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Original Article

Diagnosing Plant Pipeline System Performance Using Radiotracer Techniques

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A R T I C L E I N F O

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This study presents an experimental work in a petrochemical company for scanning a buried pipeline using Tc^{99m} radiotracer based on the measured velocity changes, in order to determine the flow reduction along a pipeline. In this work, Tc^{99m} radiotracer was injected into the pipeline and monitored by sodium iodide scintillation detectors located at several positions along the pipeline. The flow velocity has been calculated between every two consecutive detectors along the pipeline. Practically, six experiments have been carried out using two different data acquisition systems, each of them being connected to four detectors. During the fifth experiment, a bypass was discovered between the scanned pipeline and another buried parallel pipeline connected after the injection point. The results indicate that the bypass had a bad effect on the volumetric flow rate in the scanned pipeline.

1. Introduction

Radiotracers can be used for troubleshooting and solving several problems in several industrial applications [1–4]. The main advantages of using radiotracers in industrial applications are higher detection sensitivity, detection being carried out online, and the availability of many radiotracers that can be used in different phases [5]. Flow rate measurement is required for several purposes such as calibrating the installed flow meters, measuring the flow rate in systems that do not have flow meters, measuring the flow distribution in a network, or measuring the pump's efficiency [6]. Radiotracers can be used for flow velocity by injecting a radiotracer at the upstream of two detector locations, and then the peak time at the detector positions is determined. If t_1 and t_2 are the peak times of the tracer at the first and second detector positions, respectively, and L is the distance between the two detectors. The flow velocity V can be calculated as follows [7]:

$$V = L/(t_2 - t_1) \tag{1}$$

Radiotracers have been used for flow rate measurement of liquids, gases, and solids in many industrial processes. Previously, Hull [8] used a radiotracer for studying the flow pattern of materials in large units of industrial plant equipment such as moving bed pilot plant, catalytic cracking reactor, gas lift pipes for catalyst, baffles in the

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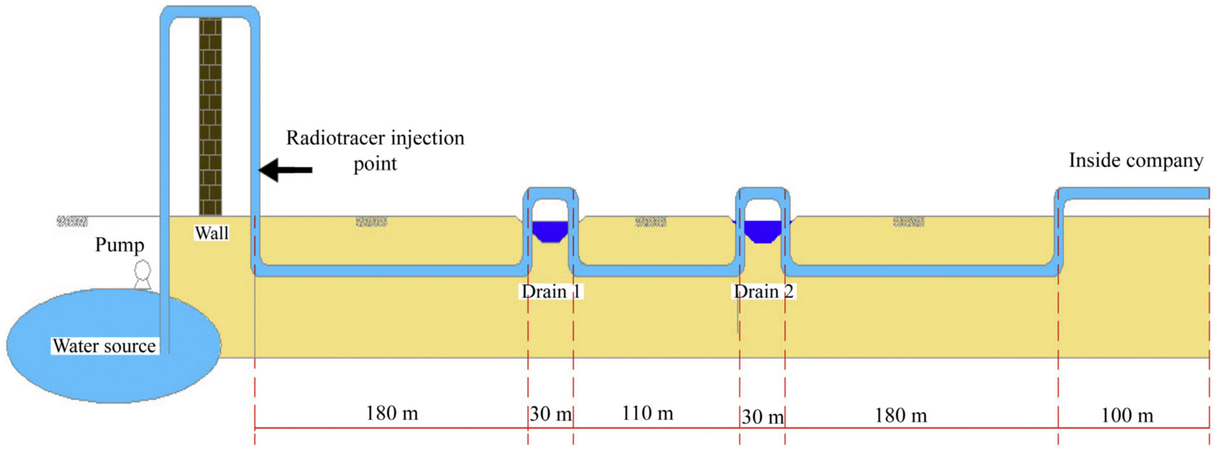

Fig. 1 – Layout description of the scanned pipeline.

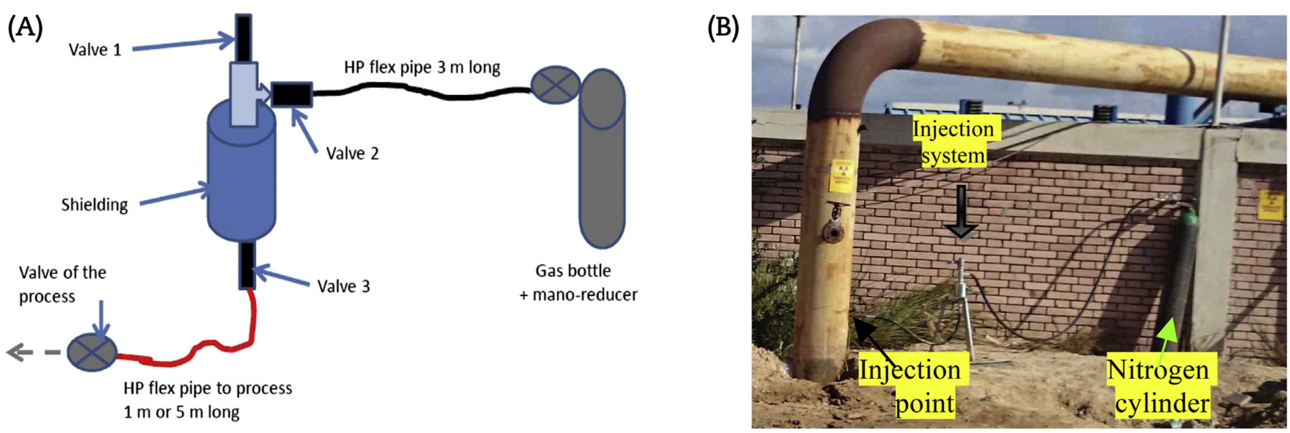

Fig. 2 – Radiotracer injection. (A) ALTIX injector model INJ-SWNB. (B) Injection process.

catalyst seal leg, and trays of the distillation column. The results show that the radiotracer can be used for measuring the uniform flow in the moving beds of solids, and malfunctioning of the moving bed processes can be diagnosed. Dunn and Gardner [9] utilized the dual tracer sphere technique for determining channel velocity and radius by measuring the velocities of two tracer spheres of different radii. The experiments indicate that the tracer sphere technique can be used for flow rate measurements with high relative accuracy.

Recently, Pant [10] used Co^{60} pellet for evaluating flow rates produced by two different propellers called PR-L and PR-R manufactured by two different companies and used in a draft tube crystallizer. The results proved that the flow rates produced by the propeller PR-L were higher than the propeller PR-R. Tugrul and Altınsoy [11] used Na^{24} for measuring the flow rate in open channel. The results showed that, the radiotracer can be used for flow rate measurement in the open channels under in situ conditions. Sugiharto et al. [12] used the I^{131} radiotracer for flow rate measurement in a multi-phase flow

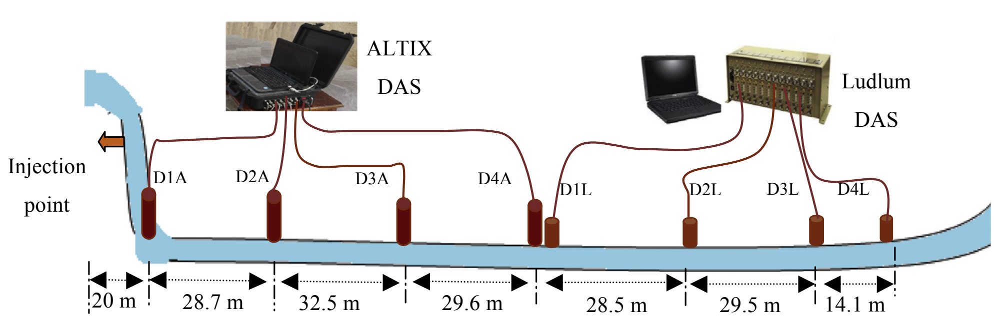

Fig. 3 – Configuration of the monitoring systems in the first experiment. DAS, data acquisition system.