



Analysis of the failure mechanism of a gripping tool steel component operated in an industrial tube draw bench

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ABSTRACT

Gripping assemblies are sophisticated machine elements, served as clamping mechanisms in draw benches, pulling the metallic rod or tube through a die. They manufactured from special alloy tool steel and subjected to high axial and repeated stresses due to successive loading and un-loading conditions. In-service failures of gripping tools, occurred in an industrial tube draw bench, led to increased maintenance costs and machine downtime, resulting in low productivity. Samples from fractured components and their connections, namely the arm, the expansion guide and the threaded rod, were brought from a metal working industry for a failure analysis investigation. Failure analysis findings suggest strongly that the failure occurred due to fatigue under high stress amplitude, initiated at the sharp corner of the arm jaw and followed by brittle quasi-cleavage overload fracture. Review of the service history (operating loads, lubrication, etc.), in combination to the examination of a potential improvement of the steel cleanliness and surface condition are mostly recommended as further fatigue failure preventive actions.

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1. Introduction and background information

Draw benches are metal working machines used in cold metal forming in ferrous as well as in non-ferrous industries, manufacturing tubes and bars of relatively large dimensions which cannot be coiled. Cold drawing is achieved by pulling the metallic tube or bar through a die at increased speeds for high efficiency. The work-piece is pointed, inserted through the die and clamped to the jaws of the draw-head [1]. The soundness and integrity of the dies, clamping tools and various forming components contribute to the overall quality of the final product. Process reliability is influenced by the performance and lifetime of tools and critical components in metal forming machinery; so the analysis of failure mechanisms and lifetime prediction is valuable. The analysis of fatigue failures encountered in forging and generally metal forming tools and the use of calculation strategy for the prediction of the corresponding tool life is vital for the consistency and sustainability of the manufacturing process; see also Ref. [2].

During copper tube drawing, the work is clamped internally by the expansion of the jaws of the gripping mechanism. The whole assembly of the gripping tool is illustrated in Fig. 1a. The expansion guide, connected with a threaded rod, is displaced towards the arm, opening the jaws and anchoring the inner tube diameter. Once the clamping process is completed the draw head/wagon is moving by means of a chain-drive transmission, drawing the tube out of the die and producing the final tube dimensions. Drawing process is taken place under ambient temperature conditions, while continuous lubrication, using oil emulsions is applied to minimize friction forces and die wear. Cold drawing requires the application of high stresses which depended mainly on work hardening rate, reduction per pass and friction. Multiple pass drawing often require intermediate

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