IMPROVING SW-SAGD (SINGLE WELL STEAM ASSISTED GRAVITY DRAINAGE)

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Abstract. *The goal of the present work is to study several strategies to improve performance of the Single Well - Steam Assisted Gravity Drainage (SW-SAGD), a new but promising thermal recovery technique aimed at the exploitation of heavy oils. The strategies are basically made up of two measures: cyclic steam injection prior to the main injection-production process; and wellbore splitting into injection and production zones by packer settings. The measures are scrutinized when used separately or together. Cyclic injection is varied according to cycle duration. Comparisons are made between the performance of oil recovery for the developed strategies and the performance of the traditional dual well SAGD technique with similar operating parameters and field conditions. The results point out the best strategy regarding key parameters such as the oil recovery factor and the steam oil ratio. Results were also verified for variations of rock and fluid properties in the range of a typical heavy oil reservoir. As a result, a new strategy for the SW-SAGD process is presented, providing oil recovery, which is higher than that yielded by the equivalent DW-SAGD.*

Keywords*: SAGD, SW-SAGD, Single Well Flooding, Reservoir Simulation, Thermal Recovery*

1. Introduction

One can only recover a fraction of oil from petroleum reservoirs. Most of it remains in the reservoir due to the complexity of the reservoirs and the little efficient recovery mechanisms. Therefore, the study and the development of methodologies that increase the extraction of residual oil are extremely necessary.

There is a demand for tertiary recovery techniques in the Brazilian terrestrial reservoirs with large volumes of heavy and high viscosity oils (^{0}API smaller than twenty), where the primary and secondary recoveries are inefficient. In other words, produce petroleum using other energy sources and/or physical, chemical or biological effects, which increase the recovery factor. Thermal methods that are used mainly to improve the drainage of viscous or bituminous oils stand out among the special recovery techniques.

The introduction of heat in the reservoir causes the increase of rock and fluid temperature, reducing the oil viscosity and residual saturation of the oil. The introduction of heat is usually carried out by the injection of hot fluids, in processes known as cyclical injection of steam and continuous injection of steam. The objective of thermal recovery is to heat up the reservoir increasing oil mobility, and displacement efficiency and consequently oil recovery.

In agreement with Rose et al. (2006), the injection of hot fluid is applied in viscous oils between 10 and 20 ^{0}API, because these are more susceptible to the viscosity reduction by heat. And in reservoirs with less than nine hundred meters of depth, due to the fact that there is less heat throughout the well and to the adjacent formations. Also, the latent heat is greater at lower pressures. Formations with permeability greater or equal to 500 MD are better, because it is easier to drain viscous oils there. The technique is applied to formations with an initial saturation greater than 0.15 m^3 (cubic meters) of oil per m^3 of rock, for a better chance of economical success, and in sandstone thickness exceeding ten meters, to limit the proportionality of the heat losses to adjacent formations. By energy conservation analysis, at least a cubic meter of oil should be recovered for every 15 m^3 of injected water as steam, should also be observed, because generators fed by oil can convert about 15 m^3 of water to steam for every m^3 of burned oil.

Vertical or horizontal wells or their derivations can all be used in steam injection, as well as in the production of liquids. The use of horizontal wells has been seen as advantageous. The disadvantage of the vertical well is its contact restriction with the thin horizontal formation reservoir. The projects for thermal recovery using horizontal wells have been effective, as mentioned by Anderson et al. (1988). Steam injection used the SAGD - steam assisted gravity drainage – process in horizontal wells, where two horizontal wells are used, one for steam injection and another for the production of the fluids.

There are two points that motivated the study of the process of injecting and producing in the same horizontal well. The first, is that in heavy oil reservoirs where the application of steam in the recovery is efficient, the cost of perforation and completion of a horizontal well to inject steam and another horizontal well to produce the fluids is very high, especially when the reservoirs are deeper; and the second point, is that there will never be enough vertical space in the reservoir for the perforation of a second horizontal well, which would make the injection process and production in separate wells unfeasible.

A comparison of the steam injection process is carried out in this study, using numeric simulation with the CMG-STARS simulator when there are two configurations: with two wells (DW-SAGD) and with only one well (SW-SAGD). The process with only one well is exploited in procedure variations with pre-heating application, that is, with the application of the cyclical injection, repeated three times, previous to the administration of continuous steam injection. Results obtained with primary recovery process simulation are shown in order to present the gain obtained with thermal recovery.

The physical model of the reservoir; the used discretization; the fluid model; and the operational conditions are similar in all of the assays and the results are compared through the indicators of the oil recovery factor and of the oil-steam ratio (OSR).

2. DW-SAGD – Dual Well Steam Assited Gravity Drainage Process

One of the main factors in continuous steam injection assisted by gravitational drainage is the natural production mechanism due to gravity. Together with the fact that the horizontal well presents greater contact with the formation in the whole extension of the well, the mechanism provides a quick cover of the whole volume of the reservoir and a larger recovery in less time. This process involves two horizontal wells, identified as "Dual Well Steam Assisted Gravity Drainage" (DW-SAGD), parallel and placed vertically one above the other.

Butler and Stephes (1981) patented this process and in this configuration type, the superior well is used as the injector and the inferior well as the producer. Steam is introduced continuously close to the bottom of the reservoir by the well injector and tends to rise. Contrary to this, the condensed steam and the warm oil tend to go down. All of the steam that enters the formation, after condensation due to contact with the cold bed, along with the mobilized oil, drains to the oil-steam interface, where the steam chamber is being formed. The viscosity of the oil heated by the latent heat of the steam is reduced, which enables it to drain into the producing well by gravity. As saturation is also decreased, the space where oil was removed from is now filled by steam, up to the extreme points of the chamber inside the reservoir. That is, the mobile oil and the condensed water drain towards the producer, while the steam continues in ascension inside the formation, maintaining constant pressure in the chamber.

The chamber expands upward as well as sideward. The vertical growth is limited by the top of the reservoir, while the horizontal increase continues until the lateral limits. Figure 1 illustrates this process.

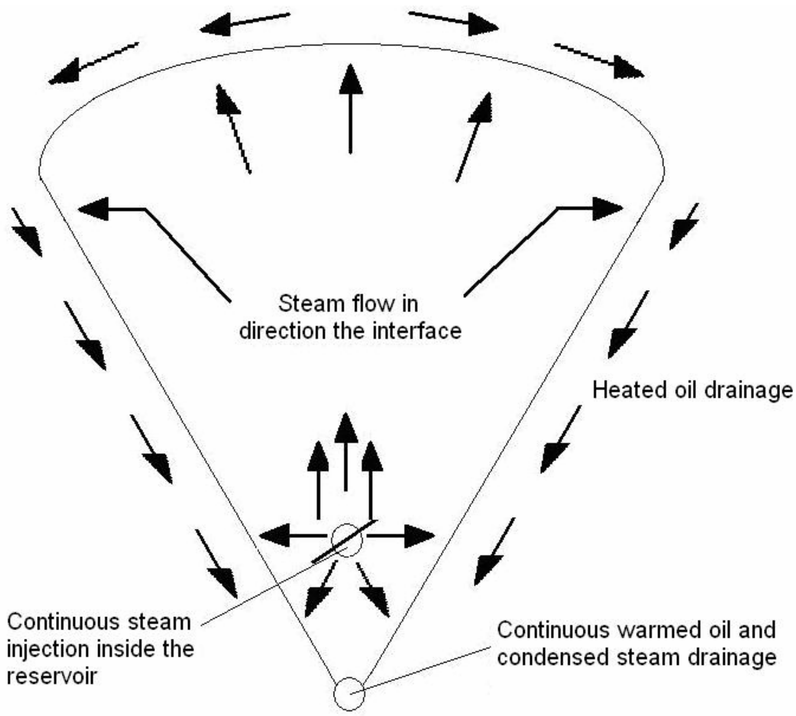

Figure 1. Gravitational drainage (DW-SAGD) scheme.

3. SW-SAGD – Single Well Steam Assited Gravity Drainage Process

The principles of the SW-SAGD process are the same as the DW-SAGD, but steam injection and oil production occur in the same well. This strategy option can be interesting so as to reduce the high cost of perforation and completion of two horizontal wells, and also for technically enabling the process in reservoirs with very fine thickness, where there is not enough vertical extension for the perforation of a second well. In this configuration, an isolated concentric tube (ICCT) located inside the well is used to take high quality steam to the final extremity of the well, and the annulus is used to produce fluids from the formation.

Falk et al. (1996) carried out an investigation on the ICCT technique that is justified due to reduction in the loss of heat to the neighboring formation. Two important aspects are fulfilled by the technique. First, the development of the steam chamber depends on the difference of density between the injected steam and the "in-situ" oil. If there is excessive heat loss in the transfer, the quality of the injected steam will be low and, therefore the difference of density between the injected steam and the "in-situ" oil will be reduced, retracting the steam chamber, and consequently reducing oil production. Second, without the isolation of the concentric tube, the heat lost to the annulus vaporizes the water inside, causing problems in the production pump located in the heel of the well.

Nzekwu and Pelensky (1997) patented this concept of using the same well to inject steam and to produce fluids. The authors point out that the steam chamber grows vertically towards the top of the reservoir under the influence of the gravitational buoyancy. And it grows laterally due to the transfer of heat in the extremities of the chamber and to the convective flow due to the high pressure of the steam injection. On the other hand, steam displacement along the horizontal well, that is, from the tip of the well to the heel, is carried out by pressure increase caused by steam injection in the tip of the well and a small pressure drop within the annulus towards the heel, as a result of the drainage friction between the injector tube and the slotted "liner."

Ashok K. et al. (2000) observed that the use of a same well for injection and production involves a significant risk that a portion of the steam returning through the well without entering the reservoir would close itself off in a short circuit. According to Shen C. (1998), this is due to the fact of the capillary pressure prevents steam flow into the rock, causing the oil recovery to be very low. The authors also verified that the temperature distribution inside the reservoir is not uniform and the heated area around the well varies a lot along the length of the well, as shown in figure 2. In the heated area, the pressure gradient along the well causes a partial movement of oil towards the heel of the well and it influences a great deal the amount of steam that enters the formation and the amount of oil and condensed water that are produced in the producing well. Besides, some steam always returns along the well without entering the reservoir, deviating into a short circuit.

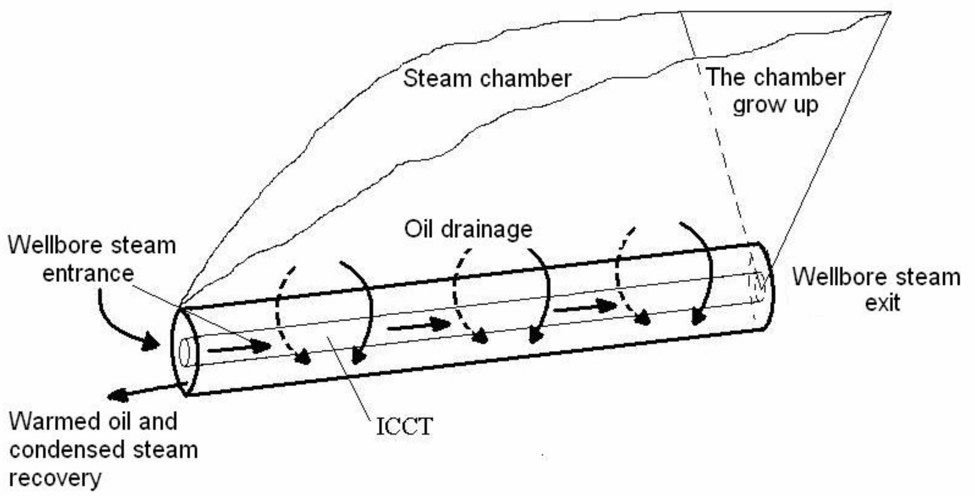

Figure 2. Scheme of the steam flow in the SW-SAGD process. Modified from Ashok et al.(2000).

4. Improvement Strategies for SW-SAGD

Some application strategies for the simple SW-SAGD process, were tested so as to accelerate the entrance of the steam in the formation using continuous injection, which is prevented by the capillary pressure "barriers", and hindered by the high pressure of the reservoir, and with the objective of better distributing the heat along the length of the well,.

4.1 SW-SAGD process with three cyclical stages

In the original SW-SAGD, the steam only enters the formation through the tip of the well and is soon recovered by the annulus. Without the pre-heating phase, the steam chamber only begins its ascension inside the reservoir, if the heat injected through the pipes reduces the viscosity of the oil. However, this only occurs after heat conduction coming from the steam of a short circuit. The steam does not enter the formation due to the capillary pressure barrier and convection does not interfere. Conduction is a slow process and it takes time for the oil around the tip of the well to be produced and steam occupies the spaces left behind and the known SAGD process is settled.

To accelerate the entrance of steam in the formation, before beginning the SW-SAGD process, a pre-heating phase is set up. Cyclic injection repeated three times was chosen for the pre-heating phase, along with the duration of each period (20, 10 and 30 days for injection, soaking and production respectively), based on the results by Elliot and Kovscek (1999).

4.2 SW-SAGD process - two well segments with three cyclical stages

Another improvement strategy, also studied by Elliot and Kovscek (2001), is cyclical injection followed by a continuous injection in a one well configuration divided into two sections. An injection section and a producing section separated by a packer. The cyclical injection operates along the whole extension of the well, that is, in both sections. On the other hand, the continuous injection is carried out only in the injection section. As a result, it is expected that the cyclical injection will offer more favorable conditions for the heating of the area close to the well, improving the final outcome. And the short circuit of the steam in the continuous injection is hindered by the separation of the injection and producer sections. The packer interrupts the oil production in the annulus, in the injection section, so that the steam will just enter the formation, without being recovered, delaying a short steam circuit.

Figure 3 illustrates the process of previous cyclical injection in this strategy. Firstly, the steam tends to enter the reservoir through the tip and through the annulus. The injection occurs through both sections of the well. As there is no production in this period, most of the steam enters the formation through the "liner". After the soaking period, the producer is opened, the drained oil is recovered and the whole cyclical process is repeated twice.

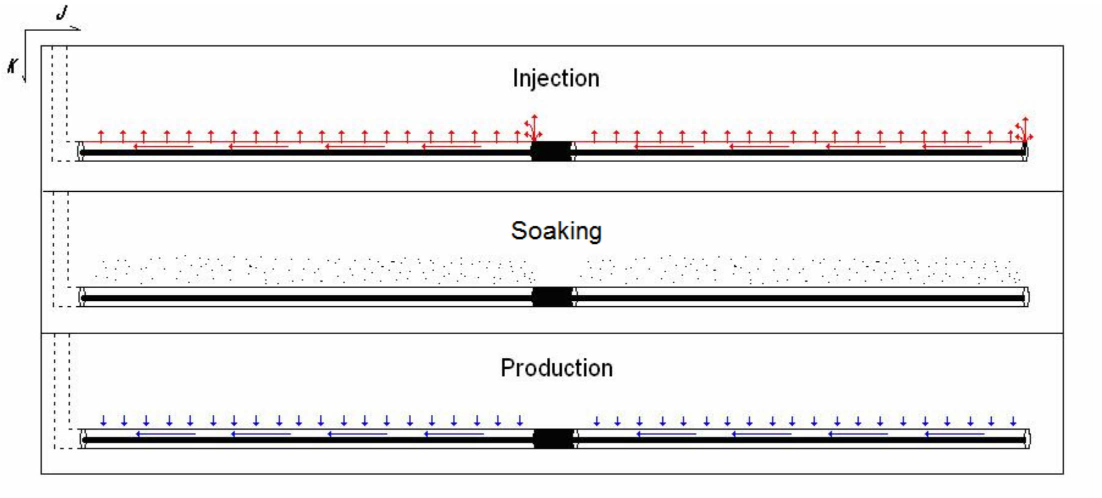

Figure 3. Cyclical stage with packer in the well.

The continuous injection in the tip of the well is initiated with greater space for the entrance of the steam in the porous formation due to the greater removal of oil in the pre-heating phase. An attempt is made to heat up a large volume in the bed close to the injector passage, due to the division of sections for the packer, and after that for the fluids to be produced in the other half, in the production section, as shown in figure 4. The steam tends to fill out the porous space and heat up the oil in the area around the injector passage before reaching the production section.

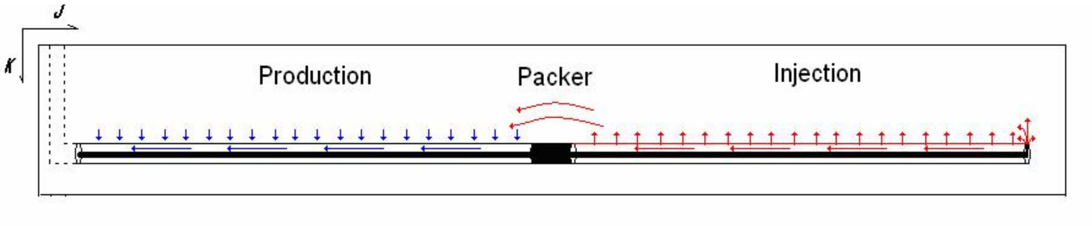

Figure 4. Continuous injection stage with the packer in the well.

5. Comparison between strategies

The comparison of the of DW-SAGD, SW-SAGD primary recovery process, with the different strategies - pre-heating and use of the packer, is carried out based on results shown through graphs and figures. Comments and observations are added to the results.

The operation time for all of the assays is ten years. This period of time was stipulated based on the observation of the thermodynamic limit of the oil-steam ratio (OSR) for the DW-SAGD process, taken as reference from the Barillas (2005) studies.

5.1 Primary recovery, DW-SAGD and SW-SAGD processes

Table 1 displays the accumulated production of oil, the recovery factor and the accumulated production and injection of water for all three assays. It can be observed that the recovery factor is significantly larger with steam injection, approximately double with only one well and the quadruple with the double well.

Table 1. Production for the recovery processes.

Type of Recovery	Final date	NP (Mm3)	RF (%)	WP (Mm3)	WI (Mm3)
DW-SAGD	29/12/2009	16.25	31.74	380.56	365.00
SW-SAGD	29/12/2009	7.97	15.70	369.10	365.00
Primary	29/12/2009	4.79	9.43	0.056	365.00

It has been verified that the SW-SAGD process presents an accumulated production of water similar to the DW-SAGD process, but a smaller oil recovery factor, under the same operational conditions. This occurs because in DW-SAGD, the steam enters the formation first, heating up the whole surroundings of the well, without being recovered. Only after the beginning of the production, when the communication between the well injector and the producer is established, does the gravitational drainage process take place. The steam, then, occupies the spaces where the oil is drained from, it creates a wide steam chamber around of the whole length of the wells and it acts at the same time in practically the whole reservoir.

Figure 5 displays a comparison between the primary recovery and the recovery improved by the two SAGD processes. The curve regarding DW-SAGD, presents no significant increase in the recovery factor after reaching 31.35%, half way through 2007. The stabilization of the curve suggests that the process has run out of its recovery potential. The number here observed is certainly associated to the process parameters adopted for the assay, among them: residual oil saturation; rock permeability, oil viscosity; and factors such as the non completion of the wells in the whole length of the reservoir and the positioning of the wells. This last one can cause notable effects, such as oil accumulation in the inferior part of the producing well, even if the production well is almost at the base of the reservoir. On the other hand, in the SW-SAGD process, it is difficult for stabilization of the curve to occur; therefore the effect of the gravitational drainage does not occur at the same time in the whole length of the well. That is, due to being a punctual injection, the recovery of the oil first takes place in the proximities of the end of the well, where the growth of the steam chamber, after reaching the superior and lateral limits of the reservoir, is driven towards the heel. One of the disadvantages of the SW-SAGD process is exactly the time it takes to recover the oil in the whole length of the well in the reservoir.

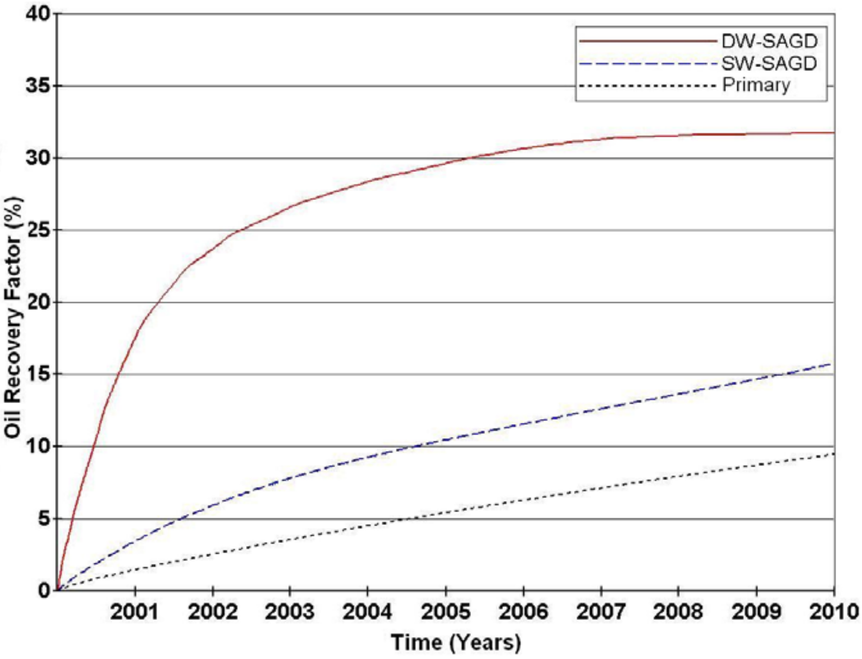

Figure 5. Recovery factor for all three processes.

5.2 SW-SAGD process with three cyclical stages

With cyclical pre-heating strategy, the steam injected by the extremity of the pipes should immediately penetrate the reservoir, but, due to the capillary pressure "barriers", the compressibility of the rock and the pressure of the reservoir, part of that steam returns through the annulus, in a type of short circuit. So that the supplied heat acts on the reservoir with a better performance, the production well is closed and the steam that is in the annulus enters the formation by perforations located in the covering along the horizontal well, in an injection process similar to DW-SAGD, however, carried out through the producing well. After 20 days injection, the well injector is closed for a 10 day waiting or soaking period, in such a way that the inserted heat dissipates to all sides around the well. Later, with the opening of the production well for 30 days, the mobilized oil, along with the condensed water from the steam in contact with the cold area of the bed, is drained by the same perforations of the covering that were previously used for injection, and produced in the annulus.

An opening is generated for larger contact of the steam with the oil area around the well after the cyclical stage. With the beginning of continuous injection, in the SW-SAGD process, the steam tends to occupy the empty porous spaces left by the oil removal. In other words, the expansion of the chamber begins at the tip of the well, allowing the transfer of heat through conduction and convection to the cold sections of the reservoir, to the heel of the well. But, while the latent heat of the steam of that continuous injection does not reach the heel, oil production by gravitational drainage in this place remains low and is carried out by the heated fluids from the previous cyclical process.

Although there is porous space between the well and the reservoir due to the removal of the oil for the pre-heating process, the performance of the steam at the beginning of the continuous injection remains restricted, after being punctually carried out at the extremity of the concentric tube. The steam does not move forward on the whole horizontal extension of the well in the reservoir. The promoted porous space is not enough for the conduction of steam to the heel of the well. The gravitational drainage of the oil inside the production well occurs only after viscosity reaches drainage point.

One can observe in Figure 5, the constancy of the inclination of the production curve, even after the middle of 2005. The injection continues being punctual and the ascension of the steam chamber takes place firstly upward until reaching the top of the reservoir to later expand sideways. Thus, there are areas where the oil impregnated in the formation is not totally removed until the end of the 10 year-old simulation.

In Table 2, the accumulated production of water (Wp) presents the same values approximately for the three studied thermal processes. This result is coherent with the injection operational conditions for a common rate for the three cases and for a same production period. The small difference among them can be explained by the connate vaporized water, for the amount of condensed water that remained in the formation at the end of the simulation period (10 years); and because the injection is not used in the cyclical stage during the soaking and production periods,.

5.3 SW-SAGD process - two segments of wells with three cyclical stages (Case 0)

In this strategy, the well is divided by a packer into two sections. The well is now made up of a passage injector and a production passage, but it continues being only one well, with pipes and an annulus. These sections are activated after the cyclical injection stages.

With the space for the entrance of steam in the porous formation due to the greater oil removal in the pre-heating phase, the continuous injection in the tip of the well in initiated. As seen in the DW-SAGD process, the steam first penetrates in the formation along the whole extension of the injector for the fluids to then be recovered in the producer, obtaining a great recovery factor. In Case 0, a great volume is heated in half of the bed, close to the injector passage, and later the fluids are produced in the other half, in the production passage section. The packer is the barrier to the immediate production of fluids. The steam tends to fill out the porous space and to heat up as great as possible a mass of oil before reaching the exit in the producing area.

Table 2 presents the values of the accumulated oil production, of the recovery factor, of the accumulated volumes of production and injection of water, for both cases tested in the strategy that includes cyclical injection. The results obtained in the 3x cyclical SW-SAGD tests and Case 0 are very similar. The use of the cyclical injection improves the performance of the steam injection in only one well. The report of Figure 6 for the recovery factor shows the progress obtained with the introduction of the cyclical injection, resulting in a greater and faster recovery of oil. This means that, a larger oil mass distributed in the formation was heated up, providing greater recovery.

It has been verified, however, that the introduction of the division of the well for the packer did not represent significant gains. The oil front displaced by the injection pressure moves towards the production area, making way through the packer and causing a steam short circuit. The blind area provided by the packer was not enough to obstruct the progress of the steam front. After the connection between the two areas, the warm oil and the condensed water that are deposited along the extension of the injection section by density difference are driven together with the steam for the production area by pressure difference. That is, after the communication between the two areas, the gravitational drainage performance in the injection area acts at the same time in which the fluids are moved by pressure difference towards the production section.

Table 2. Production values adding cyclical injection processes.

Type of Recovery	Final date	NP (Mm3)	FR (%)	WP (Mm3)	WI (Mm3)
DW-SAGD	29/12/2009	16.25	31.74	380.56	365.00
Case 0	29/12/2009	14.48	28.54	358.06	353.00
SW-SAGD Cyclical 3x	29/12/2009	14.17	28.31	356.46	353.00
SW-SAGD	29/12/2009	7.97	15.70	369.10	365.00
Primary	29/12/2009	4.79	9.43	0.056	

5.4 SW-SAGD - two well segments with three cyclical stages in optimized interval and position (Case 1)

The increase of the length of the blind interval is a logical attempt to improve the distribution of heat inside the formation, along the length of the well. There is the idea that increasing the interval between the passage injector and the production passage hinders the steam’s path towards the producer. The steam, therefore, is diffused in the area by gravity and it mobilizes a greater volume of fluid, leading to greater oil recovery and delaying the steam short circuit. Also, interval increase provides an increase in pressure and consequently in the temperature of the injection section, which tends to improve the conduction of heat to the reservoir.

The same logic appears for the variation of the position of the limited interval for the packer. With a smaller injection area, and a greater blind interval to delay the steam, a greater oil mass in the injection section will be heated without trapping the oil.

The combination of ideal lengths for the blind and production injection passages, with the optimization of their positions along the well produces a great number of options to be tested. Details of the study with the length of the interval and positioning along the length of the well can be found in Moreira (2006) and Moreira and Trevisan (2007). It was verified that the configuration which presents best performance is the one represented by Case 1 (300.30.180). In this situation, the well has a 300 meter long production passage, 30 meter blind interval between wells limited by a packer and 180 meter long injection passage.

However, based on the results presented in Figure 6, making up the DW-SAGD, SW-SAGD, 3x cyclical SW-SAGD primary recovery processes, the configuration with two wells still provides a better recovery factor.

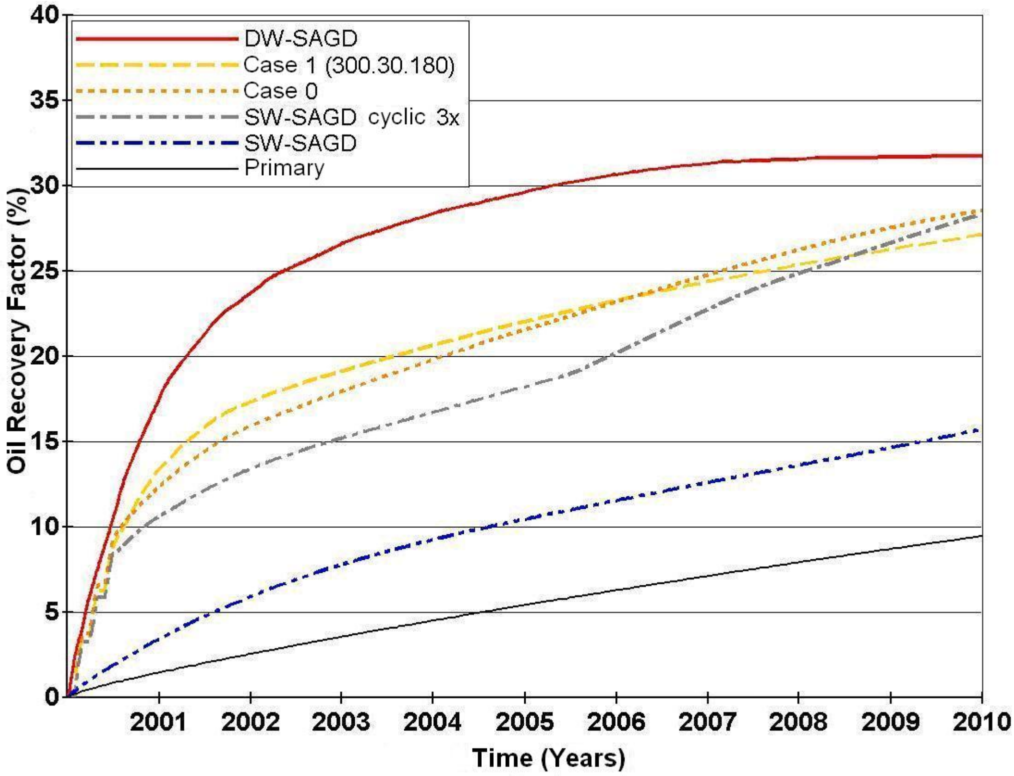

Figure 6. Recovery factor adding the cyclical injection processes

6. Injection rate increase

It has been verified that the cyclical injection is the file that presents greatest impact on the results. The injection rate is an important control parameter in this procedure. Through the increase of the injection rate, a greater steam volume is injected into the reservoir. And a greater amount of oil will be heated faster around the horizontal well. The variation of the injection rate is studied for the strategy of Case 1 (300.30.180) only in the pre-heating phase, continuing the 100 m^3/d of continuous injection in the tip of the well after the cyclical stages.

The results show, for the studied configuration, that an increase in the injection rate causes a considerable increase in the recovery factor, reaching levels similar to those observed in the DW-SAGD process, during all those years.

The increase of the injection pressure is limited by the formation fracturing risk. The pressure cannot be taken at very high levels due to the mechanical properties of the rock reservoir and the confinement phenomenon in the injection section should be looked at, because it increases the pressure, while the steam does not cross towards the production area.

In order to obtain an optimal steam injected volume under a limited injection pressure, the duration of the injection-soaking -production cycle periods can also vary. For instance, one can diminish the injection pressure and still increase the injected volume of steam, with the increase of injection time. Obviously, the dynamics of the process, that also involves waiting time for the soaking and the production period, should be considered.

7. Variation of the cycle periods

The initiative to modify the cyclical periods is to reduce the injection pressure to avoid the fracturing of the reservoir while at the same time guaranteeing a better distribution of the heat without the delay of the beginning of the continuous injection. The increase of the cyclical periods depends on several factors, like for example: the time that one can wait to begin to produce, the vapor title, the permeability of the rock, the oil type among others.

The results obtained with the variation in the periods of the cycles show a committed relationship between the acceleration in oil recovery and deterioration in oil-steam ratio. Figure 7 shows the results obtained for strategy Case 1 (300.30.180), with the injection rate modified to 100 m^3/d and 250 m^3/d and cyclical stages of (40.20.60) and (50.20.80), compared with one of the DW-SAGD processes.

The choice of Case 1 (300.30.180) with a 100 m^3/d injection and cycles of (50.20.80) as the best strategy occurs due to the oil-steam ratio (OSR) evaluation, as shown in Figure 7. It can be observed that, when the injection rate for 250 m^3/d is increased four fold, a greater amount of water vapor is injected into the formation and a greater volume of oil is recovered. However the increase of the volume of injected water is greater than the increase in the volume of produced oil, reducing OSR in relation to the DW-SAGD process.

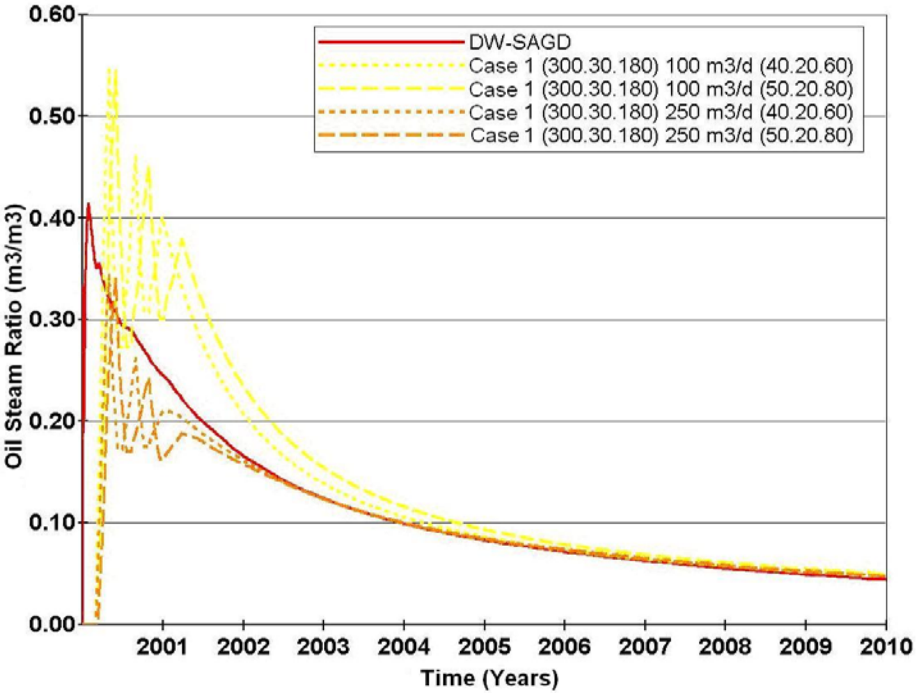

Figure 7. Best strategy choice by ROV.

8. Improved SW-SAGD

In Table 3, improved SW-SAGD, the name of the best strategy for Case 1 (300.30.180) with 100 m^3/d injection and (50.20.80) cycles presents better results in the accumulated oil production (NP) as well as in the recovery factor (RF). The production of water (Wp) is almost the same as that observed in the other processes, because all the condensed steam is recovered. The small difference of values among them is due to the connate water, which is recovered as steam, at time zero in the cyclical stage and other previously explained factors.

Table 3. Production values adding the best strategy.

Recovery Process	Final Date	NP (Mm3)	RF (%)	WP (Mn3)	WI (Mm3)
SW-SAGD Improved	**29/12/2009**	**17,44**	**34,47**	**356,14**	**350**
DW-SAGD	29/12/2009	16,25	31,74	380,56	365
Case 0	29/12/2009	14,48	28,54	358,06	353
SW-SAGD Cyclic 3x	29/12/2009	14,17	28,31	356,46	353
SW-SAGD	29/12/2009	7,97	15,7	369,1	365
Primary	29/12/2009	4,79	9,43	0,056	365

Figure 8 displays the values of the recovery factor for the primary recovery, SW-SAGD, 3x cyclical SW-SAGD, Case 0 and DW-SAGD processes, compared to the best chosen strategy for the SW-SAGD process.

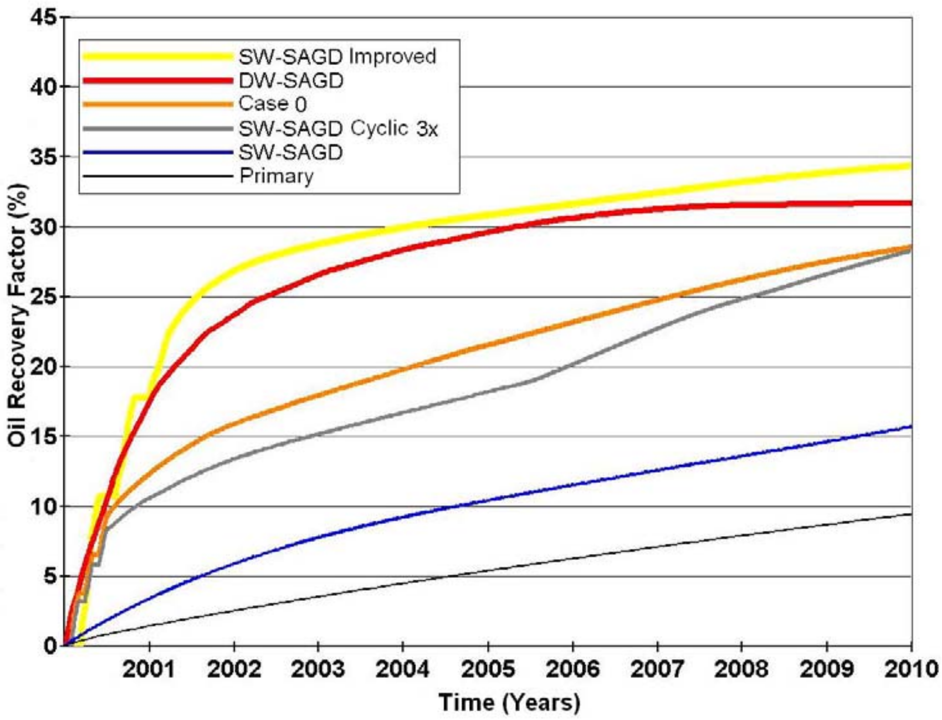

Figure 8. Recovery factor for the best strategy.

9. Conclusions

- The punctual injection of steam (SW-SAGD) without the pre-heating phase, despite causing higher temperature in the area of the steam-oil interface of the steam chamber, does not produce greater oil recovery, than that obtained with the injection process along the whole horizontal well (DW-SAGD).
- The previous cyclical injection, as a pre-heating phase, is fundamental for the good performance of the SW-SAGD.
- The pre-heating in the SW-SAGD process generates an opening for better steam contact with the oil around the well, it improves the distribution of the heat in the formation in relation to the SW-SAGD process without pre-heating and, consequently, it increases oil production.
- The increase of the cyclical period, that is, of the injection, soaking and production periods, induces a better heat distribution in the reservoir and reduces the required injection pressure, however, it increases the waiting time for the continuous injection process.
- The division of the well by a packer and the injection of the steam in two points, in the middle and at the extremity of the well, help the distribution of the heat in the formation and favor oil recovery in the cyclical injection phase.
- In the continuous injection phase, after the cyclical stage, the division of the well induces an increase of the volume of the steam chamber, and improves the oil recovery in relation to the SW-SAGD process.
- The simple increase of the blind interval, between the injection and production passages, increases the difference of the pressure and drives the displaced oil in the injection section into the production area. However, this increase causes imprisonment of the oil in the injection section, reducing the recovery factor.

- The confinement of the steam in the injection area, due to the increase of the length of the interval between the sections, maintaining continuous injection, can lead to an unwanted increase of the injection pressure.
- The acting of the SW-SAGD process is extremely variable and modifications in the operation strategies can lead to better recovery factors and oil steam ratios than those obtained with the DW-SAGD process.

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