

MONITORING AND DIAGNOSIS OF SYSTEMS AND EQUIPMENT OF NUCLEAR AND INDUSTRIAL PLANTS II

¹Castro, A.J.C.; ¹Ting, D.K.S.; ²Ferreira, W.R.; ¹Mesquita, R.N.; ³Cabral, E.L.L.

¹Centro de Engenharia Nuclear - IPEN/CNEN-SP; ²ETN; ³Departamento de Engenharia Mecânica, Escola Politécnica - USP

Keywords: eddy current; tube defects; steam generator; self organizing maps; artificial intelligence; subcooled boiling; vibrations; nuclear power plants.

Classification of steam generator tube defects from nuclear power plants using Eddy-current test signals with self-organizing maps - Many important objectives were attained during the referred period. Under a cooperation project between IPEN/CNEN-SP and The University of Tennessee, Knoxville (UTK) a classification and diagnosis system for steam generator tube defects was developed. A Ph.D. thesis was finished by Mesquita, which main features included: filtering, calibration, "intelligent" system training for automatic recognition and characterization of steam generator tube faults using Self-Organizing Maps. Two international conference papers were presented during this period and an international journal paper was submitted and accepted for publication. Different artificial intelligence methods were applied and integrated to diagnose steam generator tube defects including many feature extraction techniques and other features as the power plant steam generator design where data were acquired.

Subcooled boiling detection using pressure transducers signals spectral analysis - The optimization of heat exchangers, steam generators and nuclear reactors has the common objectives of minimizing flaws occurrence with increasing thermal efficiency and power densities thus reducing costs. These equipment are extensively used in process and power plants and increasing efficiency and durability will certainly represent an important capital and energy saving for the modern industry competitiveness. Considering the above objectives, the operation in a partially developed subcooled boiling regime is an important condition to be pursued in heat transfer processes when high heat fluxes and/or small transfer areas are present. In this region, located between the onset of nucleate boiling (ONB) and the onset of fully developed boiling (OFDB), significant increase in the heat transfer coefficient is obtained when compared to the single-phase convection values. The significant increase in the pressure drop and in the void fraction found in the fully developed boiling regime is not present neither.

Another important aspect related to the operation in this regime is that it is safer as far as occurrence of critical heat flux (CHF) is considered since generally speaking CHF will occur after the points of ONB and OFDB. The method of spectral analysis of pressure transducers signals applied to the detection of two-phase flows characteristics presents among other advantages, as an excellent option for the detection, monitoring and also, to develop correlation for the ONB and OFDB points to optimize heat exchangers design. In this method, dynamic pressure sensors detect the pressure waves caused by the bubble collapse and their signals are processed using spectral analysis techniques. In this present work, the

method is verified by phenomenological interpretation of these two points. An important and clarifying comparison with the existing experimental correlation in the literature for the determination of ONB and OFDB, is also presented.

Monitoring of the vibrations signatures at the Angra I Nuclear Power Plant steam generators feedwater systems - The safety and reliability are the primary criteria in the design and operation of a nuclear power plant. However, due to the aging of the plant and its components, it is difficult to assure that what was originally built and qualified under strict standards is still guaranteed. In order to assure safety, reliability, availability and capacity, aging management through predictive maintenance techniques are being introduced in most plants around the world. In this present work, the monitoring of the vibrations signatures at the Angra I nuclear power plant steam generators feedwater systems main components such as the main feedwater pumps, pressure breaker blocks and the by pass valves, is presented. The vibration data was acquired, afterwards some major repairs were performed and during the startup commissioning procedures. Some of the major repairs performed are: changing of one pump shaft with balancing and alignment, replacement of the original bypass control valves by new disk stack type pneumatic control valves.