

新型综合增注剂 LJ 系列的研究与应用

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摘要 介绍了新型综合增注剂 LJ 系列的增注机理、性能、作用及其在克拉玛依油田、彩南油田等新老区块各类大注井上的应用情况。现场施工 57 井次,有效率达 98% 以上。现场应用表明,LJ 系列综合增注剂解除了吸水层堵塞,满足了地质配注要求,与压裂增注相比,具有解堵厚度大,适应于多个吸水层的特点。LJ 系列综合增注剂有两大组成部分:预处理剂 LJ-2 具有很好的渗透分散作用;主处理剂 LJ-3 起到了防止粘土颗粒运移、膨胀及溶解水中微生物菌体、机械杂质的作用,达到疏通孔道之目的。

主题词 注水井 化学处理剂 解堵 增注 试验 研究 应用

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LJ 系列增注剂是针对新疆石油管理局注水开发过程中普遍存在的注水层堵塞而研制的高效增注剂。曾在新疆油田的采油二厂、三厂、彩南油田、北三台油田等进行现场试验,通过 57 口井的施工,证明该系列增注剂能有效地解除因水质污染、颗粒运移等各种因素造成的堵塞,使各注水井满足地质配注的要求,解决了油田生产的实际问题。

一、LJ 系列增注机理

LJ 系列增注剂分 LJ-2 预处理剂和 LJ-3 主处理剂两部分。LJ-2 预处理剂成分中的非离子表面活性剂及有机烃,在注水井上使用可起到较好的渗透分散作用,其极性分子同孔隙中的原油及蜡质等极性物质相作用,可降低原油对孔隙的作用力,起增溶作用。另一方面,溶剂烃在一定程度上溶解了部分堵塞的有机物,降低了孔隙内界面张力,解除了 W/O 乳化所造成的乳化堵塞。

LJ-3 主处理剂中的酸液可有效地分解堵塞物中的无机颗粒及机杂等堵塞,其杀菌成分可杀死水中的细菌,解除微生物菌体造成的堵塞,有效地防止二次沉淀的产生。

二、室内试验

1. 预处理剂 LJ-2 清洗油泥试验 将原油与膨润土按 1:0.5 比例充分混合制成油泥,在烧杯壁上均匀涂满 0.5~1mm 厚油泥,加入不同浓度的 LJ-2 溶液将其浸没,做静态清洗试验,观察其洗净率,其结果见表 1。

表 1 不同浓度的 LJ-2 溶液清洗油泥效果

溶液浓度(%)	2	4	6	10	15
洗净率(%)	85	95	95	90	90
分散性	好	好	好	好	好

由表 1 可看出,LJ-2 溶液在浓度 4%~6% 时,洗油效果最好。

2. LJ-2 静态驱油试验 试验用岩心砂为克拉玛依油田五 3 中地层岩心砂,原油为五 3

中区稀油,按岩心砂:原油=5:1的比例将两者混合搅拌均匀,装入带刻度的试管,上部留有一定的空间,然后分别做不同浓度的LJ-2静态驱油试验,试验时间为30min,其结果见表2。

表2 不同浓度的LJ-2静态驱油试验

溶液浓度(%)	2	4	6	10	15
洗油量(mL)	1.0	3.0	3.0	2.0	2.0

由表2可看出,LJ-2溶液浓度在4%~6%时,驱油效果最好。

3. LJ-2缓速性能 LJ-2地层清洗剂除具有清洗油泥、蜡质等作用外,与酸液作用还具有缓速效果。

4. 主处理剂LJ-3的溶蚀性试验 将LJ-3主处理剂、10%的HCl及土酸溶液做对岩心的溶蚀性试验,其结果见表3。

表3 40℃地层温度下不同配方的溶蚀率

配方	用量(mL)	反应时间(min)	岩心重(g)	溶蚀率(%)
10%HCl	50	40	1.043 0	13.88
10%HCl+4%HF	50	40	1.188 0	19.33
20%LJ-3水溶液	50	40	1.472 3	16.84

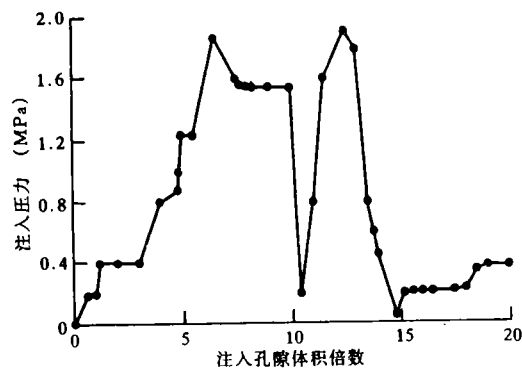
从表3可看出,LJ-3主处理剂稀释5倍后,其对岩心的溶蚀率仍大于10%的HCl。

5. LJ-3对堵塞物质的解堵性能 配制人工堵塞物成分为:FeS 0.5g、CaCO₃ 1.0g、Fe(OH)₃ 1.0g、MgCO₃ 1.0g、膨润土 2.0g、SRB、TGB菌体各5瓶。将以上物质充分混匀后,加入20%LJ-3水溶液20mL,在静态情况下测定其溶解率,在5min内溶解率达98%,证明LJ-3能解除各类堵塞物造成的堵塞。

6. LJ-3主处理剂的杀菌性能 取采油厂的含油污水测定水中SRB含量为10⁵~10⁶个/mL,TGB含量为10³~10⁴个/mL,然后向含有SRB、TGB菌的水样中加入浓度为4%的LJ-3溶液,测定细菌生长情况。结果杀菌率为100%。

7. LJ-3腐蚀试验 考虑到现场施工设备、管线的因素,用LJ-3、自来水做静态开式系统8h腐蚀试验,现场施工最长时间不超过3h。结果LJ-3对设备的腐蚀率为0.112 9mm/a,自来水的为0.112 7mm/a,说明主处理剂在8h内不会对设备造成腐蚀。

8. 人工模拟岩心试验 用渗透率为125×10⁻³μm²、残余油饱和度为30%、束缚水饱和度为35%的岩心做水驱油试验,试验温度为80℃。试验用污水进行驱油,驱至岩心压力升到一稳定值为止(即6.5PV处);从6.5PV处开始注入4%的LJ-2溶液到10PV,记录岩心压力变化,反应时间0.5h;从10PV处注入20%LJ-3溶液到13.5PV,记录岩心压力;作用4h后,继续水驱,记录压力下降情况,试验结果见图。



LJ系列增注剂人工模拟试验图

从图可看出,被堵塞的岩心在用LJ-2和LJ-3处理后,在注入流量不变情况下,注入压力下降,所以渗透率迅速恢复,起到了解堵作

用。

三、现场应用情况

利用 LJ 系列增注剂,在各采油厂不同区块的各类欠注井上进行解堵增注施工,有效率达 98%,增注幅度普遍在 40%以上,有效期在半年以上。

1. 施工工艺 施工时用 4%的 LJ-2 溶液为预处理剂先注入地层,其目的是清洗地层,解除有机物堵塞,使主处理剂能更好地与地层堵塞物接触。其液量据井的污染情况而定。LJ-2 注入地层后需关井 30min,使其与地层充分接触与反应,将杂质溶解掉。再向地层注入 20%的 LJ-3 溶液,解除地层中的其它堵塞物,疏通渗流孔道,达到解堵之目的。注完 LJ-3 后关井 2~3h,开井正常注水。

2. 现场施工效果 LJ 系列新型增注剂,先后在采油二厂、采油三厂、彩南油田等不同区块的新、老注水井上进行增注施工 57 井次,解除了吸水层的堵塞,而对吸水层的破坏程度是很微弱的,它同压裂增注相比,具有解堵厚度大、适应于多个吸水层的特点,可避免因压裂造缝形成的注水锥进问题。如在采油二厂八区克上组施工的 8200 注水井,用 LJ 系列增注施工后,同位素吸水剖面测试表明各层吸水相对均匀(见表 4)。

表 4 8200 注水井吸水剖面同位素测试结果

层位	井段(m)	吸水百分数(%)	吸水量(m ³ /d)	吸水强度(m ³ /d·m)
S ₄ ¹⁻¹	2 077.6~2 079.5	29.9	11.9	6.3
S ₄ ²⁻¹	2 104.2~2 106.2	24.9	9.96	4.98
S ₄ ³⁻²	2 112.6~2 114.3	13.6	5.44	3.2
S ₅ ¹⁻¹	2 125.0~2 127.8	31.6	12.6	4.5

表 5 为用 LJ 系列增注剂的部分施工井效果统计表(截止到 1997 年 11 月底)。

表 5 注 LJ 系列增注剂的部分井施工效果统计

井号	施工日期	井口压力(MPa)		注水量(m ³ /d)		累积增注(m ³)	有效期(d)
		注前	注后	注前	注后		
8200	1992.4	12.8	10.0	6.7	41.0	23 500	810
C111	1995.4	8.5	6.4	15.6	42.3	24 781	1 020
5771	1995.3	16.3	16.2	18.0	29.4	16 700	1 051
5826	1995.8	16.0	10.5	20.0	30.0	5 001	840
50078	1995.6	16.5	13.5	2.0	19.0	12 601	900
50059	1996.9	15.5	12.0	0	12.0	11 400	810
50043	1996.4	16.5	15.0	8.8	50.0	4 995	575
50045	1996.4	16.5	14.4	16.7	40.0	2 856	575

由表 5 可看出,新型综合增注剂 LJ 系列在注水井上都见到增注效果,应用十分成功。

四、结论

1. 用 LJ 系列综合增注剂处理因细菌、乳化、水锁、机杂等污染物造成的注水层流动孔道堵塞是可行的、行之有效的办法。

2. 用 LJ 系列增注剂对注水井实施解堵增注不会对注水井的渗流孔道造成伤害。

3. LJ 系列增注剂适应性较广,可推广使用。

4. 在今后的工作中应录取好测压资料,获取反映油层污染情况的有关数据。

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with the chromatogram peak of the commingled—produced oil, the contribution of oil in different layers to the well can be identified. This provides reliable basis for the adjustment of the production measures and the working out of the production plans of an oil well. With the help of it, the oil—produced degree of different layers can be known, which will provide direction for the next production potential tapping. This paper also introduces the calculation software developed by using chromatography, presents the research results of the actual contribution of the main layers of wells Jin2—C5—215 and Jin2—6—307 in Jin—16 block to the single well productivity during the commingled production.

Subject heading Liaohe Oil Field crude oil chromatography analysis technique
research application

RESEARCH AND APPLICATION OF POST — FRACTURING TREATMENT TECHNIQUE FOR LOW PERMEABILITY OILFIELD

by Yu Guodong, Lu Dakai, Zhang Ying'an

Abstract Fracturing is one of the main stimulation measures for developing the new field and stabilizing the production of matured field in low permeability Jilin Oilfield. The effects of fracturing are influenced by a lot of factors. This paper, starting from the analyzing of the influential factors, points out that the man—made fractures should be treated in the proper time after fracturing, the substances damaging the fractures must be cleaned out, the flow conductivity of the fractures should be recovered. By doing so, the output of the oil well can be increased, and the effective period of fracturing can be prolonged.

Subject heading fracturing fracture proppant fracturing fluid residue flow conductivity injury complexing agent oxidizing agent disposal fracture

APPLICATION OF NEW LJ SERIES OF COMPOSITE INJECTION INCREASE AGENT IN KERAMAYI OILFIELD

by Zhao Lingli, Li Jianjiang

Abstract This paper introduces the injection increase mechanism, property and action of new LJ series of composite injection increase agent, introduces the application of them in the underinjected wells in both new and old blocks of Keramayi Oilfield and Cainan Oilfield. The injection increase agent had been used for treating the underinjected wells for 57times, and the efficiency was more than 98%. The field application of the agent showed that it had removed the plug of the injection layers, satisfied the requirements of the injection allocation. Comparing with the method of fracturing and injection increase, it has the characteristics of removing plug of thicker layers and being suitable for several injection layers at the same time. The LJ series of composite injection increase agent is composed of 2 parts. The preconditioning agent LJ—2, which is with good permeableness and dispersion actions; and the main conditioning agent LJ—3, which can dredge the pores and throats by means of preventing the clay grains from migrating, swelling, and by means of dissolving the microorganisms' body and injected particles in the water.

Subject heading water injection well chemical conditioning agent plug removal
injection increase testing research application

RESEARCH OF NEW SALINITY GRADIENT WATER INJECTION TECHNOLOGY

by Li Hongjian, Li Haitao, Zhao Min, Gong Liwu, Zhang Yutao

Abstract Water injection is one of the major measures to keep formation pressure and improve oil recovery. But water sensitive damage caused by waterflood is also one of the major reasons causing the descending of injectors' injectivity for the sandy formation with sensitive minerals. A new gradient water injection technology of descending step by step the injection water salinity to the formation water salinity was developed based on the characteristics of with higher sensitive minerals in formation of Rongxingtun Oilfield. At the same time, in order to enhance waterflood effect and be convenient to implement in oilfield, clay inhibitors were put into injected water. The experiment in lab and application in oilfield showed that the new technology had greater adaptability than other routine measures and had produced good stimulation effects.

Subject heading water injection well injection water formation water salinity
gradient injection increase technique research

FIELD PRACTICE OF INTEGRAL PROFILE CONTROL AND WATER SHUTOFF IN MONGGULIN SANDSTONE RESERVOIR

by Ju Dengfeng, You Jing, Gu Yi, Zhang Wei

Abstract Monggulin sandstone reservoir is a thin layered heavy oil reservoir with weak edge water. The permeability in different layers in this reservoir is very different, and the oil—water viscosity ratio is 224. After putting into waterflood production, the water fingered forward rapidly, the waterflood effect was poor. Therefore, a profile control and water shutoff agent suitable for this reservoir was developed. Meanwhile, properties such as the crosslinking time of the agent, the viscosity of the gel, the thermal stability and the plugging degree of the agent in the porous media and so on were tested and evaluated. This paper demonstrates the method how to prevent or reduce the damage of the agent to the low and middle permeability formations, presents the corresponding technologic measures, and also puts forward the new method for determining the injection pressure based on the lab simulation test and reservoir features. Field test proved that the contradiction between layers of Monggulin sandstone reservoir had been successfully resolved.

Subject heading Monggulin Oil Field sandstone reservoir profile control water
shutoff agent laboratory testing injection pressure starting time field testing