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Comparing force and cup thickness variations in deep drawing of thick sheets in flat, conical and tractrix dies

M. Sedighi, M. Rasti

ABSTRACT

Deep drawing is one of the most important processes in manufacturing of CNG pressure vessel liner. Due to the high thickness of initial blank, liner manufactures can use different types of dies such as conical, tractrix and flat dies. In this paper, a sample of "type 3" aluminum liner has been selected and the deep drawing process has been simulated by using finite-element method. Three types of dies behavior have been compared for parameters such as the required drawing force and cup wall thickness variations. Available experimental data was used to verify the numerical results. The results have shown that in a tractrix die, the required drawing force will decrease, and minimum wall thickness variations can be obtained.

KEYWORDS

Deep drawing, Flat die, Conical die, Tractrix die, Simulation, CNG Vessel.

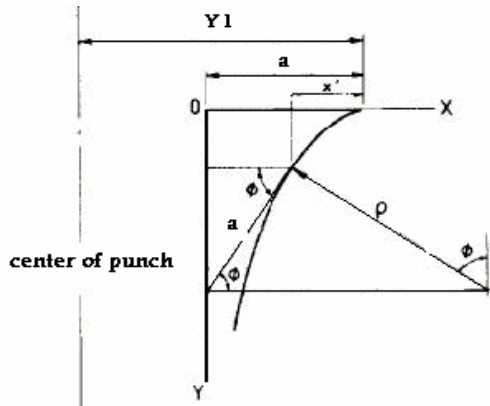
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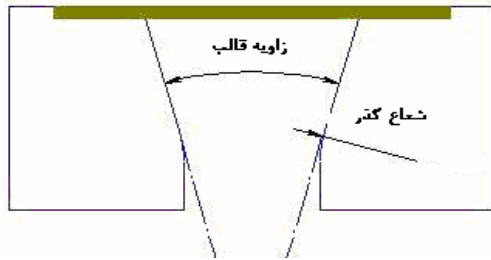
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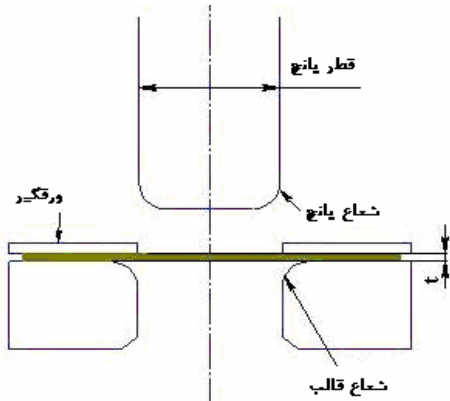
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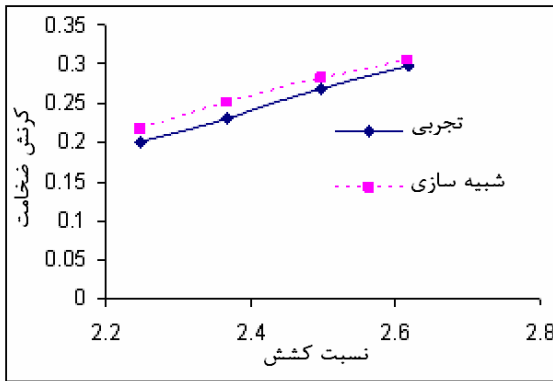
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$8 \leq \frac{d_p}{t_0} \leq 20$	$r_t = 0.66 d_p$
$36 \leq \frac{d_p}{t_0} \leq 95$	$r_t = 5t_0$
$20 < \frac{d_p}{t_0} < 36$	$5t_0 < r_t < 14t_0$

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$$\frac{dy}{dx} = \tan \phi = \frac{\sqrt{a^2 - x^2}}{x} \quad ()$$

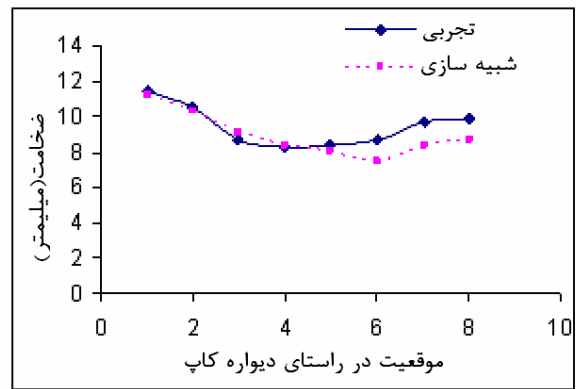
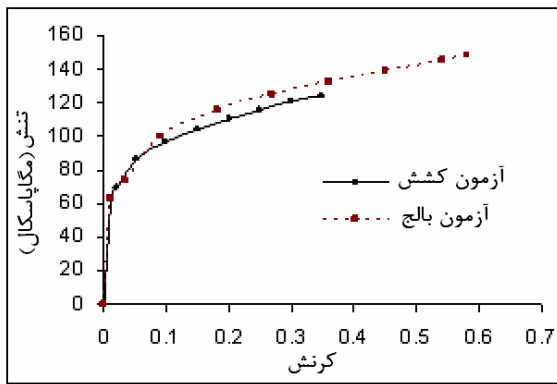
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$$y_D = -\sqrt{a^2 - x^2} + a \ln \left(\frac{a + \sqrt{a^2 + x^2}}{x} \right) \quad ()$$

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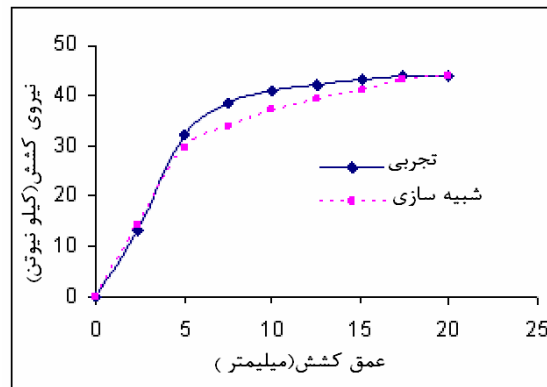


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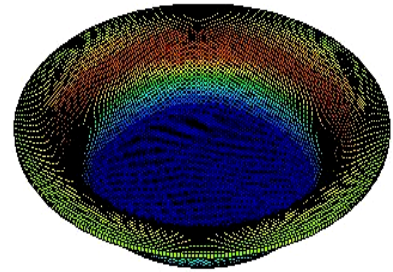
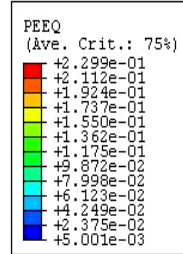
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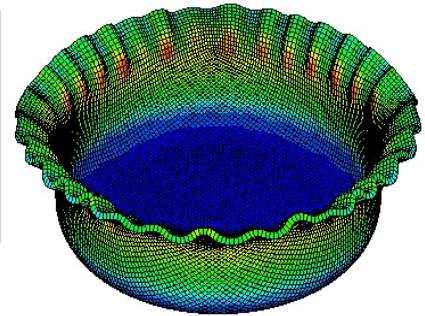
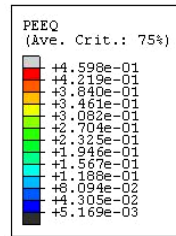
/	$258 \operatorname{Ln} \left(\frac{258 + \sqrt{66564 - x^2}}{x} \right) - \sqrt{66564 - x^2}$	
/	$240 \operatorname{Ln} \left(\frac{240 + \sqrt{57600 - x^2}}{x} \right) - \sqrt{57600 - x^2}$	
/	$231 \operatorname{Ln} \left(\frac{231 + \sqrt{53361 - x^2}}{x} \right) - \sqrt{53361 - x^2}$	
/	$222 \operatorname{Ln} \left(\frac{222 + \sqrt{49284 - x^2}}{x} \right) - \sqrt{49284 - x^2}$	

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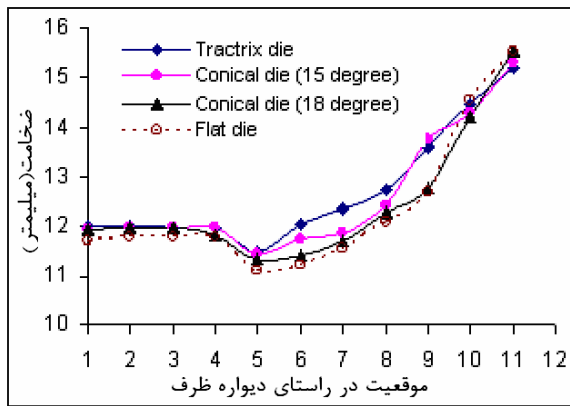
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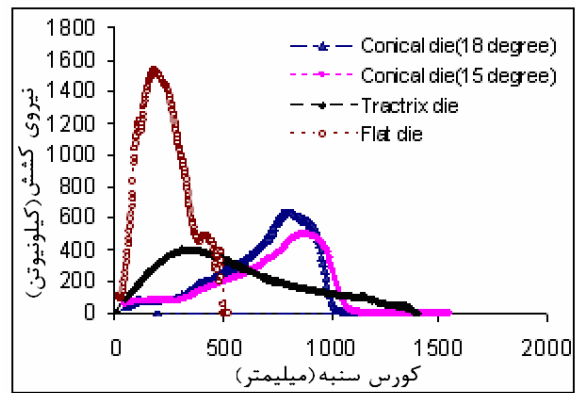
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- ¹ Ironing
 - ² Spinning
 - ³ Compress Natural Gas
 - ⁴ Tractrix Dies
 - ⁵ Dynamic Explicit
 - ⁶ Large deformation