TECHNICAL SPECIFICATION

SDI-5954

In-Line Small Diameter Bar and Tube Inspection System

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In-line Bar and Tube
Inspection System

1. INTRODUCTION

The SDI-5954 ultrasonic system is designed for the in-line inspection of precision tube and bar stock. It employs continuous helical feed of cylindrical material through an immersion tank. A variety of transducer arrangements and part following mechanisms allow a wide range of tests and material sizes to be accommodated. This rotating tube approach has considerable advantages over other techniques. In particular:

- Out-of-straight material can be tested.
- A wide range of material diameters can be tested on the same equipment.
- System reconfiguration is simple and rapid; especially if some of the SDI automated options are incorporated.
- Transducer stations can be easily added to extend the range of tests performed.
- Conventional transducers and ultrasonic components are used for ease of maintenance.
- System mechanics are simple, reliable and easy to maintain.

The SDI-5954 system combines the reliability of proven rugged precision mechanics with the through-put benefits obtainable from advanced automation and control. All mechanical and electrical components designed to require minimum maintenance under harsh operational conditions.

Options range from conventional manual setup systems (where the part transport devices, transducers and flaw detectors are manually configured) to fully automated systems with rapid computer controlled reconfiguration of most test parameters.

The SDI-5954 system will inspect bars or tubes with diameters ranging from 0.2 to 1.0 inches. The number of modular transport stations used determines the length tested. A minimum length of 3ft is required to accommodate the inspection station length.

2. SYSTEM MECHANICS

The SDI-5950 system is configured for a particular range of applications from a number of standard modules. The principal modules are:

Test Station
Material Transport Devices
Control
Instrumentation

The modular design allows rapid reconfiguration of the system to accommodate different types, lengths and diameters of bar or tube. The detailed description of the modules is given below.

2.1. Test Station

The test station is the main operating station of the system and contains the test tank and system controls. The test tank houses the transducers and material supports required to maintain correct alignment between the transducer and material during the test. The exact arrangement of transducers and part followers is determined by the requirements of the test. In the majority of systems, the instrumentation and system controls are also housed at the test station, as this is where the operator will usually be located.

The test station frame is fabricated from welded steel and finished with epoxy paint. The overall length is 76in. and the depth 36in. The transport roller centerline height is 39in. The stainless steel test tank (stuffing box) length is 30in. Height and width are 18in.

The test station is also equipped with two independent drive modules at the input and output of the stuffing box. These modules consist of a pneumatically actuated friction drive wheel powered by a low voltage dc servo drive. The actuator and motor speed are controlled and sequenced by the system controller. The drives will function in either direction with continuously variable speed. The maximum speed is 200 surface ft per minute.

There is a wide range of attachments for the test station. These test station devices comprise transducer positioners and material supports.

2.2. Material Transport Stations

The material transport stations are four different modules for handling the material as it progresses through the test system: (1) Drive Station, (2) Idler Station, (3) Loading Station and (4) Off Loader Station. All transport stations are manufactured from heavy duty welded and bolted steel construction. Adjustable leveling feet are used on each station to allow precise alignment. The rollers used are manufactured from high-density polyurethane or neoprene as determined by the application. The frames are finished with epoxy paint. The overall length is 76in. and the depth 36in. The transport roller centerline height is 39in.

2.2.1. Drive Station

This station contains two or more independent drive modules as described above. Drive roller idlers have adjustable skew angle to vary the helix pitch. This design reduces drive mechanics and the likelihood of drive component damage.

2.2.2. Idler Station

Where additional transport length is required and existing rotation power is adequate, idler stations can be used. The idler stations have adjustable support rollers and optional overhead load rollers. They can also be fitted with pneumatically operated overhead load rollers and restrainers.

2.2.3. Loading Station

Product is loaded onto a feed ramp, which can be built to any size. A pneumatically operated part selector separates a single tube or bar and positions it on the feed rollers. The tube then rotates and moves to the test station at a speed determined by the roller lead angle.

2.2.4. Off loader Station

Air actuated off-loaders are available with various numbers of lifting arms to suit particular applications. The tested parts are off-loaded with pneumatically operated actuators. Defective parts can be directed to a reject stack. Automatic defect marking can be provided.

3. ELECTRICAL DETAILS

3.1. Drive

The system drive is provided a number of independent drive modules each with a servo motor with resolver feedback. The drive speed is continuously variable and can be set by the operator or the system controller.

3.2. Controller

The degree of automated control provided with the system is determined by the customer requirements. In simple systems, control is usually under direct operator supervision with some automation of defect marking. In more complex systems, fully automatic programmable operation is provided. Operator control in programmable systems is provided through a touch screen display. The integrated SDI-1840 system controller is configured in three functional modules. The event controller, the test controller and the system controller.

3.2.1. Event Controller

This module receives input from various sensors on the system and instrumentation and determines a sequence of events based on these inputs. Such actions include the raising and lowering of the drive wheels and speed adjustment.

Typical parameters monitored are rotational speed and linear velocity of the material. Part diameter can be entered manually or automatically measured.

There are a range of programmable controller responses, examples of these are 1) delayed response, for the action of downstream devices, such as paint markers or sorting stations, and 2) defect indication suppression. This is required at or near the end of a tube or pipe.

3.2.2. Test Controller

The test controller programs the ultrasonic parameters for the selected test. Previous setups can be stored and recalled automatically. The functions controlled include:

- Instrument setup; gain, gate position and gate threshold.
- Instrument response monitoring - either the alarm condition,

the signal amplitude or the time of flight.

- Multi-channel sequencing to prevent cross talk by sequencing pulsing, gate position and gate width on each pulse.
- Transducer manipulation where motorized transducer positioners are used the positions of each transducer for each material, type and size can be stored as part of the test parameter setup.

3.2.3. System Controller

The system controller controls the drive speed together with the sequenced actions of the load station, off load station and sorter.

It also provides direct operator jog control allowing the system to be reversed to investigate defect indications.

4. SYSTEM INSTRUMENTATION

The instrumentation incorporated into the system is again dependent on the selected degree of automation. In a minimum configuration system the instrumentation will consist of a multi-channel flaw detector with gate logic outputs. In more advanced systems it will include such devices as encoders, tachometers, linear displacement transducers, and optical switches. Additionally, in multi-function systems eddy current equipment may be incorporated.

4.1. Ultrasonic Instrumentation

The ultrasonic instrumentation provided with the SDI-5954 consists a rack mounted Socomate USPC7100 unit with flaw amplitude gates and additional time-of-flight gates for wall thickness monitoring. This multi-channel configuration allows high repetition rate on each pulser/receiver module for high throughput speed. Details of the instrument are given in the instrument product brief.

5. AUXILIARY MODULES

A number of auxiliary modules are available for improving the inspection efficiency.

5.1. Defect Markers

Automatic defect markers are available for indelibly marking the product

downstream of the test station. Both paint jet and felt tip markers are available.

5.2. Defect Logging

A computer-based defect logging package is available for producing a tabular output of defect location and material length.

5.3. C-Scan Display

Amplitude and time of flight data can be displayed and stored in C-scan format.

5.4. Water Conditioning Unit

A recirculating pump and filter system ensures water quality is maintained under normal working conditions. Optional temperature control and de-airation units can be provided.

6. TEST RESULTS

Test result output is produced on a digital strip chart recorder for ease of interpretation. Optional digital defect logging modules are available for computerized archiving of test results. The SDI-1961 Posilog data acquisition package option will provide tabulated defect location in a report format.

6.1. TEST TECHNIQUES

Ultrasonic test configurations are tailored to suit specific requirements. To achieve maximum throughput, multi-channel interleaved scanning may be necessary. Up to eight channel configuration can be provided with transducers for longitudinal and circumferential shear in two directions and a single compression probe for thickness monitoring. The ultrasonic inspection is performed to meet the requirements of ASTM E213-14.