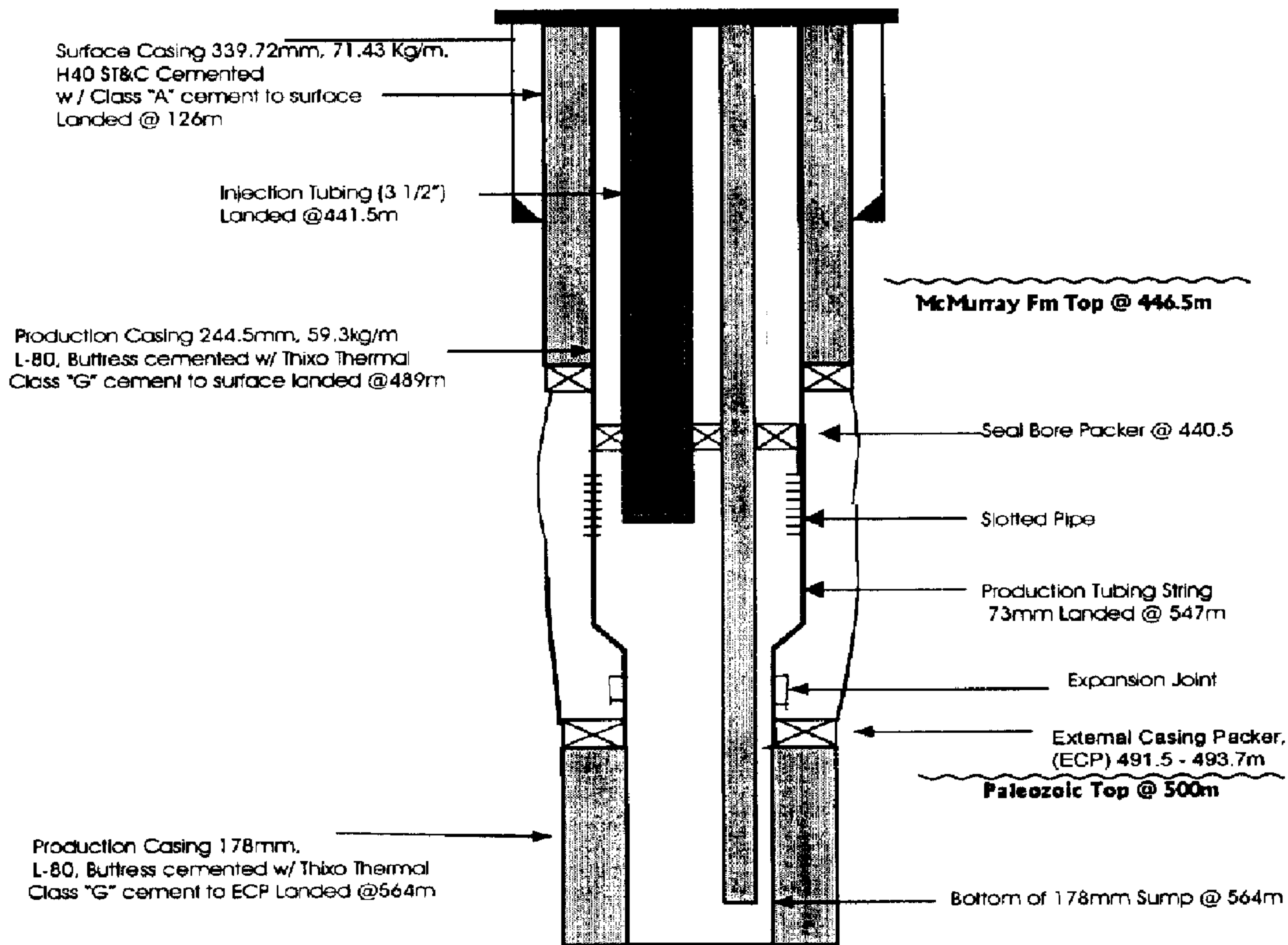
AEC D1 Fisher 1-21-70-4W4

Wellbore Schematic



K.B. = 674.1m

Figure 1



K.B. = 674.1m