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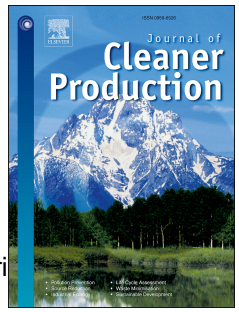

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CFD analysis of natural gas emission from damaged pipelines: correlation development for leakage estimation

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Abstract

Natural Gas (NG) leak may occur from either an above- or an under-ground pipeline, resulting in environmental and financial consequences. Although there are some relations for estimating the gas leak from an above-ground pipeline, there is no equation for the calculation of a buried pipeline leakage. The main objective of this work is to develop precise gas leak calculator equations for low- and medium-pressure buried pipelines. For this, an under-ground gas pipeline is numerically modeled considering the surrounding soil as a porous medium. Two- and three-dimensional models are used to investigate the gas leak through a hole intentionally made on the pipe. Pure methane, with a steady state, compressible and turbulent flow, is assumed through the pipe. The developed correlations are functions of the pipe diameter, the hole diameter, and the gas flow pressure. Comparison of the results with previous works in the field demonstrates that considering a one-dimensional model for the pipe and neglecting the length of the pipe after the hole causes up to 20% error. The results indicate that a two-dimensional model is not precise enough for estimating the gas leak from an under-ground pipeline (due to the soil resistance in three directions in a real situation). In addition, linear, second order and fourth order relations are observed between the amount of gas leak and the three effective parameters of the pipe entry pressure, the hole diameter, and the ratio of the hole diameter to the pipe diameter, respectively. Analysis of the results indicates that the relative difference between the results of the simulation and the results given by the developed correlations is within the range of ±7% for all cases.

Keywords: Three-dimensional simulation; Numerical investigation; NG emission; Buried pipelines; GHG emission