

QUESTIONS & ANSWERS FOR GREENZYME®

A BIOLOGICAL ENZYME & ITS APPLICATIONS IN OILFIELDS.

Written by: Philip Lau (Version: 072215)

Q1: What is GreenZyme®?

A1: **GreenZyme®** is a biological liquid enzyme, developed, trademarked and produced exclusively by Apollo Separation Technologies of Houston, Texas.

GreenZyme® is the first biological enzyme ever massively produced in Houston since 1990 for **E-EOR**, namely **Enzyme-Enhanced Oil recovery**.

One of the main uses for **GreenZyme®** is for enhancement of crude oil recovery from most oil wells, both onshore and offshore.

Q2: How long has Apollo Separation Technologies been in business in Houston?

A2: We are continuously in business since 1990.

Q3: What is a biological liquid enzyme?

A3: A biological liquid enzyme is a protein-DNA based non-living catalyst, which facilitates the completion of biological reactions.

Q4: Is GreenZyme® similar to any other living microbe's method?

A4: The answer is no.

GreenZyme® contains non-living enzymes derived from living microbes. However, an enzyme is completely different from a microbe. Similarly speaking, a chicken egg is derived from a living chicken, but an egg is not a living chicken.

Enhanced Oil Recovery process using **GreenZyme®** versus using living microbes are two completely different processes. They are not the same.

Q5: How do you produce GreenZyme®?

A5: **GreenZyme®** is produced by a proprietary process, which involves impregnating a high protein nutrient soup with the DNA of selectively cultured microbes.

The final product contains enzymes associated with oil-eating microbe's DNA. Nearly all-living microbes are made inert at the end of the manufacturing process.

Q6: What is CAS number for GreenZyme®?

A6: CAS numbers are assigned to known chemicals only, CAS number do not applied to any biological materials with DNA.

For this reason, there is no CAS number for **GreenZyme®**, just like there is no CAS number for a chicken egg.

Q7: How safe is GreenZyme®?

A7: Under normal applications, **GreenZyme®** is totally harmless to any individual's health, as well as to the environment. **GreenZyme®** is near neutral in pH during injection; biodegradable and environmentally friendly.

Please refer to our Manufacturer's Material Safety Data Sheet (MSDS) for proper handling of **GreenZyme®** product.

Q8: How does GreenZyme® increase crude oil production in most oilfields?

A8: When injected into oil-bearing sand formation of any oilfield, **GreenZyme®** can instantly and quickly release hydrocarbon oil from the surface of these sands in a catalytic fashion, changing the nature of these sands from either oil-wetted surface or water-wetted surface to a non-stationary **GreenZyme®** protected water-wetted surface (i.e. GPWW surface).

GreenZyme® does not cause any chemical reactions.

Unlike chemical or polymer additives, when these additives encounter paraffins, asphaltenes, ground water and other clogging problems inside the sand formation, these chemicals can quickly weaken and diminish themselves in strength and effectiveness by their own complex chemical reactions.

GreenZyme®, being a catalyst however, does not diminish or weaken itself when encountered with the same problems.

Since **GreenZyme®** is biological in nature, it performs only its biological duty to release-crude-oil, even in the presence of large quantities of ground water and other solid causing-and-clogging problems like paraffins and asphaltenes.

Since **GreenZyme®** is insoluble in crude oil and soluble only in water, the **GreenZyme®** proteins can be carried by formation-water to deeper regions of the

surrounding formations through pressure-induced diffusivity and concentration-gradient-differential diffusivity, i.e. due to pressure differentials, osmotic and diffusional forces at work etc.

GreenZyme® can open more new flow-channels and creating new fingerings-of-flow within the sand-formation for months and years to come.

Most of our past successful applications all indicate that **GreenZyme®** is capable of releasing more of the so called non-recoverable crude oil from the oil-bearing sands than previously thought possible.

Q9: Under what conditions should I use GreenZyme® to enhanced oil recovery (i.e. E-EOR) in my oilfield?

A9: The best conditions to apply **GreenZyme®** to your oilfield are as follow:

- a) Any old well: suddenly shows rapidly decreasing in crude oil production; a sign showing formation of positive-skins; some formation-clogging problems or slight rising water-coning problems occurred.
- b) Any new well: to minimized problems of overshooting cements and drilling chemicals.
- c) Any repaired well: to prevent overshot cements and chemicals that may cause clogging problems later.
- d) A new well that produces very little total-fluid-flow since from day-one.
- e) A relatively young well begins to encounter increasing water production problems.
- f) Use **GreenZyme®** before: water-flooding wells; chemical fracturing wells; steam injection wells; thermal and heat-burning-and-treatment wells etc.

Typical candidate oil well for **GreenZyme®** varies greatly, an ideal one is as follow:

- 1) Initial oil production when new > 100 BOPD, the higher number the better.
- 2) Current oil production > 15 BOPD.
- 3) Water cut < 75 % water.
- 4) Porosity > 15%, with sufficient formation pressure.
- 5) Piping integrity and pump are in good working condition.

Of course, **GreenZyme®** also works for other lesser ideal oil wells also.

Note: **GreenZyme®** should not be used on dead oil wells, or very low and marginal producing oil wells, i.e. those producing less than 10 BOPD oil wells, the reason is because even if **GreenZyme®** application is successful, the net oil gained may be non-economical and non-attractive in profit returns.

Q10: How do I pick my oil wells for GreenZyme® applications?

A10: A simple way is to pick an oil well with current daily oil production still maintains above the 20% level when this oil well is new and current water cut is below 80%.

For example: When new, this oil well was 200 BOPD with 30% water cut. Today this oil well is producing 40 BOPD (i.e. still 20% of its highest output level), and 80% water cut. This oil well is a good choice for **GreenZyme®** IOR-EOR.

Q11: What other areas is good for GreenZyme® in my oil field?

A11: **GreenZyme®** is very effective when simultaneously applied to a localized oilfield consisting of more than 2 wells for small and big water-flooding projects.

For example: in a local oilfield consisting of 10 wells, use 8 wells out of the 10, which have the least positive-skins as the crude oil producers, and then use the remaining 2 wells as the injection wells.

Injecting both the produced-water and **GreenZyme®** into this formation as the driving force, the formation usually yields good results for more oil production.

By this water-flooding method, the crude-oil freed by **GreenZyme®** within the formation can be easily driven towards the 8 target-production wells.

This **GreenZyme®** enhancement method can achieve a much higher crude oil production rate than most experts previously thought impossible.

Similarly, for those oil wells that need steam-stripping, chemical treatment or fracturing works, **GreenZyme®** can also be used alone or in conjunction with any one of these other technologies, usually with astounding results.

Q12: Is there any other requirements needed for GreenZyme® applications?

A12: Before you consider using **GreenZyme®** in an oil well, you will need to be sure both the tubing and the casing integrity are in excellent working condition.

You need to be sure the target oil well does have a measurable Static Liquid Level (i.e. SLL) inside the tubing section of the oil well.

If there is a pour-point temperature problem for the crude oil, make sure the formation temperature is at least 20 degrees centigrade higher than the pour-point temperature of the crude oil, with proper insulation protection of all piping.

If the crude oil produced from your oil well at ground level is pour-able at ambient temperature, even in the coldest month of the year, then this oil well is acceptable for **GreenZyme®** applications.

Q13: Do we need to worry about formation complexities like pH, high salinity, presence of heavy metals, high wax content and high temperature conditions when using GreenZyme® in our oil wells?

A13: Since **GreenZyme®** is a DNA-based non-living biological catalyst, **GreenZyme®** has no chemical reactions with most complexities found in the formation.

Please notice that, you **do not** need to worry about any of the following conditions:

- a) pH of the fluid in the sand-formation.
- b) Salinity of the fluid in the sand-formation.
- c) Temperature in the sand-formation because, in laboratory tests, **GreenZyme®** under pressure does not degrade and perform very good at testing temperatures at 270 degrees C. **GreenZyme®** also performs very well for steam-huff-and-puff application under pressure at 450 degrees centigrade.
- d) Presence of any metallic ions in the sand-formation. Since **GreenZyme®** is a biological agent, not a chemical agent; **GreenZyme®** does not react with most natural chemical agents present inside typical sand-formations.
- e) Presence of paraffins, naphthenes, asphaltenes or sulfur at any percentage.
- f) Any radio-active isotopes (i.e. NORM) in the crude oil.

Q14: What equipment do we need to inject GreenZyme® in my oil well?

A14: You will need the following equipment:

- a) One high pressure pump, capable of up to 4,500 PSI pressure, if possible.
- b) One large, mobile mixing tank for diluting **GreenZyme®**.
- c) Saline water (i.e. local produced water) for **GreenZyme®** dilution and capping.

Q15: Which side to inject GreenZyme®? Casing-side or Tubing-side piping?

A15: In any kind of oil well, **GreenZyme®** is usually injected into the targeted formation or pay zone through the casing-side, this is a simpler and cheaper process.

If you must inject **GreenZyme®** through the tubing-side of the oil well, you need to remove the packer first before **GreenZyme®** injection.

Q16: Can I repeatedly re-inject GreenZyme® again at a later date as long as I maintain the oil output above 20% its initial highest level and how?

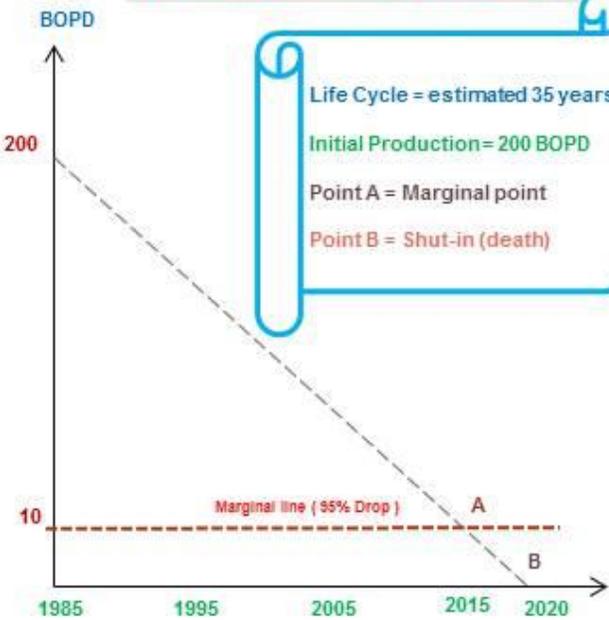
A16: Yes, after initial **GreenZyme®** application, daily oil output will shoot up to a higher level, this may last from a few months to over 3 years, depending on each oil well and its formation conditions.

When this oil well drops back to about 20% of its maximum daily oil output level, be prepared for the second **GreenZyme®** injections. This is also true for the third, the fourth plus more reinjections of **GreenZyme®** later, as long as the daily oil output in each case is above 20% of its maximum level, see graphs below:

80% Decline Rule: When is the best time to inject GreenZyme®?

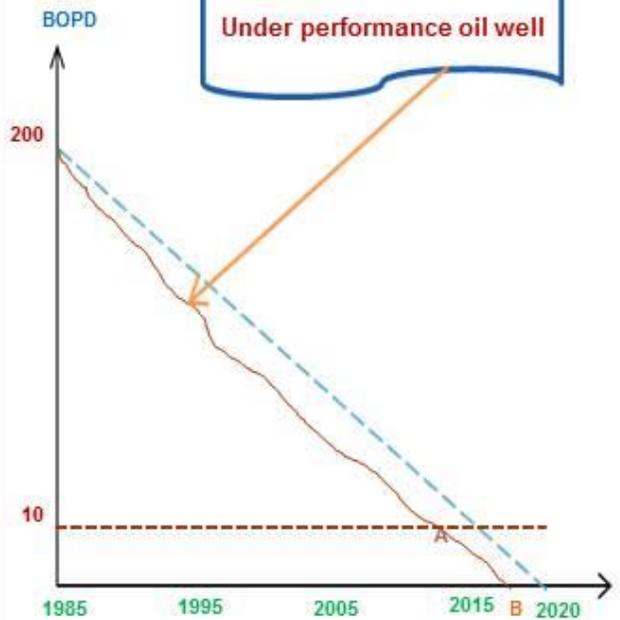
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Typical life expectancy of 1 oil well



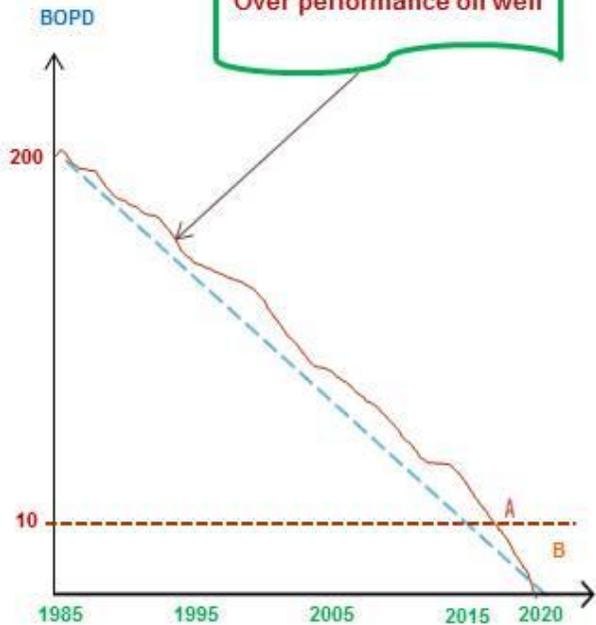
Duration in calendar years

Under performance oil well



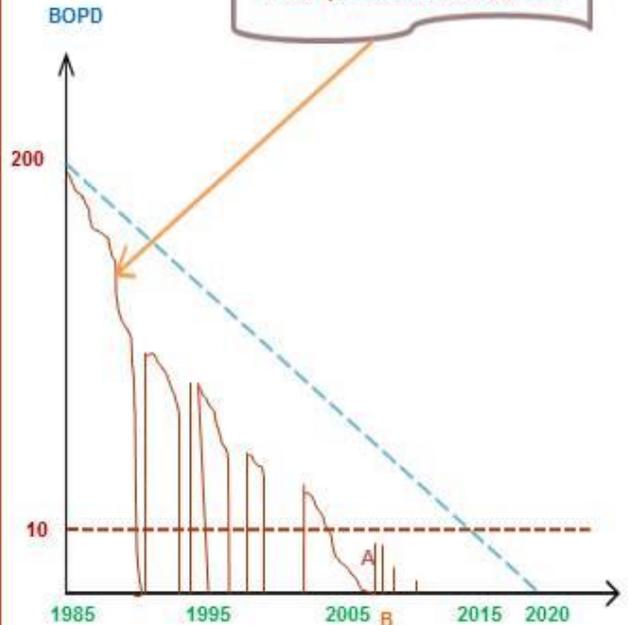
Duration in calendar years

Over performance oil well



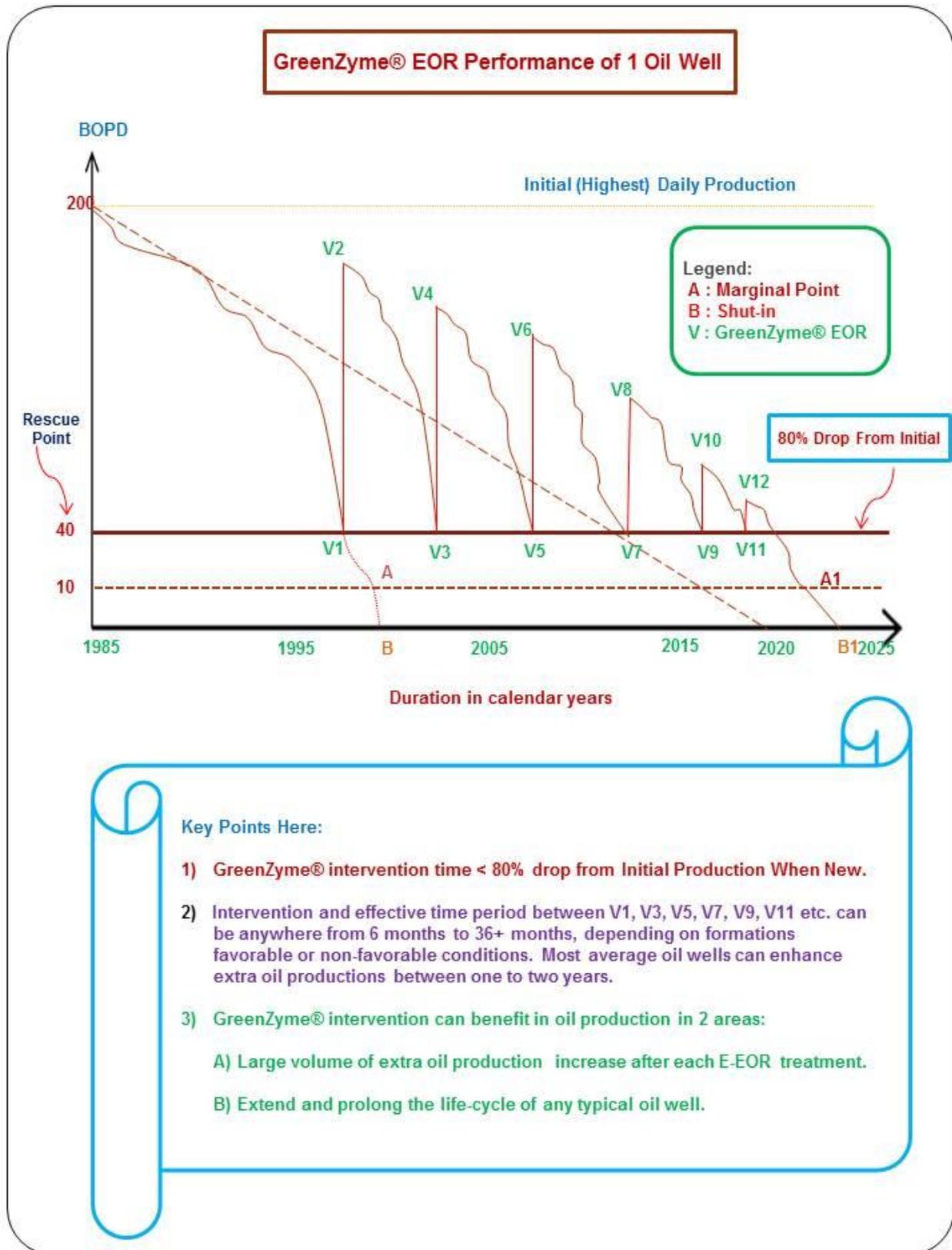
Duration in calendar years

Poor performance oil well



Duration in calendar years

GreenZyme® rescue before 80% decline from highest oil production level.



Q17: Can GreenZyme® be applied to both sand-stone formation and lime-stone formation oil wells?

A17: Yes, **GreenZyme®** can be used in both types of formations. For sand-stone formation oil well, using only **GreenZyme®** injection alone is sufficed.

However, only for lime-stone formation oil well, beside **GreenZyme®** injection, depending on the total depth of this well and total daily fluid production, we also need to inject some quantity of dilute acid, (e.g. 1-3% HCl) either before or after **GreenZyme®** injection.

Q18: How do we start injecting GreenZyme® into my oil well?

A18: If you have identified a good candidate oil well for **GreenZyme®** application, then you need to decide the total volume of **GreenZyme®** you will need and the shut-in time required before resuming regular oil production.

Under normal operations, the pumping process for most oil wells can be finished from eight hours to a day or less, depending on well depth and pay zone depth.

Q19: What volume of GreenZyme® do we need to inject for an oil well?

A19: The right volume of **GreenZyme®** injection depends mainly on pay zone (i.e. T_o) in the sand-formation. See table as suggested guidelines for your candidate oil well:

a) For onshore vertical oil well:

Thickness-of-oil in the sand-formation. T_o in meters (M)	Quantity of GreenZyme® required, under more favorable conditions: (Drum) (100%, 55-gallons)	Quantity of GreenZyme® required, under less favorable conditions: (Drum) (100%, 55-Gallons)
$T_o < 10$ M	4 Drums	5 Drums
$10 < T_o < 20$ M	6 Drums	8 Drums
$20 < T_o < 30$ M	8 Drums	10 Drums
$T_o > 30$ M	10 Drums	12 Drums

b) For onshore horizontal oil well:

$T_o < 500$ M	8 Drums	10 Drums
$T_o > 500$ M	10 Drums	12 Drums

c) For offshore oil well: typically similar to horizontal oil well.

$T_o < 1000$ M	14 Drums	16 Drums
$T_o > 1000$ M	18 Drums	20 rums

d) For water-flooding drive oilfield:

Use **GreenZyme®** in 250 ppm to 500 ppm range, also utilize the formation as a giant mixing tank underground, no above ground mixing is needed in this case.

Note: Favorable conditions are: oil density < 0.85; Porosity > 20%; Pour point temperature of oil is fluid at most ambient temperatures; underground formation is mostly oil-bearing sand.

Unfavorable conditions are: oil density > 0.90; Porosity < 10%; Pour point temperature of oil can be a problem at some ambient temperatures; underground formation is mostly oil-bearing limestone.

If your oil well has conditions in-between the above favorable conditions and unfavorable conditions, use your own judgment and use quantities of **GreenZyme®** between the two numbers in the above table.

Q20: What percentage GreenZyme® dilution should I use for my oil well?

A20: **GreenZyme®** should always be mixed with the same formation produced-water from your oil well, normally in a 5% strength before injection.

If your water-cut is more than 70% water, then you can use 8% to 10% strength.

If your water-cut is less than 20% water, then you can use 3% to 4% strength.

If your water-cut is 0% water, then you can use 1% to 2% **GreenZyme®** strength.

Q21: I have a problem, my oil well has 10 different pay zones, and all through only one-continuous-production-tubing, the total oil-thickness is over 100 meters. How much GreenZyme® do I need for this application?

A21: Since in this well, oil is not producing from only one targeted pay-zone, but producing from an open perforation of all 10 pay zones of over 100-meters; we do not want to waste a high number of drums of **GreenZyme®** to all 100-meters plus pay zone, because we do not know which particular pay zone is actually producing the majority of crude oil, whereas the rest of say 9 pay zones only contribute less than 10% of the oil.

We know we will need at least 4-drums of **GreenZyme®** here even for one target pay zone, we then pick a number, say 8-drums total for all 10 pay zones, and

using say 2% **GreenZyme®** dilution strength for injection, followed by a much larger quantity of produced water, all inject through the casing-side of the well.

Even though we do not know exactly how much quantity of **GreenZyme®** goes to which individual pay zone, but we do know the total quantity of **GreenZyme®** and the produced water we have injected.

This is all right here, because from our past experience, we had seen the end-result of total oil increase like this case is usually good, and the success rate is high, although a lot of guessing is used here.

Q22: What is the effective-radius do you use in GreenZyme® injection?

A22: When you use all chemical and polymer injection method into an oil well, you usually need to calculate an effective radius-of-injection, which is usually a very small number, e.g. as in inches from the perforation holes.

Why?

It is because all these chemicals and polymers diminish themselves as soon as when they enter into the pay zone, and then these polymers will instantly react chemically with the crude oil and the formation-sands.

In other words, they are not catalysts; their life-cycle is quick and short.

A successful oil well under chemical injection lasts only a few short months, also the total quantity of oil increase is quite small when compared with **GreenZyme®**.

However, the term effective-radius-of-injection for **GreenZyme®** is not quite appropriate to be used here, the reason being **GreenZyme®** is a biological catalyst; it does not react chemically with the crude oil and formation-sands.

The life-cycle for **GreenZyme®** is long lasting, in terms of many months and years in the formation, not until **GreenZyme®** is losing strength slowly and eventually in quantity by flushing out with the produced-water in the daily oil production.

The net increase in crude oil production by **GreenZyme®** in the treated oil well is usually huge when compared with those same types of oil wells using only chemicals and polymers injection.

Q23: What is the desirable shut-in time (i.e. capping time) required after finishing injection of GreenZyme® in my oil well?

A23: After injecting **GreenZyme®** into an oil well, the recommended shut-in time is as follow:

Shut-in Time (Days)	Oil well conditions
3 days	Oil density < 0.85; Porosity > 20%; Pour point temperature = OK.
4 days	Oil density < 0.90; Porosity > 20%; Pour point temperature = OK.
5 days	Oil density < 0.95; Porosity > 20%; Pour point temperature = OK.
6 days	Oil density < 1.00; Porosity > 20%; Pour point temperature = OK.
7 days	Oil density >1.00; Porosity > 20%; Pour point temperature = OK.
4 days	Oil density < 0.85; Porosity < 20%; Pour point temperature = OK.
5 days	Oil density < 0.90; Porosity < 20%; Pour point temperature = OK.
6 days	Oil density < 0.95; Porosity < 20%; Pour point temperature = OK.
7 days	Oil density < 1.00; Porosity < 20%; Pour point temperature = OK.
8 days	Oil density >1.00; Porosity < 20%; Pour point temperature = OK.
9 days	Every condition is BAD!

Q24: What can we observe during the time of injecting GreenZyme® into my typical oil well ?

A24: You can learn a lot about the underground formation by observing the pressure gauge readings alone during the **GreenZyme®** injection stage.

When an oil well shows a rapid decrease in oil production, one of the typical conditions is formation-blockage, i.e. positive skins formed under the sand-bearing formation.

These positive skins would hinder both crude oil and saline water flow, sometimes so severe that the tubing side fluid supply was reduced to practically “zero” at the pump. This required the oil well to be shut down.

During the **GreenZyme®** injection operation, at first the diluted **GreenZyme®** was shown to be under vacuum, the pressure gauge showed a negative reading.

A short while later, the pressure gauge then rose to zero PSI, (i.e. pound per square inch in pressure) and then rose to a small positive side when **GreenZyme®** actually began entering into the formation.

When half-way through the injection operation, very often we saw a “sudden surge” in pressure reading, say to 2000 PSI for a few minutes, and then followed by a “sudden drop” of pressure to say, 1200 PSI. This was an indication that a few near-bore head blockages had been broken down and cleared by **GreenZyme®**, a very good sign.

Sometimes we might observe more than one or two of these pressure-surge and pressure-drop phenomenon, a very good sign again.

Sometimes the pressure even rose to quite a scary pressure ranges, say from 3,500 PSI for five minutes, and then drop back to 1,800 PSI for twenty minutes. This again showed positive-skins bursting at locations further away from the bore-head of the oil well, again a very good sign.

Finally after all the **GreenZyme®** injection operation was finished, the pressure gauge might stay at a lower range, say only 1,100 PSI, this was the time for shut-in.

Q25: How do we determine if GreenZyme® injection process in my oil well was successful or not after resuming steady state fluid production?

Q25: After shut-in time, the first sign indicating that the **GreenZyme®** injection process was successful is a huge rise in static liquid level (SLL). The new SLL is very often and common to be six hundred meters higher than the pre-Apollo **GreenZyme®** injection reading, depending on the size and depth of the oil well.

Comment: a huge increase in the static liquid level (SLL) after **GreenZyme®** injection is a positive indicator that our process was successful.

Q26: What about water-cut after GreenZyme® injection?

A26: Water-cut reduction after **GreenZyme®** injection is not the deciding factor to judge the success or failure, only a raise in SLL is the positive factor judging for success.

A month or two after **GreenZyme®** injection, the majority of oil wells do show a slight reduction in the water-cut.

However many other oil wells show relatively stable water-cut percentages but at a higher daily total fluid production. One thing in common is: all successful

GreenZyme® treated oil wells do show a much higher SLL and total fluid production.

Q27: Can I keep my old production pumping rate after GreenZyme® injection?

A27: Absolutely no, in order to enjoy the oil production increases, you must increase the pumping rate after **GreenZyme®** injection.

With a new and raised SLL after **GreenZyme®** injection, a large quantity of “freed oil” near the vicinity of the perforation area is waiting to be pumped out immediately.

If you keep your old pumping rate as before, this large quantity of “freed oil” will be accumulated and aged near the vicinity of the perforation area, this “freed oil” then slowly begins to form positive skins, i.e. high pressure barrier zones, blocking fluid flow patterns and creating rapid reduction in total daily fluid production.

This is quite harmful to your oil well.

Q28: What happens after shut-in time is over and we begin to resume normal oil well production?

A28: After the capping time is over, normal oil well production can be resumed.

As soon as the renew production begins, the first sign is a new very high static liquid level (i.e. SLL) inside the tubing. This new and higher SLL is a solid proof that the **GreenZyme®** injection process was successful.

You should use this new SLL as a production guideline to increase your oil production rate; you can do this as follow:

- a) From the pump jack, raise the number of stokes-per-minute to a higher level. If the new SLL still keep on rising, you should raise the stokes-per-minute to an even higher level, until the new SLL maintains a steady and stable level. This will be the new daily fluid production rate of this oil well.
- b) Increase the length of the pump jack cylinder while maintain the same number of strokes-per-minute, to maintain a steady and stable new SLL.
- c) Or do both steps a) and b) above.
- d) For an electrical submersible pump, please increase the RPM of the pump rate.

At the beginning, total fluid production can show huge increases, with high water content coming out first for a few days or weeks, then gradually the oil-water ratio changes everyday towards more oil than water.

After a few weeks, this oil-water ratio becomes steady, with very little variations for the next few months. Total fluid production maintains at a steady and high

production rate, depending on each individual oil well, this rate usually lasts anywhere from 12 to 18 months or more, before showing gradual slow decline later.

The total extra oil production using **GreenZyme®** injection can be a handsomely profitable and rewarding during this oil production time. This oil production enhancement is almost impossible to be achieved by using any other known IOR-EOR methods and processes.

Q29: How high a water-cut in percentage can I use GreenZyme®?

A29: We prefer **GreenZyme®** to be used on less than 80% water-cut.

However our authorized agent had been using **GreenZyme®** in water-cut as high as 90% with success. This is a straightly a cost-and-profit business decision. Normally we prefer water-cut level less than 75% for most **GreenZyme®** applications.

If your water-cut level is higher than 90+%, you may need to inject water-blocking chemicals first into your oil well, let the water-cut drops to below 75% level, then use **GreenZyme®** injection for IOR-EOR.

Q30: What will happen to my oil-water ratio (OWR) after shut-in time is over and I am resuming normal crude oil production?

A30: Immediately after resuming normal crude oil production, the following things may happen:

- a) A significant increase in the static liquid level (**SLL**) inside the tubing.
- b) A significant increase in total fluid release from the formation, in which the oil well operator needs to adjust by increasing the pumping rate based on the new higher static liquid level (**SLL**) available.
- c) A significant amount of water will come out first, depending on the total initial **GreenZyme®** injected.

The first few days or weeks can be mainly water. The oil-water ratio (**OWR**) will then begin to drop towards more oil than water after the initial periods of a few days or weeks, and finally become stabilized at a fairly stable **OWR**, which is similar to pre-**GreenZyme®** treatment level.

Very often the application of **GreenZyme®** process will reduce the water content slightly in the normal crude oil production, but the water-cut reduction is not a deciding factor to judge whether our **GreenZyme®** process was a success or not.

Q31: Can I re-inject GreenZyme® into my oil well after a successful previous treatment?

A31: Yes, you can reinject **GreenZyme®** into the same well after previous success job; there is no limitation on how many times you can use **GreenZyme®** in your oil well.

Q32: Is oil well spacing important in my GreenZyme® injection process?

A32: Yes, oil well spacing is important; we like each **GreenZyme®** treated oil well to have covered at least 40-acres of space (i.e. sand formation spacing) by itself if possible, the greater the spacing, the better, before meeting the next neighboring oil well of the same depth and at same formation.

Comment: if you have two oil wells very close to each other, and both oil wells are drilled into the same formation depth, you can use the **GreenZyme®** injection process for both wells at the same time.

Please be noted that, if you have decided not to treat the two adjacent oil wells at the same time, then by using **GreenZyme®** injection process on only one oil well, and if the neighboring non-treated oil well is only a few hundred yards away, then **GreenZyme®** will affect oil production of both wells with enhancement, but the total net oil increase is smaller than if you have treated both two oil wells together at the same timing.

Q33: If my oil well has been treated previously by other enhanced-oil-recovery (i.e. EOR) methods, can my oil well still be good for the enzyme-based biological method utilizing GreenZyme® injection?

A33: Yes absolutely, your oil well can still be good for the **GreenZyme®** process. We have numerous successful **GreenZyme®** treated oil wells that had been previously treated with acid jobs, hot oil jobs, living microbes-injection jobs, chemical polymer jobs, steam-injection jobs, as well as fracturing jobs.

Q34: My oil well is under steam-injection and huff-and-puff production cycles right now, can GreenZyme® injection process offer any help?

A34: Yes, **GreenZyme®** injection process can work very well and synergistically with your steam-injection process. Some oil wells with heavy oil due to temperature, wax and other geological problems can only be effectively produced using steam-injection cyclic process. However if you use **GreenZyme®** injection first before your routine steam-injection in your oil well, the total crude oil recovery can be significantly higher in quantity per cycle than the one by steam-injection alone, and the cycle-period can be significantly extended.

Q35: My oil well had been fractured before, can I use GreenZyme® injection also?

A35: Yes, see the same logic here as in question 34 above.

Q36: Can I use GreenZyme® on my gas well?

A36: No, **GreenZyme®** cannot work on 100% gas well; **GreenZyme®** works only on oil producing well. For a mixed well, i.e. a well is producing both crude oil and natural gas, only simple economic decisions will determine to use **GreenZyme®** or not.

If your well is producing 60% equivalent gas and 40% equivalent crude oil, then **GreenZyme®** can be used in this well to affect the 40% oil-equivalent-portion only, i.e. crude oil production can be increased slightly by **GreenZyme®**, but not much for the natural gas.

Q37: I have water-conning problem on my oil well, with 90+% water-cut and still gradually increasing daily. Should I use GreenZyme® in this well?

A37: No, you should solve the water-cut problem first before using **GreenZyme®**. For instance, you can use water-blocking chemicals to reduce the water-cut to below 75% first, and then use **GreenZyme®** injection for this oil well.

Q38: I have sand-control problems in my oil well, should I use GreenZyme®?

A38: No, you should solve the sand leaking problems first before using **GreenZyme®**. For instance, you can use sand-control chemicals and sand-control screens to solve the problems first, and then use **GreenZyme®** injection in this well.

Q39: How long can GreenZyme® be stored and use effectively?

A39: **GreenZyme®** is most effective if used within 3 years of manufacturing.

We recommend **GreenZyme®** be stored indoor from temperatures between 35 to 110 degrees F.

Under prolonged storage, the top of the **GreenZyme®** plastic drum may show slightly bloated shape, this is absolutely normal for **GreenZyme®** under storage, because a small quantity of carbon dioxide (i.e. non-toxic due to small amount only) has been built-up under pressure inside the plastic drum.

You can easily release this pressure built-up inside the plastic drum, from time to time, by opening one of the tight top caps and then immediately re-closes the top cap tightly.

Q40: Is there a method to evaluate GreenZyme® for quality control purpose?

A40: Unlike chemical products, there is no easy direct analysis method for a biological product like **GreenZyme®**. For example: there is no chemical analysis to measure the quality of a biological product like a dozen chicken eggs or a dozen apples.

Although you can look at the outside shell and color of a chicken egg, but you still do not know the inside is good or bad.

You just have to “trust” the chicken farmer that all of his chickens were fed with “good-feed”, and all of his chickens were healthy before-and-after laying the eggs, because only a healthy living chicken dictates the egg is good or not.

Similarly, this logic is also true when we produce **GreenZyme®**.

From batch to batch, we do have to follow straight procedures to safe guard our products to be good each and every time. We do not have any problems in quality control for **GreenZyme®**.

However, there is a quick and indirect method to check whether **GreenZyme®** is still in good working condition or not, it is to do a simple shaker-test. How?

First, place some oily-sludge sample in a glass bottle or a beaker, add 4 times its own volume of water, and shake the sample vigorously for one minute.

You will see no oil or very little oil has been released on top of the water-layer.

Now add a few drops of **GreenZyme®** to the same sample, shake it vigorously again for one minute of time. This time you will see a lot of oil had been released; this indicates that the **GreenZyme®** sample you have in hand is still in good working condition.

Q41: I had left a drum of GreenZyme® outdoor below freezing, what should I do?

A41: Your **GreenZyme®** is still good, just bring the drum indoor for slow de-freezing, the content inside the drum is still 100% useable.

Q42: What is the best way to start using GreenZyme® in my oil wells?

A42: The best way is to trust nobody but practice and gain experience by you.

Just pick a trial of say 3 oil wells, and then start injecting **GreenZyme®** to each oil well to gain first experience and knowledge.

See how the 3 oil wells perform and the net gain of crude oil over time. Judge only by the end results to evaluate the ability of **GreenZyme®** in EOR projects.

Q43: How do I know my oil well is a good candidate for GreenZyme® process?

A43: Like anything else in this world, knowledge comes with experience. After experiencing a few **GreenZyme®** treated wells, most people will become expert in using our **GreenZyme®** products.

For GreenZyme® performance:

From Society of Petroleum Engineers – USA.

- **SPE # 112355; SPE # 107128; SPE # 144231; SPE # 144281; SPE # 154690.**

From Center for Integrated PETROLEUM Research (CIPR) – Norway.

- **SCA2009-28**

From Academics:

1) University of Bergen – Norway

Nasiri, H., 2011. Enzymes for Enhanced Oil Recovery (EOR) PhD thesis.

2) Technical University of Denmark – Denmark

Khusainova, A., etc. Journal of Petroleum Science & Engineering 127 (2015) 53-64

For laboratory reports: Core Studies.

- **PTS Laboratories, Houston, Texas – Report no. 22507, 22594.**

For Environmental studies on GreenZyme®:

From Clariant Oil Services Laboratory Report – Norway.

- **Final report – OECD 306 tests. Study Ref: No.: 2199 / Fish; 2199 / Biodeg; 2199 / Acartia; 2199 / Skelet.**

If you still do not know how to get started, please feel free to contact us as follow:

Biotech Processing Supply – 214 884 5554 – info@btprocessing.com

We would like to send you our “**OIL WELL INFORMATION FOR GreenZyme® APPLICATION FORM**” to be filled out, for the purpose of helping you to determine if your candidate wells are suitable for consideration for our **GreenZyme®** treatment.

Disclaimer:

Apollo Separation Technologies Inc. will never give a performance guaranty for any of our **GreenZyme®** products, since we do not know the history and all related problems of your oil well..

All material information contained here is intended for use as reference only, as well as basic understanding by end-users of Apollo **GreenZyme®**.

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