ADAPTIVE ENERGY SUCCESS STORY

Ensuring Weld Strength in Honeycomb Structures for Jet Engine Casings

Deploying a multi-axis, mini-focus X-ray system to verify the capillary braze welding in mission-critical airplane components by inspecting meniscus formation

The Challenge

Honeycomb structures—structures that have the geometry of honeycomb with multiple hollow cells arrayed together—are widely used in the aerospace industry because they have a high strength to weight ratio. The Customer, an aircraft manufacturer, uses honeycomb materials for the engine cowling of its jet planes. The cowling is the metal casing and the round intake opening that surrounds the engine itself. As the structure that protects and supports the engines, it is critical that the cowling is exceptionally strong, flexible and durable, without flaws or weak points in the honeycomb core.

These honeycomb structures are formed from very thin, interlaced metal bands joined together and attached to the inside of a metal housing using a brazing technique. Brazing is the process that joins two parts of INCONEL® metal together using a thin sheet braze as a bonding agent. The bonding metal is heated and flows across the parts by capillary action, creating a strong joint. As the bonding metal cools during cure or reflow, it will naturally form a meniscus—a slight concave shape at the top exterior surface indicating that the bond has cured properly. If there are impurities or errors in the welding process that might compromise the structural strength of the honeycomb, inspecting the meniscus for uniformity will identify these flaws.

As part of the development of its next generation of aircraft, the Customer needed to be able to verify the strength and consistency of the honeycomb materials before using them in manufacturing. The company's quality engineers identified the need for an improved process for quality control of the honeycomb parts it manufactured.

The Adaptive Energy Solution

The Customer selected Adaptive Energy to develop an inspection solution due to its application know-how and experience working with many honeycomb panel manufacturers. Adaptive Energy worked with the Customer to tailor an X-ray system for ongoing inspection of honeycomb materials intended for production use.

Industry: Aerospace

Technology: Digital Radiography

Products & Services: Weld inspection

Customer Profile: A leading U.S. airplane manufacturer based in California

Business Challenge: The need for close inspection of the honeycomb structures that provide structural strength for jet engine casings in the company's next-generation airplane

Solution: A customized mini-focus X-ray inspection system for viewing all angles of the honeycomb structures to ensure that brazing has cured consistently

Benefits:

- Captures accurate images of the material from all necessary angles, providing thorough inspection of all critical structural points
- Ensures the strength and safety of the engine cowlings and allows proper air intake
- Protects the safety of passengers and crews on its planes
- Maintains the Customer's leading reputation in the industry

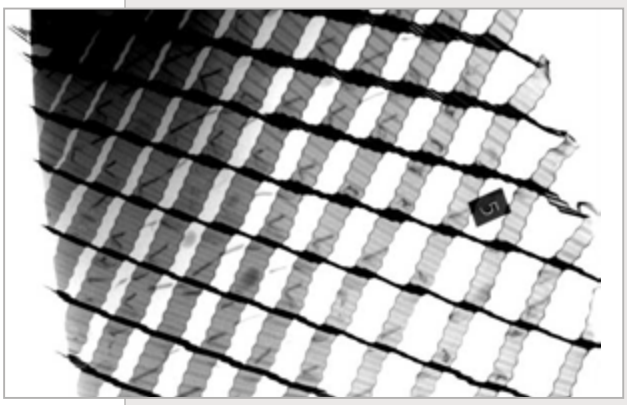
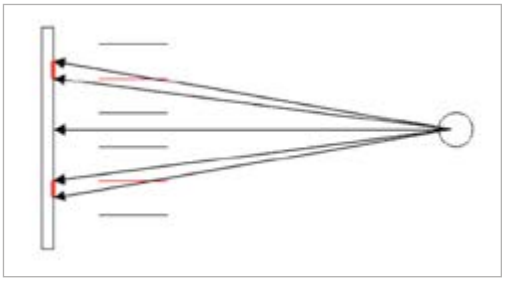


Image of honeycomb construction with accurate depiction of braze formation from all angles

Adaptive Energy has provided braze meniscus inspection solutions for metallic honeycomb construction. In simulations of either material, meniscus formation can be clearly detected in X-ray images, but only when the honeycomb structure is oriented at an angle that allows viewing of both of the bonding edges in question, and when there is no interference by other walls or structures. For effective inspection, the system must be able to capture a wide array of different visual indications, including totally open, partial and fully reflowed braze joints, as illustrated above.



Angular distortion caused by emergent beam angle from a single point source. The X-ray source is on the right, the honeycomb structure is represented in two dimensions by the series of short lines, and the X-ray image is captured on film at the far left. The red areas demonstrate how a single-point X-ray will show apparent thickness of thin lines, a distortion effect that increases from the center outward.

Since x-rays emanate from a point source within an x-ray tube, the geometry of the honeycomb panel and its overall construction must be taken into consideration. The honeycomb formation of the Customer's components were actually quadratic (not a hexagonal formation), meaning the run-lines are perpendicular and occur on two axes, X and Y. This presented an additional challenge to effective inspection, as illustrated above.

Since honeycomb can be as shallow as 0.250 inches, the effects of geometric distortion from single-point X-ray are relatively small, albeit significant enough to disallow area image formation and analysis over a reasonably large area.

The solution Adaptive Energy devised for the Customer uses a multi-axis X-ray assembly to correct for these various limitations of single-point imaging. The system allowed the Customer to capture precise images of all the critical angles of the honeycomb structures. In some cases, the reflowed braze material is seen on the surfaces of both skins as well as on the corrugated honeycomb structure.

Results

The Customer has been able to use the system on an ongoing basis for inspection of the honeycomb structures for its engine cowlings. Because the X-ray system and the associated software application were designed to be intuitive and user-friendly, the company's quality technicians can operate it with minimal training and simple maintenance.

The Customer—and the millions of passengers who fly on its airplanes every day—can rely on the structural integrity and durability of these cowlings to protect the jet engines inside.

About Adaptive Energy

Adaptive Energy creates customized, non-destructive material evaluation solutions to address mission-critical, time-sensitive testing needs. By combining the latest digital radiography, computed tomography, and ultrasonic imaging technologies with innovative mechanical and robotic assemblies, Adaptive Energy's integrated systems offer rapid deployment, are easy to learn and maintain, and perform reliably under pressure.

Working collaboratively with organizations in the aerospace, automotive, energy, petro-chemical, defense, infrastructure, and materials industries, our experts develop optimized solutions for flaw and crack detection, composite delamination, weld inspection, hardness testing, custom radiation enclosures and overhead gantry systems, and more.

Adaptive Energy is also the exclusive distributor in the U.S. and Canada of FORCE Technology's P-Scan ultrasonic scanners, including the P-Scan Stack with Phased Array, a next generation automated inspection system.

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