

## Risk Assessment of Natural Gas Pipelines in Coal Mined Gobs Based on Bow-Tie Model and Cloud Inference

**Authors :** Xiaobin Liang, Wei Liang, Laibin Zhang, Xiaoyan Guo

**Abstract :** Pipelines pass through coal mined gobs inevitably in the mining area, the stability of which has great influence on the safety of pipelines. After extensive literature study and field research, it was found that there are a few risk assessment methods for coal mined gob pipelines, and there is a lack of data on the gob sites. Therefore, the fuzzy comprehensive evaluation method is widely used based on expert opinions. However, the subjective opinions or lack of experience of individual experts may lead to inaccurate evaluation results. Hence the accuracy of the results needs to be further improved. This paper presents a comprehensive approach to achieve this purpose by combining bow-tie model and cloud inference. The specific evaluation process is as follows: First, a bow-tie model composed of a fault tree and an event tree is established to graphically illustrate the probability and consequence indicators of pipeline failure. Second, the interval estimation method can be scored in the form of intervals to improve the accuracy of the results, and the censored mean algorithm is used to remove the maximum and minimum values of the score to improve the stability of the results. The golden section method is used to determine the weight of the indicators and reduce the subjectivity of index weights. Third, the failure probability and failure consequence scores of the pipeline are converted into three numerical features by using cloud inference. The cloud inference can better describe the ambiguity and volatility of the results which can better describe the volatility of the risk level. Finally, the cloud drop graphs of failure probability and failure consequences can be expressed, which intuitively and accurately illustrate the ambiguity and randomness of the results. A case study of a coal mine gob pipeline carrying natural gas has been investigated to validate the utility of the proposed method. The evaluation results of this case show that the probability of failure of the pipeline is very low, the consequences of failure are more serious, which is consistent with the reality.

**Keywords :** bow-tie model, natural gas pipeline, coal mine gob, cloud inference

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