

THE ROTOFLUX FLUX LEAKAGE TESTER:

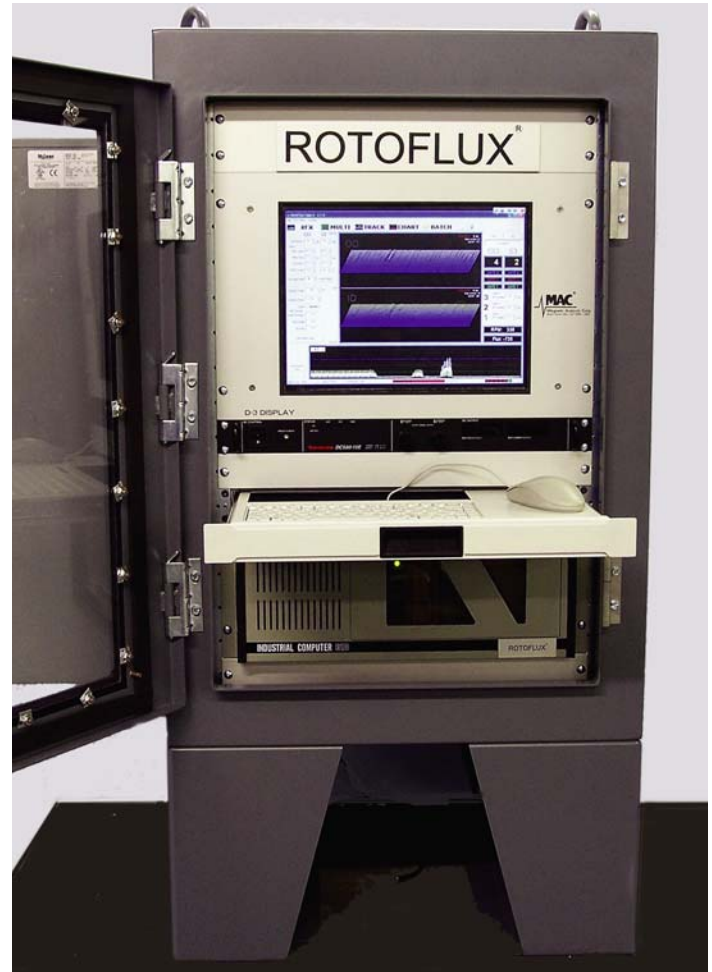
- The preferred technology to inspect for OD and ID defects in heavy wall magnetic tubular products
- Detect & differentiate between OD and ID defects
- Detect longitudinal and transverse defects as small as 5% on OD and 5% on ID, depending on material type and condition
- Multiplex probe system allows operation at greater speeds
- Built in static Flux Density measurement circuit, adjustable for wall thickness, assures correct field strength setting for accurate results
- Retractable probe assemblies handle upset and irregular shaped ends

DESCRIPTION

The latest design computer based Rotoflux® system brings flux leakage technology to the sophisticated level of MAC's eddy current and ultrasonic testers.

Flux leakage technology has long been one of the preferred methods for testing carbon steel heavy wall tube and pipe for OD and ID surface defects and defects within the wall. Now, MAC's new Rotoflux has the sensitivity and speed you need for the most demanding applications.

The new Rotoflux Rotary systems employ an enclosed ring electromagnet structure with very high magnetizing capabilities, allowing detection of longitudinal ID, OD or internal defects in relatively



Rotoflux® Electronics

heavy wall material at high throughput speeds.

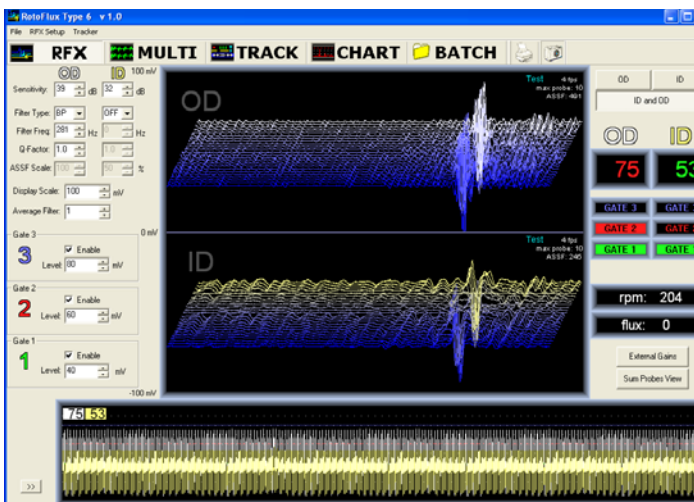
Electronics mounted in the rotary provide up to 24 separate channels from 24 test probes and allow each individual probe signal to be independently filtered, displayed, and processed. Different processors separate ID and OD channels. Color coding provides quick differentiation between ID and OD signals. The short, sensitive, probes can detect longitudinal notches as short as 0.5" (12.7mm) and through holes as small as .032" (.8 mm). In the optional, rotary transverse flaw system, with longitudinal magnetization, multiples of 12 element probe arrays are individually mounted to rotate to provide 100% surface coverage, based on the size, to detect transverse defects.

TECHNOLOGY

Active flux leakage technology utilizes a constant magnetizing source such as an electromagnet to bring the flux density in the test material close to saturation. The magnetization, driven by an adjustable DC Power Supply, creates intense flux flow within the material. When a defect interrupts and blocks some of the flux lines, they extend beyond the material, and this “leakage flux” can be detected by probes moving relative to the material (or material moving relative to fixed probes).

Test probes in MAC’s multiplex configuration detect both the low and high frequency flux patterns. Using selective filter circuits, the higher frequency signals, generally indicative of surface or near surface defects, show up on the OD portion of the screen while primarily lower frequency signals indicative of deep internal and ID defects are seen on the ID portion.

ROTOFLUX ELECTRONICS



The signal shown in the Test Screen above is from a natural ID crack on a 13” (330 mm) diameter cast iron pipe.

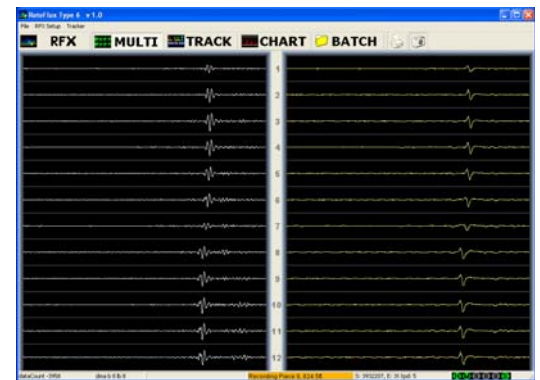
The new design Rotoflux multiplex electronics, includes 24 separate channels for longitudinal and up to 48 channels for transverse systems. Sensitivity, filters, and thresholds for each probe are set through on-screen menus, and related parameters are set with a mouse and keyboard. The software operates on a Windows® platform to store setups and results. Setup of flawtrack output delay, applicable to any of six outputs, and end suppression is also controlled by software. The flat screen presentation includes separate ID and OD displays of the signals from all channels.

The strip chart display shows the maximum ID and OD signals from any of the channels during an operator preset specified period of time, in milliseconds. Each channel can be viewed independently with zoom-in capability in



Rotoflux rotary headplate assembly with magnetizing coils on top and bottom. The probe assemblies which house the test probes are shown on either side. The rotary system is used to detect longitudinal defects such as seams, laps, and weld line defects.

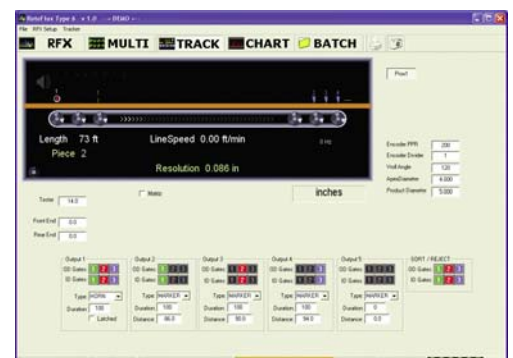
the Multi-Screen display. Thresholds for OD and ID channels can be adjusted independently.



Zoom-in view of twelve channels in the Multi-Screen display

A flux density measurement circuit, shown on a meter that can be calibrated, indicates the amount of flux density within the test material. Ensuring that a correct near-saturation flux density level has been achieved is critical in obtaining valid test results. Under or over saturation severely interferes with proper testing.

A separate Track Screen is used to change encoder and similar settings, without the need to make individual changes for each stored setup when adjustments in timing need to be made.



Track Screen for setting up encoder and other timing data for end suppression

DETECTING LONGITUDINAL DEFECTS

To detect longitudinal defects, the material under test is driven through a rotating headplate which includes magnetizing coils and test probes. Transverse magnetism is used to find longitudinal defects such as seams, laps, and weld line defects. A special mode of operation can be selected to suppress signals for acceptable welds in welded steel tube.

Using all the sensor probes, each rotation of the Rotoflux headplate will inspect approximately 1 foot (304.8 mm) of product length. For systems designed to inspect smaller diameters the headplate can be rotated up to 700 RPM, allowing test speeds in excess of two meters per second. Larger pipe sizes such as 16" (406.4 mm) diameter with greater wall thickness would generally rotate at speeds up to 400 RPM (122 m/m).

The Rotoflux headplate housing is usually mounted on a slide and elevate mechanism. This mechanism allows the housing to be positioned correctly with respect to the test material, or moved away from the drives for convenient access during calibration, servicing, or changing pole sizes.

DETECTING TRANSVERSE DEFECTS

To detect transverse defects, the magnetizing poles are placed in a fixed position perpendicular to the axis of the material under test. The material passes through this magnetic field and flux leakage signals generated by transverse defects are detected by rotating sensors.

By using this new transverse defect detection capability and the longitudinal detection capability, tube producers have the technology to comply with OCTG requirements.



*ROTOFLUX Type 1600
Rotary Head, Pinch Stands, Test & Calibration Stations, and Control Pedestal for a Longitudinal Flux Leakage Inspection system.*



An installation at a large European tube mill, shown above, features both longitudinal and transverse Rotoflux® flux leakage rotary inspections. Inspections with this type of system are being conducted routinely at a 5% or 10% notch level on common OCTG products in a size range of 50 - 180mm (1.97" - 7") diameter. Inspection complies with API 5CT - Rev 8 specifications.

The Longitudinal flux leakage unit includes rotating magnet poles and sensors. The Transverse unit places the magnet poles in a fixed position perpendicular to the axis of the tube.

**TABLE 1
ROTOFLUX ROTARY & DRIVE MECHANISMS**

TYPE NO.	SIZE RANGE OF TEST MATERIAL*	MAXIMUM WALL THICKNESS	TEST SPEED** (Longitudinal Tests)	TEST SPEED** (Transverse Tests)
750	3" - 7-1/2" (76.2 mm - 190 mm)	.625" (16 mm)	0 fpm - 700 fpm 0 m/m - 213 m/m	20 fpm - 500 fpm 6 m/m - 152 m/m
900	3" - 8-3/4" (76.2 mm - 222 mm)	.625 (16 mm)	0 fpm - 500 fpm 0 m/m - 152 m/m	20 fpm - 500 fpm 6 m/m - 152 m/m
1600	4" - 16" (101.6 mm - 406 mm)	.750" (19 mm)	0 - 400 fpm 0 - 122 m/m	20 fpm - 400 fpm 6 m/m - 122 m/m

* Smaller diameters down to 1-1/2" (38.1mm) may be tested with the addition of a small diameter package

** Exact Test Speed depends on the size and wall thickness of the tube to be tested

SPECIFICATIONS

OPERATING SYSTEM	Windows®	DISPLAY <i>(continued)</i>	TEST screen - presents a synchronized linear display of all probe signals for ID, OD or both. Time based strip chart displays maximum ID and OD probe signal amplitude from all probes, simultaneously. All three threshold lines are present in the strip chart display.
PLATFORM	Pentium IV 2.4 GHz or better single board computer with 40 GB hard disk or better.		Other screens include include: TRACK - for setting up end suppression and flaw tracking CHART - to view and print chart recorder BATCH - for defect report information MULTI-SCREEN - to view each channel independently with zoom-in capability
FUNCTION	Longitudinal Electronics: 24 channel multiplexed electronics with individual gain adjustments for uniform sensitivity Transverse Electronics: four 12 channel probe assemblies for 48 channel multiplexed electronics.		
STORED SETUPS	Unlimited setups can be stored	REPORT	Defect reporting is managed in the BATCH screen. The report contains user and product information, as well as defect location, time of the occurrence, amplitude, and phase.
FLAW BANDWIDTH	1KHz for longitudinal 500Hz for transverse	DATA STORAGE	The linear strip charts are saved and can be viewed and/or printed in the CHART screen.
SENSITIVITY	0 - 70 dB, Calibrated in 1-dB steps for overall system. -10 to +30 dB steps for each probe channel. Auto speed gain adjustment built in for transverse system.	CONTROLS	Software controls for all functions.
FILTER:	Band Pass, OUT and BP-Auto are available. Fixed filter positions will be chosen from discrete steps that will correspond to Hertz (flaw frequency). The auto filter is operated from RPM meter, and material diameter for longitudinal systems and from linear tube speed for the transverse system. The bandwidth of the BP filter can be selected through a "Q" factor dictating the ratio of high to low pass filters.	RTM (Running Time Meter)	Software controlled. Read from TRACK screen.
THRESHOLD	Three levels of Chord thresholds are available for each of the probe channels. Only active thresholds will be displayed on the screen.	OPERATOR INTERFACE	External or rackmount keyboard and mouse.
OUTPUTS	Six software controlled output modules are available on the back panel. One module is dedicated to Sort and all can be assigned to any combination of thresholds. The other five outputs can also be configured for Horn or Marker with Enable and Latch controls. Each Marker can be independently delayed.	DC POWER SUPPLY	80 V, 15 AMP DC supply for the electromagnets.
DISPLAY	A rack mounted 15" active matrix flat panel display is standard. Remote monitor is optional.	COUNTERS	Piece and threshold count.
		CABINET DIMENSION & WEIGHT	24" wide x 48" high x 27" deep environmental cabinet (60.9 cm x 121.9 cm x 68.6 cm) 250 lbs. (113.4 Kg) approx. (includes air conditioner unit)
		POWER REQUIREMENTS	<i>Electronics:</i> 120 VAC, 50/60 Hz, single phase, 30 amps (230 VAC, 50/60 Hz, 20 amps available if specified at time of order) <i>Rotary:</i> 230/380/460 VAC 50/60 Hz, 3 phase, 30 amps phase, 30 amps

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