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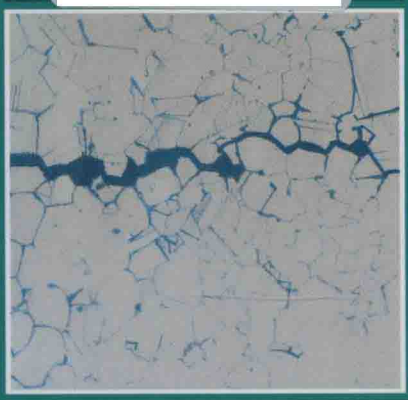

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Stress Corrosion Cracking of Nickel-based Alloys in Water-cooled Nuclear Reactors

The Coriou Effect

Edited by Damien Féron and Roger W. Staehle

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Preface

The "Coriou effect" names the stress corrosion cracking (SCC) of alloy 600 in pure water at high temperatures. Indeed, Henri Coriou and his coworkers published in 1959 that this nickel-based alloy cracks in pure water at 350°C. The Coriou effect was used with some irony up to the beginning of the 1980s, when a growing number of cracks were observed in steam generator tubes of pressurized water reactors subjected to normal operating conditions. More than 50 years after the first publication of these results, it is interesting—from both a scientific and a historical point of view—to know why such important results have not been taken into account and to understand why alloy 600 has nonetheless been widely used for such a long time, even with the numerous amount of failures that have occurred and are occurring in operating units.

In the first part of the book, main actors of that period (Roger Staehle from the United States, Gérard Pinard Legry and Philippe Berge from France, and Toshio Yonezawa from Japan) recall some historical background and facts, and then report their point of view. Coriou's results went against the dominant ideas regarding material behaviors: nickel alloys with high nickel content were supposed to be very resistant to corrosion, and pure water was supposed to be noncorrosive (only impurities may have a detrimental effect).Then, like today, when laboratory results were in disagreement with the global consensus, bad experimental conditions were supposed to exclude these results. In this sense, I encourage lecturers to carefully read these historical points of view, which prove very important for today's issues.

In the second part of the book, updated knowledge on SCC of nickel-based alloys is summarized by different well-known personalities: the understanding and the prediction of SCC in light-water reactors are detailed by Peter Andresen (GE, United States), whereas Digby Macdonald (University of California, Berkeley) focuses on the electrochemical nature of SCC. Two SCC mechanisms, which are complementary rather than competitive, are then detailed: hydrogen embrittlement, by Jacques Chêne (CNRS, France), and intergranular oxidation, by Pierre Laghoutaris and his coauthors (CEA, France). Overviews of experimental techniques and the list of standards that are used to perform SCC tests compose the practical information given at the end of the book for researchers and engineers who are working in this area.

Henri Coriou (1925–2010) joined CEA in April 1949. He graduated from the faculty of the sciences of the Sorbonne University ("licencié es sciences" in 1947 and two "certificats d'études supérieures" in chemistry and in electronics and radioactivity in 1948). For nearly 30 years he was the head of the CEA "Corrosion Section" and

then the "Corrosion Service." He gave his name to both a corrosion phenomenon (the "Coriou effect"), which is the subject of this book, and also to a nitric acid solution used to test stainless steels for reprocessing plants (the "Coriou solution"). He founded in 1967 the Working Party on Nuclear Corrosion of the European Federation of Corrosion, which he chaired from 1967 until his retirement in 1985. He received several French scientific awards: the Jean Ritz medal in 1959 (for young scientists and engineers) from the SF2M (French society of materials and metallurgy), the CEFRACOR "Grande Medaille" (French corrosion association) in 1972, and the Charles Eichner medal from SF2M in 1981. He also received two national honors: Academic Palms (1968) and Order of Merit (1970). He was a "careful and conscious scientist," following Gérard Pinard Legry, and a "modern hero," as described by Roger Staehle.

I hope that the example of Henri Coriou will be followed by corrosion scientists and engineers if they face unexpected results. I hope also that this book is useful to those who are involved in corrosion and, more precisely, in the development of, understanding of, and resolution of SCC phenomena in light-water reactors.

Finally, I thank the authors who wrote chapters containing outstanding historical, scientific, and technical content. After the "Jubilee day: Stress Corrosion Cracking of nickel base alloys at CEA – Coriou effect," held in January 2000 at CEA-Saclay (European Federation of Corrosion event no. 333), it was a long process to write and publish this book. Their support has been a continuous and great encouragement.

D. Féron
Chairman of the Working Party on Nuclear Corrosion
European Federation of Corrosion

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