

Safety Evaluation of Urban Natural Gas Pipeline Operation

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Abstract

The acceleration of the process of urbanization has triggered an increase in the use of natural gas and the acceleration of the laying of natural gas pipelines. At the same time, it has also increased the risk of safe pipeline operation. The safety evaluation of urban natural gas pipeline operation is urgent. Based on the research on the safety evaluation of existing domestic and foreign pipelines, this paper points out the deficiencies in the safety evaluation of existing pipelines in China and proposes corresponding countermeasures to reduce the occurrence of accidents, ensure the stability and safety of natural gas supply, and promote the health of the natural gas industry. development of.

Keywords

City, Natural Gas Pipeline, Safety Evaluation, Suggestions.

1. Introduction

Natural gas has been widely used as a cleaner energy source than coal and oil. It is playing an increasingly important role in the development of the national economy. According to statistics from the Bureau of Energy, my country's natural gas consumption has increased year by year in recent years. As of 2016, my country's natural gas consumption accounted for 6.2% of the primary energy consumption structure, an increase of 0.4% year-on-year [1]. In recent years, with the acceleration of the urbanization process in China, the urban population has increased sharply, and the laying of urban natural gas pipelines has been accelerated. Most cities have formed dense natural gas pipeline networks. Due to the complexity and density of urban natural gas pipeline networks, this has occurred. The possibility of safety accidents such as leakage and rupture is very high. Once the natural gas pipeline is damaged, it is easy to cause major safety accidents such as fire and explosion, which may not only cause casualties, but also may cause huge economic losses [2].

Furthermore, in addition to the fact that many urban natural gas pipelines in China have entered the aging stage, conventional preventive measures have been difficult to ensure the long-term safe operation of pipelines. At the same time, due to historical, technological, and construction reasons, leakage and explosion accidents still occur frequently. This not only caused the inability to continuously deliver natural gas, but also caused waste of resources and economic losses to the gas transmission management unit [3]. Therefore, ensuring the safety and stability of natural gas supply and reducing the possibility of natural gas pipeline safety accidents have become our key concerns. At this time, in order to ensure the safe operation of natural gas pipelines, it is particularly necessary to scientifically and comprehensively evaluate the safety of urban natural gas pipelines. This move has far-reaching significance for the healthy development of the natural gas industry.

2. Current Status of Research on Safety Evaluation of Urban Natural Gas Pipelines

2.1. Research Status Abroad

The first overseas application of the evaluation method to the safe operation of natural gas pipelines was in the "Risk Investigation Guidelines" published by the Battelle Columbus Institute of the United States in 1985 [4]. In 1996, the "Pipeline Risk Management Manual" written by W. Kent Muhlbauer summarized almost all previous research results of pipeline safety evaluation, which became the basis for future pipeline safety evaluation. Subsequently, due to the widespread use of computers, the United States used a large amount of existing pipeline data to conduct simulation experiments on pipeline safety accidents, established a comprehensive pipeline safety evaluation model, and developed corresponding safety analysis software. These software have been widely used to calculate pipelines. The probability of an accident and the prediction of its consequences.

2.2. Research State in China

Domestic scholars have put forward many pipeline safety evaluation methods that fit my country's actual conditions based on the foreign advanced research results and combined with the actual situation of my country's natural gas pipeline operation. For example, Chu Xiaoyan [5]'s improved W. Kent Muhlbauer index scoring method, Yang Maohua [6]'s natural gas safety evaluation system based on safety checklists, Yan Yu [7]'s expert survey method, Huang Xiaomei using fault trees to combine events Tree for safety evaluation and so on. Most of these evaluation methods are based on a large amount of information and data. In view of the lack of data on natural gas pipelines in my country, most of the evaluation methods are not feasible.

2.3. Problems Faced by My Country's Pipeline Safety Evaluation

Compared with foreign advanced pipeline safety management experience, my country's pipeline safety evaluation and management still have some shortcomings. Compared with the existing foreign safety evaluation models, my country's natural gas pipeline safety evaluation mainly faces the following problems[8]:

(1) The original pipeline data lacks reliability: As the natural gas pipelines laid earlier in some cities have not entered the pipeline database, most of the newly laid pipeline data is manually collected and then manually entered into the database, which greatly increases the difficulty of original data collection. At the same time, because there is no standardized and standardized data management method, many important pipeline data are not entered into the database or incorrectly entered into the database, which greatly reduces the authenticity and reliability of the original data, which also greatly increases the pipeline safety evaluation The difficulty.

(2) Unclear identification of risk factors: In view of the fact that there are too many factors that affect the safe operation of natural gas pipelines, many urban pipeline safety assessment departments or enterprises have not established clear and complete safety assessment indicators, which has led to many assessment agencies to assess risk The inaccuracy, even greatly underestimated the safety risk of pipeline operation [9].

(3) Evaluation model is not accurate: Existing safety evaluation models are often not only suitable for safety evaluation of urban natural gas pipelines, but also suitable for pipeline transmission systems such as gas pipelines, liquefied petroleum gas pipelines, and biomass gas pipelines. Reduce the accuracy of the safety evaluation model. At the same time, the evaluation process of the existing safety evaluation model has a certain lag, which makes the evaluation model unable to detect and eliminate risks in time.

3. Countermeasures for Safety Evaluation of Urban Natural Gas Pipelines

In short, although the safety evaluation of natural gas pipelines has attracted enough attention, since the safety evaluation of the operation of urban natural gas pipelines in China is in its infancy, various evaluation models and risk management methods are still in the exploratory stage. The application of safety evaluation of urban pipelines in China It needs to be improved and improved. For this reason, this article puts forward the following countermeasures and suggestions in response to the problems faced by my country's pipeline safety assessment [10]:

3.1. Establish a Comprehensive Natural Gas Pipeline Information Database

In view of the lack of earlier and important historical data in the existing pipeline database information database, most of the data is manually recorded and stored, which is not only slow but also inefficient. In order to make up for these shortcomings, it is particularly important to establish a comprehensive national urban natural gas pipeline information database. This database not only contains all important historical data, but also uses intelligent systems[11] for data collection and entry. At the same time, standardized and standardized data management methods are adopted. This not only improves the efficiency of data collection and entry, but also Ensure the comprehensiveness and accuracy of the data. The establishment of a complete database not only provides a good foundation for pipeline safety evaluation, but also makes the process of safety evaluation convenient and quick.

3.2. Carry out Scientific Research on Pipeline Risks

The application premise of any advanced technology is to have a complete theoretical foundation, and the formation of the theoretical foundation must go through a lot of research and experimentation. Carrying out experimental research on the effects of various hazardous factors on pipelines and the consequences of pipeline accidents can provide a basis for scientific and effective risk assessment. At present, domestic and foreign scholars have conducted certain researches on the possibility of pipeline failure and the consequences of failure, but they still cannot completely solve the problems encountered in production.

Therefore, the current business and academic circles--a very urgent task is to vigorously carry out scientific research on pipeline risks in the following aspects, such as corrosion, external interference, design and construction and manufacturing defects, personnel misoperation, natural and Conduct theoretical and experimental research on the effects of hazardous factors such as geological disasters on pipelines: conduct research on the interaction of pipeline hazardous factors: conduct research on the impact of pipeline leakage and failure of personnel, property, environment, and society; conduct research on pipeline geographic information Research on systems, basic databases, etc.: Research on the analysis of inspection data inside and outside the pipeline[12].

Through theoretical and experimental research on various aspects of pipeline risks, it is possible to comprehensively and scientifically grasp all the risks faced by the pipeline, and gradually improve the risk evaluation model to adapt it to the actual needs of safe and stable operation of the pipeline.

3.3. Build a Pipeline Failure and Corrosion Database

The pipeline failure and corrosion database is a collection of actual failure events, corrosion detection data, and environmental data that occurred during pipeline operation. The data is organized and analyzed through statistical methods, so as to facilitate users to grasp the historical status of the pipeline. A basic risk management tool to predict the occurrence of accidents and the development trend of corrosion. At present, most developed countries in the oil and gas storage and transportation industry have established pipeline failure and corrosion

databases to guide the design, construction and risk management of their own oil and gas pipelines.

The construction of the failure and corrosion database is the basic work in pipeline risk management, and it is also the most critical work."|The neglect of accident data for many years is tantamount to keeping a huge wealth without using it. Establishing a company's own The pipeline failure database is an urgent and important task in pipeline risk management. The construction of the pipeline failure database requires the improvement of the reporting and collection system of pipeline failure accidents or incidents. The United States, Canada and other countries all stipulate the reporting of pipeline companies in the form of laws and regulations. However, there is no relevant system in our country at the level of regulations. The introduction of regulations by government safety supervision, quality inspection and other departments to define pipeline accidents in detail and standardize corporate behavior after the accident is an effective means of pipeline safety management.

Enterprises must also proceed from their own reality, collect and sort out historical failure data of pipelines due to corrosion, external interference, manufacturing and construction, natural disasters, misoperations and other reasons, establish a sound failure database, and summarize experience, statistical analysis, and discover laws from them. Provide technical support for pipeline integrity management.

Therefore, the establishment and improvement of the failure and corrosion database is a basic work urgently needed to improve the risk management level of my country's pipelines and ensure the safe and reliable operation of pipelines.

3.4. Standardization of the Evaluation Process

By establishing a set of standardized safety evaluation processes, not only can the waste of resources be avoided, but also the safety evaluation process can be made simple and convenient [13] . The pipeline safety assessment process can be summarized as a process of continuous assessment, continuous review, continuous optimization, and recycling to achieve self-renewal. We standardize and define the process of each process. According to this process, the operation safety of the pipeline can be evaluated step by step, which can greatly reduce the process and save time, and it is also conducive to the promotion of safety evaluation technology.

3.5. Optimized Evaluation Method

There are many existing safety evaluation methods, which are applicable to different objects, and the applicable conditions and scope of each evaluation method are quite different. Therefore, we can use different evaluation methods in each link of the safety evaluation process, and adopt the most suitable evaluation method according to the characteristics of each link of the safety evaluation. This will not only make the evaluation process more flexible, but also make the evaluation results more flexible. Is precise.

3.6. Strictly Control the Safety Red Line

The safety red line proposed in this article refers to setting a safety threshold for each safety evaluation index. When the index exceeds this value, the safety factor of the evaluated link is rapidly reduced, that is, it is realized One-vote veto system for the safety red line of indicators. The safety red line value of each index can be set according to the average safety value of the index in the industry, or it can be set as the safety value specified by the state [14]. At the same time, an early warning system can be set. When the value of a certain evaluation index exceeds the safety red line, the early warning level of the safety system will respond according to the severity level. By introducing the concept of a safety red line to the evaluation system, not only the risk of each safety index can be controlled, but also the risk control of the entire safety evaluation is more accurate and comprehensive.

3.7. Carry Out Quantitative Risk Assessment

Quantitative risk assessment is sometimes called probabilistic risk assessment². It is a direct evaluation of failure probability and failure results. It determines a unit with a clear physical meaning for failure probability and accident loss consequences in advance, and calculates the probability of the final accident by calculating the probability of a single accident, and then combines the quantified probability. The accident affects the consequences, and the risk value of the pipeline is calculated. Quantitative risk assessment comprehensively uses structural mechanics, fracture mechanics, chemical corrosion and other theories. It is the most rigorous evaluation method. Its evaluation results have important practical value in safety, cost, and benefit analysis.

Quantitative risk assessment has obvious advantages, but also has disadvantages such as high technical requirements of evaluators and long evaluation time. For pipeline operating companies, they should carry out quantitative risk assessments for very important pipelines and pipe sections in situations where non-quantitative risk assessment cannot meet their needs according to their actual conditions.

4. Conclusion

Urban natural gas pipelines are characterized by intensiveness and complexity. At the same time, due to the long running time of some pipelines, this greatly increases the risk of safe pipeline operation, and it is urgent to establish a sound pipeline safety evaluation mechanism. At the same time, pipeline safety evaluation in my country is still in its infancy, and various evaluation models and risk management methods are still in the exploratory stage. A complete pipeline safety evaluation mechanism can guarantee the safety of natural gas pipeline transportation and use. Based on the review of domestic and foreign pipeline safety evaluation literature, this paper points out the shortcomings of the existing pipeline safety evaluation in China and proposes corresponding countermeasures [15], aiming to reduce accidents, ensure the stability and safety of natural gas supply, and promote natural gas The healthy development of the industry.

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