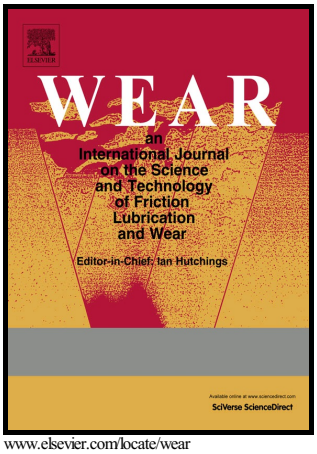

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Abstract: Erosion–corrosion is a serious problem in oil and gas gathering and transportation pipeline systems; specifically, the elbow is the weak part. Erosion–corrosion at different locations of a horizontal steel elbow through which a sand slurry was passed at different velocities was studied using weight loss measurement. Erosion samples were characterized using three-dimensional confocal microscopy and computational fluid dynamics was used to characterize the flow patterns and distribution of sand particles in the elbow. The erosion–corrosion rate increased most as the fluid velocity increased from 3.5 to 4.0 m/s. Increasing particle velocity increased the mechanical effects of the particles and induced secondary flow, leading to differing velocity contours in different cross-sections of the elbow, and thereby differing rates of erosion–corrosion. The maximum rate appeared in the outer part (annular angles φ = 45, 90, and 135 degrees) and bottom of the inner part (annular angles φ = 225, 270, and 315 degrees) of the elbow outlet with an axial angle between 75 and 90 degrees.

Key words: flow velocity; liquid–solid flow; erosion–corrosion; computational fluid dynamics

1. Introduction

In oil and gas production fields, damage to pipelines caused by erosion–corrosion is widespread [1]. Sand is allowed to be produced but the flow characteristics are managed to avoid the most important consequence: erosion. Sand erosion needs to be predicted for different conditions to set the limits of the process operating parameters [2].

The frequent occurrence of pipeline accidents attributed to erosion–corrosion damage has led to this now being one of the main hazards in this industry [3-4]. It is well known that, due to the synergistic effect, the total weight loss of materials during an erosion–corrosion process is generally much higher than the sum of pure electrochemical corrosion and pure mechanical erosion: erosion–corrosion can be considered a type of localized corrosion that presents a significant hazard [5-7]. In liquid–solid two-phase erosion–corrosion, an increase of particle velocity creates a more serious mechanical effect and greater mass transfer, which directly influence the erosion–corrosion mechanism [8]. Elbows are the weak parts of gathering and transferring pipelines [9-11]. Although the problems caused by the synergistic effect of erosion–corrosion are serious, the erosion–corrosion mechanism of the elbow, as influenced by the velocity, is still not thoroughly understood because of its complexity.