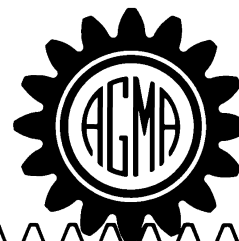


Vacuum Carburizing System for Powder Metal Parts and Components

by: J. Kowalewski and K. Kucharski
SECO/Warwick Corporation

American Gear Manufacturers Association



TECHNICAL PAPER

Vacuum Carburizing System for Powder Metal Parts and Components

Janusz Kowalewski and Karol Kucharski, SECO/Warwick Corporation

[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

Carburizing is one of the leading surface-hardening processes applied to the sintered, low-alloyed steel parts in the automotive industry. While diffusion of carbon in wrought steel is well documented, this is not the case for PM steel subject to carburizing in vacuum furnaces. In this paper we present results that show that the density of the powder metal is the main factor for the final carbon content and distribution. Also important is the state of the surface of the part; either sintered with open porosity or machined with closed porosity. The way the carburizing gas moves through the furnace might be of some influence as well.

Copyright © 2007

American Gear Manufacturers Association
500 Montgomery Street, Suite 350
Alexandria, Virginia, 22314

October, 2007

ISBN: 978-1-55589-909-7

Vacuum Carburizing System for Powder Metal Parts and Components

Janusz Kowalewski, Karol Kucharski, SECO/Warwick Corporation

Introduction

Vacuum carburizing is a non-equilibrium process [1]. Unlike atmosphere carburizing it is not possible to set the carbon potential of the atmosphere and control its composition in order to obtain a desired carburized case.

Currently the boost-diffusion technique is applied to control the surface carbon content and carbon distribution in this case. In the first boost step the flow of the carburizing gas has to be sufficient to saturate the austenite while avoiding soot deposition and formation of the massive carbides. To accomplish this goal, the calculation of the proper gas flow rate has to be made. However in the case of P.M. parts, the amount of carbon absorbed by the part's surface can be a few times higher thanks to additional internal surface created by pores present in the carburized case [2,3]. This amount will depend on the density of the part, the densification grade of the surface layer and the stage of the surface – “as machined” or “as sintered”. It is believed that enhanced gas diffusion after initial evacuation of the P.M. parts leads to faster carburization from within the pores, especially when pores are open – surface “as sintered” and interconnected – low density.

A serious problem with vacuum carburizing is delivering the carbon in the uniform manner to the work pieces. This led to the development of the different methods of carburizing gas circulation i.e., pulse/pump method developed in 1960's or pulse/pause technique applied in most of today's vacuum furnaces. [4,5]. In both cases each pressure change may deliver fresh carburizing atmosphere into the pores and leads to faster carburization from within the pores.

Since today's control of vacuum carburizing is based largely on empirical results, presented experiments may lead to better understanding and improved control of the process [6, 7].

Materials and experimental procedures.

A standard TRS bars compacted at the pressure from 480 MPa to 1080 MPa, from the blend equivalent to 8620 steel to green densities 7.0, 7.1, 7.2, 7.3, 7.4 and 7.5 g/ccm were used for the carburizing test.

The basic iron powder was a QMP Atomet 1001 HP. Alloying elements were admixed as ferro-alloys or elemental powders together with graphite and 0.2% lubricant. Sintering was at 1280 C in the nitrogen +10% hydrogen atmosphere.

As a reference coupons of 8620 steel were used. Chemical composition of the samples and reference coupons is given in table 1.

To get a machined surface, half of the samples were ground 0.1mm with two passes. Carbon content was measured at glow with a discharge spectrometer Leco GDS400. Usually five (5) runs were made for each depth level. Carbon profiling was achieved by subsequent grinding and spectral analysis.

Vacuum carburizing was carried out in a furnace with pulse/pause method and in a furnace with pulse/pump method of gas circulation.

In both furnaces process temperature was maintained at 900 C and the same boost and diffusion time – 16 min and 21 min respectively.

Table 1. Chemical composition of the samples.

Material	C	Si	Mn	Ni	Cr	Mo	Cu
8620 P.M.	0.19	0.21	0.84	0.52	0.51	0.21	0.21
8620 steel	0.21	0.323	0.81	0.57	0.54	0.20	0.20