COMPLETE FLOW MEASUREMENT SYSTEMS FOR NATURAL GAS AND LIQUID HYDROCARBONS USING WIDEBEAM® CLAMP-ON ULTRASONIC TECHNOLOGY FOR LEAK DETECTION AND CUSTODY TRANSFER PLUS MANAGEMENT OF PIPELINE AND REFINERY OPERATIONS
Controlotron Clamp-On Transit-Time Pipeline Systems For:

- Pipeline Leak Detection.......................................“LD”
- Pipeline Custody Transfer ..........Liquid “S” & Gas “GCS”
- Natural Gas Checkmetering.....................................“GC”

Controlotron provides operators of Natural Gas, Petroleum and Chemical Pipelines complete Systems that:

- Reduce operating costs
- Protect against product loss
  - State-of-the-art leak detection
  - Unauthorized product diversion (theft)
- Provide accurate custody transfer flow measurement
- Improve pipeline operations management & product quality

Economical Installation On Existing Pipelines

Controlotron systems are ideal for existing pipelines and plants since they install non-intrusively, without cutting pipe or stopping operation. In addition to saving the cost of installing conventional Turbine or PD Meters, Controlotron Site Stations average only 1/3 to 1/2 their cost. Highly reliable WideBeam clamp-on flowmeters insure very low maintenance and do not need periodic recalibration. Easy to learn and use, Controlotron systems require no change in normal facility operation.

Advantages over SCADA & Pressure Based Modeling Leak Detection Systems

SCADA based leak detection systems depend on data from existing Turbine or PD Flowmeters, and pressure and temperature instruments originally installed by others. These instruments were not originally specified to provide the extraordinarily high accuracy and calibration stability needed for leak detection. Therefore, system performance cannot be assured by the SCADA system supplier. No single party can be held responsible for SCADA based leak detection system performance.

All elements of the LD system are provided by Controlotron to assure the specified leak detection accuracy. Controlotron takes responsibility for system installation, start-up, optimization and maintenance. In addition, the LD system’s compensated volume balance principle provides continuous leak detection, not the “one shot” leak detection provided by pressure based SCADA systems.

Turnkey Or Controlotron Supervised Installation

Controlotron provides the entire system and takes responsibility to get it operating. This includes all hardware and software for data measurement, communication, processing, display and alarm. Turnkey or supervised system installation and startup lets you see a working system before final acceptance. Controlotron system optimization assures you of best possible performance, and Controlotron aftercare keeps it that way. Hands-on user staff training lets you take over operation quickly and effectively.

Superior Performance

Controlotron’s Ultrasonic technology is intrinsically more linear and rangeable than conventional intrusive flowmeters since there is no friction, inertia or wear mechanism to affect its accuracy. Leak detection system sensitivity to 0.15% of nominal flow and custody transfer flow measurement performance to 0.15% are achievable in most applications. Clamp-on technology permits site survey of actual installation conditions for firm performance estimate prior to purchase, if desired. To assure the best performance possible, Controlotron provides system optimization. This is a process of evaluating data obtained in the field and upgrading system operating parameters to more closely represent actual field conditions.
Principle Of Operation

**Time Proved WideBeam Clamp-On Technology**

Leak Detection and Custody Transfer require extremely accurate, sensitive and rangeable flow measurement.

Controlotron’s clamp-on transit-time ultrasonic flowmeters use patented Wide Beam technology to induce an axial sonic wave in the pipe wall. As it travels down the pipe, a collimated beam of sonic energy “rains” across the liquid. This wide beam completely covers the receive transducer, assuring that it cannot be interrupted by bubbles, or lost due to a change in refraction angle if liquid properties vary.

Ultrasonic signals transmit alternately upstream and downstream. Flow makes the upstream transit take slightly longer than the downstream beam. The flow computer measures the time difference, which is proportional to flow, and computes the flow rate in user selected units. Since there is no energy taken from the stream, flow detection is extremely rangeable (0 to ±150 ft/sec) sensitive (0.001 ft/sec) and bi-directional.

To permit accurate operation, liquid properties, such as density and viscosity, are determined by the system. It utilizes the well-known relationship among these parameters, the measured liquid sonic propagation velocity and temperature to compute the LiquiDent™ Sonic Signature.

**Easy To Learn and Use**

The LD System watches your pipeline for leaks, but does not need to be continuously watched by pipeline operations staff. If there is a leak, alarms immediately alert the staff. The LD System’s MultiGraph and Numerical Data screens then quickly identify the pipeline segment affected, and the extent of the leak. On-screen HELP menus reinforce Controlotron user staff training programs.

Even while monitoring for leak indication, the LD System’s MultiGraph data screens can be accessed to provide operating staff with valuable information on pipeline operation, such as interface detection, batch tracking, product quality control and many other functions.

**Data Screens**

A number of data screens are provided, depending on the particular system configuration. Some of the more typical ones include:

- Site Station Data
- Path Flow Data
- Viscosity
- Segment Diagnostics
- Reynolds Number
- Application Condition
- Line Pack/Unpack
- Batch Track Data
- Sonic Velocity
- Site Signal Conditions
- User Option MultiGraph
- API Number

The following page provides a graphic representation and detailed explanation of the following screens:

- Main Alarm
- Segment Numerical Data
- Segment Volume Balance Trends
- Key Segment Parameters
Controlotron Systems for Leak Detection/Location, Custody Transfer & Operations Management

System Description
As shown on this system diagram, non-intrusive clamp-on transit-time flow and RTD temperature transducers are installed on the process pipe. They connect to a local Controlotron flow computer. These “Site Stations” measure and compute the following data up to 10 times per second:

- Volumetric Mass Flow Rate
- Liquid Temperature
- Ambient Temperature (as required)
- Liquid Sonic Propagation Velocity, (Sonic Signature)
- Site Diagnostic Conditions
  - Empty Pipe Alarm
  - Site Operational Condition
  - Signal Strength
  - Liquid Aeration Content
  - Flow Direction

Master Station Operation
The Windows based 1010LD master station receives all Site Station data simultaneously, once per minute. Site Stations communicate their digital data serially (RS-232), via Controlotron provided communication modules. The Master Station processes this data, and once per minute updates all outputs: alarms, graphic and numerical data screens, plus both analog and digital data outputs.

Flexible Data Communication
Data communication from Site to Master Station can be accomplished available by any of the following methods:

- Dedicated Phone Lines
- Radio
- Satellite Transmission
- Optical Cable
- Direct Wire
- SCADA Communication Networks
- ModBus/Ethernet

Site Station output data can utilize your SCADA system communication network. Processed master station digital data can also be networked into the SCADA System. Controlotron communication system consultation services are available if desired.

1010LD Leak Detection System Monitor Is Part Of The User's SCADA Console
Leak Detector Operation

*Measurement Based Mass Balance Method*

The 1010LD system uses the mass balance method. A patented thermal model computes and corrects for liquid expansion due to pipeline temperature or pressure changes. Liquident™ sonic signature identifies liquid density and viscosity for standard barrel or mass flow rate computation and Reynolds number based flow profile compensation. Liquident display screens visibly identify arrival of interfaces at site stations eliminating the need for inconvenient and expensive densitometer readings.

The 1010LD system does not require continuous operator attention. Mass unbalance of any pipeline segment exceeding preset alarm thresholds of any of four integration periods: (1, 5, 15 or 60 minutes), activates the alarm and calls for operator attention. User friendly graphic screens then quickly show which pipeline segment is the source of the alarm. Operators can instantly view any of 30 graphic and numeric data screens merely by touching a “Hot Key”. These help confirm the leak condition and its extent. The LD System does not pre-empt the operating staff’s responsibility to confirm a leak but it can be used for automatic pipeline shutdown if desired.

The LD System does not require continuous operator monitoring. However, the ability to sense very small leaks, (down to a few tenths of one percent), can be achieved by utilizing “visual trending”. This enables the operator to see small imbalances that may not be great enough to exceed the alarm threshold settings.

**Dynamic Appcon™ Adjustment To Avoid False Alarms**

The LD system senses pipeline application conditions, such as liquid aeration and empty pipe. If conditions deteriorate, the LD system’s AppCon™ dynamically de-sensitizes the effected area until conditions improve to help avoid false alarms. A ReaLeak™ scatter plot screen shows the operator a graphical correlation of reported leak data with current application condition data to help validate a leak alarm.

**Implements Pipeline Operation**

Even when no leak is suspected, pipeline operators get valuable information from the LD system’s data screens. Simply depress a Hot Key and see flow rate, batch size, relative location of batches within the pipeline, current scraper location, interface location, liquid API and Reynolds numbers, Site Station diagnostics, and a host of additional data. Numerical data can also be transferred into your SCADA System. All data is automatically archived. Both graphic and numerical data screens can be instantly printed in color, if desired.
**Screens with actual data from 1010LD System now operating in the field on multi-product, bidirectional pipelines illustrate the type of information provided.**

The 1010LD system Master Station data screens are accessed by either a mouse driven menu or hot key. This permits instant access to data from any Site Station or Pipeline Segment. Thirty graphic and numerical data screens enable pipeline operators to determine leak conditions and obtain valuable information on present and/or past pipeline operations.

### Main Alarm Screen
This is the screen normally displayed when the system is in background operations mode and is viewed when the operator hears or sees the leak alarm. All site stations, and all segments of all pipelines are shown graphically. When there is no leak, all site station and segment symbols are GREEN. Any site station in fault condition is shown in RED. Any segment in leak alarm is shown in FLASHING RED until acknowledged, and afterwards in RED until the leak is corrected. Flow rates for each site and alarm codes can also be viewed from this screen.

### Segment Numerical Data
Pipeline operators faced with a leak warning or alarm alert may instantly view the numerical data for the affected segment. Simply key the segment cursor shown on the system alarm screen to the desired segment and depress hot key F2. This screen shows the numerical value of the 1, 5, 15 and 60 minute integration periods volume unbalance. The period responsible for the Leak Alert will be seen in either YELLOW or RED.

### Segment Volume Balance Trends
This MultiGraph screen shows the volume balance trends of the selected segment from the past 1 hour to the past 72 hours, for all four integration periods. It shows the exact time that an alarm threshold was exceeded. Examination of these trends helps the operator confirm a leak condition, and avoid declaring a false leak alarm.

### Key Segment Parameters
The F6 hot key MultiGraph data screen simultaneously shows the selected segment’s flow rate, 1 minute delta, LiquiDent™ and Temperature for the last 1 to 72 hours. This screen is useful in identifying the pipeline conditions at the time that a Leak Alert was declared. In addition, the LiquiDent™ data serves as an interface detector, since it instantly shows the sonic signature of each product batch as it arrives at either of the segment’s site stations.
Custody Transfer Liquid & Gas Operation

Transit-Time flowmeter’s calibration stability is superior to conventional PD and Turbine meters. Its ability to sonically identify the liquid which it is currently measuring and the presence of free water or gas is invaluable for custody transfer.

System advantages include:
• Wider flow range, from 0 to over 40 feet per second flow velocity
• Bidirectional, eliminates need for flow reversal valves
• Extreme sensitivity over entire flow range, 0.001 ft/sec
• Reliable & Maintenance Free Non-Intrusive Flow Detection
  • Permits passage of pigs
  • No wear mechanism means no periodic shutdown for repair
  • Calibration does not change with use, as in PD & Turbines
• Automatic Product Analysis
  • Detects and Displays current API Number
  • Detects presence of Water and Aeration (Free Gas)
  • Detects and indicates product non-homogeneity

This system also provides other unique functions:
• Interface Detection
• Batch Tracking, with ETA
• Pig Detection

Measures Quantity, Type & Quality Of Transferred Liquids

The Custody Transfer Master Station Provides a complete time-stamped record of all product movement, simplifying operator control of product transfer operations. Both Graphic and Numeric Data Screens are provided, including:
• Standard Volume Total
• Actual Volumetric Total
• Mass Total
• Actual Volumetric Flow Rates
• Standard Volume Flow Rates
• Mass Flow Rates
• Liquid Type (API & LiquiDent™ Sonic Signature value)

Complete Time-Stamped Replayable, Archived Data Records

Graphic and Numeric Screens show current and past flow rates, type of liquid in each batch, estimated time of arrival at any site station, and other valuable information. All screens are accessible by hot key or menu for any segment of any pipeline registered on the Master Station.

Batch Tracking Display Showing Scraper (PIG) Position

Pipeline operators see batch interfaces and their location. Numerical data indicates batch size, start date and time, average API (or SG), volume sent, estimated time of arrival to end of pipe and distance from start, etc.

Liquid Quality Display Showing Propagation Of A Slug

This MultiGraph screen simultaneously shows flow rate, LiquiDent™, API number and viscosity. As shown, at 0630 on July 12th, a non-uniform liquid slug entered the pipeline. The second site station’s LiquiDent™ shows slug arrival, permitting extraction. The API number variations show non-uniform batch consistency. Each batch’s characteristic shape remains identifiable at both Site Stations of the Segment shown.
Pre-Purchase System Performance Prediction Determined By Site Survey

Performance of any measurement system depends on actual application conditions. Accurate performance prediction depends on knowing what these conditions are. Therefore, in some cases, Controlotron recommends a pre-purchase site survey of your pipeline, or plant, using a 1010 portable clamp-on flowmeter. A detailed report providing the cost/performance tradeoffs for the recommended types of systems will then be prepared for your consideration.

Performance Verifiable Prior To Acceptance

When site stations are first installed, Controlotron confirms prior performance estimates. Previously unseen application conditions are resolved by optimization. The steps in this process include:

1. Complete initial review of user system and performance requirements and application description.
2. Site survey of actual pipeline conditions with portable clamp-on flowmeters for pre-purchase performance estimate.
3. Proposal of alternative cost vs. performance system options.
4. Data on newly installed site stations can be analyzed within the first week of operation to confirm Controlotron system performance projections prior to acceptance and start-up of master station operations.

Also Available

- Dedicated System 1010 BN
  - Pipeline Interface Detector
- Portable System 1010WP
  - MultiFunction Transit-Time Flowmeter
- Dedicated System 1010N
  - NEMA 4X MultiFunction Transit-Time Flowmeter
- Dedicated System 1010DN
  - Dual Channel/Path NEMA 4X Transit-Time Flowmeter
- Dedicated System 1010MN
  - Four-Channel NEMA 4X Transit-Time Flowmeter
- Dedicated System 1010FT
  - Low Flow Chemical Flowmeter
- Dedicated System 1010GCS
  - Natural Gas Custody Transfer
- Field Installed System 1010GC
  - Precision Natural Gas Checkmeter

Pre-Calibrated Oil & Natural Gas Custody Transfer Spools Are Also Available.