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A Method for evaluating Intensity of Water Cavitation Peening Processing

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Abstract: Water cavitation peening (WCP) with aeration, namely, a new ventilation nozzle with aeration is adopted to improve the process capability of WCP by increasing the impact pressure induced by the bubble collapse on the surface of components. In this study, in order to investigate the process capability of the WCP with aeration a standard N-type almen strips of spring steel SAE 1070 was treated by WCP with various process conditions, and the arc height value and the residual stress in the superficial layers were measured by means of the Almen-scale and X-ray diffraction method, respectively. The optimal fluxes of aeration and the optimal standoff distances were achieved. The maximum of arc height value reach around 150μm. The depth of plastic layer observed from the results of residual stresses is up to 150μm. The results verify the existence of macro-plastic strain in WCP processing. The distributions of residual stress in near-surface under different peening intensity can provide a reference for engineers to decide the optimal process conditions of WCP processing.

Introduction

Cavitation impact has historically attracted attention due to its costly damage to hydraulic mechanical parts, such as hydrofoil surfaces, turbopump impellers, pumps, and valves [1-3]; therefore, most previous studies on cavitation have focused on the damage mechanism. However, it can also induce the residual compressive stress in the superficial layer of the specimens, which can improve the fatigue life of mechanical components by a similar way as conventional shot peening [4-6], and such method is named water cavitation peening (WCP). In the past, in order to protect hydraulic structures against cavitation damage, air is normally added by aerators close to the bottom region where the cavitation number falls below a critical value [7, 8]. However, for the aerated jet-flow with high speed, appropriate aeration may accelerate the cavitation instead of preventing cavitation. During the process of the aerated jet-flow jetting out through a short pipe, if the flow velocity is close to the sonic velocity and the air concentration of aerated jet-flow is from 1.5 % to 4 %, the pressure gradient between the inlet and outlet part in the short pipe will become tremendous. According to their simulation results, D.Y. Ju et al. has designed a new ventilation nozzle by which the suitable air can be aerated into the extra high-velocity flow in the nozzle throat, the tremendous pressure gradient between the upstream and the downstream flow has formed. In this paper, in order to further verify the process capability of WCP with aeration, a standard N-type almen strip of spring steel SAE 1070 is treated by WCP with various process conditions. The arc height values and the depth distributions of residual stress were investigated.

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