ULTRASONIC INTELLIGENT SENSORS

ClampOn DSP Corrosion-Erosion Monitor

DIGITAL SIGNAL PROCESSING

CLAMPON®

ULTRASONIC INTELLIGENT SENSORS

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The ClampOn Corrosion-Erosion Monitoring system utilizes a unique way of monitoring a pipe for wall thickness loss. This instrument is based on the tried and tested ClampOn DSP sensor platform that is already widely used for subsea and topside particle and pig monitoring. The DSP (Digital Signal Processing) platform has been in use since the beginning of 2000, since when thousands of units have been brought into service by satisfied customers all over the world.

The ClampOn DSP Corrosion-Erosion Monitor (CEM) has undergone an intensive programme of laboratory development and field testing since early 1998 before being put on the market. The system monitors pipe-wall thickness loss over a large area, covering a section up to two metres in length. ClampOn systems are known for their high quality and user-friendliness – and these qualities are integral aspects of the philosophy underlying the design and development of the DSP Corrosion-Erosion Monitor. This new instrument offers users a reliable and uncomplicated solution at a reasonable price.

ClampOn CEM field installation.

Principle of operation

The working principle for the instrument is based on transmitting ultrasonic signals that propagate through the pipe material. The transmitted signal is received by a sensor and is analyzed using advanced data processing schemes. The ultrasonic signal is affected by several aspects of the pipe material including wall thickness, and these relevant changes are monitored, analyzed and reported by the system's electronics.

The Corrosion-Erosion Monitor consists of a single Main Sensor which processes and controls the signals. The Main Sensor communicates with up to eight smaller ultrasonic transducers on the selected pipe section, which transmit and receive ultrasonic signals under the supervision of the Main Sensor. This creates a pattern of thickness information for the section to be measured, and when the signals have been processed, the user can access the information in real time. A sample signal pattern is shown in figure 1.

The number of Main Sensors/ transducers to be used is decided by the client in consultation with ClampOn's technical staff. A minimum of two transducers are required for path-based Corrosion-Erosion Measurements, but a single transducer can be used for performing spot measurements. Testing has shown the Corrosion-Erosion Monitor to be both physically robust and capable of withstanding changes in pipe temperature. The system is capable of performing measurements on pipe diameters from 50 mm (2") and upwards and on material thicknesses ranging from 4 mm to 40 mm (0.157" to 1.574") Changes in average wall thickness of as little as 1% can be measured in real time.

The signal path follows the metal structure between most transducers in operation, which in turn generates a matrix of many measurements. All transducers communicate with each other under the control of the main sensor.

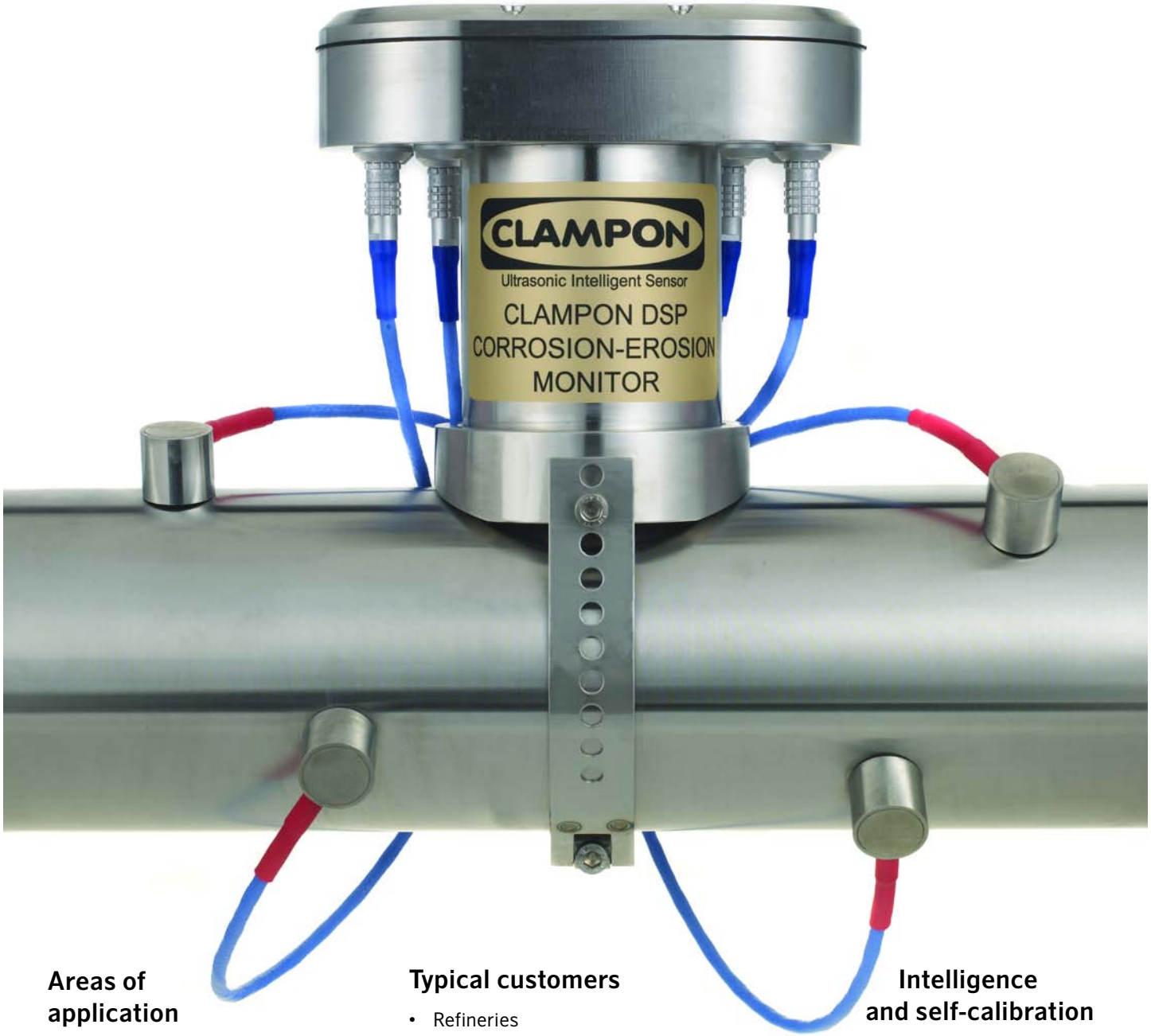
Installation

Installing a CEM is quick and simple. Two to eight transducers are glued to the surface of the pipe (or other metal plate structure) and connected to a clamp-on control unit. The control unit continuously sends and receives guided waves between the transducers, resulting in a network of measurement paths that covers the selected area.

A given pair of transducers covers more area than is defined by the transducer dimensions, and Figure 2 (right) shows a schematic diagram (top view) of the ultrasonic beam width for a pair of transducers separated by approximately 400 mm.

In a CEM installation with six transducers in operation the coverage area is large, as Figure 3 (right) shows. This set-up covers 60% of the pipe circumference. The transducers have separations of 700 mm and the pipe is 8" in diameter.

The CEM monitors real-time or according to chosen sequences. Connected to a control system the CEM will provide trends and alarms, enabling the operator to evaluate how the trends in corrosion or erosion are related to other process parameters.



Areas of application

- Pipelines
- Pipe components
- Plate sections
- Corrosion detection
- Erosion detection
- Storage tanks

Typical customers

- Refineries
- Chemical plants
- Process industry
- Power plants
- Oil and gas industry
- Transport lines etc.

Intelligence and self-calibration

The ClampOn Corrosion-Erosion Monitor self-tests the following system parameters: input level, RAM, internal voltage, internal temperatures, all internal buses and the elements.

Product advantages

- Non-intrusive
- Wide temperature range
- Not operator-dependent
- Covers large area of pipeline
- High sensitivity
- Easy to install
- Designed for “lifetime” operation

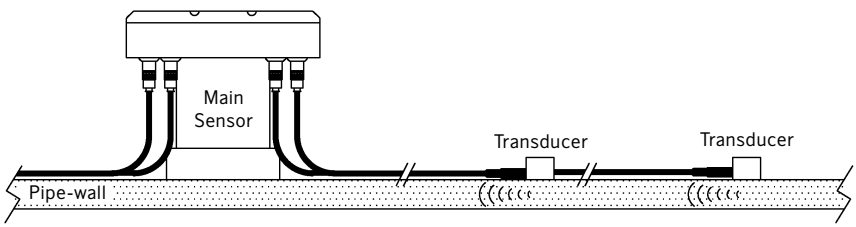
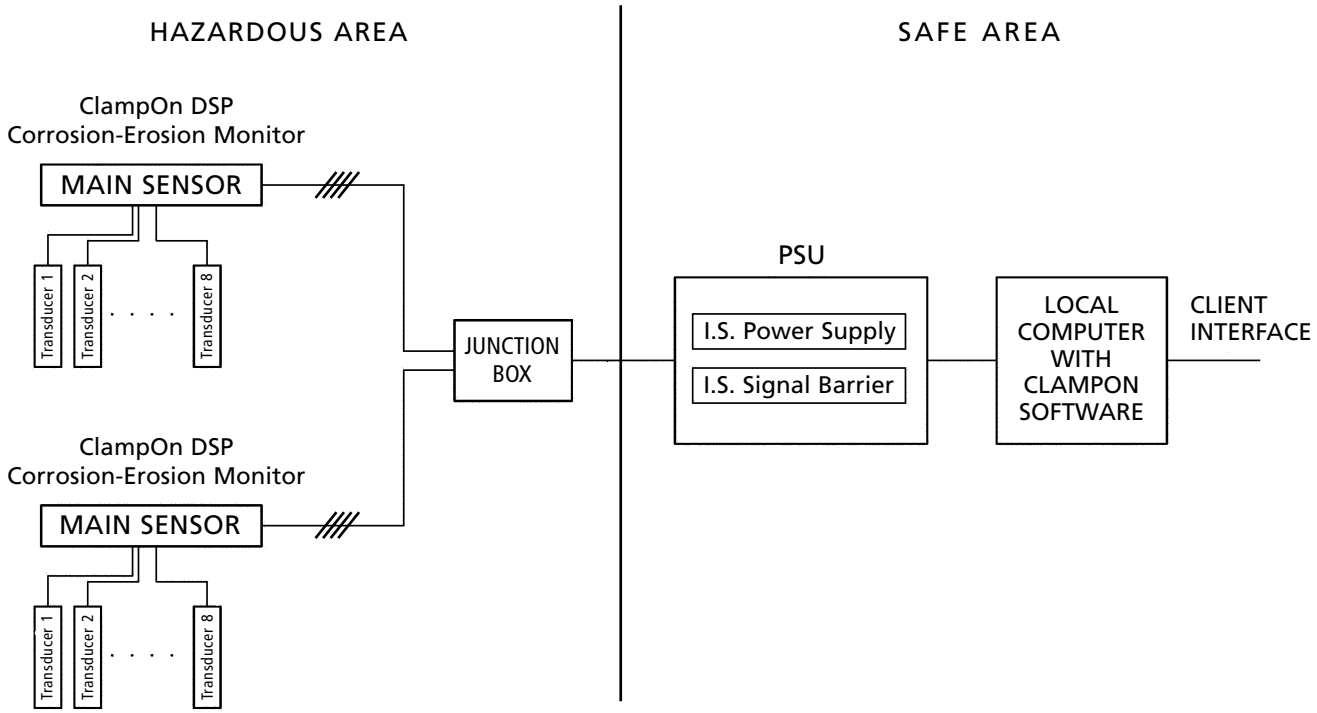
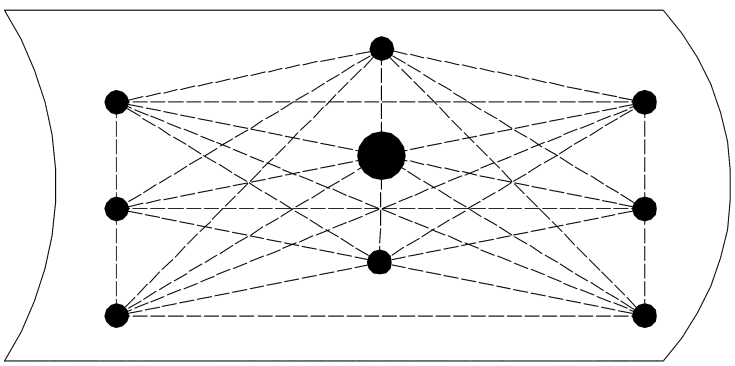


Figure showing the ultrasonic signal transmission between the main sensor and two of the four transducers installed on a pipe-wall.

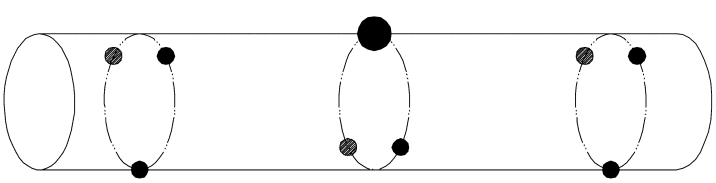
Typical system set-up





SIGNAL PATH AND COVERAGE

Figure 1. The signal path follows the metal structure between most transceivers in operation, which in turn generates a matrix of many measurements. All transceivers communicate with each other under the control of the Main Sensor.



Ultrasonic signal transmission between the master sensor and two of the four slave sensors installed on a pipe-wall.

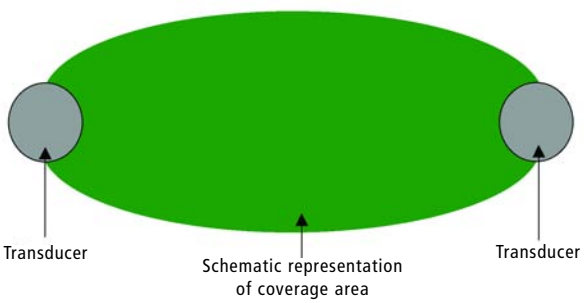


Figure 2. Approximate beam width and profile as estimated by 2D models for a representative transducer separation.

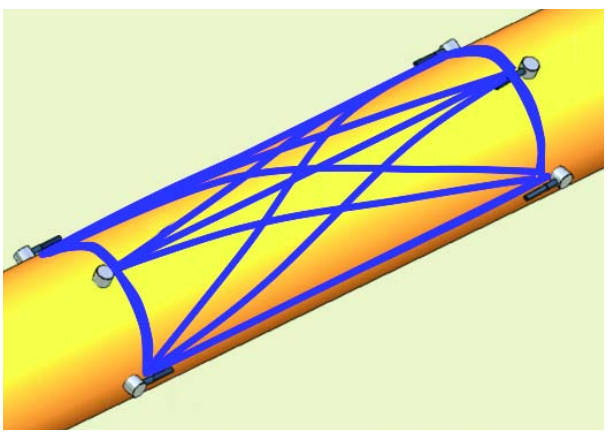


Figure 3: CEM coverage area on 8 in OD pipe, with a total separation of 700 mm and a transducer set-up = total coverage of approximately 60%.

Product specifications

ULTRASONIC INTELLIGENT SENSOR	
Principle of operation	Ultrasonic intelligent sensor, Active ultrasound, guided waves
Sensor electronics	DSP 66 MIPS
Sensor electronics input bandwidth	0 – 2 MHz
Sensor electronics output	0 – 10 MHz, ±70 Volt
Inputs	8 Ch.
Power consumption	Normal operation: 1,6 W
Self testing	Yes
Sensor output	Digital
Intrinsically safe approval	ATEX EEx ia IIB T4-T5, II1G, Zone 0
Enclosure standard	IP67
Enclosure material	316 Stainless Steel
Dimensions / Weight	ø80 mm x 167 mm (ø3.15“ x 6.6“) / 3.6 kg (7.9 lbs)
Max. pipe surface temperature	-40 to 180 °C (-40 to 356 °F)
Operating pipe temperature	-40 to 150 °C (-40 to 302 °F)
Method of installation	Main unit is clamped to pipe surface, transducers are glued to pipe
Interface options	RS485
Two-way communication	Yes
Software upgradable	Yes
Sensor configuration	Up to 8 transducers
	Distance to main sensor 0.15-1m (6”- 40”).
	Coverage distance max. 2 m (80”)

CORROSION & EROSION MONITOR TECHNICAL DATA	
Pipe diameter	Min OD 75mm (3”)
Pipe-wall thickness	2 to 35mm (0.078 to 1.37”
Pipe OD /wall thickness	> 8
Length between transceivers	0.15m to 2m
Response time	Real-time
Sensitivity	1% of wall thickness, The presence of liquid in the pipe does not affect sensitivity
Frequency range	20 to 1500 kHz
Fluid in pipe	Oil, gas, water, multiphase or other liquids
Pipe material	All metal pipes
Calibration	Once, on installation
Cable interface	Cable with connector / Flying lead / Gland for cable access
Cabling	Minimum 4x 0.75 mm^2

COMPUTER / CONTROLLER	
Minimum hardware	Computer: Pentium III (or equivalent) with 512 MB RAM
	Controller: Fieldpoint or RIO Programmable Automation Controller
Software requirements for ClampOn’s software	Windows™ 2000/2003/XP/NT 4
Input	Serial, Modbus, Ethernet, OPC
Signal output	Serial, Modbus, Ethernet, 4-20mA, Relay, Client Server

SAFE AREA EQUIPMENT	
Mains power supply	12 - 48 VDC or 100-260 VAC 50-60 Hz
Power Consumption	Max 2 W per detector + computer rack module

ClampOn - the leader in sand, pig and corrosion-erosion monitoring

ClampOn has since the beginning in 1994 grown to be the largest supplier of passive ultrasonic systems for sand/particle monitoring to the international oil and gas sector. All products supplied by ClampOn, particle monitor, pig detector, corrosion-erosion monitor and leak monitor are based on the same, well proven technology platform. Both the topside and the subsea instruments incorporate Digital Signal Processing (DSP), complete digitalization eliminating analogue filters, circuits and amplifiers.

The ClampOn Ultrasonic Intelligent Sensor processes all data in the sensor itself (patented principle), thus enabling the instrument to discriminate between sand-generated and flow-generated noise. This is of importance to the user since changes in flow rates and the gas/oil ratio will not affect the performance of the system.

A good signal to noise (s/n) ratio is vital for quality measurements of this sort, and ClampOn's sensors are the very best in this respect. With the new version, the external noise has been completely eliminated.

The sensors has memory capacity for storing up to 60 days of data, and can even be reprogrammed between being a sand monitor, a pig detector or a corrosion-erosion monitor for monitoring of changes in wall thickness.

Subsea Sensors

The subsea sensors were developed in close collaboration with Shell Deepwater Development Inc. in Houston and FMC Energy Systems in Norway. The successful outcome of the project was a sand monitoring system that combined an extremely long working life with excellent acoustic properties, offering reliability in the high pressure deepwater environment. ClampOn has since 1998 supplied approximately 500 subsea sensors to the oil and gas industry. The subsea meters have been under a continuous development in order to optimize quality and performance, and to meet the requirements in the market.

ClampOn DSP Pig Detector

The ClampOn DSP Pig detector is a Non-invasive pig detection system designed to be a first stage alarm system for pig detection providing accurate and reliable registration of the time when pigs is passing, and transmits the signal to the operator. The detector can also indicate the amount of debris following the pig during cleaning operations.

ClampOn DSP-06 Particle Monitor

All sensors are exactly alike and interchangeable, an advantage if sensors should be moved/relocated or in case of service. The DSP's increase in processing capacity enables the sensor to combine signals from several frequency ranges when analysing the flow. The ClampOn sensors are versatile, and are the only instruments on the market offering two-way communication between sensor and control system. This solution enables future upgrade of the sensor by a simple download of new software. When using digital output from the sensors, they can be installed in a "multi-drop" system.

The sensor is installed after a bend, where the particles (chalk or sand) are forced out of the flow and hit the inside of the pipe wall, generating an ultrasonic pulse. The ultrasonic signal is transmitted through the pipe wall and picked up by the acoustic sensor itself.

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