Mechanochemical corrosion of long tubes under own weight

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Mechanochemical corrosion is defined as general corrosion enhanced by mechanical stresses [1]. The problems of corrosion under stress have received a wide response among scientists. Most solutions obtained neglect the action of body forces [2-6]. The motivation of this work was to investigate the effect of own weight of a long tube on its durability under corrosion conditions to assess whether it is justified to neglect it.

An elastic vertically standing or hanging long tube loaded with its own weight is considered. The tube is subjected to inside and/or outside general corrosion with the rates linearly dependent of the maximum (in absolute value) principal stress at the corresponding points of the surface. The virgin tube may have an imperfection, such as an initial thickness deviation. It is assumed that the initial narrowing of the tube wall is gradual and does not cause a stress concentration. It is required to find the longitudinal stress and the thickness along the tube during the corrosion, and to assess its lifetime. Loss of stability of vertically standing tubes is not taken into consideration.

The problem is solved numerically. The time and spatial step sizes are estimated.

It is obvious that the maximum in absolute value normal stress, which is the longitudinal stress, is at the upper cross-section for a hanging tube, and at the lower end for the standing tube. Therefore the stress and the thickness at this very cross-section determine the service life of the tube. As expected, the mechanochemical effect is noticeable only for very long tubes. Analysis of calculation results revealed that, despite the fact that the stress grows very slowly during the corrosion process, using the simplified formula ignoring the effect of synergetic growth of stress and corrosion rate is not justified when the mechanochemical effect should be taken into account.

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