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Safety assessment and technique of pressure sealing, application in pressured pipeline petrochemical leakage

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Abstract

The emergence of pressurized sealing technology has played a major role in eliminating the hidden dangers of running, emitting, dripping, and leaking in production equipment in the process industry, and has produced huge economic and social benefits. This article briefly introduces the definition, characteristics and relevant national standards, industry standards, laws and regulations of pressurized sealing technology. At the same time, from the technical perspectives of stress analysis, safety assessment, and safety structure, the pressure pipeline leaking and sealing process under pressure was deeply discussed, and the theoretical basis, evaluation criteria and practical methods to ensure construction safety were put forward. Pipelines are widely used for the transportation of hydrocarbon fluids over millions of miles all over the world. The structures of the pipelines are designed to withstand several environmental loading conditions to ensure safe and reliable distribution from point of production to the shore or distribution depot. However, leaks in pipeline networks are one of the major causes of innumerable losses in pipeline operators and nature. Incidents of pipeline failure can result in serious ecological disasters, human casualties and financial loss. In order to avoid such menace and maintain safe and reliable pipeline infrastructure, substantial research efforts have been devoted to implementing pipeline leak detection and localisation using different approaches.

This paper discusses pipeline leakage detection technologies and summarises the state-of-the-art achievements. Different leakage detection and localisation in pipeline systems are reviewed and their strengths and weaknesses are highlighted. Comparative performance analysis is performed to provide a guide in determining which leak detection method is appropriate for particular operating settings. In addition, research gaps and open issues for development of reliable pipeline leakage detection systems are discussed.

The use of pipeline is considered as a major means of conveying petroleum products such as fossil fuels, gases, chemicals and other essential hydrocarbon fluids that serve as assets to the economy of the nation. It has been shown that oil and gas pipeline networks are the most economical and safest mean of transporting crude oils and they fulfill a high demand for efficiency and reliability.

For example, the estimated deaths due to accidents per ton-mile of shipped petroleum products are 87%, 4% and 2.7% higher using truck, ship and rail, respectively, compared to using pipelines. However, as transporting hazardous substances using miles-long pipelines has become popular across the globe in recent decades, the chance of the critical accidents due to pipeline failures increases. The causes of the failures are either intentional (like vandalism) or unintentional (like device/material failure and corrosion) damages, leading to pipeline failure and thus resulting in irreversible damages which include financial losses and extreme environmental pollution, particularly when the leakage is not detected in a timely way.

The average economic loss due to incidents of pipeline leakages is enormous. Over the past three decades, pipeline accidents in USA damaged property which costed nearly $7 billion, killed over 500 people and injured thousands. For example, the incident of pipeline explosion in the community of San Bruno, California, USA on September 6, 2010 killed eight people, and injured more. In a similar incident of pipeline defect that occurred in Michigan, USA on July 26, 2010, more than 840,000 gallons of crude oil spilled into Kalamazoo River with estimated cost of $800 Million. The causes of pipeline damage vary Sensors 2019, 19, x community of San Bruno, California, USA on September 6, 2010 killed eight people, and injured more than fifty. In a similar incident of pipeline defect that occurred in Michigan, USA on July 26, 2010, more than 840,000 gallons of crude oil spilled into

Kalamazoo River with estimated cost of $800 million. The causes of pipeline damage vary. Shows a pie chart that illustrates statistics of the major causes of pipelines failure which include pipeline corrosion, human negligence, defects during the process of installation and erection work, and flaws occurring during the manufacturing process and external factors. Hence, it is possible to reduce the loss rate, injuries and other serious societal and environmental consequences due to the pipeline failures.