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Regulatory Management in California Oil & Gas Underground Injection Control Operations

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Abstract: Chinese oil & gas companies have not paid attention to the fluid injected into the reservoir that causes the loss of mineral resources and pollution in the environment. Underground injection control regulation is lacking in China. A foreign country's related experience in regulation and commissioning methods would be able to expedite the regulatory process. The California Division Oil & Gas regulatory agency is currently using underground control regulations to manage all its properties: the underground control evaluation process, aquifer exemption, area of review, injection project monitoring, testing & reporting and publicizing injection project information. In order to stabilize oil & gas production in China, the country will need to establish a new management method. The provincial government should legislate underground injection control regulations, establish a regulatory agency, and publicize the data information. Only then will China be able to protect its mineral resources and the environment.

Keywords: Underground Injection Projects, Protect the Mineral Resources, Regulatory Commission, Legislate Underground Injection Control Regulations

1. Introduction

After decades of exploitation, most of oil fields in eastern China have become in their middle and later stages of development. Water injection and other methods are usually adopted to maintain reservoir pressure and improve crude oil production. The water cut of some oil fields' production liquid is over 90%. When the fluid is injected into the underground layer, its environmental threat is more damaging. After more than 100 years of oilfield development in California, USA, it has established a set of regulations and supporting technologies for the injecting fluid. Since most of those oilfields are highly depleted, fluid injection has become important part of the daily operation. A set of newly proposed research in modeling and database acquisition have been applied in the technology advancement. New regulation has also been proposed in the legislation. These regulations and techniques will become a good example to Chinese oil and gas regulatory legislation and provide training to their technicians in the future.

2. The Regulatory Experience of Oilfield Underground Injection Control in California

2.1. The Regulatory Process of Underground Injection Control in California

The California Laws and Regulations for Conservation of Petroleum & Gas, 2018 is being used by the Division of Oil, Gas & Geothermal Resource (DOGGR) [1]. The main task is to encourage the oil companies exploiting the oil and gas production to the best production mode, so that the resource recovery of the reservoir can be the highest. At the same time, the laws and regulations require oil companies to protect the people's lives, assets and the oil and gas resources.

According to the California Laws and Regulations for the conservation of oil & gas, the US Environmental Protection Agency (EPA) granted the authority to DOGGR to regulate the production operations and injection projects of the oil

and gas companies. Also, under the Clean Water Act of the United States (1972) [2] and Underground Safe Drinking Water Act (USDW) (1986) [3], the DOGGR regulates the injection program which has TDS of the oilfield less than 10000 mg/l.

More than 60 years ago, the California's oil and gas companies injected gas and water into oil and gas zones and water zone for production enhancement and waste disposal. So far, there are about 55,000 injection wells in California mainly for secondary and tertiary recovery of oil and gas reservoirs. At present time, the California produces 15 barrels (2.05 tons) of waste water for every barrel (0.14 tons) of crude oil produced, and a total of 2/3 of the waste water (60 million barrels, or 8.22 million tons) needs to be reinjected into the original reservoirs. About 300,000 barrels (40,000 tons) of waste water are treated and mixed with other available water for agricultural irrigation and industrial use. About 2.7 million barrels (370,000 tons) of waste water are injected into the 1,800 type II injection wells designated by the EPA [4]. In accordance with the EPA type II injection fluid regulation of the United States, the authority will issue project approval, drilling and workover permits after reviewing the injection projects and will monitor logging and inspect operations on the spot, such as testing the injection well, plugging the abandoned well, collecting statistics on information and making public announcements.

It is a long process to establish and perfect the relevant laws and regulations in California.

2.1.1. 1930-1977: Injection Project Has No Relevant Regulation During This Period

During this period, the information of injection projects submitted by oil and gas companies was very incomplete due to absence of specific regulations. There were frequent cross-flows between production wells and injection wells. In the first annual report of the DOGGR established in 1951, there were nine vertical and horizontal cross-flows had been recognized and many reservoirs were damaged, and resources were lost at the same time. In 1958, the DOGGR required the oil and gas companies to submit the production forecasts of the reservoir and waste water treatment plans for the production project. But the pollution of injection wells and formation were still ignored.

2.1.2. 1978-1982: DOGGR Formally Implemented the Injection Project Regulations

In 1978, the DOGGR began to officially implement the regulations of underground injection projects and injection wells, including: reviewing injection projects and waste water injection projects, providing the well completion information about the injection projects, auditing and providing information on steam stimulation and steam injection, auditing the natural gas injection projects and storage projects, developing two standards about injection well for testing and operation as shown in the Figure 1.

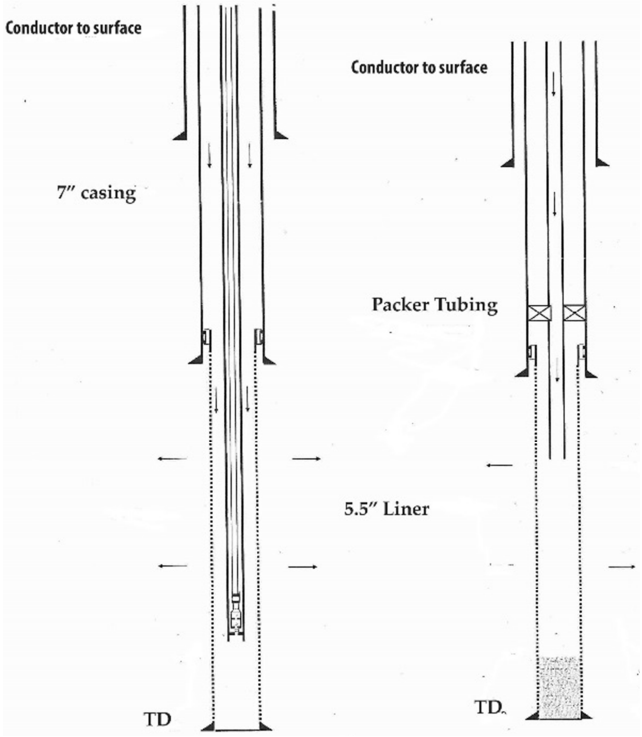

Figure 1. *Two standards about injection well for testing and operation.*

In the figure 1, the left well was adapted to steam stimulation wells which could be injected and produced simultaneously and though the casing injection and the tubing production. The right injection well was through the inner tubing, and there was a packer under the tubing to prevent the injection fluid back-flow which was a safer injection condition, and is often used in water-flooding, steam-flooding, gas-flooding and waste water and waste gas injection wells.

During the same period, the DOGGR began to pay attention to the problems of the well completion and the cross-flow of the oil, gas and water underground. It required that the annulus must be plugged with cement for 30 meters in the completion zone of the injection well and be connected with the natural isolated layer such as shale.

2.1.3. 1982-2010: DOGGR Authorized to Enforce the USDW

In 1982, The EPA officially authorized the DOGGR to be the sole enforcement agency of the USDW, since the injections of fluids and water are likely to affect the oil and gas reservoirs and water zones. For convenience of management, all California injection projects must be managed by the DOGGR whether it is federal or not. In particular, the California and some States had special regulations for underground water resource conservation required total dissolved solid below 3000 mg/l for clean water that far below the federal requirement of 10000 mg/l, which added to the implementation burden of injection project management.

2.1.4. Since 2010

Since the regulation and commission for injection projects were full implemented in 1982, California had achieved

significant results in controlling the potential for aquifer pollution and ground subsidence from such projects. At the same time, there are problems such as insufficient personnel, improper management and lack of training for employees due to the heavy work of law enforcement and supervision, which lead to the deficiencies and errors in the review work. In order to improve this situation, the DOGGR hired more technical staff to train them in order to use the modern technology such as three-dimensional geologic image and numerical simulation. The DOGGR believed that many of the regulatory errors may be caused by insufficient information acquisition, storage and analysis. Therefore, the DOGGR is prepared to introduce a new database management system. In the future, the work such as permit application and approval and project review will be completely in electronic format to reduce the information lost and errors.

2.2. The Key Point of Regulatory Commission

The California government legislates injection well regulations in accordance with federal legislation and authorizes the DOGGR to make the more detailed regulations, which forms a part of the California code of regulations that is known as the California Underground Injection Control Regulation Act. The purpose of this Act is not only for reservoir management, but also to protect the ecological safety of underground water sources and prevent groundwater resources from being polluted by the cross-flow of the injection fluid, which ensure the safety of public drinking water.

The California Underground Injection Control regulations can be summarized as several key aspects: first, the injection projects approval and the injection well operation permits; second, the safety of underground drinking water is protected; the third is to audit the completion status of each oil and gas wells and injection well within the radius of influence of injection fluid to ensure that there is no casing damage to oil, gas and water crossflow; and fourth, information disclosure is needed.

2.2.1. Project License Approval

When oil and gas companies undertake the secondary and tertiary oil recovery and waste water injection projects, they should submit detailed geological, reservoir engineering and injection fluid data and injection plans to the DOGGR to apply for the project approval. After the project is approved, the DOGGR issues the project approval letter to the company. The letter contains: the requirements for the injection wells, the special requirements for reinjection of commercial wastewater, the requirements for the mechanical integrity and completion of the injection wellbore, the requirements of well logging for injection well, the requirements of annual project evaluation, the requirements of injection facilities and the general requirements for the project.

According to the requirements of California and Federal regulations, the project approval letter requires the relevant safeguarding measures for the injection project. For example, specifying a minimum fracture gradient or using the step-rate testing to calculate the maximum surface allowable pressure to ensure that no fractures occur during the injection period. During the injection period, the pressure fall-off test must be executed every year to ensure that radius of influence after injection does not exceed the injection range to prevent underground water pollution. If the injection plan is changed, the injection well is replaced or a new well is drilled, a new permit must be applied to the DOGGR. The injection rate, injection pressure and chemical analysis report of waste water should be kept in the archives of the DOGGR and the information should be transparent. The oil and gas companies must be submit the annual reports to the DOGGR to ensure that the project is carried out as planned.

2.2.2. The Zonal Isolation of the Injection Layer from Other Strata to Prevent Pollution to the Underground Water Layer and Oil and Gas Reservoir

The DOGGR requires all damaged and abandoned wells within the injection range must be plugged and sealed in accordance with the regulations. Meanwhile, the injection wells are required to plugged with cement back to 30 meters above the injection layer during the completion process. The DOGGR reviews the company's the geology and engineering information very seriously. The purpose is to ensure the isolation of oil and gas production and injection zones from the other zones as a very important requirement for drilling and completion.

2.2.3. Every Injection Well Should Achieved the Standard of the Wellbore Integrity

In the injection area, the cement return height of casing annulus for all injection wells must be qualified to form the isolation layer with shale or an extremely low permeability formation so that the oil, gas and waste water cannot cause channeling and leakage. The injection wells must be tested in a specified schedule because of the possible damaged and rusting problems after a long-term use. All tests must be monitored and evaluated on site by the DOGGR inspector.

2.2.4. The Public Announcement of Information for Injection Project

To reduce the peer and the public doubts about the potential harm of the injection projects, the injection project information should be opened to the public and to the oil and gas companies in the affected area. According to the regulations, the oil and gas companies intend to implement the injection project must achieve the following two requirements: 1) during the review period, the oil and gas company within the injection project affected area need to send registered letters to explain to the other companies about the possible impact of the injection project. If any company raises an objection, the DOGGR must conduct a further review to determine the objection is reasonable or not. If the objection is reasonable, the DOGGR will require the oil and gas company improve the injection project according to the new findings. 2) When an injection project has been approved by the DOGGR, project information must be published in a newspaper for three days and the public must be given two weeks for inquiry. The open and transparent injection project information is given an opportunity for oil and gas companies to communicate with

the public which will reduce the peer and the public doubts about the potential harm of the injection project and the conflict between the public and the company.

The author has given many presentations in China and learned that the conflicts often occurred between the Chinese public and the oil and gas companies due to the former operational problems such as the deaths caused by hydrogen sulfide gas. There were no effective communications and mutual trust between oil and gas companies and public. Although the DOGGR regulates the injection fluids and wastewater in accordance with the California and federal laws and regulations, the agency also requires the active cooperation of oil and gas companies. The oil and gas companies must manage the projects strictly in a responsible attitude to the public while comply with the requirements of laws and regulations. If the project information is opened and can be transparent to the public, the conflicts between the public and the oil and gas companies will gradually disappear.

2.3. The Regulations and Management for Injection Projects in California

2.3.1. The Establishment of Injection Exempt Area

In 1972, the U.S. Congress passed the Underground Safe Drinking Water Act which is applied to two aspects in the oil and gas field development.

According to this Act, if the oil and gas production waste water needed to be reinjected, the fluid must be the type II injection fluid. California is short of water, there is a more demand in the underground water. Therefore, the authorities require a higher standard in the underground water. If the total dissolved solids of the oil and gas production waste water is within the range of 3000~10000 mg/l and the fluid is not allowed to reinject. The EPA established the injection exempt area where the type II injection fluid can be injected as the water quality is not suitable for human consumption, meanwhile the fluid is not allowed to inject the type II injection fluid outside of exempt area.

The figure 2 shows an injection exempt area for an oil field in California and the black shadow area in the figure is the injection exempt area (California Oil & Gas Fields, 1985). This is a simple representation but also is error-prone. If a production well happens to be near the dark shadow, can it be changed to an injection well in the future?

The EPA is very cautious about approving the injection exempt area, which can be applied at two levels. If the total dissolved solids in the aquifer are between 3000 and 10000 mg/l that can be applied to the California Environmental Protection Department. If the total dissolved solids are below 3000 mg/l that can only be applied to the EPA, which is generally difficult to obtain the approval. During the application process, the oil & gas companies' application must be reviewed and approved by the DOGGR and the Regional Water Board (RWB), and then apply to the EPA on behalf of the DOGGR.

According to the author's experience, the injection exempt area should be dynamic. During the whole production process of oil field, there will be the invasion of natural gas, underground water and changes during the process of the secondary and tertiary oil recovery. The water quality of oil layer and underground water layer are constantly changing. Now the DOGGR has recognized this problem and plans to use the three-dimensional numerical simulations to analyze the change in water quality. The author believes that China should use the three-dimensional numerical simulations to analyze and treat the changes in water quality of oil and underground water layers from the beginning. In this case, the future uncertainties can be avoided.

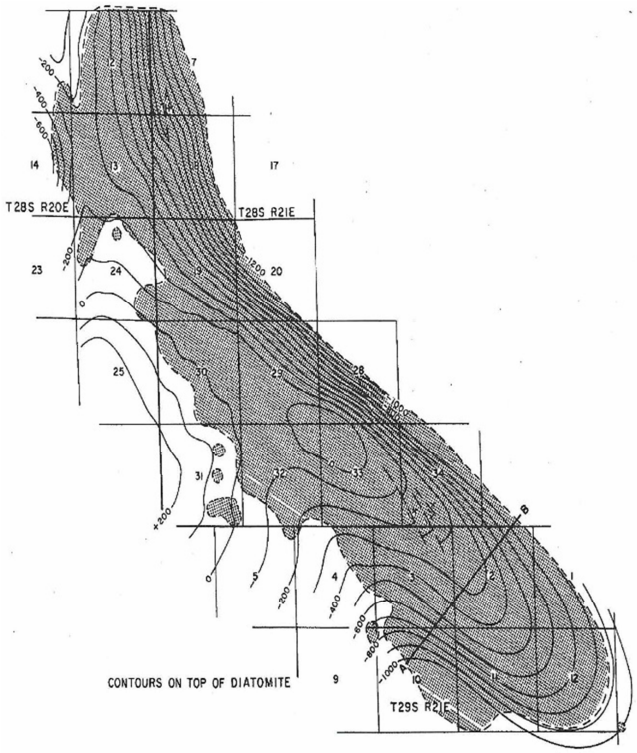

Figure 2. *The injection exempt area of the California oilfield.*

2.3.2. Review of the Radius of Influence for Injection Projects

Based on the Safety Drinking Water Act of the United States, the review of the injection project must be carried out individually on the production and injection wells within the injection radius of influence area [5]. An injection project increases the formation pressure due to the injection, but the injection does not cause the injection fluid to crossflow outwards is called the Area of Review (AOR) or the Zone of Endangerment Influence (ZEI) review where the injection area may be endangered by the injection. The names are different, but requirements are the same in the review process.

There are two ways to review the radius of influence and the first one is using the fixed radius. The radius from the injection well is assumed not more than 1/4 mile (402.34m). When the review radius is a fixed radius, some important reservoir parameters are considered; such as the chemical composition of the injection fluid, the quality of the reservoir fluid, the hydrogeology, the use of underground water by the nearby residents and the historical records of the

underground water use etc.

The second way is using the unfixed radius according to the actual calculated radius. This is to be calculated in form of a ZEI review that is likely to be affected by injection hazards in an area. The success of the secondary and tertiary oil recovery injection projects is related to the characteristics of reservoir fluids but are also related to the geological characteristics of the reservoir such as the porosity, the permeability and the structure of the injection layer. During the review process, special attention should be paid to the cross-flow and the channeling of the injected fluid in the formation. The possible cross-flow and leaking channels include: the cross-flow and channeling in the formation, the natural fractures, the fault cross-flow formed by geology and formation structure and the cross-flow between the injection layer and the other oil, gas and water layers caused by poor separation for production wells, injection wells and the poor sealed wells.

Therefore, the requirements for each well's casing and the casing annulus cement plugged back heights are particularly strict in the process of review to ensure that each well has a good completion history and will not become a liquid channeling path in the future. If it is found that some wells fail to plug the cement as required, the oil and gas company are required to repair these wells. In special circumstances, the isolation of the damaged well is required if a well is unable to meet the standard completion requirements.

Before the injection radius of influence area is reviewed, the oil and gas companies need to provide the following information; such as: the project area, geological and geologic structure data; the cross-sectional and contour maps, the reservoir characteristics of oil, gas and water injection layers; the location and chemical analysis of the underground and surface water; the characteristic data of injection fluids; the measure of the vertical pressure gradient data and the requirements of project operations.

The radius of influence area for the type II injection fluid can be calculated as a fixed radius (1/4 mile or 402.34 meters). The DOGGR routinely uses a fixed radius to review the radius of influence area in most of the injection projects, but this review is not enough in wastewater injection wells and gas flooding projects. It is because of the increasing injection pressure and the high permeability of the rock to the gas, the injected fluids may be channel out of the radius if there is no pressure test measurement and prediction. Therefore, these types of projects are to be reviewed in form of a ZEI method which is likely to be affected by injection hazards in an area.

The heavy oil production in California is not restricted by well spacing because the viscosity of heavy oil is so high that the flow of heavy oil is limited even under the high steam temperature, so the injection radius of influence of heavy oil may be as large as the steam chest. The DOGGR engineers use the steam chest method to calculate the injection radius of influence, which is particularly suitable for the heavy oil steam flooding and the steam stimulation.

Other flooding methods also can be reviewed in the form of a ZEI review which is likely to be affected by injection hazards in the area.

2.3.3. Testing of the Injection Projects

To prevent the large-scale oil leakage in reservoir flows to the ground that causes a large area of pollution, there are three different kind of tests are focused in DOGGR such as the step-rate testing, the pressure fall-off test and the casing logging.

Step-Rate Testing: The step-rate testing is specially used to measure the fracture gradient pressure, especially for the oil and gas formation and injection layers without the known fracture gradient [6].

Fall-off Test: The fall-off test is a pressure well testing and pressure transient analysis method. According to the data obtained from the fall-off curve that can calculate the pressure plume and pressure influence radius for injection fluid [7]. The EPA requires the type I of injection (industrial waste) well must be tested annually to analyze and calculate the pressure plume and pressure influence radius of the injection. There is no such special requirement for the type II injection fluid (waste water from oil and gas fields). However, the large-scale oil channeling to the surface after a collapse formation in some fields, the California authority requires oil and gas companies to conduct this test every 2 to 3 years.

After the step-rate testing, the maximum allowable pressure of the formation can be calculated to ensure that the undesirable fracture will not occur during the injection period. In California, this formula of the maximum allowable pressure has established basing on a long experience:

MASP=0.9 or 0.8×（FG－HG）×the bottom hole depth of the uppermost shot holes [8]

Where, HG is the hydraulic pressure gradient (22.97kpa /M).

The DOGGR pay special attention to protect the freshwater aquifers, so there are different safety factors are applied in the equation, such as: the safety factor is 0.8 in the case of freshwater aquifer and the safety factor is 0.9 in the case of no fresh water aquifer. The interference test and the pulse test are the same kind of test methods as the step-rate test, but both need to use the nearby monitoring well and injection well in order to get the required results. Therefore, the step-rate test is simpler and more practical.

Casing logging. The casing logging includes two kinds of tests: one is the standard annulus pressure test inside the casing annulus, which is a pressure test to determine whether the casing and tubing can reach the mechanical integrity requirement under a long-term injection. The other test is radioactive tracer test and it is used to verify the zonal isolation of the injection layer.

The standard annulus pressure test is divided into three test periods. The first step testing is used before the injection and the injection well must pass the pressure test without the leakage possibility. The second step testing is conducted three months after the injection and the injection well must pass the pressure test without the leakage possibility. The third step (or the multiple) test periods have different

requirements according to different type of injection wells, such as the waste water wells, the waste gas wells, the air injection wells and the gas injection wells are required to test once a year, the water-flooding wells are required to test every two years, the steam flooding and the steam stimulation wells are required to test every 5 years.

It's worth noting that the degree of damage to the well will be different on account of the different response of the formation. For example, the diatomite shale in California is very soft so that the casing damage by formation collapse occurred more frequently. Therefore, the steam injection well is required to be tested every three years. The DOGGR can also order a testing of the nearby injection wells in the event of a surface breakouts.

The radioactive tracer test is a multi-functional and the following results can be obtained in a single well logging: (1) the injection profile can be displayed and the relative injection quantity can be estimated for each perforation area; (2) the relative injection quantity can be identified for each injection layer if there are multiple injection layers; (3) the possible casing and tubing leaks can be detected and the leakage is due to packer leak or not; (4) the blocked perforation or area can be found in the formation; (5) it is possible to estimate how many perforations and layers are clogged by incoming mud and sand.

To facilitate the oil and gas companies to arrange and perform the testing tasks, the DOGGR requires the same length of time period for cased hole logging.

To meet the requirement of the DOGGR, the service companies will use other logging methods such as the temperature log and the noise log to assist the test. The damage and extrusion in the injection wells are occurred due to the serious collapse problem of the formation. In order to meet the requirement of the regulation, the oil and gas companies has specially installed the distributed temperature sensor for long-term monitoring of the injection well and the monitoring report shall be submitted to the DOGGR for reference.

3. The Lack of the Specific Supervising Department and Regulations for Water Injection Commissioning in Chinese Oilfield

Although the oil and gas resources exploitation will endanger the ecological and environmental conditions of the surface water, the underground water and the atmosphere, there is a lack of specific legislated regulations in oil and gas exploitation in China's current legal system. The environmental protection supervision of the oil and gas exploitation is still mainly focused on the general norms on legislation and only a few provinces in some oil and gas enrichment areas have formulated such specific regulations. The obligations of the current norms and specific regulations are strong in principle but lack of operational specific measures, which cannot solve the special problems for the oil and gas resources exploitation. In addition, there is no full-time regulatory agencies to enforce the regulations that create some management loopholes.

Now in each Chinese oilfield, most injection wells use the water-flooding development method which can cause the pollution if mishandled. Since there is no well-defined legal supervision for waterflooding or gas flooding development, many environmental accidents occurred during the past development process. Fortunately, the Chinese oil companies have taken on the environmental responsibility while considering the economic benefits at the same time and some of the experience and practice are worth learning. It should be noted that even if pollution accidents are dealt with in a timely manner, the ecological impact sometimes is irreversible. Therefore, the pollution prevention related to people's livelihood should focuses on prevention and must be managed in accordance with laws and regulations, not only relies on the administrative instructions of oil and gas companies' management.

In April 2009, the Exploration and Production Company of CNPC issued the Guidelines for Oilfield Water Injection [9]. The fifth chapter of the Guidelines explains the management of water injection process that emphasizes the source of water injection carefully prepares the injection allocation scheme, injection optimization in production technologies, controlling the quality of injected water and strengthens the production management of injection wells. The guidelines also demand staff to conduct a good job for analysis and evaluate in the whole process of water injection management and water injection quality about the single well and the well group, and the whole oilfield from the underground in the wellbore to the surface in order to track and control the water injection in real time. There is a detail description in Guidelines about the wellbore integrity and the submission of injection well data as well as the water quality management. Obviously, the main purpose of oilfield water injection management for the company is to promote the production and development of the oil fields. However, it is insufficient for the environmental protection and underground drinking water protection. There are no corresponding effective measures and laws and regulatory technologies to prevent the pollution, which requires future change and reform.

4. The Suggestions

4.1. Emphasis More on Regulations of Oil and Gas Production Related Pollution and Establish a Professional Regulatory Department

The current Chinese governmental institutions that have environmental protection supervision functions are scattered among various departments such as environmental protection, water conservancy, and transportation at the county level and above. However, there is no specialized oil and gas regulatory department to manage the water-flooding and wastewater treatment of oilfield. There is urgency to establish a specialized professional management organization.

4.2. Establish Injection Standards for Oil and Gas Production Methods to Improve the Operations

The current Chinese environmental quality standards and pollutant discharge standards are mainly aiming at the atmosphere, the surface, the underground water aquifer and the unknown layer of soil. The deep well disposal uses the geological storage space to dispose pollutants, there is no such quality standards and emission standards for this type of disposal method at present time.

In March 2012, the State Environmental Protection Administration issued “the Technical Policy of Pollution Prevention in Oil and Gas Exploitation Industry”. The principle of the Technical Policy requires that oil and gas fields are suitable for water-flooding exploitation in the development process should be reinjected the treated production water after meeting the standard. For the heavy oil steam injection production, the produced water is encouraged to be reused for steam-injection boilers. The oil and gas field production water should be treated by a combination of coagulation, air flotation and biochemical treatment. The Technical Policy is a special document to regulate the well reinjection in the absence of national legislation in China, however it is still strong in principle but weak in execution. In response to the Law of the People's Republic of China on the Prevention and Control of Water Pollution, PetroChina Chongqing Oilfield Branch has established “Measures for Standardized Construction and Management of Water Source Protection and Well Site Environmental Protection in Development Areas”, which clearly stipulates the environmental protection issues involved in drilling, formation testing and oil production in the development area. The Management Measures is a powerful complement to the Technical Policy, and the operability is stronger.

At present time, there is an urgency to formulate the legal document like the California Underground Injection Control Regulation, which regulates and approve the oil production water injection projects with the mandatory professional standards and operational procedures to improve the recovery of petroleum resources and to protect the ecological condition of water sources.

4.3. The Government Regulatory Agencies Should Actively Compliant the Environmental Protection Supervising Roles

The environmental supervision reflects the government's public functions. The various administrative departments such as the Environment Ministry and Environment Department are the functional agencies to supervise the production of oil fields. However, the current government's regulatory functions are insufficient in the present institutional arrangement. The main method of supervision is to require the oil and gas companies to comply with various regulations and the supervision measures are mainly based on post-punishment. There is a lack of supervision during the process of the oilfield production. This problem also reflects the central administrative department is beyond the reach of local management. Each province and autonomous region should establish their own specialized regulatory agencies to increase regulatory efficiency. Combine all local environmental protection departments as a unified regulatory agency which actively cooperates with oilfield companies to carry out the dynamic supervision. This supervision is a successful experience of Daqing Oilfield to achieve environmentally friendly production. This method is the core of California's regulatory system, which can be extended to a broader level of environmental protection to all the oil and gas exploration.

4.4. Establish Independent Onsite Supervising Team

The oil and gas exploration inspectors are a supervising team composed by the professionals. The inspectors are a very good complement to the environmental supervision of oil and gas exploitation and they can further strengthen oil and gas exploration supervision. The team should conduct their work on daily routine basis. Take California as an example, the inspector team is established as an independent supervising inspector in the field. They certainly conduct their work more professionally and improve both environmental and operational efficiencies.

4.5. Complete Information Disclosure to the Public

The DOGGR also undertakes the task of supervision and consultation on the information disclosure of the injection projects. It clearly requires the information of injection projects must be published in local newspapers for three days and the public is given two weeks to response to the information enquiry.

One Chinese Environmental Protection Department has undertaken the task of information disclosure. For example, the Ordos Environmental Protection Bureau announced the Notice on the Approval of the Environmental Impact Assessment Document for Construction Projects to be made on July 20, 2015. However, the information published only in the website of the environmental protection department, and the posting time is relatively short for just five days. In this case, the public is in a disadvantageous position. The purpose of disclosed information cannot reach them and the intention cannot be achieved.

5. Conclusion

In the recent 40 years, China has been leaped and bounced in technology advancement in all phase of industries; including oil & gas operations. However, Chinese oil industry has not paid attention to the regulatory management in operation and environmental protection. There were numerous reports on injection and production related problems. Some of the problems can be preventable if the industry is under scrutiny of the regulation and commission. Both Chinese government and industry will need to consider the establishment of this legal system in the near future.

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