Welded Tube

Application Bulletin # 01.09

Magnetic Analysis Corporation www.mac-ndt.com info@mac-ndt.com

Testing Welded Tube

- ***80 plus years of experience***
- ***Superior test systems***
- ***Knowledgeable fieldstaff***
- ***In or off-line NDT equipment***
- ***Eddy current***
- ***Ultrasonic***
- ***Flux leakage***
- ***Custom systems***
- ***Material Handling***

Factors Influencing Test Methods

Factors that influence system selection include the capabilities and limitations of each technology, as well as the diameter, wall thickness, tube condition, and throughput speed of the product under test. Where the test is applied in the manufacturing cycle also influences the choice of method and apparatus. This can range from tests limited to the heat affected zone on the weld mill with perhaps an in-line anneal, to full body inspection of cut lengths after drawing and annealing or other heat treating. Each test method has inherent capabilities and limitations that are different.

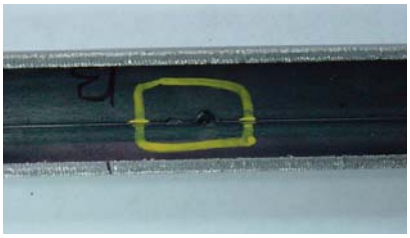
Common Defects Detected

Generally, for tube applications that require high throughput speeds, eddy current is the preferred method to detect small, short, incomplete welds, and some subsurface cracks in carbon steel or non ferrous tube. For full body tests, including the detection of long, continuous defects such as incomplete seam welds in tube, and inclusions, voids or cavities, ultrasonic test systems are recommended. Flux leakage systems are available to accurately detect longitudinal and transverse surface defects on the OD and ID of heavy-wall magnetic tubing.

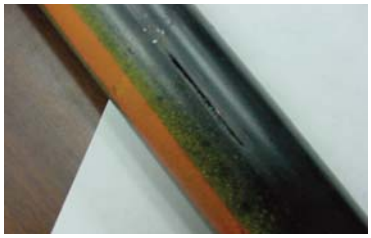
MAC Eddy current and ultrasonic test system for ERW

Weld Types

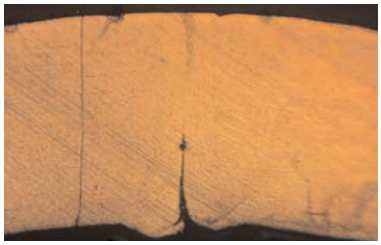
The process of ERW and Induction welding is preferred for most carbon and alloy steel. Defects that may arise include all of those previously mentioned. TIG welding is a slow process usually used for stainless steel or titanium. Incomplete ID weld defects are a common concern in this process. Laser welding is a much faster process used for stainless steel, titanium, duplex & nickel alloys. Typical defects include very short pinholes, and long continuous ID defects such as incomplete or miss-match welds.



The picture above shows a short pinhole flaw that was detected by eddy current, but was difficult to detect using ultrasonic tests.



Some weldline cracks, such as this one, may be detected by both eddy current and ultrasonic equipment.



This picture shows a cross section of a tube wall with a long, continuous poor ID weld that was detected by ultrasonic methods, but not by eddy current.

Eddy Current Instrumentation

MAC eddy current instrumentation includes the MultiMac®, MAC 400 and Minimac® equipments. Installations can be in-line, or off-line. Eddy current technology is most effective on tube with wall thickness up to 3/8" (9.5 mm) and diameters up to 8.85" (225 mm). Defects detected by eddy current test methods are short OD and ID, some subsurface, laps, open welds, and other weldline defects in magnetic and non-magnetic tube.

MULTIMAC®

The MULTIMAC® is a “top of the line”, Windows® based tester for use with encircling or sector/tangent test coils and/or rotary probes.

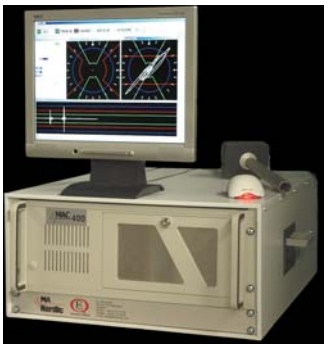
Features include up to 8 test channels and a broad test frequency selection from 1 KHz to 5MHz.

All test channels can operate simultaneously at the same or different frequencies. Tubing test speeds up to 1000 fpm can be handled. Installation can be on or off-line.

End suppression circuitry with an optional optical sensor can ignore signals from leading and trailing ends in cut length tube. User configurable reports including data on the test product, defect location, time, amplitude and phase can be stored locally or on a network server.

MultiMac® comes with a builtin monitor and pull-out keyboard. A 4 channel MultiMac® SM with a builtin touch screen monitor is available in a compact environmental cabinet or a 2 channel Multimac AC in CAB001.

MAC 400



The MAC 400 is a Windows® based tester that displays test results and settings in large onscreen windows. An optional touch screen is available.

Up to 4 independent test channels can be used for applications where multiple probes detect different defect types, or where multiple sensors are in a single segmented encircling coil, or for marking and sorting on up to 4 weld lines.

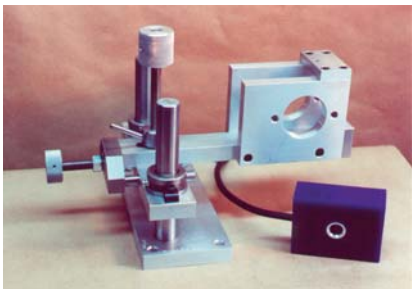
MINIMAC®

The Minimac® Mac 40 is a low cost, single channel, Windows® based tester.

It is designed primarily to operate on continuous product on a production line. The unit is controlled with a keyboard or optional keypad in conjunction with a separate monitor supplied by the customer or by MAC as an option.

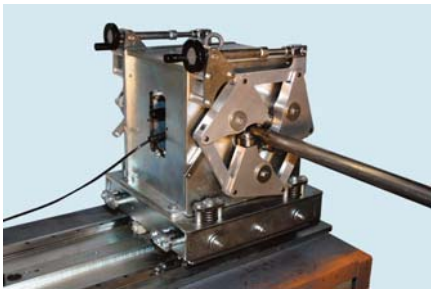
Coil Platforms

Test coils or sensors include encircling coils for material up to 9” (101.6 mm) diameter, and for higher sensitivity, segmented encircling coils may be used for tubes ranging from 2.5”-8.85” (65-225mm). Sector or tangent coils are available in a wide range of custom sizes.



CP10 with encircling coil for testing non-magnetic material

Standard encircling coils are designed to inspect non magnetic material such as smaller diameter copper and aluminum tube. For light wall stainless and carbon steel with minimal permeability variations, permanent magnet test coils can be used.



CP65 with encircling coil and DC saturation

For most carbon steel and certain grades of stainless, direct current saturation is required to reduce permeability variations that can interfere with the eddy current test. MAC encircling or sector DC saturation coil platforms, air or water cooled, provide the required saturation for the test.

CP90 features a tangent coil and guide rolls on either side to maintain proper position of the material

Tangent (sector) coils are used on some weld lines, where threading the material through a coil is difficult and only the weld zone area needs testing. They are also used on larger diameter heavier wall thickness tube where encircling coils are not practical.

Because they cover a limited test area of the tube under inspection, an improved signal-to-noise ratio may result. Sector coil platforms with or without DC saturation are available.

Ultrasonic Instrumentation (UT)

For more demanding test specifications, MAC provides ultrasonic test (UT) systems such as the ECHOMAC® for full body or weld zone (HAZ heat affected zone) inspection of welded tube. Generally, full body tests are conducted off the weld line on cut lengths.

FD-4 Electronics

The FD-4 is a computer based ultrasonic inspection instrument designed for in-line flaw detection, and thickness and ID/OD diameter measuring. Up to 32 channels can be installed in a single system and more channels may be used with additional units. The FD-4 is housed in an environmental cabinet.

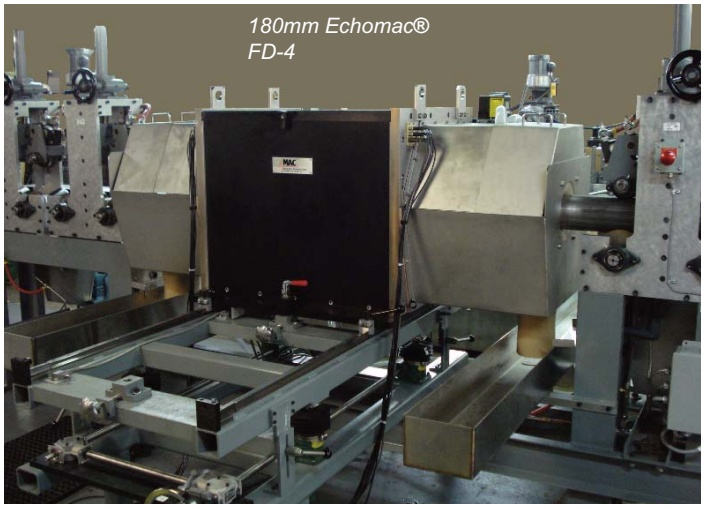
The FD-4 software allows the customer to configure individual channels to detect dimensional variations or flaws. The software package comes with multi-channel A-scan viewer/ recorder, test signal recorder, end suppression, tracking system, strip chart viewer, production logging, data compression, storage, color printing, and remote network interface.

ECHOMAC® Rotaries

MAC ECHOMAC® rotaries house the transducers and couplant and can handle material up to 220mm (8.66") diameter. For tests on some small diameter tube, generally up to 75mm (3"), MAC UT rotaries can be installed on the weld line where they can operate at production line speeds.

For larger diameters, MAC has worked with Reliant Technologies to provide mechanical handling, fixturing, data acquisition, and irrigated transducer shoes that position the transducers and maintain coupling with the test material. MAC also has developed systems using alternative coupling methods, including bubblers and squirters. MAC FD-4 electronics can also be used to upgrade customer's existing immersion tank systems.

The A Scan Screen - Displays detection of an OD surface notch using sheer waves that also detect defects. The stripchart display in the lower portion of the screen shows the peak amplitude of the signal within the gate.



180mm Echomac® FD-4

Typical defect capabilities include longitudinal and transverse, short or continuous, and better ability than eddy current test methods to detect ID stringers, inclusions, incomplete weld, hooks, cracks, and tapered defects. Typical throughput speeds depend on the length of the notch specified, the diameter, length, and wall thickness of the tube.

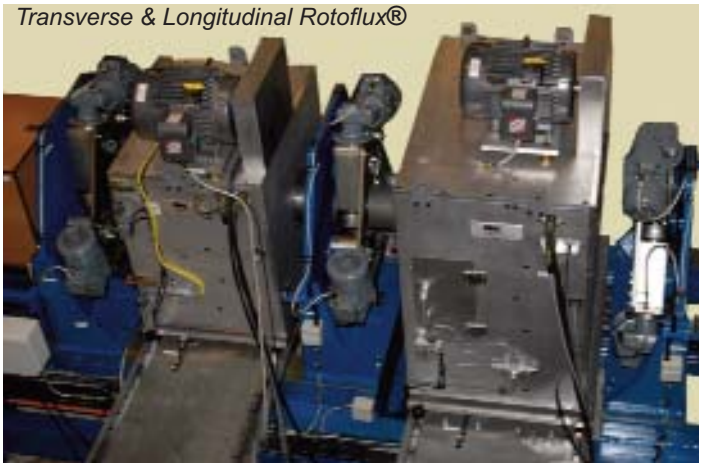
Flux Leakage Instrumentation

MAC's Rotoflux® flux leakage test systems accurately detect longitudinal and transverse OD and ID defects as small as 5% of the wall in annealed heavy wall magnetic tubular products including oil country tubular goods to meet API specifications. In line seam annealing makes physical properties more uniform and allows for precise test results. Recent MAC systems have featured 24 channels for longitudinal defect detection and 48 for transverse defect detection.

Rotoflux®

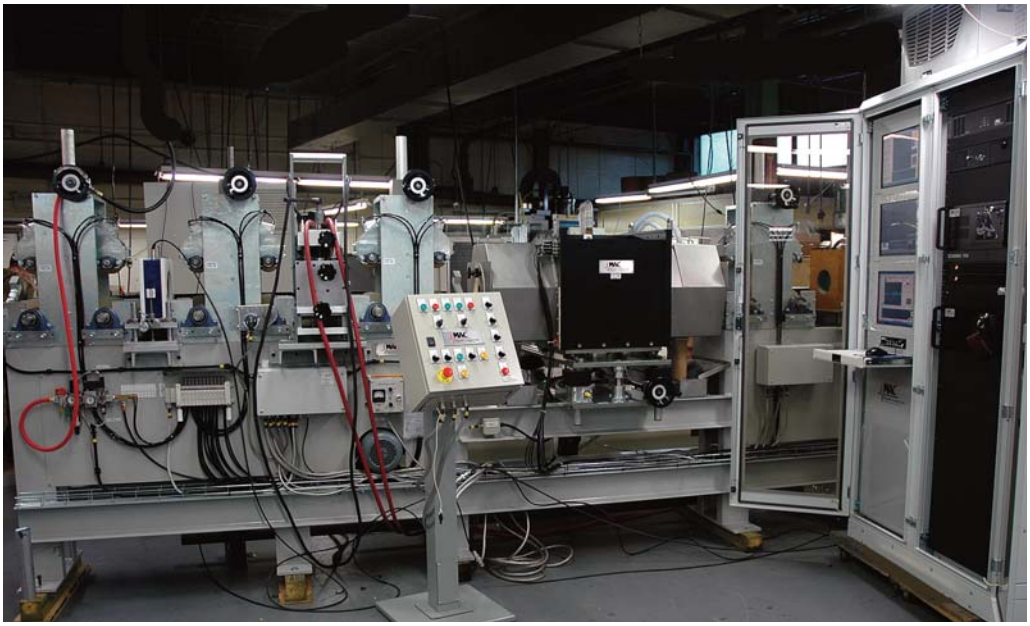
The transverse and longitudinal Rotoflux® tests pipes from 2.5" (63.5mm) to 16" (406.4mm) in diameter at greater throughput speeds and lower running costs than many NDT systems. The electronics are capable of differentiating between ID and OD defects, using a unique multiprobe feature which allows for convenient operation. A flux measurement circuit is included to indicate whether the test piece is properly saturated.

The detection of longitudinal notches can be as short as 0.5" (12.7mm) and through holes as small as 0.032" (0.8mm). Longitudinal test speeds range from 0-700 fpm (213m/m) and transverse speeds vary from 20-500 fpm (6-152m/m) Smaller diameters may be accommodated.



Transverse & Longitudinal Rotoflux®

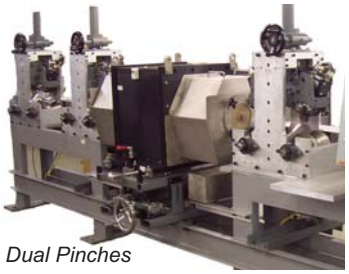
For many applications, the optimum solution is a combined system that utilizes both eddy current and ultrasonic test instruments to take advantage of the relative strengths of each technology.



The picture above depicts a multitest system for inspecting welded tube using an Eddy Current Rotary & Encircling Coils Test, an Ultrasonic Rotary Test, & Demagnetization.

MAC automated test systems for welded tube incorporate comprehensive computer controls, eddy current and/or ultrasonic test electronics and test sensors, pinch stands or guides, and accessory equipment such as demagnetizers, markers, conveyors etc. as needed. These components are mounted on V roll or Constant Center test benches.

A Conductor computer system supervises and executes communication with the bench. The system is Windows® based and comes with a rack mounted monitor. This is the operator console where setup and control is performed with the use of a keyboard and mouse. The Conductor software package controls the test bench, the end suppression, the dual pinches, sorting and marking. The Conductor also calculates all compensations required to adjust for speed and diameter variations.

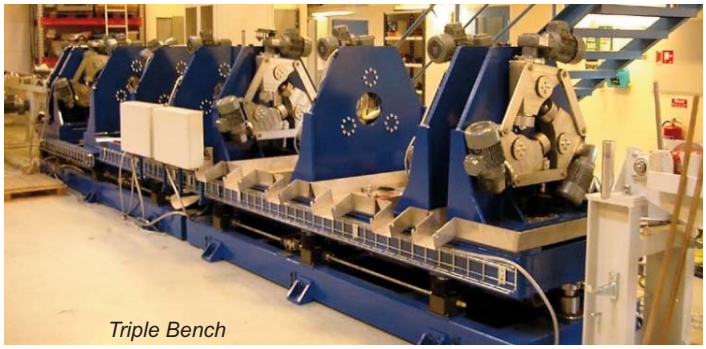


Dual Pinches

There are 2 types of benches, the V Roll and the Triple Bench. The V roll consists of dual pinch roll stands that are driven by AC frequency controlled motors. These pinches along with the testers and motors are mounted on an integrated weldment to ensure a secure framework for the system.

The MAC Triple Bench is a guiding and driving unit that centers the tubes through the test units. The bench features dual leading and trailing triple guides to guarantee a controlled entrance and exit from the test stations. Each triple pinch has a separate AC motor. A slide mechanism is provided to allow for the test heads to be moved off-line for setup and maintenance.

A water system is included with Ultrasonic inspection systems. It is comprised of a chiller for maintaining couplant temperature within an acceptable range, filters for removing contaminants and pumps and reservoirs for moving the water through the system.



Triple Bench

MAC

535 South 4th Avenue, Mount Vernon, NY 10550-4499
http://www.mac-ndt.com

Tel: 800-4NDT-MAC
e-mail: info@mac-ndt.com

Fax 914-699-9837
Tel: 914-699-9450