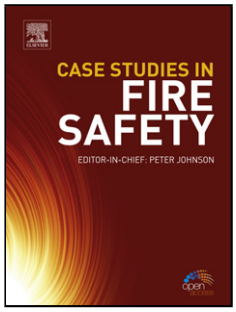

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Clustering of corrosion pit depths for buried cast iron pipes

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Highlights

- Long-term pitting corrosion tends to occur mainly in clustered cohorts that are of similar incremental pit depth for a given soil pH.
- The pit depth increments are greater for soils with lower soil water pH, consistent with the electrochemical potential driving pit development. They are not correlated with period of exposure and appear little affected by soil salinity.
- Individual pits amalgamate through sideways growth similar to earlier deductions for the corrosion of mild steel in seawater

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Abstract

The exterior surfaces of cast iron pipes buried in clay soils for up to 129 years show clustering of pits of similar depth at progressively greater overall corrosion pit depth. Within experimental accuracy, the pit depth increments are approximately constant over the whole range of pit depth for each soil. They increase with lower soil pH and appear insensitive to other soil properties and to burial period. These new findings are interpreted relative to pitting electrochemical potential and compared with field observations for pitting in marine corrosion of steel. Implications for modelling maximum pit depth development are considered.

Keywords: Iron; Modelling studies; Weight loss; Pitting corrosion

1. Introduction

Internally cement lined cast iron water pipes buried in soils constitute a large proportion of the pipes in the water supply distribution systems of many large cities. Failure of these critical parts of the water supply infrastructure can have significant direct and indirect costs and consequences [1]. Most commonly pipe failure is by pipe wall fracture caused by temperature variation and soil movement. Failure also has been associated with corrosion of the exterior surface of the pipe wall, that is, the metal surface in contact with the soil. For cement-lined pipes Interior corrosion usually is negligible. For pipe wall fracture caused by corrosion to be feasible, under the water pressures typical in water supply systems, significant loss of pipe wall thickness is required [2]. Careful examination of fractured pipes exhumed from active service has shown that loss of pipe wall section is most likely the eventual outcome of corrosion caused by highly oxygenated freshwater from inside the water pipes entering the region between the cast iron surface and the graphitized layer. This can result only from pipe-wall perforation caused by pitting from the exterior surface inwards [3].

It follows that for overall management of water pipe systems prediction of the time to wall perforation is an important parameter. Ideally such prediction requires good quality modelling of the progression of the maximum depth of pitting as a function of time and the exposure environment. Various models, such as the partly empirical power law, have been proposed but increasingly it appears that they do not necessarily provide a good representation of longer-term pit depth development [4]. Also, comparison with actual field data shows that the effect and the quantification of potential influencing factors requires further research [5]. This is despite the availability of several substantial databases for pitting corrosion as well as general corrosion, including for cast irons and steels in a variety of soils [6, 7,8].

The present paper is part of a wider study of the development of corrosion and pitting of cast iron water pipes buried in soils [9, 10]. It presents observations of the topography and pitting of cast iron pipes exposed to clay-type soils at 16 different locations for periods ranging from 34 to 129 years. The soils in the study have generally similar characteristics. The sites from which the pipes were exhumed and soils examined