MANUFACTURING SEAMLESS RESERVOIRS BY TUBE FORMING

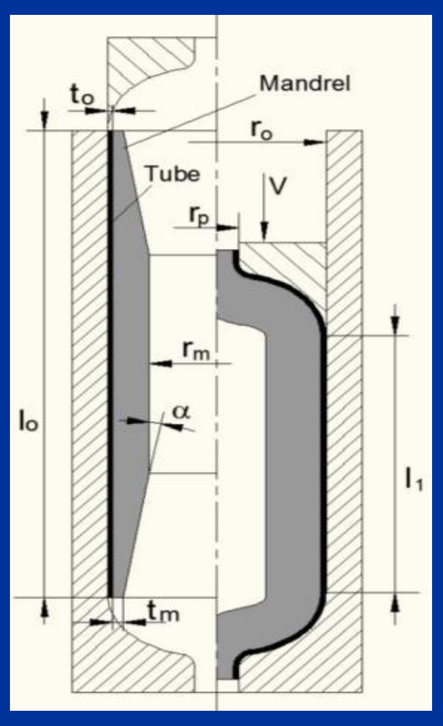
Luis M. M. Alves, Paulo A. F. Martins

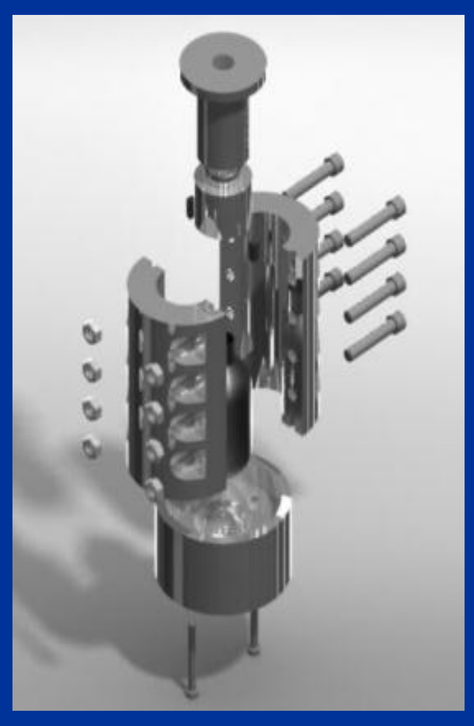
IDMEC – Instituto Superior Técnico, Technical University of Lisbon, Portugal

INTRODUCTION

- Innovative manufacturing process for producing seamless, low-cost, axisymmetric metallic reservoirs by tube forming.
- The process makes use of sharp edge dies and internal, recyclable, mandrels.
- The process avoids joint mismatching and geometrical imperfections from half-shells welding, allowing utilization of materials other than steel.
- Applications in anaesthetic and analgesic medical systems, supplemental and emergency oxygen needs for patients, scuba divers, high altitude mountain climbers and transportation systems, high pressure gas storage systems for automotive and aerospace vehicles and compressed air tanks for paintball and other leisure equipment, among others.

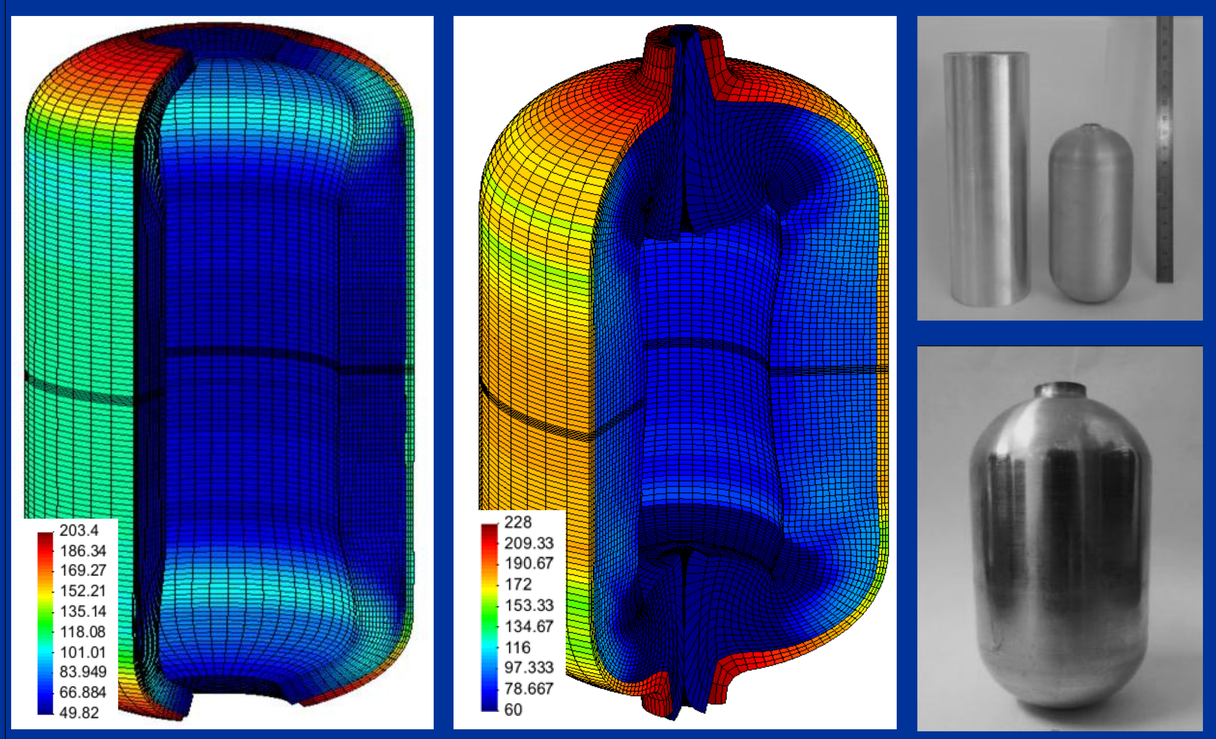
METHODS





- The forming operation is accomplished by axial pressing the open ends of tubular preforms with two hemispherical shaped dies until achieving the desired geometry. The sharp edges of the hemispherical dies are protected against collapse by means of a floating ring which acts as a shrink fit tool part.
- The mandrel provides internal support to the tubular preform during plastic deformation in order to avoid collapse by wrinkling and local instability at the equatorial region.
- The mandrel is made from a low melting point alloy that is capable of continuously adapting its shape to that of the formed tube and is easily removed by melting (and recyclable), while leaving the reservoir intact, at the end of the process.
- Project and design of the tool system was performed by finite element analysis.

RESULTS



Finite element predicted distribution of effective stress (MPa) after 45 mm and 90 mm displacement of the upper die.

- The proposed manufacturing process allows fabricating small size, seamless, reservoirs made from a variety of materials and available in many shapes and sizes.
- The process extends the tools and techniques commonly utilized in tube forming in order to include two innovative features related to the utilization of sharp edge dies and internal, recyclable, mandrels made from low melting point alloys.
- Thickness variation along the cross section of the reservoirs shows a significant growth as the circumferential perimeter decreases with values above 150% at the open poles.
- The increase in thickness at the poles is very useful for installing devices or fixing the end caps.
- The ultimate forming load for producing seamless reservoirs is small enough for enabling the process to be industrialized in a low-cost, small capacity, press.