# Effect of Heat Treatment Process on the Wear Resistance of Industrial Pure Iron and Sintered Pure Iron

ムハッマド, コジン



出版情報：九州大学, 2020, 博士（工学）, 課程博士
バージョン：

（様式２）

氏　　名　：Muhammad Kozin (ムハッマド　コジン)

論 文 名　：Effect of Heat Treatment Process on the Wear Resistance of Industrial Pure Iron and Sintered Pure Iron
（工業用純鉄および純鉄焼結材の耐摩耗特性に及ぼす熱処理プロセスの影響）

区　　分　：甲

# 論　文　内　容　の　要　旨


Wear is one of the types of mechanical failure other than corrosion, fatigue, creep, and brittle/ductile fracture. The wear occurs in many industrial applications such as dies, molds, piston rings, gears and so on. It is considered that approximately 80% of tribology problems within the machine-building industry is attributed to wear due to sliding and rolling of elements. Wear results from a contact between a surface and a body/substance, manifested by a change in appearance and profile of a surface. It influences a persistent service condition of materials, leading to economic and technical consequences.

In this paper, the effects of nitriding-quenching followed by tempering (NQT) and carburizing-quenching followed by tempering (CQT) on the wear resistance were studied for both industrial iron and sintered pure iron under the condition without lubrication. It was elucidated that a specimen produced by the CQT, which contains high-carbon martensite near the surface, shows as high wear resistance as a specimen produced by the NQT, which contains a compound layer of high nitrogen martensite without pores. The wear resistance of sintered pure iron produced by the CQT was slightly higher than that of the sintered pure iron produced by the NQT treatment. The factors affecting the wear resistance were mainly investigated by using nano-indentation hardness tests, the electron back scatter diffraction analysis and the X-ray diffraction analysis. This paper is consisted with five chapters, the abstracts of each chapter are as follows.

In chapter 1, an introduction of this study was presented. The economic aspects of wear, known wear mechanisms, factors affecting the wear resistance of steel, wear testing methods, surface hardening for wear resistance, and characterization techniques in this study were

presented.

In chapter 2, the effects of various conditions of NQT on the wear resistance were examined for industrial pure iron. The NQT increases the wear resistance of the industrial pure iron due to the compound layer and martensite layer. The presence of pores in the compound layer decreased the effective load bearing of the cross-sectional area, which leads to the increase in the stress concentration. Thus, the wear resistance of the industrial pure iron was reduced.

In chapter 3, the effects CQT on the wear resistance investigated for industrial pure iron, comparing the effect of NQT. The specific wear rate of the specimen with CQT showed as low value as that with NQT. The nano-indentation hardness of the specimen with NQT was lower than that with CQT before a sliding test. On the other hand, the hardness of the specimen with NQT was markedly increased after the sliding, showing the same hardness as the specimen with CQT. In the NQT material, the large area of metal flows due to the sliding was found at the surface layer of 20 μm. The area subjected to the metal flows is corresponding to the area where the hardness increased. Therefore, it can be concluded that the increase in hardness is due to the strain hardening.

In chapter 4, the wear properties of sintered pure iron with NQT and CQT were investigated. The specific wear rate was much lower in both specimens with NQT and CQT compared to the specimen without a heat treatment. The wear resistance of the specimen with CQT was slightly higher than that with NQT, despite the former specimen had lower initial hardness. The hardness of the surface in the specimen with CQT after the sliding tests significantly was increased relative to that with NQT, resulting in the better wear resistance. Since the retained austenite was decreased during the test, the wear resistance should be improved by the surface hardening due to the stress-induced transformation of the retained austenite in addition to the strain hardening of the lath martensite. The wear resistance of the sintered pure iron is similarly improved by both CQT and NQT.

In chapter 5, the important points obtained from this thesis are summarized as the conclusions. From these results, it can be concluded that both NQT and CQT are effective to increase the wear resistance of both industrial pure iron and sintered pure iron. The temperature for NQT was lower than that for CQT, so that the NQT treatment meets to the production for the low thermal distortion.