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PREDICTION OF THE FATIGUE BEHAVIOUR OF CLADDING MATERIALS USED IN THE MANUFACTURE OF REACTOR PRESSURE VESSELS

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ABSTRACT

In this work, an analysis of the fatigue requirements of cladding materials as described by ASME B&PV and KTA codes has been performed using a stringency level methodology. Thus, ASME B&PV curves show a maximum fatigue stress requirements greater than those required by the KTA standards for the same number of cycles; this is from a value of 10 up to 2 x 10^5 cycles. Applying the stringency level (SL) methodology, we have obtained a SL equal to 5 for ASME fatigue requirements and a SL equal to 4.6 for KTA fatigue requirements.

Keywords: fatigue requirements, manufacturing codes, fatigue limit, requirements stringency.

INTRODUCTION

Fatigue behaviour is often associated with a variety of parameters such as the range of stresses, cycles to failure, the surface finish and the in-service conditions. Cracks usually start from small surface defects. Some manufacturing codes describe curves to predict fatigue crack initiation; these curves indicate the permissible number of cycles under mechanical stress condition to avoid cracks nucleation.

The operating conditions of reactor pressure vessels require that the material used in the process of inner cladding present an adequate resistance to fatigue, because the materials used in the inner cladding of the vessel will substantially suffer the effects of fatigue stresses. To address this issue, an analysis of the fatigue requirements of cladding materials described by ASME B&PV and KTA codes has been performed.

METHODOLOGY

The methodology combines comparative calculations and graphic representation to estimate fatigue limits with the application of a stringency level (*SL*) methodology (Rodríguez-Prieto *et al.*, 2016) to analyze the differences among KTA curves (KTA 3204, 2008) with the three specified classifications of severity (A, B and C) and ASME B&PV curve (ASME B&PV III, 2015).

RESULTS AND CONCLUSIONS

Fig. 1 represents the maximum allowable stress versus the number of cycles specified by ASME B&PV and KTA manufacturing codes for cladding materials to be used in reactor pressure vessels

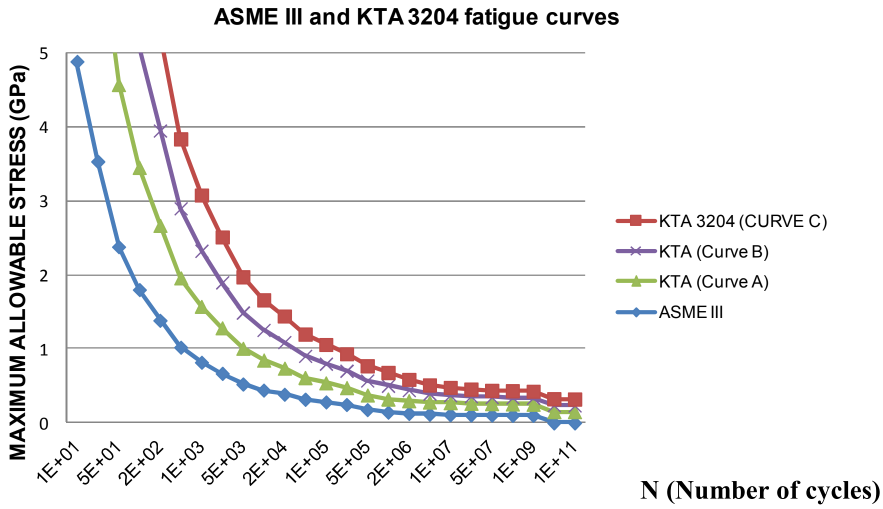

Fig. 1 - Representation of maximum allowable stress (MPa) versus number of cycles for KTA Curves A, B and C compared with ASME III

ASME B&PV curves show a maximum fatigue stress requirements more stringent than those required by the KTA standards for the same number of cycles; this is from a value of 10 up to $2 \cdot 10^5$ cycles. Table 1 exhibits the fatigue limit obtained by graphic representation of the values described by ASME B&PV and KTA codes.

Table 1 - Fatigue limits and ratio between KTA curves (A, B and C) and ASME B&PV curve

	ASME B&PV	KTA		
		A	B	C
Fatigue limit (MPa)	100	150	105	85
Ratio KTA/ASME		1.5	1.05	0.85

Considering that, in operating conditions and even under anomalous conditions, fatigue by cyclic stresses below the fatigue limit found at $2 \cdot 10^5$ cycles is not expected. Therefore, ASME B&PV fatigue requirements are more stringent that fatigue requirements specified by KTA. Applying a stringency level (*SL*) methodology, we have obtained a *SL* equal to 5 for ASME fatigue requirements and a *SL* equal to 4.6 for KTA fatigue requirements.

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