THE CAUSES, DETECTION AND CORRECTION OF DECARBURISATION

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ABSTRACT
Decarburisation may be commonly described as loss of carbon from the surface of ferrous materials. It is generally an undesirable material characteristic in the manufacturing industry. When components are hardened, decarburisation will reduce the surface hardness of the material and hence decrease its operational life under conditions of wear. This unwanted condition must therefore be eliminated from the heat treatment process. This paper summarises the causes of decarburisation in heat treatment and gives some troubleshooting tips for industrial practice, together with a case study.

INTRODUCTION
There are generally two types of surface change commonly encountered when metals are heated in furnaces. One is oxidation/reduction; the second one is carburisation/decarburisation that relates to the reaction of the gases with the metal surface in such a way as to add carbon to the surface of low-carbon steel or to remove carbon from the surface of high-carbon steel. The latter is known as decarburisation.

Any air that leaks in will change the chemistry inside the furnace. Increasing leak rate decreases oxygen potential and this leads to increasing decarburising potential. Decarburisation occurs according to following reaction:

\[ \text{Fe}(C) + \text{O}_2 = \text{Fe} + 2\text{CO} \quad [1] \]

Neutral or carburising atmospheres generally contain CO and H\textsubscript{2} to protect against decarburisation and oxidation. Unfortunately it is a fact that furnace atmospheres are inevitably contaminated during real practice e.g. air leaks, water, oils and lubricants from work pieces, furnace structure or atmosphere pipe lines [1].

DETECTION AND ESTIMATION OF DECARBURISATION
There are several ways to determine the presence and the level of decarburisation. The fastest method is metallographic examination. Decarburisation may also be determined by chemical analysis of samples taken from the surface, substrate and core. A further method would be a file test, using files of specific hardness to determine the surface hardness.

CORRECTION OF DECARBURISATION
Oxygen, water, and carbon dioxide in the furnace atmosphere cause oxidation and/or decarburisation, so it is important to exclude them. In industrial practice, leakage in heat treatment furnaces is very common. However the oxidation and decarburisation problem only begins after a certain level of leakage has been reached. At that stage there is a very easy way to find leaks in the furnace structure: the smoke test can be applied to sealed quench and continuous type furnaces [2].

CASE STUDY
Midas Metal Construction Works Inc. based in Turkey; produces nuts and bolts, not just for the construction industry, but also for the automotive industry. They therefore need the highest quality standards in their products and decarburisation limits are very important to this quality. They employ hardening under a nitrogen-based atmosphere with natural gas addition in conveyor belt type continuous furnaces. Normally, the company has a regular programme to check for leaks from the furnace by smoke tests. Just before a smoke test was due, there was a problem of excessive decarburisation. After carrying out some tests on the incoming material and after each process step, it was decided to carry out a smoke-bomb test to find possible leaks and approximately 20 leakage points were found.

CONCLUSION
Decarburisation is a common problem in industrial heat-treating applications. It has several possible causes; these might be material specifications, process parameters, one of the furnace atmosphere constituents, and/or the furnace structure itself. To find the source of the problem each of these should be examined. The case study described in this paper has shown only one of the tools for solving the problem, the smoke-test.

References