



RFET – Tube Inspection

Remote Field Electromagnet Technology
适用于管道内部检测的电磁检测技术

Theory of the RFET probes

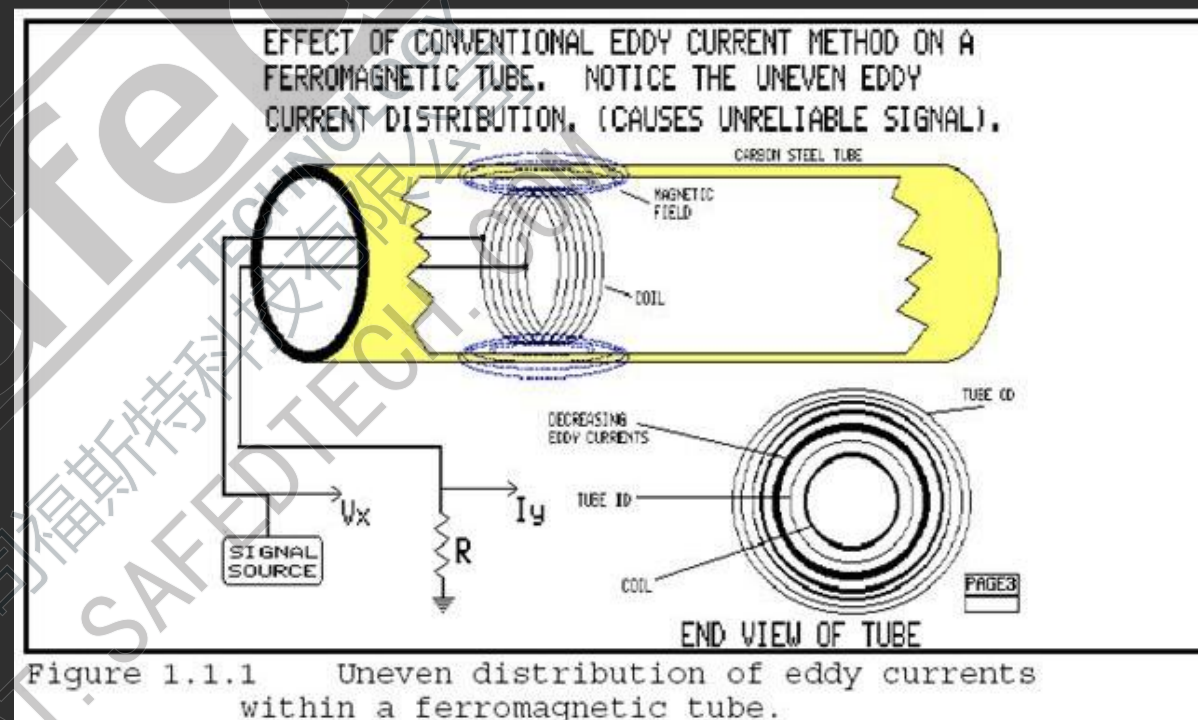
RFET 扫查头技术原理

Two cylindrical coils are placed in a conductive cylindrical tube as shown in Figure. One of the coils, known as the driver-coil or transmit-coil, is excited with a low frequency AC signal. The other coil, known as the pickup-coil, will then receive a signal that is the vector sum of:

- (a) A direct-coupled signal from the driver-coil.
- (b) A very weak remote-field (RFET) signal from the tube wall.

两个圆柱形线圈放置在导电圆柱形管中，如图所示。其中一个线圈（称为驱动线圈或发射线圈）由低频交流信号激励。另一个线圈（称为拾波线圈）将接收一个信号，该信号是以下矢量和：

- (a) 来自驱动器线圈的直接耦合信号。
- (b) 来自管壁的非常弱的远场 (RFET) 信号。



RFET probes

RFET 扫查头



RFET 优势

- ✓ Minimal tube preparation, requires no couplant, 最少的表面准备处理, 无需耦合剂
- ✓ Uses no magnets 不使用磁铁
- ✓ I.D. or O.D. scale have no signal impact 内径或外径尺寸对信号没有影响
- ✓ Standard probe sizes from 0.320" (8mm) to 6" (150mm) 标准探头尺寸为 0.320" (8mm) 至 6" (150mm)
- ✓ Tests approximately 300 tubes per shift 每轮班可检测约 300 支管
- ✓ Fill factor is not critical (can be as low as 40%) 填充系数可以低至 40%
- ✓ Full circumferential coverage over entire length 整个长度上的全周向覆盖
- ✓ Wide frequency range allows ferrous or non-ferrous testing 宽频率范围允许检测黑色金属或有色金属
- ✓ 高分辨率3D彩色图形 High Resolution 3-D color graphics



RFET probes

RFET 扫查头

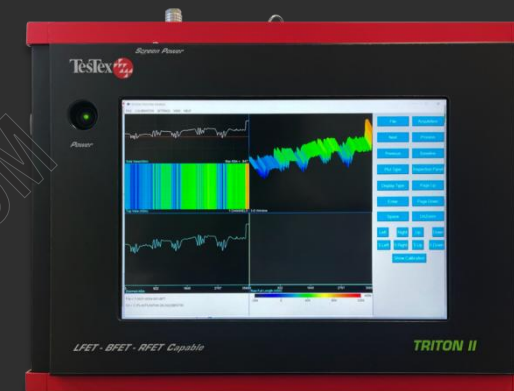


■ 显示控制一体机 Triton II

重量 Weight	4.9 kg
尺寸 Size	353 mm × 274 mm × 122 mm
通道数 Channels	1~8 通道
供电电源 Power	110/220VAC (可调节)
50/60Hz	
操作系统 OS	Windows 10

■ 扫描器 Scanner

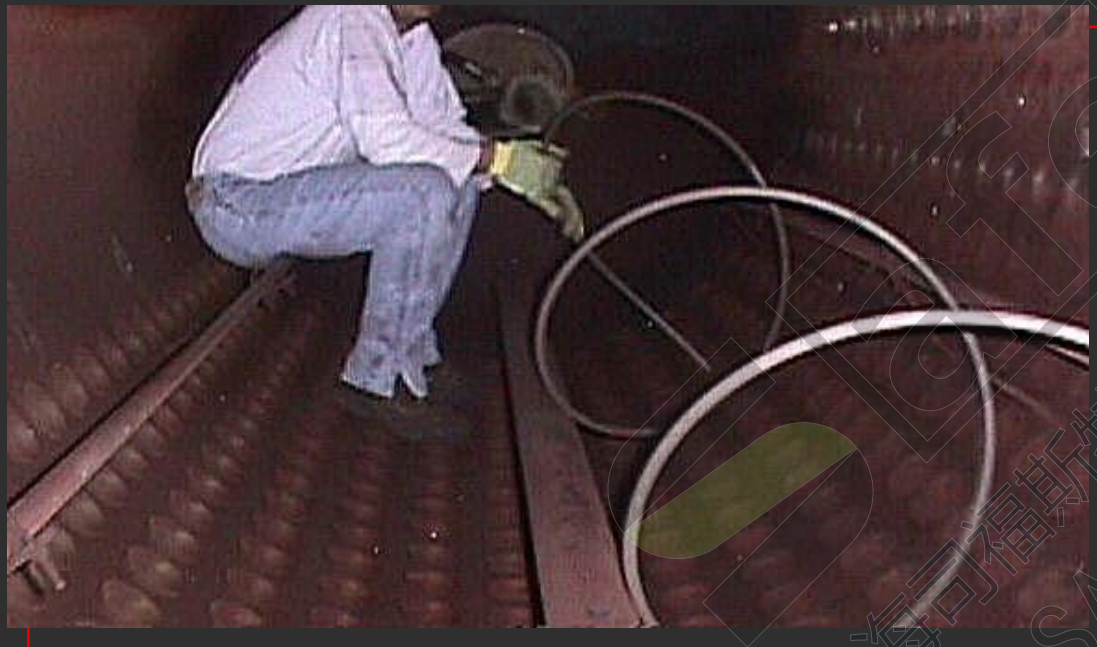
重量 Weight	0.14 - 0.7 kg (根据应用变化)
尺寸 Size	$\phi \geq 6 \text{ mm}$
填充率 Fill Factor	$\geq 40\%$
长度 Length	U to 30 m
探头/通道数 Channels Sensors	由 1-16 个探头提供 1-8 通道



Full Length Boiler Tube Inspection



锅炉管道全长检测



▲ Probe insertion/retraction from a boiler steam drum
探头从锅炉汽包插入/缩回

Boiler inspections are performed on drum to drum type boilers as well as straight tube boilers. These tests are full length examinations from the tube I.D. giving a quantitative evaluation of each tube. Applications include power boilers, recovery boilers, waste heat boilers, fire tube boilers, dowtherm boilers, and related boiler components such as tubular air heaters, etc. With the flaw characterization process, defects such as areas of wall thinning, pitting, cracking, erosion/corrosion, soot blower thinning, flue gas thinning, etc. are exposed and evaluated.

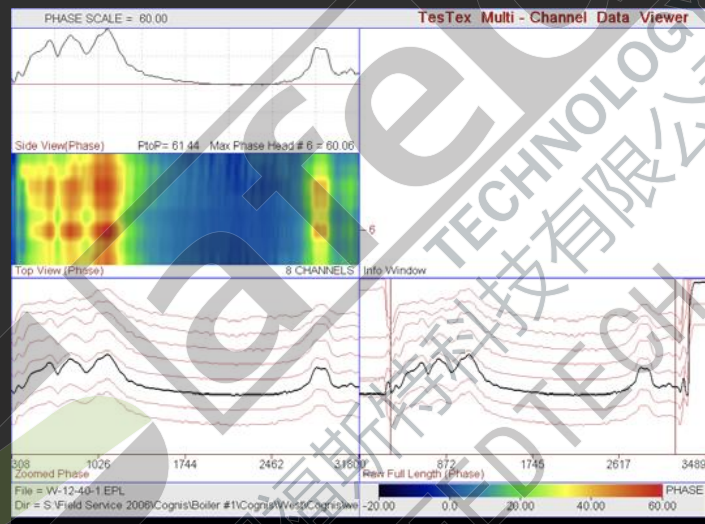
锅炉检查针对锅筒到锅筒式锅炉以及直管式锅炉进行。这些测试是从管内径开始的全长检查。对每个管子进行定量评估。应用范围包括动力锅炉、回收锅炉、余热锅炉、火管锅炉、道热锅炉以及相关锅炉组件（例如管式空气加热器等）。通过缺陷表征过程，可以识别壁薄化、点蚀、裂纹、侵蚀等区域的缺陷 / 腐蚀、吹灰器细化、烟气细化等进行暴露和评价。

Full Length Boiler Tube Inspection

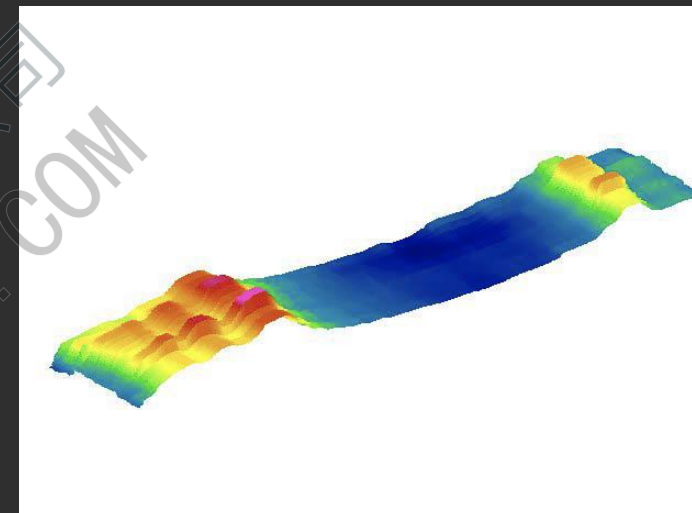
锅炉管道全长检测



Single channel drum to drum boiler data showing 35% to 40% wall loss
单通道汽包到汽包锅炉数据显示壁损为 35% 至 40%



Multichannel drum to drum boiler data showing 65% to 70% wall loss near the mud drum bend
多通道汽包到汽包锅炉数据显示，泥浆汽包弯曲部附近的壁损失为 65% 至 70%



3D representation of the above waveform showing the 65% to 70% wall loss near the mud drum bend
上述波形的 3D 表示显示泥浆汽包弯曲处附近有 65% 至 70% 的壁损

Heat Exchanger Tube Inspection



换热器管道检测



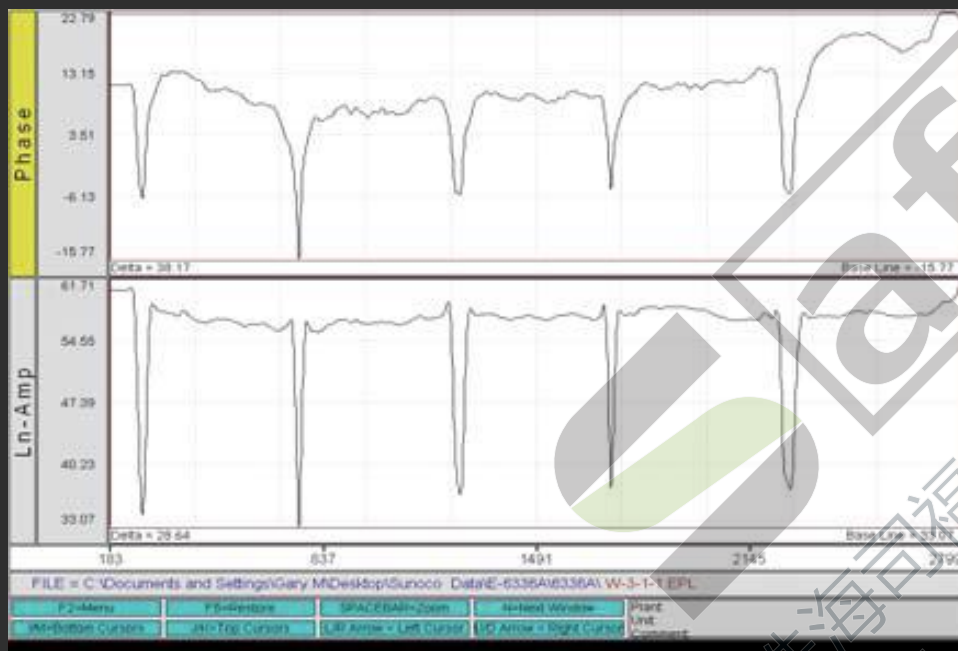
Heat Exchanger inspections are performed on straight shell and tube exchangers, U-bend bundles, and finned tube exchangers. Applications include feedwater heaters, air coolers/fin fans, chillers/coolers, air heaters/ pre heaters, MSR's, reformers/ultraformers, condensers, reactors, reboilers, etc. Types of defects located in these units are wall thinning, pitting, cracking, vibration/fret wear, erosion/corrosion, steam cutting, etc.

热交换器检查是在直壳管式换热器、U 形弯管束和翅片管换热器上进行的。应用包括给水加热器、空气冷却器/翅片风机、冷却器/冷却器、空气加热器/预热器、MSR、重整器/超成型器、冷凝器、反应器、再沸器等。这些装置中的缺陷类型包括壁薄化、点蚀、裂纹、振动/磨损、侵蚀/腐蚀、蒸汽切割等。

Heat Exchanger Tube Inspection

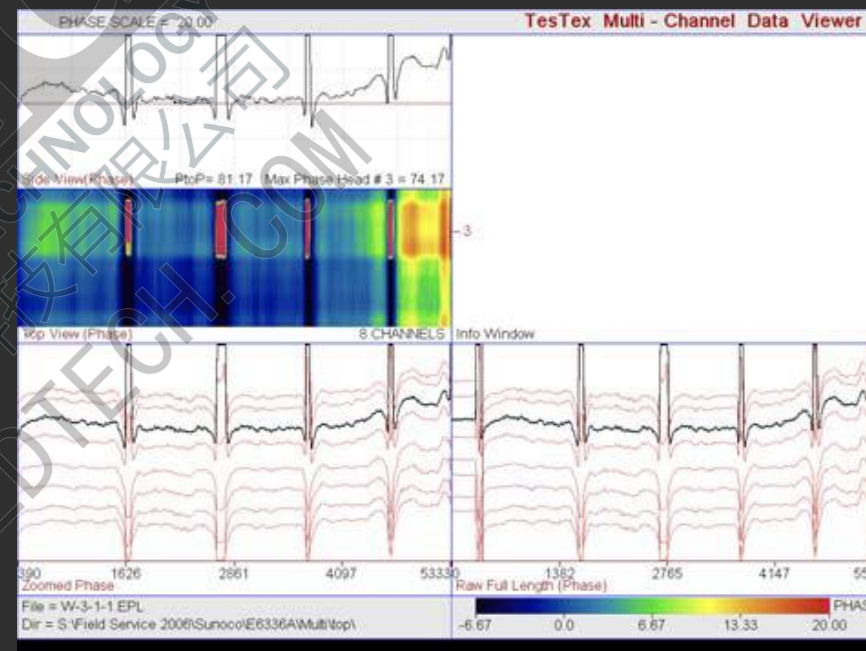


换热器管道检测



Single channel heat exchanger data showing wall thinning near the tube sheet

单通道换热器数据显示管板附近的壁变薄



Multichannel view of the same waveform showing wall thinning near the tube sheet

同一波形的多通道视图显示管板附近的壁变薄