when HCl is included in the acid combination, the values of permeability and porosity increase less. When acidifying sandstone, the mixtures of hydrofluoric and phosphoric acid and fluoricfluoboric and formic acid can be used as the primary acids. The most effective mixtures are 3% HF: 9% H3PO4 and 3% HBF4: 12% HCOOH. Hydrochloric acid does not perform as well as phosphoric (H3PO4) and formic acid (HCOOH) do as buffers (HCl).

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STEAM-ASSISTED GRAVITY DRAINAGE.

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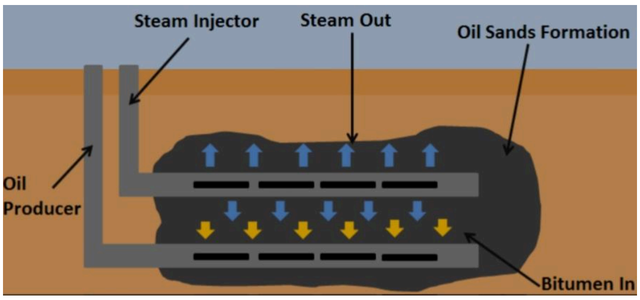
Abstract. Heavy crude oil and bitumen are produced using the increased oil recovery technique known as steam-assisted gravity drainage (SAGD). A pair of horizontal wells are dug into the oil reservoir, one a few meters above the other. This is an advanced method of steam stimulation. In order to heat the oil and diminish its viscosity, high pressure steam is continuously fed into the upper wellbore. This causes the heated oil to drain down the lower wellbore, where it is pumped out. In the 1970s, Dr. Roger Butler, an engineer who worked for Imperial Oil from 1955 to 1982, developed the steam assisted gravity drainage (SAGD) method. Butler “invented the idea of developing certain bitumen resources thought to be too deep for mining utilizing horizontal pairs of wells and injected steam.”

Key words: crude oil, bitumen, SAGD, horizontal wells , injected steam.

Description. The steam injection methods that were initially created to produce heavy oil from the Kern River Oil Field in California have been improved by the SAGD process for producing heavy oil or bitumen. Delivering heat to the producing formation in order to lower the heavy oil’s viscosity and enable it to migrate toward the producing well is essential to all steam flooding procedures. Some Alberta oil sands, such as the Cold Lake oil sands, were able to produce oil using the cyclic steam stimulation (CSS) method developed for the California heavy oil fields, but the Athabasca oil sands and Peace River oil sands, which contain the majority of Alberta’s oil sands reserves, struggled to produce bitumen from heavier and deeper deposits. The Alberta Oil Sands Technology and Research Authority and other industry partners helped Dr. Roger Butler of Imperial Oil develop the SAGD process in order to create these significantly greater reserves. The National Energy Board estimates that the SAGD method will be profitable when oil prices reach at least $30 to $35 per barrel. Two parallel horizontal oil wells are drilled in the formation, one about 4 to 6 meters above the other, as part of the SAGD process. The lower well also recovers water from the condensation of the injected steam. The top well injects steam, and the lower one collects heated crude oil or bitumen that flows down naturally. In order for the injected steam to form a “steam chamber,” thermal communication must first be established with the reservoir. The steam’s heat causes the bitumen or heavy crude oil to become less viscous, which makes it easier for it to flow into the lower wellbore. Since the steam and associated gas are less dense than the heavy crude oil below, they tend to rise in the steam chamber, filling the empty space left by the oil. This prevents steam from being created at the lower production well. Over the steam, associated gas creates a thin layer of an insulating heat blanket. Oil and water enter the bottom well bore through a countercurrent, gravity-driven drainage. By using progressive cavity pumps, which are effective at moving high-viscosity fluids with suspended solids, the condensed water and crude oil or bitumen are recovered to the surface. Sub-cool is the difference between the actual temperature and the saturation temperature (boiling point) of water at the same location where pressure is recorded. Lower temperatures and higher sub-cools are associated with higher liquid levels above the producer. It becomes very challenging to achieve a uniform sub-cool along the full horizontal length of a well since real-world reservoirs are generally diverse. In order to maintain the bitumen’s heat throughout the entire wellbore and keep its viscosity low, many operators, when faced with unevenly stunted steam chamber development, permit a small amount of steam to enter the producer. This has the added benefit of transferring heat to colder areas of the reservoir along the wellbore. When operators intentionally circulate steam in the producer after a lengthy shut-in period or as a restart step, the process is frequently referred to as partial SAGD.

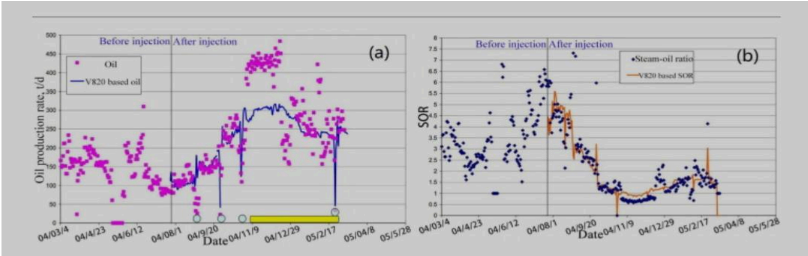
Although a high value of sub-cool is preferable in terms of thermal efficiency because it typically involves a decrease in steam injection rates, it also has the unfavorable effect of somewhat reducing production because bitumen becomes viscous and less mobile at lower temperatures. The potential for steam pressure to eventually become insufficient to support steam chamber development above the injector is another disadvantage of very high sub-cool. This can occasionally lead to collapsed steam chambers in which condensed steam floods the injector and prevents further development of the chamber. The instability issues that plague all high-pressure and cyclic steam processes are eliminated by continuous operation of the injection and production wells at approximately reservoir pressure, and SAGD produces a smooth, even production that can be as high as 70% to 80% of oil in place in suitable reservoirs. As the rock is heated, differential thermal expansion allows steam and fluids to gravity flow through to the production well, making the process largely insensitive to shale streaks and other vertical barriers to steam and fluid flow. Even in deposits with several thin shale barriers, recovery rates of 60% to 70% of oil in place are possible because to this. The earlier CSS technique is typically twice as efficient thermally, while SAGD causes significantly fewer wells to be harmed by the high pressures involved with CSS. This makes SAGD significantly more cost-effective than cyclic steam procedures where the reservoir is reasonably thick when combined with the greater oil recovery rates attained.



SAGD in China. The majority of China's super-heavy oil reservoirs are continental deposits with deep burial depths and significant heterogeneity, both of which significantly favor the use of SAGD technology. The first SAGD pilot test was conducted in the Guantao Formation and Hexing VI Formation in the Du84 block of the Liaohe oil field in 1996, followed by the drilling of the first pair of horizontal wells in the Shu1 region of the Liaohe oil field. There will be 161,100-ton SAGD production wells in the Liaohe oil field by the end of May 2019. The Chong32 and Choang37 blocks of the Xinjiang oil field hosted the first SAGD pilot tests in 2008, and hundreds of SAGD wells have since been successfully drilled.One million tons of super-heavy oil have been produced at the Xinjiang oil field, and a comparatively advanced SAGD technological system has been established. Since the super-heavy oil reservoirs in the Liaohe oil field are thick and deeply buried, many vertical-horizontal well SAGD techniques are used to take advantage of the existing vertical wells. The super-heavy oil resource in the Xinjiang oil field is narrow and buried shallowly, hence dual-horizontal wells SAGD are primarily used.

SAGD in Azerbaijan. Currently, this method is not used in Azerbaijan, but in the future, we can use this method to extract high-viscosity oils. For example, with the help of this method, we can exploit the high-viscosity deposits located in the Qirmaki valley section. The primary oil and gas fields in Azerbaijan are situated in the Lower Pliocene productive layer, which is stratotypically represented by the Qirmaki valley section. The Qirmaki valley, which is situated in Baku’s Binagadi district (Northern Absheron) and opens the stratotype section of the oil-saturated strata of the productive layer, creates a distinctive erosion environment in the washed arch of the same-named brachyanticline. In the past, high-viscosity deposits were exploited in the Qırmaki mountain using the internal combustion method. However, this method caused a lot of damage to the environment. If we use SAGD method in this area, we can exploit it without harming the environment.

Multimedia assistant SAGD. The quick upward expansion of the steam chamber during the SAGD operation to extract thin-layer super-heavy oil can significantly reduce the amount of super-heavy oil that can be extracted by causing heat loss and harming the cap rock's physical qualities. Steam and Gas Push (SAGP), Expanding Solvent-Steam Assist Gravity Drainage (ES-SAGD), and other modified SAGD technologies have all been presented in order to optimize the steam chamber in the early or late stages of SAGD in order to improve the steam chamber expansion and increase oil recovery. SAGP. The SAGP operation involves a minor co-injection of non-condensable gas together with steam into the reservoir, which alters the lateral expansion of the steam chamber and improves the eventual oil recovery. This occurs because the injected non-condensable gas collects at the top of the steam chamber and has low thermal conductivity, high viscosity, and high oil solubility. The built-up gas can lessen heat loss and steam consumption, maintain steam chamber pressure, and so speed up oil drainage.In particular, the SAGP's co-injected nitrogen acts as a heat insulator to boost overall thermal efficiency, and the



nitrogen fingering boosts the steam flow capacity. The co-injected CO2 in SAGP lowers oil viscosity after dissolving into the crude oil, and the fractured water-in-oil emulsion lowers oil-water interfacial tension, improving oil mobility. Although the co-injected flue gas in SAGP contains both CO2 and nitrogen, its thermal insulation effect is less than nitrogen despite having the processes of both gases. ES-SAGD. In contrast to the SAGP, during the ES-SAGD the hydrocarbon solvent is co-injected into the reservoir to improve the eventual oil recovery. Following gasification, the co-injected hydrocarbon solvent constantly absorbs and dissolves the crude oil around the steam chamber, lowering its viscosity and enhancing interfacial tension. Numerous studies of the phase behavior, solvent flow rate, and ideal solvent concentration have been done in order to improve the steam chamber during the ES-SAGD.According to earlier studies, the hydrocarbon solvent should be injected as soon as the steam chamber contacts the top of the reservoir because an early injection can thin out the crude oil and reduce viscosity, which causes crude oil to flow downward from the shallow slope. Recent laboratory tests, however, have demonstrated that early solvent injection can quicken the vertical expansion of the steam chamber and enable an increase in production. Extensive field testing of the ES-SAGD technology has also taken place, and the majority of these tests, like the n-hexane ES-SAGD in the Liaohe oil field and the butane ES-SAGE at the Christina Lake oil field, are showing promising results.

Disadvantages of SAGD.

1) Oil and water nexus. Surface mining methods used to obtain Canadian oil sands petroleum can use up to 20 times as much water as traditional oil drilling. The amount of water used in the increasingly significant steam-assisted gravity drainage technique (SAGD) approach, however, was not well known as of 2011. The produced water from SAGD operations can be treated in evaporators to create high-quality

freshwater for SAGD operations. However, evaporators generate a large amount of blowdown trash that needs additional control.

2) Use of natural gas for steam generation . Cost of steam generation is a significant portion of the cost of producing oil, as it is in all thermal recovery processes. Due to the sizeable stranded gas reserves in the oil sands region, natural gas has historically been used as a fuel for Canadian oil sands projects. The cost of gas has, however, become a crucial factor with the construction of natural gas pipelines to foreign markets in Canada and the United States.Another issue is that Canada’s natural gas production has peaked and is currently dropping. Other methods of producing heat are being considered, including the gasification of the heavier fractions of the produced bitumen to create syngas, the use of adjacent coal reserves, or even the construction of nuclear reactors.

3) Use of water for steam generation. To produce the steam needed for the SAGD process, a huge freshwater and brackishwater source as well as massive water recycling facilities are needed. In terms of water consumption and management, water is a hotly contested topic. As of 2008, the United States’ petroleum industry produced more than 5 billion gallons of produced water daily. The quality of the water is more important than the proportion of water consumed when it comes to the issue of excessive water use. In the past, fresh, surface water accounted for over 70 million cubic meters of the total water volume used in the SAGD process. As of 2010, when 18 million cubic meters of fresh water were consumed, there has been a dramatic decrease in this usage.Though industry has started to considerably increase the amount of saline groundwater utilized in order to counteract the sharp decrease in fresh water demand. Since production started, surface water usage by oil sands activities has decreased by more than threefold thanks to this and other, more general water conservation methods. Because SAGD relies on gravity drainage and calls for relatively substantial and uniform reservoirs, it is not appropriate for all heavy-oil producing locations.

Material Balance. The volume swept by the steam chamber can be used to compute the oil production rate. As a result, before the steam chamber reaches the cap rock, the oil production rate per unit of horizontal well length is as follows.

$$q = 2\pi \rho \phi \Delta S R (dR/dt)$$

where q, in kg/(md), is the rate of oil production per unit of horizontal well length; ф is the porosity; is the oil density, expressed in kg/m3; R is the steam chamber’s m-diameter radius; Soi + Sor = So; Initial oil saturation is denoted by Soi, residual oil saturation is denoted by Sor, and time is denoted by t.

For example: if ф=30 %, p= 998 kg/m3, t=200d , R= 6,10m , S= 0,75 , dR=1,10 ,dt=10 d

q= 2π*998*0,75*0,3*6,10*(1,10/10)= 946,7 kg/(m*d)

Conclusions: 1) In Canada, shallow- and middle-depth super-heavy oil reservoirs have developed a relatively mature SAGD technology because to their favorable physical characteristics. Although China's super-heavy oil resources are deep and highly diverse, 100-ton SAGD wells have been developed. Because of the limited effective heat exchange area in thin-layer super-heavy oil reservoirs, the steam chamber must be improved, and SAGD technology modification is a good way to do this.

2) Although media-assistant SAGD has shown promising results in field tests, there are still some issues with the technology, including difficult field control, ambiguous injection times, and high cost. Before the field injection, a thorough analysis based on the physical characteristics of the reservoir and the oil quality must be carried out. The steam chamber expansion can be optimized at various phases using gas- and solvent- assisted SAGD, but the injection time and concentration need to be carefully examined.

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PAYLAYICI ŞƏBƏKƏDƏ QAZ TƏNZİMLƏYİCİ MƏNTƏQƏLƏRİN OPTİMAL YERLƏŞDİRİLMƏSİ

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Xülasə: Təbii qaz yüksək səmərəli enerji daşıyıcısıdır və iqtisadi kontekstdə qazlaşdırma sosial-iqtisadi inkişafın əsasını təşkil edir və iş şəraitinin yaxşılaşdırılmasına xidmət göstərir. Təbii qazdan istifadə zamanı əsas vəzifə onun rasional istehlakıdır. Qazpaylayıcı və qaz istehlakı sistemlərinin texniki və iqtisadi cəhətdən əsaslandırılmış layihələndirilməsi istehlakçılara müəyyən təzyiqlə lazımi miqdarda qazla təmin etməyə kömək edir. Eyni zamanda, qəbul edilmiş texniki və iqtisadi həllər etibarlılığı təmin etməli və maksimal məhsuldarlıqla optimal texnoloji rejimlərdə qaz şəbəkələrinin işləməsini icra etməlidir.

Qazpaylayıcı şəbəkələr mürəkkəb quruluşa malik dairəvi və dalanvari şəkildə qurulmuş bir mühəndis sistemidir. Şəbəkənin işinə müxtəlif təsadüfi amillərin təsiri və tələbatçılar tətəfindən qazın qeyri-bərabər şəkildə alınması təzyiqin dəyişilməsinə ehtimal səciyyə gətirir. Bunu nəzərə almaqla, istehlakçılara qəbul olunan etibarlılıq göstəricisi ilə qazın verilməsi şəbəkədə təzyiq rejimlərinin operativ tənzimlənməsini tələb edir. Təzyiq rejimlərinin tənzimlənməsi layihələndirilmə zamanı şəbəkənin hidravliki hesablanması əsasında kəmər hissələrinin diametrlərinin düzgün seçilməsi və düyün nöqtələrində lazımi təzqyiq rejiminin saxlanılması hesabına baş verir. Hal-hazirda qaz şəbəkələrinin hidravliki hesablanması üçün müxtəlif proqramlar hazırlanmış və praktikada tətbiq olunur. Lakin qaz şəbəkəsində axınların optimal şəkildə paylaşdırılması və təzyiqlərin tənzimlənməsi imkanlarının araşdırılması aktual olaraq qalmaqdadır.

Açar sözlər: təbii qaz, qaz şəbəkəsi, qaztənzimləyici məntəqə, əhatə radiusu, hesablanma alqoritmi

Qaz şəbəkəsində təzyiqin tənzimlənməsi qaz tənzimləyici məntəqələr (QTM) vasitəsilə aparalır. Həmin məntəqələrin əhatə radiusunun və saylarının optimal seçilməsi mühüm əhəmiyyət kəsb edir. Bu məsələlər baxılan işdə əsas tədqiqat məsələsi olmuşdur.