新编石油工程英语

刘地渊　刘德云　左新华　徐恩信　等编

中国石化出版社

内 容 提 要

本书编辑收集了近5年来国内外油气开采方面涉及到的专业英语，内容新颖且有许多词汇和术语首次出现，尤其是涉及到化工、机械、仪表、新技术领域的专业英语，以英汉对照形式编排。适合于油气开采行业中高级技术人员阅读，对高等院校师生学习尤其是研究生也有重要参考作用。

图书在版编目(CIP)数据

新编石油工程英语/刘地渊等编.
—北京：中国石化出版社，2004
ISBN 7-80164-678-9

Ⅰ.新… Ⅱ.刘… Ⅲ.石油工程-英语 Ⅳ.H31

中国版本图书馆CIP数据核字(2004)第114898号

中国石化出版社出版发行
地址：北京市东城区安定门外大街58号
邮编：100011 电话：(010) 84271850
读者服务部电话：(010)84289974
http://www.sinopec-press.com
E-mail:press@sinopec.com.cn
中原石油报社彩色印刷厂排版印刷
新华书店北京发行所经销
*
787×1092毫米 16开本 13.75印张 349千字
2005年1月第1版 2005年1月第1次印刷
定价：38.00元

《新编石油工程英语》

编 委 会

序

世界石油工业的发展日新月异，新技术、新装备、新工艺大量涌现，随之产生、发展或派生出大量新词汇、新专业术语以及新技术方法，这已在近年来西方原文技术杂志或交流文献中体现出来。《新编石油工程英语》一书正是随着目前石油工程中生产，科研和对外科技交流之需要即将奉献给广大读者，它充分反映了美、英、法等西方发达国家近年来的技术发展和科学成就，对于广大中、高级技术人员学习专业英语知识，加速传播石油技术信息，了解世界石油工程的发展动态，推动科研、生产以及技术管理诸方面的工作定会大有裨益。希望该书将成为广大科技工作者以及高等院校师生欢迎的参考和阅读资料。

左新华

2004 年 10 月

前　言

随着世界油气工业的迅速发展，全球范围内的油气田普遍进入高含水期，我国东部各主力油田包括大庆、胜利、辽河、中原、华北、南阳油田尤为明显，油气开采技术不断更新和发展，许多技术与世界各国在该领域的技术密切相关，如酸化、压裂、三次采油、堵水调剖等方面。各油气田每年都有不同程度的国外技术引进项目，大量的科研课题都在追踪着世界先进技术。科研、生产和教育战线上的广大科技工作者和中高层管理人员阅读、参考国外原版杂志和技术文献的机会越来越多，对外直接交流的项目也日益增多。

尽管多年来许多石油院校和科研机构编辑出版过一些油气开采方面的专业英语书籍，但远远落后于目前新技术发展的速度，其内容深度和广度皆不够。笔者近年来广泛收集和积累了现场急需的主要国外专业技术参考资料，分门别类地进行了充分编译和筛选，以英汉对照形式奉献给读者。经过近一年的时间对其英汉语言进行了推敲，尽可能达到通俗易懂，既能满足大专院校高年级学生学习要求，也能供给科研、生产和管理机构的中高级技术人员参阅，相信会对读者加快新技术英语的学习和掌握，乃至加速科研和生产进度起到推动作用。

在本书编辑过程中，中原油田采油二厂副厂长刘地渊同志任主编，信息中心主任左新华、培训中心副主任刘德云、高级工程师徐恩信分别为副主编，杨瑞民同志为编委。编辑内容分工为：刘地渊同志从 $P_1 \sim P_{35}$，约 5 万字；左新华同志从 $P_{36} \sim P_{64}$，约 5.1 万字；刘德云同志从 $P_{65} \sim P_{100}$，约 5.3 万字；石凤岐同志从 $P_{101} \sim P_{134}$，约 6 万字；许伟同志从 $P_{135} \sim P_{168}$，约 5 万字；杨瑞民同志从 P_{169} 到书末，约 5 万字。全书由徐恩信同志审校和统稿，张广勤同志给予充分指导。

由于本书内容较新，涉及油气开采专业知识面较广较深，许多专业英语知识在国内首次出现，加之时间仓促和作者水平限制，书中定有不当之外，希读者批评指点为盼。

编　者

目　　录

第一章　最新提高采收率技术英汉对照译文

(一)

Although there were all the uncertainties in this ASP simulation study caused by missing or inaccurate data, it was still very clear that such a study was very useful. It helped us identify the missing data and the most important data. It gave us some preliminary idea of the qualitative behavior of the process in this particular reservoir with a given description that could be used to plan a detailed simulation design study. It showed the use of the model, e. g. , the graphical tendency of each physical puoperty such as phase behavior, and gave some idea of the cost of running the simulator on the scale of interest. This was also needed for planning purposes, as well as for the discrimination of any model problems that might need attention or any further model development that should be considered. It was used to evaluate completely different alternatives, e . g, should polymer flooding be considered as an alternative to ASP and resulted in the selection of the ASP process ofr the field pilot. Taken together, these study were very important, and the fact that it was feasible to make such affordable field - scale mechanistic simulations of ASP flooding in three dimensions. Using stochastic reservoir properties is significant since it indicated the potential of such modeling to help us greatly improve, via optimization studies, the efficiency of the ASP method and hence its economics under specific field conditions.

尽管由于散失的或不精确的数据造成所有的 ASP 模拟研究具有不确定性,很明显的是这样的研究是非常有用的。它帮助我们识别散失的数据和最重要的数据。它运用已知的用于计划详细模拟设计研究的描述,对这一特殊油藏给我们一些有关工艺定性的初步概念。它阐明了模型的使用,例如每一物理性能(比如相态特性)的图解趋势,并给出了采用这一模拟设计的效益成本概念。这对于计划目标,以及区分任何模型需要注意的问题或进一步考虑模型开发也是必需的。它常常用来评价完全不同的备选方案,比如说,如果聚合物驱油作为 ASP 的一项备选方案,就导致了先导试验的 ASP 工艺的选择。总的来说,该项研究是非常重要的,以现场规模对 ASP 驱油进行三维机械模拟效果是显著的。采用随机油藏特性是可行的,因为它表明通过优化研究,这样的模拟有助于提高 ASP 方法的效率,从而提高在特定的现场条件下的经济效益。

(二)

The total recovery from a waterflood predicted by the layered geologic model BL, is 32% of the oil in place, or 3.8 MMBO at a 96% water cut.

The first model recorded polymer fronts as a function of the increasing rate of the stabilized zone water saturation. Polymer adsorption was a function of injection stage, but kept a constant value in the injection stage. Mobility modifications were made by polymer. But there was no attempt to account for polymer related flow resistance, The total recovery from this model predicted by BL ,is 38% of the oil in place, or 4.6 MMBO at a 98% water cut.

根据分层地质模型 BL 方法预测,水驱总的开采量是地层原油的 32%,或者含水量为 96%时的 3.8 百万桶油。

第一个模型记录了聚合物前缘,将其作为稳定层含水饱和度上升速度的函数。聚合物吸附是注入阶段的一个函数,但在整个注入阶段保持一个恒定值。聚合物改善了流度,但是还没有给出与聚合物相关联的流动阻力的解释。由 BL 预测该模型总的开采量是地层原油的 38%,或者含水量为 98%时的 4.6 百万桶油。

(三)

Polymer enters the formation at the lower section of a horizontal well at high rates if the injection inflow profile along the horizontal well is uneven. To know the effects of high injection rate into the formation and possible concomitant irreversible shear degradation, a 1550 ppm solution of HPAM in 13,600 ppm brine was injected into a core plug (3.6 cm diameter, 7.3 cm long) at Darcy velocities from x to y ft/day. The pressure gradient, effluent viscosity, and polymer concentration in the effluent were measured at each velocity.

The viscosity of the polymer flowed out did not decrease at velocities up to 26 ft/day. A decrease in viscosity was first seen at 51 ft/day and became more severe as the rate was increased up to 355 ft/day. Yhe pressure gradient curve revealed that the flowing polymer possessed a substantial shear - thickening/viscoelastic effect at the higher rates, despite that the polymer was being irreversibly sheared. These effects should be considered during simulation, and the loss in viscosity should be compensated by using a higher concentration of injected polymer.

如果沿水平井的注入流动剖面不均匀,聚合物可能会经调整从水平井底部进入地层。为了确定高速注入地层时的效应和随之而产生的不可逆的剪切降解,13600ppm 盐水中 1550ppmHPAM 溶液以 $x \sim y$ft/d 的 Darcy(达西)速率注入岩心塞(直径 3.6cm,长度 7.3cm),在各速度下测量压力梯度、排放物粘度及其中的聚合物浓度。

在速度达到 26ft/d 时,排放出的聚合物粘度不降低。第一次粘度降低是速度为 51ft/d,速度上升至 355ft/d 时情况更严重。压力梯度曲线表明,在较高的流量下,尽管不可逆地剪切聚合物,但流动聚合物显示出相当大的剪切增稠/粘弹效应。在模拟过程中应当考虑到这些效应,用较高浓度的注入聚合物补偿降低的粘度。

(四)

One of the most important observations with regard to bypassing and mass transfer is shown in the results of horizontal gasfloods in the presence of water saturation. It exhibits a monotonic trend in recovery with enrichment. The MCM and submiscible recovery cures are similar to those mentioned above, but the FCM recovery curve is relatively higher, This indicates the reduction in gravity iverride, which could be indicative of an increase in the viscous to gravity force ratio. In the presence of water, the effective permeability of the hydrocarblon phase, k, is decreased, increasing $N_{v/g}$, The recoveries in horizontal gasfloods in the water – wet core with x S_w are not a strong function of enrichment and very poor compared to the horizontal, water – wet results at n S_w i. e. , the recovery in horizontal gasfloods in the oilwet core with p S_w. That is due to redistribution of water in the water – wet rock during gasfloods.

最重要的观测结果之一就是在水饱和的情况下,水平注气中存在旁通和传质。它显示伴随富集,采收率趋势是单调性的。MCM 和亚混相采收率曲线类似上述曲线,但 FCM 采收曲线相对高一些。这表明重力上窜在减小,同时粘性对重力比率影响的增大。

在有水情况下,烃相渗透率系数 k 是减小的,$N_{v/g}$是增大的。水润湿 S_W 为 x 岩心的水平注气的采收率与富化的关系不大,且与水润湿 S_W 为 n 的结果相比很差,即具有 pS_W 的油润湿性岩心的水平注气的采收率。这是由于注气期间水在水润湿性岩心中重新分布造成的。

(五)

The oil recovery by near miscible WAG in this reservoir may have an upside potential com – pared to the simulating results. The WAG process black oil formulation was believed to give too low oil recovery by ignoring the compositional exchanges. The compositional model underestimates that oil recovery by not including three – phase relative permeability hrsteresis. The ideal simulation would use the three – phase hysteresis model in a compositional model to provide good estimates of oil recovery. Field tests have indicated that the details of local reservoir heterogeneity may be controlling the gas breakthrough. History match of the production from the field may be dominated by the description of high permeable thief zones. This fact do not preclude from using the most correct fluid flow description in the predictive pre – studied and in any history match approach on a later stage. When the physics of fluid flow in the WAG process is correctly described, accuracy of history match by revising reservoir description is assumed to be improved.

比较模拟结果,在这种油藏中近混相 WAG 的原油采收率可能有上升的潜力。通过忽略组分交换,确认 WAG 处理黑油成分给出太低的原油采收率。在不包括三相相对渗透率滞后时,组分模型低估了原油采收率。为了更好地估算原油采收率,理想的 WAG 模拟把三

相相对渗透率滞后用在组分模型中。现场试验表明了可控制气突破的局部油藏非均匀性细节。通过高渗主力层的描述,可以支配油田生产的曲线匹配。这一事实不妨碍把正确的流体流动描述用于预言性的先期和后期曲线匹配研究方法中。在正确描述了 WAG 过程中流体流动的物理过程时,通过调整油藏描述提高了曲线匹配的精度。

(六)

MI efficiency can be determined directly by dividing produced EOR oil into injected MI, and can measured indirectly by assuming that MI remaining in the reservoir has mobilized EOR oil. MI efficiency shows likely to end up between x and y Mscf per stb of incremental oil. This is in keeping with the performance appeared in the simulation. Although the MIST process is complex. it appears that returned MI can be used as a reliable indicator of the process. Small volumes of returned MI indicate that the process is efficient . Once large volumes of returned MI are seen, it is time to either shut in the affected production well until injection is completed or to stop solvent injection into bulb. In a gravity – dominated reservoir, the MIST process appears to be commercially competitive with conventional WAG using inverted five – spot patterns.

混相注入剂的效率可以通过将采出的原油除以被注入的混相剂而直接求得。可以假定滞留于储层内的混相注入剂已经起到了提高采收率的作用而间接地求得。每增加一桶原油,混相注入剂的效率大概在 $x \sim y$Mscf 之间,这与模拟研究中所见情况相符。

尽管混相注入剂增产工艺很复杂,但返回的混相溶剂似乎可以作为处理可靠的指示剂。返回少量的溶剂说明工艺有效。一旦返回大量的溶剂 MI,说明此时需要关掉相关生产井直到完成注入,或需要停止向球状区注入溶剂。

对于受重力支配的储层,与常规的采用反五点井网的水气交替注入工艺相比,混相注入剂增产工艺似乎在商业上更具竞争性。

(七)

The results are based on earlier study. Plan to continue similar experiments by changing parameters included permeability, the layout of the different permeability zones, core length, and oil saturation. But the preliminary results show htat the delay of CO_2 breakthrough in the high permeability region is a favorable phenomenon, when surfactant solution is used with CO_2 to form foam, oil displacement is more efficient. Substantial reduction of CO_2 mobility in higher permeability regions helps improve the sweep efficiency. Uader the test cinditions, although the results show that foam is more effective in oil recovery in the isolated coaxial core system than in the capillary contact core system, all favorable oil recovery results indicate the potential of using foam for improving oil recovery in heterogeneous porous media.

结果根据早期的研究产生。设计通过改变参数诸如渗透率,不同渗透率层的结构,岩

心长度和含油饱和度继续进行类似的实验。但初步的实验结果表明，在高渗透层 CO_2 突破的延迟是有利的现象，当用表面活性剂溶液和 CO_2 溶合形成泡沫，油的驱替更有效。高渗透层 CO_2 流动度缩减可帮助提高波及效率 。在试验条件下，虽然结果表明泡沫在隔开的同心岩心系统比毛细管接触的岩心系统驱油方面更有效，在非均质孔隙介质中表明用泡沫改善驱油效果具有潜力。

（八）

Final oil recovery surpasssed 95% in all the tests and is not greatly affected by petrophysi – cal parameters and rock texture. Gas stripping of oil intermediate components occured in all displacements; the compsition of the gas fladhed from the oil produced revealed an enrichment of light components; the volume of enriched gas used to cover a unit volume of reservoir ranged from 299 to 499 Nm^3/m^3, which at reservoir conditions, considering a deviation factor(z) of the gas, became x m^3/m^3.

最终原油采收率在所有实验中都超过了95%，且最终原油采收率受岩石物性参数及岩石结构影响不大。在所有驱替过程中，中间组分都产生了脱气。从油中闪蒸出的气组分表明轻组分富化。包覆单位体积油藏所需富气为 299 ~ 499Nm^3/m^3。如果在油藏条件下，考虑到气的偏差系数变为 xm^3/m^3。

（九）

After the success of the polymer gel treatment program to improve pattern performance, several patterns were treated, and y of those were with polymer gel volumes in the z bbl range. The success of these larger volume treatments has been the impetus for developing a lower cost, CO_2 gelled foam system. There have been several patterns treated with this system and are described.

While treatment life has been evaluted to extend for a minimum of two and a half years, there are plans to evaluate the economics of re – treatments. The initial treatments are diverting fluid from the highest permeability and conductivity pathways to the next highest pathway. When this pathway has been processed by four years of CO_2 injection , the CO_2 utilization will decrease and the expense will begin to increase. The candidate selection process will include the evaluation of pattern retreatments.

在聚合物凝胶作业改善井网性能成功之后，几个井网被处理。聚合物凝胶用量在 z bbl 范围的有 y 个，这些较大用量的成功作业对于开发低成本的 CO_2 凝胶泡沫体系是一个有力的促进。用这一体系进行作业的井网有几个并被描述。

进行评价的作业期限延长至2.5年，那么将有计划地评价重新处理的经济效益。初始的作业正在将流体从高渗和高导流能力通道导入下一个高渗通道。经过4年的 CO_2 注采后，CO_2 利用率降低而开采费用又将增加。候选过程包括再处理井网的评价。

(十)

Tte well is an oil producing well in a carbonate reservoir. Tt has been dead due to high water production. The well has a high permeability streak which contributes more htan 65% of the total well flow. The well has an open hole completion with a significant surface washout. A sodium silicate/urea gelling system was used to plug the water zone and revive the well. The treatment was using a coiled tubing unit over three days. First day, sodium silicate/urea solution was injected followed by a cement slug, which was capped by sodium silicate solution. No cement was examined after this treatment. The procedure was modified on the second day by adding calcium chloride solution prior to the sodium silicate/urea solution. The objective of calcium chloride solution is to react with sodium silicate and precipitates calcium silicate, which will act as a barrier until the cement is set. After the second treatment, cement was detected in the open hole. Although the treatment did not plug the zone, the well was revived and it has been producing x MBD of oil.

该井是一口开采层位在碳酸盐油藏的产油井,由于产出水多已经停产。此井有一个高渗透薄夹层,有65%的井液出自该层。该井是裸眼完井,具有显著的表面侵蚀。为了堵住产水层使该井恢复生产,使用了硅酸钠/尿素凝胶体系。用挠性管作业机进行三天时间的施工作业:第一天,硅酸钠/尿素溶液首先被注入地层,随后注入了水泥塞,该段塞被硅酸钠溶液覆盖。施工作业后没有探测到水泥。第二天改变了作业程序:在硅酸钠/尿素溶液之前加入氯化钙溶液,使之同硅酸钠反应生成硅酸钙沉淀,在水泥凝固之前充当阻挡层。

二次处理后裸眼中可探测到水泥。尽管施工作业没有堵住层位,油井还是恢复了生产,并且产出油为 xMBD。

(十一)

Tests concentrated on delaying gelation time by changing gelant composition and using retarding agents are continued and results are unavailable.

In the core flooding test, E_6 polymer – gel showed good injectivity, the data proves the effect of disproportionate permeability reduction. After the treatment, the effective permeability to water was significantly decreased in contrast with gas effective permeability. Additional effect of dissolution of gels by oxidizer was also studied. The test of chemical degradation on gel sample E_6 demonstrated that gel formulations could be completely dissolved in a water oslution of sodium hypochlorite and sodium hydroxide. This gives one chance for well treatment in case of premature gelation, or bringing the system back to pre morte state if total shutoff occurs in the near wellbore zone.

通过改变凝胶成分或使用缓速剂的办法集中试验胶凝时间延迟问题,最终结果还未得

出。在对岩心进行的驱替试验过程中，聚合物胶 E_6 展现了其令人满意的注入率；数据证明渗透率的降低呈不匀称状态。处理后，对水的有效渗透率与气的有效渗透率相比，呈较大的降低状态。对凝胶中加入氧化剂后所产生的附加溶解反应也进行了研究。通过对凝胶试样 E_6 的化学降解试验表明：这些凝胶成分在次氯酸钠和氢氧化钠的水溶液中可被完全溶解。这为油井处理时过早胶凝提供了一个补救的机会，一旦近井眼周围发生总体堵水现象，可使系统恢复到原始状态。

（十二）

The conformance problem being related by treatment C is similar to that for treatment B. Production from the Ml pattern is limited by poor areal sweep efficiency due to rapid CO_2 breakthrough to the producer well, AC9, situated to the south - east of the injector well. The M1 target CO_2 injection for zone 1 is 90 vol% ,considerably higher than that for M10. The treatment appears to have improved the M1 injection profile relative to the targets. CO_2 injection has been decreased for zones A and B and increased to 66 vol% for zone C. In this pattern, zone A has been over processed compared to the other zones and this is reflected in the low target for CO_2 injection, namely. 1.9 vol% , However, a higher CO_2 entry into zone 3 could be advantageous if the CO_2 is transfered to increase sweep towards the producers.

处理方案 C 遇到的有关波及问题与处理方案 B 相似。M1 井网的产量下降，原因是 CO_2 快速窜入注入井东南部的 AC9 生产井中，导致 CO_2 横向波及效果差。M1 井的 CO_2 注入的目标是第一层注入量占 90%，远远高于 M—10 井。此次处理相对其目标看来似乎改进了 M1 井的注入剖面，但是 CO_2 的注入量在第 A 层和 B 层的注入量降低了，第 C 层却上升到 66%。在此井网中，第 A 层同其它层位相比已经是过处理，具体体现在 CO_2 注入量较低，只有 1.9%。然而，如果地层中分流的 CO_2 量增加，波及了生产井，较高的 CO_2 突进第三层段比较有利。

（十三）

Polymer stability studies have been made for a olng time. Two cores of different permeabilities, MA and MB, were used respectively.

The initial untreated permeability for core MA was 340 mD. After inoculation of Product A and incubation for seven days, sufficient biopolymer had produced to decrase the initial core permeability by 95% to 18 mD . At 4 and 8 months slight increases from the one week treated permeability were noted as 23.0 mD and 35.5 mD. The initial untreated permeability ofr core MB was 700 mD, two times greater than that of core MA. After the 1 week incubation time, the permeability had reduced by 96% to 27.7 mD. Again, at 4 and 8 montsh slight increases from the one week permeability were notde as 45 mD and 42 mD, respectively.

These results indicate that the biopolymer formed by probuct A has kept stable over 180 days. The slight increases in calculated permeabilities at 3 and 6 months do not indicate any significant degradation of the biopolymer. The stability of the polymer is very useful for permeability modification applications, but further studies to optimize the overall injection method for product A are needed.

聚合物稳定性的研究已进行多时,本研究中采用了不同渗透率的两种岩心 MA 和 MB。原始没经处理的岩心 MA 其渗透率为 340md。接种了产品 A 并培育一周之后,形成了生物聚合物并使得渗透率降低了 95% 达到 18md。4 到 8 个月后,其值比一周时处理的渗透率分别上升 23md 和 35.5md。

MB 岩心原始未处理渗透率为 700md,比 MA 大一倍。培育一周之后其值降低了 96% 为 27.7md。同样 4 到 8 个月后分别为 45.0md 和 42md。

这些结果表明产品 A 生成的生物聚合物在 6 个月的实验期内比较稳定。虽然在 3 和 6 个月期间渗透率有所回升,但生物聚合物没有表明任何大的退化。这种聚合物的稳定性尤其适用于改善渗透率,有待进一步研究为产品 A 做出优化整体注入方案。

(十四)

A series of core tests were made to investigate the effect of spoore concentration, nutrient slug size, and enclosure period, The results are as follows: 0.5 N means half pore volume of nutrient and lidewise 4N refers to four pore volumes. In general, increasing spore suspension concentration by orders of magnitude tends to increase permeability reduction. But, continuous nutrient injection plan, as expected, resulted in a higher permeability reduction than smaller nutrient slug size. The main point mentioned here is that the permeability reduction could be controlled to a significant degree by a judicious choice of injection design involving spore and nutrient concentrations and amount.

为调查孢子浓度、营养物段塞大小和封闭时间的影响,做了一系列岩心实验。结果所示,0.5*N* 指的是半孔隙容积,4*N* 指的是 4 孔隙容积。通常是通过提高孢子悬浮液浓度的数量级以扩大渗透率的减少量。然而,正如所希望的那样,连续的营养物注入方案比小的营养物段塞产生更大的渗透率降低。本文主要观点是通过选择有效的注入方案,包括孢子和营养物的浓度和数量,渗透率降低可控制在一个理想的程度上。

(十五)

These simulations were performed by keeping the amount of surfactant and polymer the same. A fixed proiect life of about 1500 days was determined as the criterion to stop and com - pare these simulations. The results of cumulative and incremental oilrecovery compared to that from the continuing waterflood are summarized. The continuing water flood gives the smallest oil

recovery of about 2.8%, whereas ASP gave the highest recovery of 25%, Neither waterflooding nor polymer flooding are favorable for this reservoir, because the average oil saturation of 0.6 before chemical flooding is not much greater than the residual oil saturation of 0.36, which means a small targert oil for both processes.

进行这些模拟时保持表面活性剂和聚合物用量相同。大约 1500 天的固定开采期限选择作为停止和对照这些模拟的标准。总结了同水驱相比较的累积产油量和增产油量的结果。连续的水驱给出了大约 2.8% 的最少的产油量。而 ASP 给出了 25% 的最高的采出油。对于这一油藏,不论是水驱还是聚合物驱效果都不好。因为在化学驱之前 0.6 的平均含油饱和度并不比 0.36 的残余油饱和度大很多,这意味着两种处理方式的的目的层原油都不多。

(十六)

Each injection well was formed by calculating the permeability from the core derived porosity – permeability relationships. Logging porosity was determined at one – foot intervals. The site permeability was given by the square root mean of the calculated permeabilities. The daily field injection rate was proportioned to each injection well based on each well's calculated kh value. Each injection well was provided by site specific model. The flow into each layer was in terms of on layer permeability. The injection models are site specific where as the geologic model to determine oil recovery is based on an average representaion of the entier oil field.

通过由岩心得出的孔隙度—渗透率关系式推算渗透率,建立每一口注入井的模型。以一英尺间距确定测井孔隙度。现场渗透率用计算的渗透率的平方根平均值来表示。根据每口井计算的 kh 值,将油田的日注入量按比例分配给每口注入井。每一口注入井都用井场专用模型来表示。注入每一层的流体都有赖于其地层渗透率。注入模型是井场专用的,正如确定产量的地质模型以整个油田的平均表示法为基础一样。

(十七)

Successful software packages were used to estimate the unit pressure gradient for a seven cp aqueous fluid flowing at 39,000 bpd in seven in. pipe with an absolute roughness of 0.0019 in. This viscosity was seleceed as the best estimate fro polymer viscosity in the field pipe after preliminary tubing runs and high – shear – rate measurements with a cone and plate rheometer. The calculated pipe τ_w was then used to design the tubing by multiplying the pipe unit pressure drop by the ratio of the pipe ID to the tubing ID. The flow rate needed to reach this tubing pressure drop was determined by tuial and error, and was found to be about x and y mL/min for the x_1 and y_1 cm ID tubing, respectively. To provide a safety factor and enhance the confidence in the results, additional tests were made with the larger tubing in which the polymer was subjected to

even higher shear by increasing the flow rate to produce a x_2 increase in τ_w.

利用一套成功的软件包来评价粘度为7cp的含水流体、以3900bpd的流速、在绝对粗糙度为0.0019in的7in管子中流动时的单元压力梯度。在油管下入、并用锥度板流变仪高剪率测量后，聚合物粘度作为最佳评价。计算的管子 τ_w 用来设计油管，用管子内径与油管内径比值乘以管子单位压降。由试差法确定达到该油管压降所需的流速，对于内径 $x_1$cm和 $y_1$cm的油管分别为 $x$ml/分和 $y$ml/分。为了提供安全系数，增加信心，用大油管再进行实验，通过增加流速使 τ_w 增加 x_2，使聚合物处于较高的剪切状态下。

(十八)

It shows that the wettability has significant influence over mass transfer. Mass transfer is strengthened under oil – wet conditions over water – wet state. But it does appear that the influence of wettability is less as gas/oil capillarity increases, as in MCM and submiscible floods. This increase can be the cause of the better connectivity of the oil – phase in the oil – wet media. There was little effect of water saturation on mass transfer in an oil – wet core. FCM mass transfer is governed by diffusion or flow in oil films. The results from the oil – wet core suggest that the water holds the larger pores and does not shield oil from the flowing gas in the gap space, unlike those observed in the water – wet core in the presence of water saturation. The same conclusions can be obtained for the MCM and submiscible gas experiments. A slight decrease in recovery is seen as water saturation increases due to increased gas – oil capillary forces.

它表明润湿性显著影响整个传质。油润湿环境的传质比水润湿环境的高。实际上，随着气/油毛细管作用增大且用MCM和亚混相驱时，降低了润湿性的影响。这个增大可归为油相在亲油介质中良好的连通性的作用。对于油润湿岩心，水饱和度对传质的影响小。扩散或油膜的流动控制FCM传质。对于油润湿性岩心，结果表明水占据着较大空隙且不阻止油从空隙中的自喷气里流出，在水润湿岩心，有饱和水存在时，观测到的不是这样。对于MCM和亚混相注气实验有相似的结论，由于气/油毛细管作用增强，造成水饱和度增加，使得采收率略降低。

(十九)

The results of the tuned black oil model have been shown previously by comparing water injection. But the WAG injection had serious numerical difficulties when vaporising oil/dis – solved gas was included. The model ran well until around ten years, where the timesteps de – creased from days to hours and difficulties with the convergence of the iterations was observed. The grid was expected to have a large influence on the numerical behaviour of the simulations. Test with a piece of model was therefore used for further study with the black oil simulator. The black oil model underrated the oil recovery compared to the composition model. Gas production is

larger in the black oil than in the compositional model. This can be expounded by gas vaporisation, which would not be anticipated in the black oil formulation. The black oil model therefore overestimated gas production and underestimated oil yield.

通过比较注水,已经表明了调节的黑油模型的结果。然而,包括组合的 WAG 和蒸发油/溶解气时,WAG 注入有严重的数字错误。直到大约 10 年才观察到时步从几天降至几小时,迭代难以收敛。在此之前模型一直用得很好,预计网格对数字模型特征有很大影响。

因此,薄片模型测试用于将来研究黑油模拟系统。与组分模型比较起来,黑油模型过低估计了原油的采收率。在黑油模型中气产量大于组分模型中的气产量。这能够用气体蒸发来解释且在黑油模型中是不能预料的。因此,黑油模型过高估计了气产量,过低估计了油产量。

(二十)

It shows the comparison between the simulator and actual oil rates. The field produced much more oil than the thief model. The field is returning less MI than the thief model and using MI more effectively. Because of the delayed returned MI production and the high oil rates, it appears that the thief does not extend across the entire interwell distance. The no-thief model produces oil too slowly and it shows that there must be a thief zone present across part of the area. Since the field is returning significantly less MI than the model, the thief may be more favorably located than in the model.

它是模拟器与实际产油量的对比。实际增产的原油远比取样模型高得多。现场回采量比模型要低,故正在更有效地使用混相注入剂。由于混相剂回采滞后,产油量很高,很显然漏失层并未跨越整个井间距离。无漏失层模型油流产量太低,估计存在一个漏失层。鉴于现场的回流量明显低于模型,漏失层的确定或许比模型更有利。

(二十一)

To test the effectiveness of foam on oil recovery, three important tests were made on a core that was presaturated with the curde oil. The first test was performed using CO_2 as the displacing agent. As predicted, the CO_2 breakthrough occurred earlier in the annulus region at x PVthan in the center region at y PV. Using CO_2/brine to displace the oil resulted in a silght delay of CO_2 breakthrough in both regions. When foam was utilized to displace the oil, a significant delay in breakthrough time in the annulus region and an earlier breakthrough in the center region were known. The cumulative GOR increases substantially in the center region when foam is used as a displacing agent. This shows that foam assists in correcting the nonuniform displacement usually associated with the heterogeneity.

为了检测泡沫对采油的有效性,在原油浸透岩心之前做了 3 次重要试验。第一次试验