LABEIN PUBLICATIONES TILL 2006

2004

Title: Conformado por deformación a alta velocidad: conformado electromagnético

Journal/Congress: XV Congreso de Máquina-Herramienta y Tecnologías de Fabricación: Donostia-San Sebastián, 20-22 octubre 2004. INVEMA Fundación de Investigación de la Máquina-Herramienta, AFM Asociación Española de Fabricantes de Máquinas-Herramienta

Authors: B. Gonzalez

Abstract:

El conformado electromagnético, basado en el principio de inducción magnética, se enmarca dentro de los procesos de conformado a alta velocidad. Puede ser utilizado tanto para la deformación y unión de chapa como de tubo. Algunas de las ventajas más destacables frente a la embutición tradicional son: mejora de la formabilidad, reducción de arrugas, reducción de la recuperación elástica (Springback), alta repetibilidad de piezas, así como la reproducción de pequeños micro detalles. La técnica de conformado electromagnético se encuentra actualmente en estado de investigación pre-competitiva. Algunos usos excepcionales que se llevan a cabo en el ámbito industrial son para la unión de componentes, pertenecientes en su mayoría al sector militar o aeroespacial

Title: Improved Crimp-Joining of Aluminum Tubes onto Mandrels with Undulating Surfaces

Journal/Congress: ICHSF: 1er Congreso Internacional de Conformado a Alta Velocidad: Dortmund, 30 de Marzo-1 de Abril

Authors: Inaki Eguia, Peihui Zhang, Glenn S. Daehn

Abstract:

Over its history electromagnetic forming (EMF) has probably seen far and away more application in assemblies tubes or rings on to (or in to) nominally axisymmetric mating elements. The vast majority of these assemblies do not require any significant structural integrity or strength. However, a small fraction of these are designed and fabricated for mechanically-demanding applications. There are two key factors (which seem to be largely independent) that are key in the design and performance of a crimped-electromagnetic tube joint. First is the state of residual stress that exists after the crimped joint is created. A natural interference fit seems to be a fairly general feature of EMF crimp joints. This interference gives a backlash-free joint that will not fret. The second key issue is the configuration of the joint. The fabrication of designed interlocking geometries are required to create a joint that maximizes mechanical strength while minimizing the electromagnetic energy and forces required to create it. Both of these issues will be considered here. Here we consider crimping on to 'textured' surfaces such as screw threads and knurls. We show experimentally that approaches of this type can give joints that exceed the strength of the tube both in torsion and axial loading. Analysis methods based on coupling impact-indentation and break-before-strip criteria can be used to compare joints made in this way with those based on the more traditional large scale deformation of the tube. One of the advantages of forming onto 'textured' surfaces is that a number of small pulses (possibly generated by small and inexpensive capacitor banks) can be used to create joint that has the strength of the parent tube, without any heat affected zones or distortion. Again, the natural interference fit developed by impact eliminates the potential for fretting.

2005

Title: Experimental study of springback elimination using electromagnetic forming

Journal/Congress: IDDRG 2005 International Deep Drawing Research Group

Authors: Edurne Iriondo, Beatriz González, Iñaki Eguia, Marian Gutiérrez and Glenn S. Daehn

Abstract:

Electromagnetic forming is a high-velocity forming technique where high values of dynamic pressures are distributed to conductive materials by pure electromagnetic interaction. this technology is specially suited for conductive materials like aluminium. However, scarce efforts have been made concerning High Strength Steels (HSS). Since one of the most critical non desired effects when HSS and aluminium are used is the elastic recovery or springback of the components formed, this paper intends to give an insight into how the springback effect can be addressed when the EMF technique is used as a corrective process. An experimental study has been carried out using the EM impulses as a corrective step after the parts have been bended by traditional metal forming. The selected preformed specimen shape is L-shape and the materials are the

HSS DP600, in 0.8 and 1.95 mm thickness, and Aluminium Alloy 5754, in 1 and 2 mm thickness. This study examines the role of the parameters, like conductivity and thickness of material, that take first order importance on electromagnetic forming. This is an innovative approach for correcting springback and as proved by our experimental results, it is effective.

Title: Electromagnetic and high velocity forming: opportunities for reduced cost and extended capability in sheet metal forming
Journal/Congress: Manufacturing Engineering, núm. August
Authors: Glenn Daehn, Edurne Iriondo, Manish Kamal, Mala Seth, Jianhui Shang
Abstract:

While it is presently uncommon, there are many reasons to consider utilizing impulse, impact and inertia in metal forming. Many persistent problems with control of dimensions, strain distributions and materials properties are treated. Hopefully this paper has shown that with some imagination and willingness to try new techniques, manufacturers can develop and utilize robust techniques that avoid many of the common problems in metal forming.

2006

Title: Efficiency improvement and analysis of changes in microstructure associated to a uniform pressure actuator
Journal/Congress: ICHSF: 2nd International Conference on High Speed Forming: Dortmund, 20-21 March
Authors: P.Jimbert, A. Arroyo, I.Eguia, J.I.Fernandez, E.Silveira, I.Garuz, G.S.Daehn
Abstract:

During the 1st international Conference in HIGH SPEED FORMING held in Dortmund in 2004, a new forming coil giving significant advantages was presented, in the framework of ongoing R&D programs at OSU (The Ohio State University). It established the improvement provided by the return path for currents induced in the workpiece..

To quantify the mentioned improvement, Labein has performed classical cone forming experiments with both configurations and analyzed energetic efficiency using well known alloys, more precisely AA 6016 and 1050. Both deformation mechanisms and contour analysis of the specimens where studied. General purpose Multi-Turn coils

provide pressure distributions not extended to the whole forming area, resulting in zones undergoing significant delay as to the deformation sequence is referred.

As a result, varied deformation patterns can be found along the contour of a cone specimen formed in such way. Firstly, macroscopic survey of the specimens shows that uniform pressure distributes deformation over the entire formed area during the deformation process. Secondly, the effect on efficiency provided by this new coil concept is focused not only on the ability for distributing deformation, but on the energy required to create such deformation.

Finally, to validate the whole simulation, the predicted strain level, shape and internal energy of the work piece are compared with the experimental specimens. A key point in the validation process is checking the internal energy. It is known that the ratio of stored energy to deformation energy ranges in the order of 30 %. The procedure for the experiments follows this methodology.

Title: Electromagnetic springback reshaping
Journal/Congress: ICHSF: 2nd International Conference on High Speed Forming: Dortmund, 20-21 March
Authors: E. Iriondo, B. Gonzalez, M. Gutierrez, V. Vonhout, G. Daehn, B. Hayes
Abstract:

Electromagnetic forming is an impulse-based forming technique where high dynamic pressure is distributed to conductive materials by pure electromagnetic interaction. The aim of this paper is to present how springback can be controlled when the EMF technique is used as a second corrective step; bringing formed parts to the desired final shape by means of magnetic impulses in critical areas of the formed components. This analysis is based on the results of two experimental studies. In the first, the selected preformed specimen shape is the L-shape bent part of HSS DP600, in 0.8 and 1.95 mm thickness, and Aluminium Alloy 5754, in 1 and 2 mm thickness. The second geometries are two rocket nozzle panels made of a thick but soft copper alloy. While the geometry and the material are the similar, the first approach of this work was developed using smaller panels (about 30 cm along) and the full size (about 1 m long), in order to study the behaviour of the material and the approximate energy levels required to scale up the full size panels. Overall this study shows EM forming can have a potent effect in controlling springaback.

Title: Conformado electromagnético y conformado electrohidráulico: influencia de procesos de deformación a alta velocidad en la embutición de piezas de forma cónica

Journal/Congress: XVI Edición del Congreso Máquina-Herramienta: San Sebastián, del 19 al 21 de Octubre, 2006

Authors: Iñaki Eguía, José Ignacio Fernández, Beatriz González, Pello Jimbert

Abstract:

Si bien los denominados Procesos de Conformado a Alta Velocidad (High Velocity Forming, Pulsed Power Forming) se caracterizan por exhibir velocidades procesales de orden superior a las presentes en operaciones convencionales de conformado en prensa, el conjunto de procesos que las forman (Conformado Electromagnético, Conformado Electrohidráulico y Conformado por Explosivos) poseen mecanismos propios que las convierten en particulares.

Con el propósito de poner de relieve las principales diferencias entre dos de ellas, Labein Tecnalia ha llevado a cabo el siguiente estudio con un enfoque principalmente experimental.

En lugar de centrar el estudio en el análisis de la evolución característica de dichos procesos, se deducen los aspectos más relevantes de los mismos mediante el estudio del estado que presentan las geometrías objetivo conformadas. La geometría o pieza de estudio elegida posee forma cónica, siendo una forma exigente desde el punto de vista de la conformabilidad, poniendo a prueba ambos procesos. De las serie de muestras obtenidas, se han establecido relaciones entre las características de la pieza final obtenida en términos de distribución de deformaciones, variación del espesor a lo largo de las generatrices del cono, del estado final de la micro estructura, etc. y el proceso de alta velocidad con el que se ha conformado.

Title: Deformación de chapas de aluminio AA1050 y AA6016 a alta velocidad mediante conformado

Journal/Congress: X Congreso Nacional de Propiedades Mecánicas de los Sólidos: Santiago de Compostela, 5-8 septiembre, 2006 electromagnético y electrohidráulico

Authors: Iñaki Eguía, Iñaki Fernández, Edurne Iriondo, Pello Jimbert

Abstract:

El objetivo del presente trabajo ha sido analizar las diferencias existentes entre dos técnicas de Conformado de Alta Velocidad: el Conformado Electromagnético (CEM) y el Conformado Electrohidráulico (CEH), así como sus mecanismos de deformación y su influencia en las propiedades finales de piezas de estudio clásicas. Mientras que en el CEM la deformación es generada por una repulsión magnética, en el CEH es una onda de choque en el interior de un fluido la que genera la presión necesaria.

Las aleaciones de aluminio utilizadas son AA1050-O y AA6016-T4. Se han realizado experimentos de deformación contra una matriz en forma de cono, para determinar las máximas energías suministradas hasta llegar a la fractura. Para establecer una comparación entre CEM y CEH, no resulta adecuado hacerlo en términos de parámetros de máquina y de útiles, por las diferencias inherentes entre ambas técnicas. Por ello, el análisis de resultados se ha basado en la comparación de la geometría final obtenida y de las energías de deformación en cada procedimiento y material. Podemos destacar que para el AA6016 no se obtuvo ningún cono sin rotura mediante CEH, debido a su escasa ductilidad y a la profundidad de la deformada requerida.

Title: Influence of High Speed Forming Technologies in the Forming of Conical Specimens: Fluid -Specimen Interaction against Magnetically Induced Repulsion

Journal/Congress: International Deep Drawing Research Group IDDRG Conference, Porto, Portugal, 19-21 June

Authors: Iñaki Eguía, Edurne Iriondo, Pello Jimbert

Abstract:

Over the past few years High Speed Forming (HSF) production methods are being re-studied especially for sheet metal workpieces. The use of this technology instead of the more conventional ones lies in important benefits that can be obtained in final parts' characteristics and behaviour in service: increased formability, reduced wrinkling, toughness on the specimen can be increased while high repeatability is maintained.

LABEIN-Tecnalia has been making extensive research in Electromagnetic Forming (EMF) during past years. The interest on HSF processes followed with the addition of experimental equipment destined to produce parts by electrohydraulic forming (EHF). Different interface conditions exist while deformation occurs in each case. Magnetic interaction will launch the specimen towards the die, while a fluid shock wave drives the process in the latter case. Since contact conditions differ, it is expected that this will have an influence on various aspects of the specimen: Activated deformation mechanisms, resulting from dissimilar deformation rate; Adjustment to die wall, due to material restraining capacity of water.

In this paper the work done to establish the differences between those two HSF methods in the mentioned aspects is presented. Finally, the thickness and deformation distribution along the cone will be measured and the main differences

established. A microscopic study of the failure mode and the damage degree will be performed if mayor differences arise between the two methods.

Title: Corrección de la recuperación elástica en chapas estampadas mediante impulsos electromagnéticos

Journal/Congress:: XVI Congreso de Máquina-Herramienta y Tecnologías de Fabricación: San Sebastián, 11 de octubre, 2006. INVEMA

Authors: Edurne Iriondo, Beatriz González, Marian Gutiérrez, José Luis Alcaraz, Glenn S. Daehn

Abstract:

El presente artículo muestra cómo la recuperación elástica que sufren las piezas de chapa estampadas puede ser corregida mediante la aplicación de impulsos electromagnéticos (EM). El procedimiento consiste en aplicar una deformación adicional en la dirección del espesor del material, de forma que las tensiones residuales se relajan y se controla la recuperación. Esta técnica correctiva e innovadora ofrece gran flexibilidad y eficiencia, al permitir aplicar los impulsos en el área limitada por las tensiones residuales, sin afectar al resto de la pieza.

Se presentan los resultados de dos trabajos experimentales, en los que se analiza el comportamiento de la recuperación frente a impulsos EM y se seleccionan las energías óptimas para su corrección. El primer proceso se desarrolla aplicando impulsos a piezas predobladas en L de AA5754 y DP600, y el segundo a paneles de tobera para cohetes de aleación de cobre y se comparan los resultados obtenidos con otro estudio previo de corrección por calentamiento.

Todas las piezas sufrían de recuperación y su consecuente desviación geométrica y el procedimiento para su eliminación consistió en la introducción de las mismas en una matriz con la geometría objetivo, aplicándoles impulsos con diferentes energías. Como resultado se ha obtenido la corrección total de la recuperación en las piezas predobladas y una aproximación mejor a la geometría objetivo de los segmentos de las toberas que la resultante por calentamiento.