DEFORM® Application #130

Radiant Tube Stamping

Background

Nicro SpA has over 30 years of experience in the production of special equipment and fixtures for heat treatment furnaces. Specialized in development and construction of high Nickel content steel alloy components, Nicro offers solutions for complex industrial projects involving high temperatures and corrosive environments.

Recent trends toward reduced energy consumption, environmental sustainability, increased furnace operating temperatures and greater production volumes spurred Nicro to produce a new type of radiant heating tube. The new products, made of 3-4 mm thick sheet metal, are becoming increasingly popular as replacements for old cast tubes.

A study was made into the cold stamping of a four-way radiant tube product, known as a “double P”. The nickel-chromium-iron tube material, Alloy 601, was selected for its suitability in extreme environments.

Production costs in the three-stage forming process were high due to its time-consuming setup, complex per-station tooling, long material lead times and batch-inventory storage requirement. The scrap rate was 4% due to the formation of sheet metal cracking during the second drawing operation. This also contributed to die wear issues.

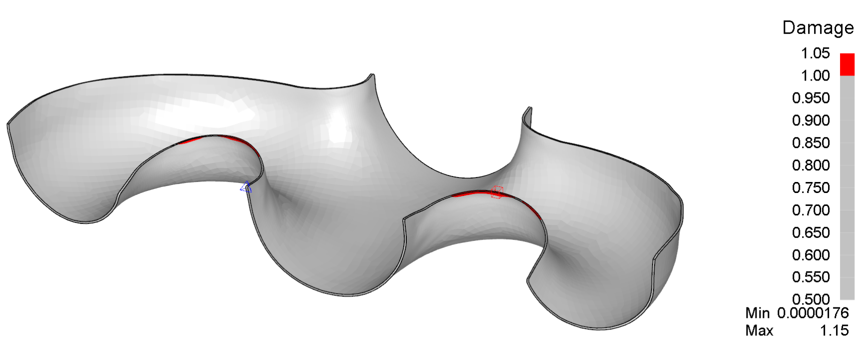
Modeling the Existing Production Cycle

Nicro partnered with ECOTRE Valente Srl, the exclusive DEFORM distributor in Italy, and the University of Brescia to evaluate and resolve the production problems.

ECOTRE first analyzed the existing production cycle using DEFORM-3D, which allowed the team to study the risk of fracture in the sheet metal. This was accomplished using the integrated forming limit diagram (FLD) damage model. Forming limit diagrams are routinely used for investigating failure in sheet metal components.

DEFORM-3D automatically calculates and tracks accumulated damage within the metal sheet throughout the entire deformation sequence. A significant risk of fracture is indicated when the damage value, in a local region of the part, exceeds the forming limit curve on the FLD.

The images shown here compare the cracked experimental part (above) to the simulation result (below). In the simulation, the area highlighted in red exceeded the forming limit curve. This indicator of a high fracture risk matched the location of the known defect.



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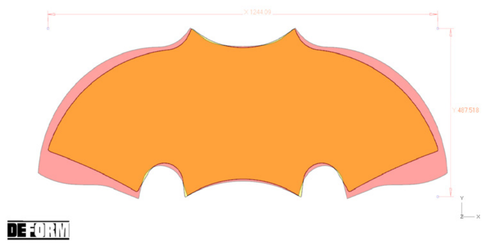
Design Environment for FORMing

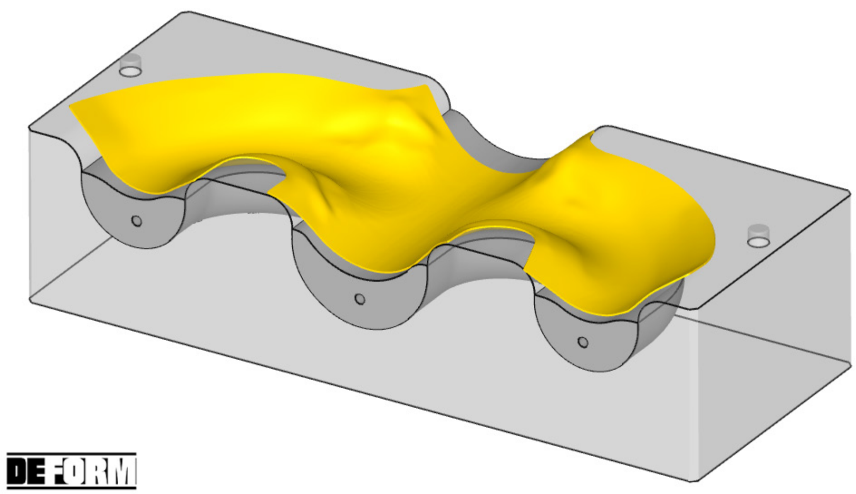
Development of a New Production Cycle

The team investigated modifications to the input stock shape and the die geometries. The proposed configurations were analyzed with the intent of eliminating cracking and reducing the number of cold forming operations.

Three sheet geometries were tested, with the third providing a suitable damage value. A comparison between the original sheet shape and the optimized one is shown. If the elimination of cracks had been the only concern, then the number of stamping operations could have been reduced from three to one.



However, it was determined that a preform operation was required to avoid wrinkle formation. The preform die was designed to easily sit in the bottom die during the first operation (below). The preform tool reduced the die stroke in the operation, preventing wrinkles and fracture in the sheet metal. It also eliminated the need for cumbersome and expensive batch processing. The preform tool simply was simply moved in and out of the cavity, as necessary.



Conclusion

This study illustrated how DEFORM-3D predicted the influence of process parameters and geometric features on final product quality. The redevelopment project achieved the following objectives that led to reduced production costs.

- Cracking was eliminated and wrinkles were avoided in the final product.
- The robust design allowed for less stringent material requirements on the Alloy 601 sheet stock.
- Use of standard sheet stock increased flexibility in production scheduling and reduced costs, since the standard material was often on hand.
- The number of stamping operations was reduced from three to two, which shortened the production cycle time.
- Continuous processing eliminated the need for in-process inventory.
- Machine tooling and setup time were reduced.
- Overall delivery time was improved.

DEFORM-3D is a valuable tool for providing critical process feedback to engineers and tooling designer early in the development cycle. It is an equally powerful tool for performing root cause analysis on existing production problems. With root cause identified, potential solutions may be iteratively evaluated in a shorter time than is possible with physical trials.

Acknowledgement:

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