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PIPELINE FAULT DETECTION METHODS

The previous chapter highlighted the exponentially growing need for pipelines and the associated safety concerns. In this chapter, a reader will get an overview of available pipeline monitoring techniques for fault detection (focused on leaks). The basic principle of leak detection in a pipeline is also explained in detail. Merits and demerits of fault (leak) detection techniques are listed so that readers can select a method per their needs. Finally, a critical assessment of fault detection studies is also presented.

Types of Fault Detection Techniques (FDD)

Faults in a system cannot be fully eliminated because every component of a system has limited useful life, or it can malfunction for variety of reasons. That is why continuously monitoring and maintaining a system against faults is needed. Numerous techniques are being developed in fault detection and diagnostics (FDD) in pipelines. In old times, the soap-bubble method was used to locate small leaks. Today, computer-based intelligence methods detect, estimate, and locate leakages in real time.

FDD techniques can be classified in several ways. FDD techniques are categorised based on sensor placement, available system knowledge (Quantitative/ Qualitative), and type of models [7],[17]-[18],[20]-[26]. According to Arifin et al. [25], leak

detection systems can be classified into software (internal parameter) based, hardware (external parameters) based, and non-technical methods. Like Arifin, FDD techniques are classified into hardware-based, software-based and non-technical methods (Figure 2.1). Pressure Point Analysis (PPA), Negative Pressure Wave (NPW), and computational intelligence methods like Artificial Neural Network (ANN) are under the umbrella of software-based methods. In contrast, hardware-based methods include electric, acoustic, thermal, and optical sensors. Non-technical methods include the soap-bubble process, visual inspections, hearing inspection and smelling inspection.

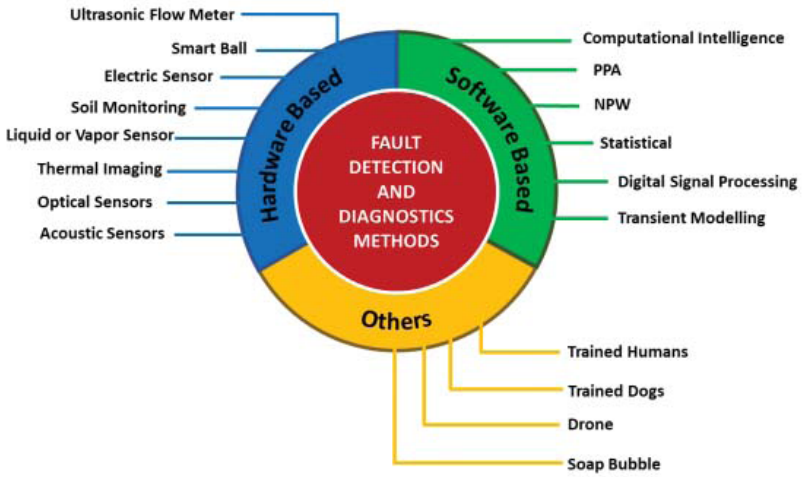

Figure 2.1 General classification of fault detection and diagnostics techniques

Non-technical methods

Non-technical methods are also called biological processes because these techniques utilise the sense of hearing, smelling and seeing human beings or animals to observe faults. These are the time taken approaches and require lots of workers. In some cases, the inspector cannot inspect; for example, consider the case of the sub-sea and buried pipeline. The Soap-bubble method is an old but accurate leak localisation method in which soap water is poured into the pipeline. The point of the leak can be easily located by observing the bubbles. The challenge is the application in long pipelines; this method makes continuous monitoring impossible.