DOI 10.1007/s11041-020-00576-3
Metal Science and Heat Treatment, Vol. 62, Nos. 5 – 6, September, 2020 (Russian Original Nos. 5 – 6, May – June, 2020)

CORROSION

UDC 620.193.1

INVESTIGATION OF THE INFLUENCE OF THE STEEL 20 MICROSTRUCTURE ON THE CARBON DIOXIDE CORROSION RATE

P. E. Yudin,[1] T. M. Pugacheva,[1] L. A. Kondratyeva,[1] M. V. Bogatov[1]

Translated from *Metallovedenie i Termicheskaya Obrabotka Metallov*, No. 6, pp. 61 – 65, June, 2020.

The influence of various heat treatment modes (annealing, quenching, tempering) of steel 20 on the carbon dioxide corrosion rate in a 3% NaCl solution in combination with carbon dioxide (CO_2) barbotaging was studied. It is established that the quenching followed by high tempering is the most effective heat treatment of steel 20 to achieve a combination of increased mechanical properties and corrosion resistance in a carbon dioxide environment.

Key words: heat treatment, steel 20, carbon dioxide corrosion, carbon dioxide, microstructure, corrosion rate, quenching followed by high tempering.

INTRODUCTION

Carbon dioxide corrosion is one of the main destructive factors in the operation of steel pipe products. The mechanism of carbon dioxide corrosion [1 – 3] consists of several sequential stages:

– a layer of carbonates is formed on the surface of the metal, in which discontinuities (pores) are formed later;

– the formation and growth of pittings under a layer of iron carbonate is observed, which leads to a decrease in carbonate adhesion, the appearance of an electrochemical galvanic pair and accelerated growth of pittings;

– removal of carbonate crystals, stripping of the pipe metal;

– the process of the three stages above is repeated in other areas.

Schematically, the process of carbon dioxide corrosion is presented in Fig. 1. In the presence of water, carbon dioxide (CO_2) dissociates forming carbonic acid (H_2CO_3): $CO_2 + H_2O \rightarrow H_2CO_3$.

Typical carbon dioxide corrosion consists of three cathodic and one anodic reactions [10].

Cathodic reactions:

– reduction of carbonic acid into bicarbonate ions $H_2CO_3 \rightarrow H^+ + HCO_3^-$;

– reduction of bicarbonate to carbonate ion $HCO_3^- \rightarrow H^+ + CO_3^{2-}$;

– reduction of hydrogen ions $2H^+ + 2e^- \rightarrow H_2$.

The anodic reaction is the iron dissolving: $Fe \rightarrow Fe^{2+} + 2e^-$.

When the concentration of CO_3^{2-} and Fe^{2+} ions exceeds the solubility of iron carbonate, formation of a solid precipitate is observed: $Fe^{2+} + CO_3^{2-} \rightarrow FeCO_3$.

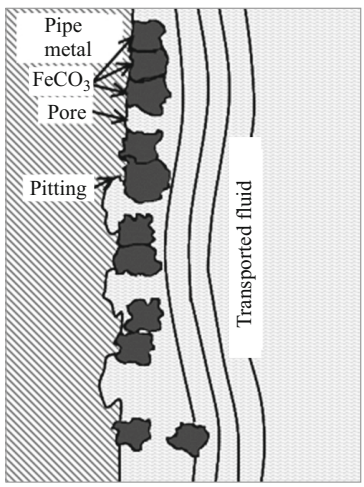


Fig. 1. Schematic representation of the carbonate corrosion process.

[1] Samara State Technical University, Samara, Russia (e-mail: bogatof.mak@yandex.ru).

0026-0673/20/0506-0415 © 2020 Springer Science+Business Media, LLC