

# Chapter 13

## Cold End Forming of Welded Steel Tubes

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### ABSTRACT

*The production of custom and specific tube end shapes by cold end forming using a die is generally limited to seamless tubular parts. Current research work in the field follows the same trend as that of industry and, therefore, there is no accumulated experience, no practical design rules, and no information available in the specialized literature concerning the utilization of tube end forming for shaping the end of thin-walled welded tubes. This paper is concerned with the lack of knowledge and is a contribution towards the understanding of the mechanics of deformation of tube end forming applied to welded tubes. The presentation addresses the influence of major operating parameters on the formability limits of the process with the purpose of understanding feasibility and establishing design rules for the benefit of those who design tubular parts in daily practice. The authors effectively contribute to transferable technological knowledge opening new market opportunities that stimulate innovations among carbon and stainless steel tubular products.*

### INTRODUCTION

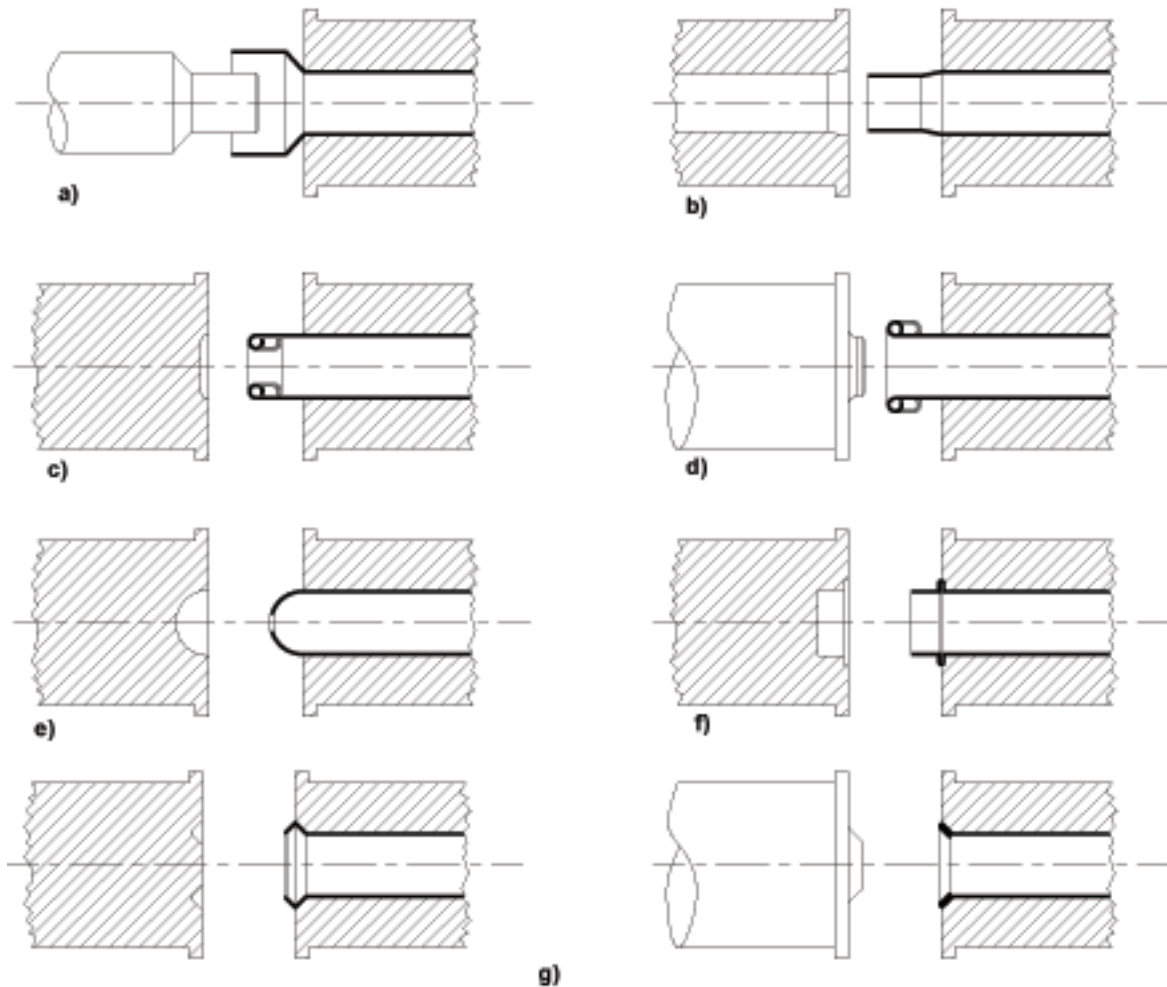
Tube end forming processes are commonly utilized for producing of a wide variety of shapes and profiles such as inversions, flares, expansions, reductions, beads and noses by means of single or multiple forming operations (Figure 1).

The historical review of research on tube end forming can be organized in three different periods. The first period (1960-1990) draws from pioneer studies on axial loading (Alexander, 1960; Allan, 1968) to the external and internal inversion (Guist & Marble, 1966; Al-Hassani et al., 1972; Al-Qureshi & Morais, 1976; Reddy, 1989). In this period most attention was given to the identifica-

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Figure 1. Tube end forming processes. a) Expansion, b) Reduction, c) Internal inversion, d) External inversion, e) Nosing, f) Compression beading and g) Flaring



tion of the main operative parameters, development of theoretical models to explain the mechanics of the processes (Avitzur, 1980) and correlation between theory and experimentation (Kinkead, 1983).

The second period (1990-2000) kept research focus on tube inversion and refined existing knowledge on the mechanics of deformation. The investigation on forming load and formability limits by means of analytical methods (Reddy, 1992; Tomesani, 1997; El-Domiaty, 1997) was progressively replaced by numerical simula-

tion based on the finite element method (Yang, 1995) in an effort to better understand the typical modes of deformation. In contrast to tube inversion, published research work in other tube end forming processes during this period, was practically inexistent. At the end of the second period basic design rules were mainly derived from the accumulated experience of both manufacturers of tubular parts and suppliers of machine tools (Miller, 2003).

The third period (2000-until now) has been the most active in research and is being driven by

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