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Editorial

Environmental Fatigue Assessment of Metallic Materials and Components

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1. Introduction and Scope

At present, sensitive industrial sectors (such as the nuclear, oil, and gas sectors) face important challenges. Among them, the long-term operation of existing equipment and installations ensuring safety condition and the design and construction of new safe efficient ones are surely two of the most significant challenges. Thus, safety is a common objective in both scenarios. This requires the adequate management of in-service components and innovative designs for new ones.

In this sense, when dealing with safety issues in structural components and constructed installations, material fatigue is of major concern. Additionally, the recent literature demonstrates that there are currently several significant gaps when performing fatigue assessments, with empirical observations and theoretical issues that have not been properly addressed. Besides purely mechanical conditions, the fatigue life may also be affected by the operational environment, which may accelerate the crack initiation and propagation stages, significantly reducing the fatigue life.

This Special Issue intends to discuss significant advances in the existing knowledge of environmental fatigue. It was proposed within the framework of the INCEFA–PLUS project (Euratom Research and Training Program 2014–2018, grant agreement No. 662320), which dealt with environmental fatigue analyses in nuclear power plants. However, contributions from other sectors (e.g., oil and gas, the chemical industry, offshore installations, civil infrastructures, etc.) were welcome and appreciated. The effect of factors such as the environment, mean stress, the existence of hold time periods, or surface roughness were of particular relevance in addition to their corresponding interactions.

2. Contributions

Eight research contributions have been published in this Special Issue. Six contributions [1–6] are directly derived from the INCEFA-PLUS project, whereas two [7,8] are external contributions.

In the context of nuclear power generation, the impact of the environment on the fatigue life is often characterized by means of an environmental F_{en} factor:

$$F_{en} = \frac{N_{air}}{N_{env}}$$

where N_{air} is the fatigue life in air at room temperature and N_{env} the fatigue life in the environment. Cicero et al. [1] present the F_{en} factor and other approaches for assessing environmental fatigue and demonstrate the use of the F_{en} in a case study on a charging nozzle of a nuclear power plant.

Three contributions in this special issue analyze the influence of different factors on the F_{en}: While Vankeerberghen et al. [2] address surface finish and hold-times, Spätig et al. [3] focus on the effect of mean stress under load and strain controlled conditions, and

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Citation: Cicero, S.; Bruchhausen, M. Environmental Fatigue Assessment of Metallic Materials and Components. *Metals* **2021**, *11*, 1565. https://doi.org/10.3390/met11101565

Received: 2 September 2021
Accepted: 27 September 2021
Published: 30 September 2021

Shao et al. [7] present an extensive comparison of approaches to take different strain rates into account when calculating the F_{en}.

While Simonovski et al. [4] present a technical paper on the calibration of strain measurements on the shoulder of uniaxial specimens in autoclaves, Gourdin et al. [5] introduce an innovative device for experimental investigations of environmental fatigue under biaxial conditions.

Bruchhausen et al. [6] statistically evaluate the collection of 250 uniaxial fatigue tests carried out within the INCEFA-PLUS project.

The special issue is completed with a contribution from the oil and gas industry in which Engler et al. [8] analyze the fatigue and corrosion fatigue behavior of alloy 718 at elevated temperatures.

3. Conclusions

The contributions of this Special Issue provide significant advances in the environmental fatigue assessment of structural components. Their application affects a number of engineering sectors, although they are particularly focused on the nuclear industry. Obviously, there are still many open issues to solve in this context. However, as guest editors, we hope this Special Issue provides a substantial impact and that both the scientific community and members of various industries found it interesting.

Finally, we would like to thank all of the authors for their contributions, and all of the reviewers for their outstanding efforts to improve the scientific quality of the different documents composing this Special Issue. We would also like to give special thanks to all the staff at the Metals Editorial Office, especially to Marina Tian, who managed and simplified the publication process.

Author Contributions: Writing—original draft preparation, S.C., M.B.; writing—review and editing, S.C., M.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by EURATOM, grant number 662320.

Conflicts of Interest: The authors declare no conflict of interest.

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