Corrosion of a Thin-Walled Spherical Shell Under Time Dependent Internal Pressure

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ABSTRACT

Thin-walled elastic spherical shells are typical structural component, they are often used as a part of high-pressure vessels. During operation pressure vessels may be under mechanical loads and in aggressive environment. Aggressive environment cause corrosion damage, which, being intensified by stresses, becomes more destructive [1]. General corrosion accelerated by mechanical stresses is called mechanochemical corrosion. For metals, the rate of mechanochemical corrosion is often linearly dependent on stresses [2].

Mechanochemical corrosion of thin-wall spherical and cylindrical shells under pressure was considered in [4–5], where the stresses are assumed to follow Laplace's law. In [6] an analytical solution for thin pressurized sphere exposed to double-sided corrosion was presented taking into account the effect of hydrostatic pressure and the difference of hoop stresses on the inner and outer surfaces.

However, solutions mentioned in [4–6] deal with constant internal and external pressures, whereas another chalenging problem is the case of pressure that changes with time. Such problem arises in different areas of engineering, for example, the pressure in oil well declines with time during production, depressurisation problems arise in many critical situations on aircraft and underwater vessels.

In the present paper a linearly elastic thin-walled closed spherical shell is considered exposing to mechanochemical corrosion under constant external pressures and internal pressure decreasing with time. The dependencies of the vessel lifetime on the intensity of pressure decrease is investigated.

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REFERENCES

[1] A. Groysman, *Corrosion for everybody*, Springer Science & Business Media, 2009.

[2] P. A. Pavlov, B. A. Kadyrbekov and V. A. Kolesnikov, *Strength of Steels in Corrosive Media*, Alma Ata, Nauka, 1987. (in Russian).

[3] V. M. Dolinskii, "Calculations on loaded tubes exposed to corrosion", *Chemical and Petroleum Engineering*, Vol. **3 (2)**, pp. 96–97, (1967). (in Russian).

[4] M. S. Kornishin and V. G. Karpunin, "Stability of plates and shells with general corrosion taken into account", *Proceedings of a Seminar on Shell Theory*, Vol. **6**, pp. 58–66, (1975). (in Russian).

[5] E. M. Gutman, R. M. Bergman and S. P. Levitsky, "Influence of internal uniform corrosion on stability loss of a thin-walled spherical shell subjected to external pressure", *Corrosion Science*, Vol. **111**, pp. 212–215, (2016).

[6] Y. Pronina, O. Sedova, M. Grekov, and T. Sergeeva, "On corrosion of a thin-walled spherical vessel under pressure", *Int. J. Eng. Sci.*, Vol. **130**, pp. 115–128, (2018).