

延长油田压裂裂缝监测技术应用研究

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摘要: 本文运用嵌入式人工裂缝实时监测技术在南泥湾油田实施压裂井裂缝实时监测及井下压力-温度实时监测, 获得多井人工裂缝方位、长度、高度等几何尺寸, 地层能量、压力变化与储层渗透性的关系等; 运用地质统计分析方法, 结合区块其它地质资料, 分析该油田主力油层人工压裂裂缝的形成及分布规律及井下地层能量、压力变化与储层渗透性的关系。

关键字: 裂缝监测; 裂缝方位; 裂缝长度; 裂缝高度

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0 引言

通过压裂可在地下形成人工裂缝, 改善地层的渗流条件和注水效果, 提高油井的产能。但压裂是否形成裂缝以及裂缝的方位、长度、影响高度及地应力等的估计, 对压裂施工分析、压裂效果分析、地质构造认识、改造层认识、潜力层分析、油田开发等具有十分重要的意义。因此, 对人工裂缝进行实时监测是势在必行的。

1 储集层系特征

南泥湾油田主要储集层油藏埋深浅(油层深度480~860m, 平均630m), 为典型的特低渗岩性油藏, 储层非均质性强, 岩性、物性、含油性在纵、横向上变化较大。这些油层属于特低渗储层, 平均孔隙度10%, 平均渗透率0.710-3, 油井普遍无自然产能, 需经压裂改造才能获得工业油流。

2 嵌入式人工裂缝实时监测技术

嵌入式人工裂缝实时监测技术主要采用微地震方法, 实时监测压裂过程中地层破裂产生的微地震波。确定微震震源位置。由微震震源的空间分布可以描述人工裂缝轮廓, 进而给出裂缝的方位、长

度、高度、产状及地应力方向等地层参数。

3 裂缝分布监测可行性及监测实例分析

3.1 裂缝分布监测的可行性

针对南泥湾油田的主要储集层由灰、灰绿色的细粒长石砂岩组成; 储层地层平缓, 为西倾单斜, 地层倾角在0.5°左右; 储层埋深较浅, 主要分布在300~1000m之间; 储层改造厚度较薄, 一般小于20m; 井底破裂压力小于70MPa, 井底温度小于50℃的特征, 利用嵌入式人工裂缝监测技术完全可以监测到压裂时人工裂缝形成过程中产生的微地震波, 进而解释获得裂缝产状及几何尺寸。

3.2 裂缝监测实例分析

1) 储层物性

长4+5层位共压裂了3口井, 射孔厚度均为2.0米, 渗透率在0.86-1.25mD之间, 孔隙度在8.29%-9.65%之间。总之3口井的射孔厚度小, 物性差。

2) 压裂规模

长4+5层位共压裂了3口井, 总用量在90-118方之间, 平均为101方, 总加砂量在16-22方之间, 平均为19.3方, 排量都是1.2-2.5m³/min。3口井的压裂规模相差不大, 但比长6层位的稍大

一些。

3) 裂缝结果

(1) 裂缝形态与方位

长4+5层位共压裂了3口井, 除y364-5井为水平裂缝方位不明显之外, 其它2口井的方向均为北东-南西向, 方位角在44.5-48.5度之间, 根据最小主应力原理, 水力压裂人工裂缝总是产生于强度最弱、阻力最小的方向, 即岩石破裂面垂直于最小主应力方向, 说明压裂井区长4+5层位的最大主应力可能为垂向应力, 也可能为水平应力。分析产生水平裂缝的原因可能是y364-5井长4+5储层较浅, 造成垂向应力最小, 形成水平裂缝。

当垂向主应力最大时, y731-7和c122-2两井水平最大主应力方向在北东46度左右。

(2) 裂缝长度

一般压裂液量、砂量越大, 即规模越大, 产生的裂缝越长, 反之越短, 两者呈正相关。

长4+5储层的压裂设计规模为液量约100m³、沙量约20m³、排量约1.2-2.5m³/min, 在此规模及现行射孔单封压裂工艺下, 长4+5储层压裂产生垂直裂缝的单翼平均长度在62m左右。

目前开发井网采用160m×160m, 裂缝的半长接近井距的一半, 对于长4+5低渗透油藏, 基本上适合的。

3口井裂缝向两翼的延伸都比较均衡, 反映了压裂井区储层局部的均质性相对较好。

(3) 裂缝高度

垂直裂缝的高度在10.1-11.3米之间, 分布在射孔段上下4-5米之间, 储层厚度在15m左右, 说明缝高控制的比较好, 施工排量设计合理。

4) 液体滤失

y364-5井为水平缝, 闭合时间很短, 只有15.4分钟, 比垂直裂缝的另外2井要短得多, 说明了水平裂缝的闭合模式与垂直裂缝完全不同; 水平缝的液体效率也比垂直缝低得多, 说明压裂产生水平缝的过程中压裂液的滤失比较严重。

3口井的表皮系数均为正值, 表明了这3口井压裂过程裂缝端面存在一定污染, 但随着后期排液和生产, 裂缝端面污染会得到很大程度缓解。虽然并不严重, 但仍说明应加强压裂液的选择与配制, 加强压裂液与地层的配伍实验等, 减少液体对储层的

污染。

5) 措施前后产量

长4+5层位共压裂了3口井, 压裂后平均单井液量增加0.33方/天, 增加的幅度都不大, 与压裂规模对比分析可知: 压裂规模越大, 液量增加的幅度也相对较大。

4 结论及认识

通过对10口井的压裂分析, 形成以下结论与认识。

1) 储层压裂裂缝主要是垂直裂缝, 即垂向主应力最大。当井较浅时(约500m)有水平裂缝产生。

2) 储层垂直裂缝方位以北东向为主, 即水平最大主应力方向为北东向。当个别井局部地应力场发生变异时有北西向裂缝产生, 因此应加大监测力度, 指导井网的部署。

3) 不同的压裂规模产生不同的裂缝缝长, 裂缝的长度与压裂规模呈正相关关系。长4+5、长6储层目前的压裂规模(液90m³, 砂20m³)产生的裂缝半长约为70m, 与当前的井网是适合的。

4) 嵌入式人工裂缝实时监测技术给出了压裂人工裂缝的方位、长度、产状等结果, 对评价压裂效果、挖掘剩余油等具有重要作用。

5) 压裂裂缝的方位主要与局部地应力场相关, 对注采井网有重大影响, 开发部署注采井网时应特别关注。

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Analysis on Problems of Genetically Modified Food Safety

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ABSTRACT: In recent years, genetically modified food (GMF) has been approved in large-scale commercial production. The problems of genetically modified food safety have become a hot topic. This paper explores the problems of genetically modified food safety. The study shows that GMF may have potential risks on ecological environment, human health and national security. The risks are given comprehensive analysis. Finally, the development countermeasures of GMF are proposed. Some effective measures should be taken to lower the risks and minimize the harm. We must treat GMF with specific standpoint, active exploration and conservative practice.

KEY WORDS: genetically modified food; safety; development countermeasures

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1 Significance on study

Transgenic technology is high-tech in 21st century. Genetically modified food (GMF) accounts for a large share of the food industry and has colorized the food market. Nevertheless the potential risk of GMF is always the hot topic since the naissance. There are some links between GMF and ecological environment, human health and so on. Though we have consumed GMF for a long time, we can not assume that it is absolutely safe. The author thinks that we cannot make absolutely affirmation or negative judgments on GMF. Rational analysis should impose on this issue. Besides, we found that the average consumers knew little about GMF. So we analyze the potential problems of GMF safety in this paper aiming to expand awareness of GMF and propose the development countermeasures of GMF.

2 Brief introduction to GMF

GMF is genetically modified food or gene modified food. The chosen favorable exogenous genes are implanted into recipient organisms (animal, plant and microbial) with the method of genetic engineering to

change the genome to obtain the new quality and characteristics. Genetically modified food is produced with these creatures as raw materials^[1]. GMF has many strong points, such as improving economic efficiency, increasing food output to alleviate the food crisis, making food more nutritious and delicious, reducing the use of pesticides and so on. So GMF is the inevitable result of technological development. Although the United States is the largest producer of GMF, the domestic consumption of genetically modified foods is rarely. The products are mainly used as feed or exported to developing countries such as China and India. The countries of EU resisted GMF basically. Russia and Japan hold a conservative attitude. In China there are no direct restrictions and some experts declared GMF should become staple food in the near 3 to 5 years^[2]. Actually, we have consumed GMF more or less in our daily diet.

3 Analysis on problems of GMF safety and Development countermeasures

With the progress of science and technology GMF has become a very important part of consumers' daily

lives and commercial production. Though there are many merits of GMF, the incidents of food safety such as O157, BSE, Dioxins and Listeria contamination indicated that GMF may have some potential risks and side effects in some certain aspects. So we try to provide detailed analysis on potential risks. According to our analysis, we aim to seek feasible solutions to lower the risks and minimize the harm.

3.1 Effects on ecological environment and Development countermeasures

Actually, the effects on ecological environment of genetically modified organisms attract the most attention. Transgenic technology destroys the natural law. There is no doubt that it will have an impact on our ecological environment.

3.1.1 Destruction of ecological balance In theory, genetically modified organisms have broken down the traditional boundaries. With the superior characteristics which the general species do not have, it is possible to change the competitive relationships among species if released into the environment^[3]. As a result, it will lead to the destruction of the original natural ecological balance. Some new species will appear and some species will disappear for the destruction of food chain. Some genetically modified organisms become the advantaged group causing the decrease of some populations. If the diversity of biological resources was destructed it would bring great loss to genetic breeding, industrial and agricultural production, ecological environment. For example, Mexico is the origin of maize. It has extensive germplasm resources. In recent years, it has already had some impacts on the genetic diversity of maize as the introduction of U.S. genetically modified corn. Cotton Research Institute of Chinese Academy of Agricultural Sciences found: due to Bt toxins planting in cotton farms, cotton bollworms were killed by Bt toxic protein, resulting in significantly few parasitoids of cotton bollworm. Quantity of a biological population reduction or extinction has impact on the survival of predators, biodiversity and even the entire food chain and eventually destroys the ecological balance.

3.1.2 Gene or Biological contamination The important raw materials of GMF are genetically modified crops. Genes can spread among the populations by hybridization and biological pathways. Hybridization between transgenic crop plants and related species by pollen, the genes transfer to non-transgenic plants. In the production process of GM crops, the seeds are transported or brought to new ecological environment by insects, birds, wildlife and other ways to bring spread, breeding or transferring genes to other plants. Genetic drift to non-target plants may produce a super weeds, thus the loss of ecological environment could be immeasurable. Take our country as an example, once the large-scale production of genetically modified rice was promoted, it is bound to bring seeds pollution. When we find defects in genetically modified rice, then we will want to use the original Chinese rice seeds. But the original seeds have already been contaminated due to genetic drift and no longer exist. The irreversibility of transgenic rice industry and the commercial production is the main concern from other countries. Because once we involved in it, there will be no way back.

3.1.3 Increasing use of pesticides GM crops can reduce the use of pesticides. Herbicide-resistant transgenic crops acreage increased, following with a sustained growth in herbicide usage in traditional crops. Herbicide transfers to other places with the rain, erosion, etc., resulting in a continuous soil, water and environmental pollution. In addition, the extensive use of herbicides reduces the biodiversity. In Huanghuai basin of our country transgenic cottons are planted for a long time. Because the cotton bollworm becomes resistant, the farmers must use high dose of pesticides to control it, thereby causing varying degrees of pollution to the environment^[4].

3.1.4 Soil pollution Soil is a vital part of our environment. Residues and root exudates of GM plants contain some stable compositions such as Bt toxic protein which is not easily biodegradable in soil. It can maintain insecticidal activity for a very long time and kill the soil microbial. Eventually, it will reduce the soil

biodiversity, and affect the micro ecological cycle of the soil.

3.1.5 Measures proposed Due to the aforementioned impacts of GMF, it has far-reaching side effects on ecological environment. We should clearly recognize this point and take positive and effective actions to protect our ecological environment.

3.1.5.1 Partition planting and species protection

As the planting of GMO has no strict boundaries, it is easy for GMF and natural foods to cross-action. Because GM crops could spread to new gene varieties of wild plants, it will create new creatures unmanageable. Therefore, in order to effectively prevent this, the planting of genetically modified crops should have strict control region, that is the cultivation of GM crops should be implemented with complete independence, to prevent cross-contamination and protect our ecological environment.

Protection of species diversity is vital, so firstly we suggest that we could apply diversity index in standardizing ecological system. Though it is very difficult in measuring ecosystem diversity level, we can construct ecosystem diversity index from the perspective of the relationship between populations or nutrition structure. Shannon-Wiener Index and Simpson Index are recommended. There are still technical obstacles in evaluating the genetic diversity such as chromosomes and protein determination. So we should attach great importance to scientific research in this area.

Secondly, it is recommended to use Bar Code technology in protecting species. ONA bar code is a new technology in molecular identification proposed recently. This technology is helpful to find new species and protection of biological diversity. It can supply rapid inspection and accurate identification effectively when the species are attacked by harmful organisms and invasion of seeds. Relatives of species can be distinguished with ONA bar code sequence. So it can make more meticulous and overall biodiversity analysis to protect species without delay.

3.1.5.2 Strengthening research and safety inspection

Research of testing methods on GMF safety should be strengthened, and we should take detailed actions in supervision and management^[5]. If the test sample contains genetically modified composition without detected or detection of GMO in the sample which does not contain genetically modified ingredients, these results will cause economic losses. Detection of GMF requires fast, accurate, simple and sensitive testing methods. Foods containing genetically modified ingredients are more complex. Genetically modified ingredients to be detected may be in very low levels or have degraded. So there are great difficulties in detecting. The key testing of GMF safety is purification and extraction of DNA^[6]. If DNA degraded and contaminated, the test results will not achieve the desired goal. So research should be strengthened to obtain efficient testing method in detecting GMF.

3.1.5.3 Perfection of the evaluation system on GMF safety

Management on experimental study, pilot, environmental and commercial production of GMF should be added to legal system. We should evaluate GMF with accurately scientific and technological means. We suggest that we could train technical personnel in GMF safety area^[7]. In addition, we must strengthen monitoring of environmental impact, implement real-time reporting system, construct database for biological safety and realize the sharing of resources.

3.2 Risks to human health and countermeasures^[8]

GMF alters the natural characteristics of the food. The biomass which is transplanted in GMF is not part of our human food safety. And it still does not go through security experiment in human for a certain long time and it will have a great harm to human health. 3.2.1 Decrease of nutritional value Currently safety assessments on GMF of many countries focus only on the phenotypic traits, molecular characteristics and main nutritional components of GMF comparing with the traditional corresponding food. So a variety of comprehensive effects, gene silencing, inhibiting phenomenon, etc do not be taken into account. The

current evaluation method is not reasonable enough. GMF, actually, is possible different in the major or trace nutrients and anti-nutritional factors from traditional food, and thus the nutritional value of GMF decreased, leading to the imbalance of nutrition structure to some extent. In addition, the necessary important nutrients may be degraded in GMF.

For example: American research data showed that hormones and other ingredients such as isoflavones decreased. These ingredients are effective in preventing cancer. False freshness of transgenic food confuses consumers. Shiny red tomatoes can be stored for several weeks longer but with low nutritional value.

Some GMF aimed at strengthening nutrition in food, such as Golden Rice with β - carotene genes transplanted. Every coin has two sides. We strengthen some nutrition while affecting the original nutrients. The worse thing is that it is uncontrollable and hard to predict. Long-term consumption of GMF will lead to lack of some nutrition and some strange diseases may be caused.

3.2.2 Causing allergic reactions This is due to the introduction of exogenous genes in GMO. So it will make the genetically modified organisms create new protein and metabolites after digestion and absorption. As our human being' immune system was evolved in the natural environment, it may be difficult to adapt to these new proteins and metabolites. So allergic reactions may occur after consumption or contact by some special groups.

Transgenic technology can produce unforeseeable and unknown allergens in GMF. For example, scientists transplant genes of Brazil nuts to soybean, resulting in making some people who are allergic to walnuts after eating the soybean produce an allergic reaction. It is difficult to defend effectively.

3.2.3 Toxicity problems It is easy for GMF to produce and in some of the genetically modified food residue some toxins. The main ingredients in these substances are inhibitors of the Protease activity or the endotoxin to insect resistance. So it has certain harm to human body

health.

Although the toxicity of some insect-resistant GMF is still not confirmed by science, the principle to kill pests is straightforward. The insect-resistant genes are mainly transplanted to make protein with special functions in disrupting the digestive system and even causing the death of pests express, so as to achieve the purpose of killing pests. Therefore, this kind of genetically modified crops could trigger chronic or acute poisoning, even cause cancer, malformation, gene mutation, and so on. These new genes may enter into our tissues to cause new diseases. Super- bacteria may produce and rampant. It has been confirmed in 2007 by the French scientists that one certain genetically modified corn produced by The Monsanto Company of America was poisonous and harmful to livers and kidneys of human beings. The kidney is the organ for detoxification. These new foreign genes are considered by our kidneys as poisonous. So the kidney is always hard working to protect our human body and ends up with lesions or cancer. Experiments on animals have confirmed this very early.

GMF will reduce the human body immunity. Genetically modified soybeans are used in oil production in large scale. Recent research showed that transgenic soybeans contained chemicals like analogue of estrogens which affected human hormones, resulting in abnormal reproductive organs and damaging the immune system. In addition, the common problem of consumption of GMF is leading to sterilization. Research in India and America showed that miscarriage, premature birth and sterilization frequently increasing in water buffaloes and pigs fed with genetically modified crops. Phenomenon of human infertility is increasing. Further study of GMF safety is crucial. There may be some links between the phenomenon and consumption of GMF. This cannot be overlooked.

3.2.4 Countermeasures The hazards of GMF are depending on the foreign genes, expression products and metabolites. So if we can detect these three parts totally, we can judge GMF safe or not as a food, regardless of

other problems of GMF safety. As we mentioned above, we should pay more attention to research on testing methods. Detected sufficiently with our high technology, we can perfect the nutrition and eliminate the probable toxins to assure human health.

Furthermore, we recommend applying label system^[9] in GMF. All GMF should have special labels. Each link of GMF from farmland to dining table should be identified, so as to ensure the traceability of GMF. Firstly, it is our right to know whether it is GMF or not and choose independently according to our own will. Secondly, it is helpful for special groups who are fragile to some ingredients to avoid allergic reactions.

Finally, we should be cautious in applying this technology in staple food. We can not be blind to promote for some short economic interests. Some Chinese experts said it was safe to promote large-scale cultivation of rice in China. The author thinks that is very dangerous. We should implement a large number of experiments on animals to make sure absolute safety for our human beings.

3.3 Influence on national security and strategy

3.3.1 Affecting social stability The process of genetically modified foods includes research, development, cultivation, production and sales. It may lead to unfairness among different stakeholders in profit distribution, attacking our present agricultural structure, challenging the traditional values of people. Large-scale commercial cultivation of genetically modified crops will cause many farmers to bankruptcy. Thus it will affect social stability to some extent.

3.3.2 Disturbing economic order Unfair competition will disturb economic order and increase the gap between rich and poor. Some developed countries constantly rob genetic resources from developing countries in pursuit of economic interests. Genetic resources are robbed by “genes-pirates” in developed countries to apply for patents. So developing countries have to pay high fees for it. The transgenic technology was monopolized by multinational company such as Monsanto Company, mastering the management

rights and patent rights firmly. Small and medium-sized companies cannot compete with them, not to mention profit distribution. In the long term, small and medium-sized companies will go bankrupt. This will increase the gap between developing countries and developed countries intensifying the conflicts of interest^[10].

3.3.3 Endangering food security The former American secretary of state Kissinger once said: "if you control the oil, you control all countries; if you control the food, you can control all of the people."

In traditional agriculture, farmers can remain seeds from the harvest. But transgenic seeds are turned into suicide seeds by Monopolies for sake of economic interests. Farmers must buy new seeds every year. If we plant GMO in large-scale while we do not have the key technology, it will become a huge threat to food sovereignty of China. The key technology is grasped tightly in the hand of America. China's food security is of great hidden trouble. We do not have independent intellectual property rights on the 8 transgenic rice breeds which our country is applying for commercial cultivation. America owns 533 patents in GMF. So if we cultivate genetically modified rice nation-widely, we will lose the initiative in food production. Food will become the important weapon of United States to control China. Once Sino-U.S. relation becomes strained, the United States can completely stop offering genetically modified food technology and seeds to China. As a result, 1.3 billion Chinese people will be starved and in chaos. So “food security” problem turns into "safety regime". China will be colonized and controlled by the United States.

3.3.4 Strategy As we analyzed above, the influence of GMF on national security is serious, not to mention the effects on ecological environment and human health. We must be cautious on this new technology. So we can not promote GMF abruptly. Maybe we can prove GMF safe one day, but we still do not master the key technology. The author thinks the most important thing is strengthening scientific research on genetically technology independently. Only when we assure the

security of GMF and master the core genetically technology can we popularize GMF, especially for genetically modified rice production. Besides, we suggest that our country should enact a strict and feasible supervision system on GMF.

4 Conclusion

Above we analyzed the problems of GMF safety. Though transgenic technology has a huge potential advantage, the probable risks still exist. We are likely to pay high and unimaginable price for carelessness and wrong judgment. But the biggest error is to refuse GMF blindly or support it without a second thought. The effect of any technology is twofold, transgenic technology is of no exception. Generally speaking, it brings us great benefits while causing no specific and serious harm until now. Refusing the technology blindly is stupid. Actually we should try our best to strengthen the development of the transgenic technology in our country. We should make use of its advantages under full consideration to prevent any possible harm on our ecological environment, human beings and national security.

The future of genetically modified food is that we should apply existing technology carefully and move forward step by step. Genetically modified food is a new technology product. Though there are many problems existing in GMF, GMF may become more and more perfect. We believe that we can enjoy colorful and rich lives in the future with transgenic technology if we

develop the new technology according to certain rules.

In a word, we must treat GMF with scientific standpoint, active exploration and conservative practice.

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转基因食品的安全问题分析

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摘 要: 近年来转基因食品(GMF)的商业化生产规模在不断扩大。转基因食品的安全问题已经成为一个热门话题。本文探讨了转基因食品的安全问题并进行深入的分析。研究表明, GMF可能对我们的生态环境存在潜在的风险, 危害人类健康和国家安全。在对转基因食品的安全问题进行风险综合分析的基础上, 提出了GMF的发展对策。提供了一系列有效措施来降低风险和减少伤害。我们必须从特定的角度对待转基因食品, 进行积极探索和保守的实践, 充分利用的同时减少危害风险。

关键词: 转基因食品; 安全; 发展; 对策