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Failure analysis of nickel 200 sintered filter cartridges

C.R.F. Azevedo *

Laboratory for Failure Analysis, Instituto de Pesquisas Tecnológicas do Estado de Sao Paulo, P.O. Box 0141, 01064-970 Sao Paulo, Brazil

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Abstract

The premature failure of nickel 200 sintered filter cartridges used to separate the solid catalytic particles has been investigated. The failure is due to the formation of holes and transversal cracks, which occur preferentially on the upper part of the cartridges, near the welding. Microstructural and fractographic characterisation indicated that the failure started on the internal surface of the cartridges, which presented intense secondary intergranular cracking associated with corrosive attack. Fractographic examination on the surface of the transversal crack near the external surface indicated the action of a ductile intergranular fracture mechanism, while near the internal surface it featured a faceted and jagged topography, with cracks propagating inter and transgranularly. The results suggested that the premature of the cartridge failure was promoted by an environmental-assisted mechanism (stress corrosion or hydrogen embrittlement).

Keywords: Powder metallurgy; Nickel 200; Environmentally assisted cracking; Intergranular fracture; Transgranular fracture

1. Introduction

A new route for the production of DSIDA (disodic imino diacetic acid), a raw material for the production of an eco-herbicide, won the Presidential Green Chemical Challenge (Alternative Synthetic Pathways Award) in 1996. This new technology, called catalytic dehydrogenation of diethanolamine, represents a major breakthrough allowing the production of an environmental friendly herbicide in a safer and more efficient way. DSIDA was traditionally manufactured via the Strecker process using ammonia, hydrochloric acid, formaldehyde and hydrogen cyanide, being the last two reagents highly toxic [1–3].

The new route to DSIDA produces a product flow that, after the filtration of the catalyst, is of such high quality that no purification or waste cut is necessary [4,5]. The filtering units employ nickel 200 sintered filter cartridges to separate the solid catalytic 77.5%C–20%Cu–2.5%Pt particles (size from 1 to 40 μm) from

* Tel.: +55-11-3767-4117; fax: +55-11-3767-4413.
E-mail address: crfaze@ipt.br (C.R.F. Azevedo).

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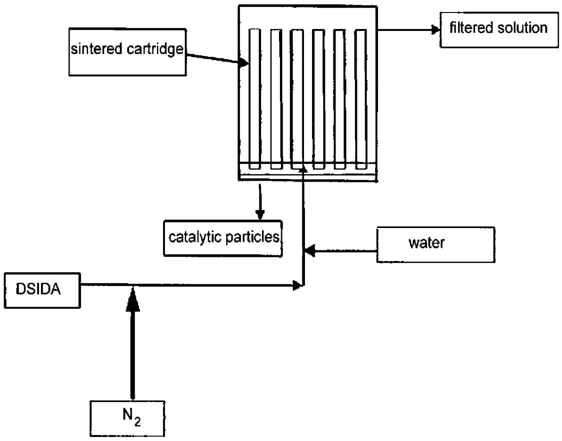

Fig. 1. Filtering and cleansing process.

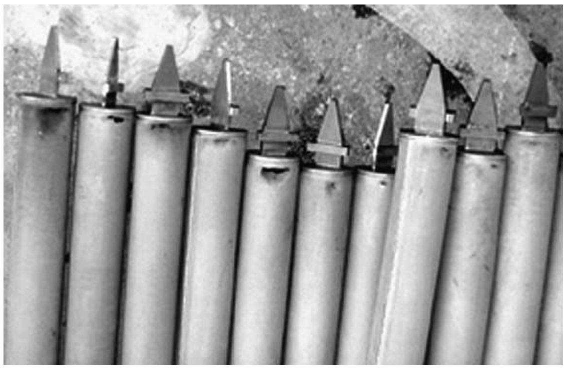

Fig. 2. Location of the defects near the top of the sintered cartridges.

the organic solution. Each filtering cycle lasts 6 h, being followed by a cleansing procedure, which consists of N_2 and demineralised water injections, see Fig. 1.

Nickel 200 is commercially pure (99.6%) nickel, which presents a face centred cubic (FCC) crystal structure and whose microstructure exhibits a minor amount of non-metallic inclusions, mainly oxides. It shows good mechanical properties and excellent resistance to many corrosive environments, being normally used at temperatures below 600°F. At higher temperatures, it can suffer graphitisation, which can severely compromise its properties. For service above 600°F, nickel 201, which presents much lower carbon content (0.02% max against 0.15% max. for nickel 200) is preferred [6]. The present study will investigate the possible causes for the premature failure of the nickel 200 sintered filter cartridges (see Fig. 2).

2. Experimental procedure and results

The comparison of the chemical analysis results with the specification of nickel 200 (see Table 1) indicates that the cartridge presents higher carbon and sodium and lower nickel contents, suggesting that the result was modified by the contamination of the sample by the disodium iminodiacetate solution.