

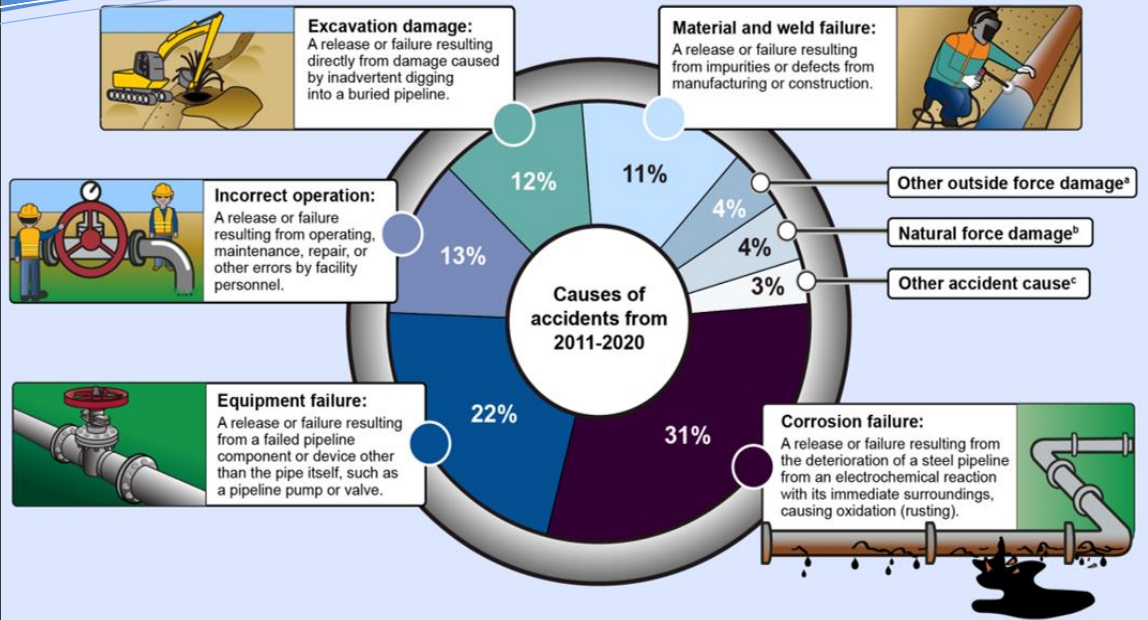


AVANTE HOLISTIC AND INTEGRATED PIPELINE INTEGRITY MONITORING SYSTEM FOR OIL & GAS TRANSMISSION

- NON-INTRUSIVE AND COMPREHENSIVE DIGITAL SENSORS INSTALLED AT THE CHOKE POINTS AND ALONG THE OIL AND GAS TRANSMISSION PIPELINE FOR USE IN PROVIDING COMPLETE VISIBILITY AND HOLISTIC SAFETY AND SECURITY MANAGEMENT

AVANTE Holistic Pipeline Integrity Monitoring System (PIMS) for Oil and Gas Transmission:

- ❖ Pipeline failures are attributable to corrosion and particularly internal wall thinning at weak spots for the different contaminants in the fluid flowing through the transmission pipeline. AVANTE PIMS monitors the degree and rate of corrosion quantitatively.
- ❖ Equipment such as valve, fitting and pump fails over time. Data on change of flow rate and vibration analysis at choke points is used for predictive maintenance.
- ❖ Operational errors can be monitored with flow, flow rate and other related data for timely corrective remediation.
- ❖ Excavation approaching the pipeline provide vibration signature and alerts for corrective actions.
- ❖ Drilling-cutting for theft provides different vibration signature for timely alerts for actionable.
- ❖ Pipeline movement, bending and distortion overtime by soil movements and other geohazards. Strain monitoring provides early warning for remedies.
- ❖ AVANTE PIMS also incorporates temperature, galvanic potential, and other sensors to provide supplementary data to avoid false alarms.



AVANTE Pipeline Integrity Monitoring System (PIMS) for Oil and Gas Transmission:

Pipeline transmission accidents caused by multiple factors. AVANTE patent-pending holistic Pipeline Monitoring System is designed to install non-intrusively and easily onto the surface of the pipeline, to measure quantitative data, trending characteristics, and rate of changes to provide predictive and/or preventative capability for managing pipeline failures and errors.

- Corrosion (internal) are being monitored by periodic pipe thickness measurement (relative or calibrated).
- Corrosion (external) are being monitored by periodic galvanic potential and/or current measurements.
- Equipment failure including valve, fitting, joint and welding, pump, and other components that affect the fluid flow are monitored with relative rate of change in fluid flow using ultrasonic flow monitoring at judicial branching pipelines and choke points.
- Incorrect operation or operational errors are monitored by the same relative rate of change in fluid flow in comparison using ultrasonic flow monitoring at judicial branching pipelines and adjacent monitoring unit.
- The excavation and stealing related damage to the pipeline is predictively monitored by the low and high frequency vibration and the increase in intensity.
- The geohazards such as soil erosion, and other related geohazards are monitored periodically with strain data.
- Temperature sensors help to provide supplementary data when the changes are sudden and/or extreme.



AVANTE Integrated Pipeline Integrity Monitoring System is designed to provide holistic visibility of oil and gas pipeline transmission for preventive remediation actions before failures and disasters



AVANTE HOLISTIC AND INTEGRATED PIPELINE INTEGRITY MONITORING SYSTEM FOR OIL & GAS TRANSMISSION

- FLUID FLOW-FLOW RATE-DIFFERENTIAL CHANGE OF FLOW RATE IS USED FOR HOLISTIC OPERATIONAL SAFETY AND SECURITY MANAGEMENT
- VIBRATION ANALYSIS IS USED FOR EXCAVATION AND THEFT DAMAGE MONITORING

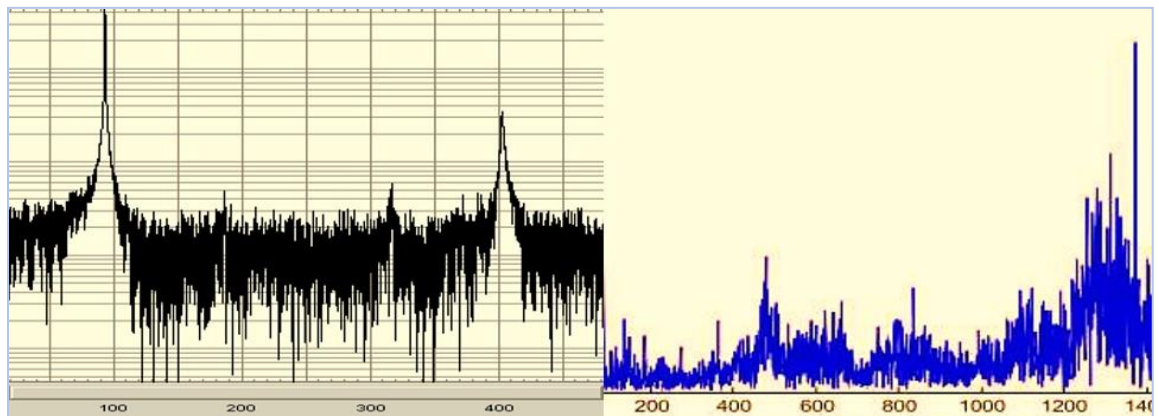
AVANTE Holistic Pipeline Integrity Monitoring System (PIMS) for Oil and Gas

Transmission:

- AVANTE Pipeline Integrity Monitoring System incorporates multiple modules of sensors that are installed externally and non-intrusively for quantitative and/or relative measurements of factors along the pipelines that affects functioning.
- Changes in relative flow rate; flow paths, present-absent of flow; coupling with vibration and temperature data are used in leakage and operational errors analysis to provide actionable alerts and remedial actions.
- Vibration analysis is used in AVANTE PIMS in distinguishing excavation and geohazards from drilling and cutting for tampering and theft.
- The data from all sensor modules are gathered in suitable period and duration, they are collected in a separate controller and processor that are powered by AC, battery and preferably backed with recharging from solar when other power sources are not available.
- The locations besides pre-assignment IP addresses of the monitoring unit and are logged with the data that are also tagged with GPS location and date-time incorporated in the monitoring system.
- The data are communicated in high speed with one of cellular, satcom, Wi-Fi, LoRAN, wireless mesh network, etc. to central monitoring center server for 24/7/365 monitoring and in case of exceptions, to provide real-time alerts.

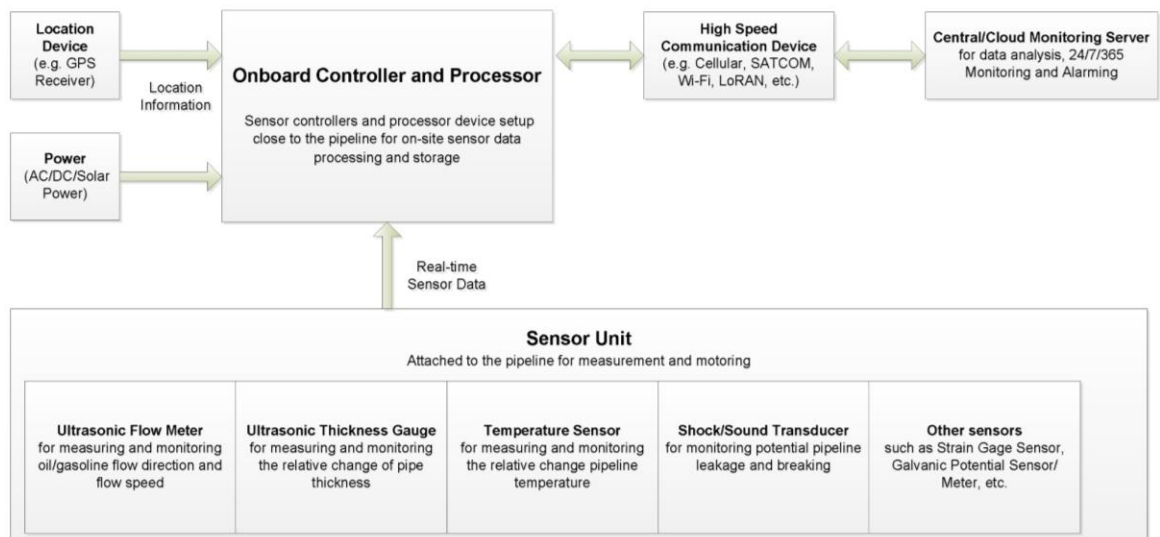


Non-Intrusive Monitoring of Changes in Relative Flow Rate; Flow Path, Present-Absent of Flow Along with Vibration and Temperature Data are Used in Leakage, Operational Errors Alerts



Vibration Analysis is Used in Distinguishing Excavation and Geohazards from Drilling and Cutting

AVANTE 24/7/365 OIL-GAS PIPELINE TRANSMISSION MONITORING SYSTEM



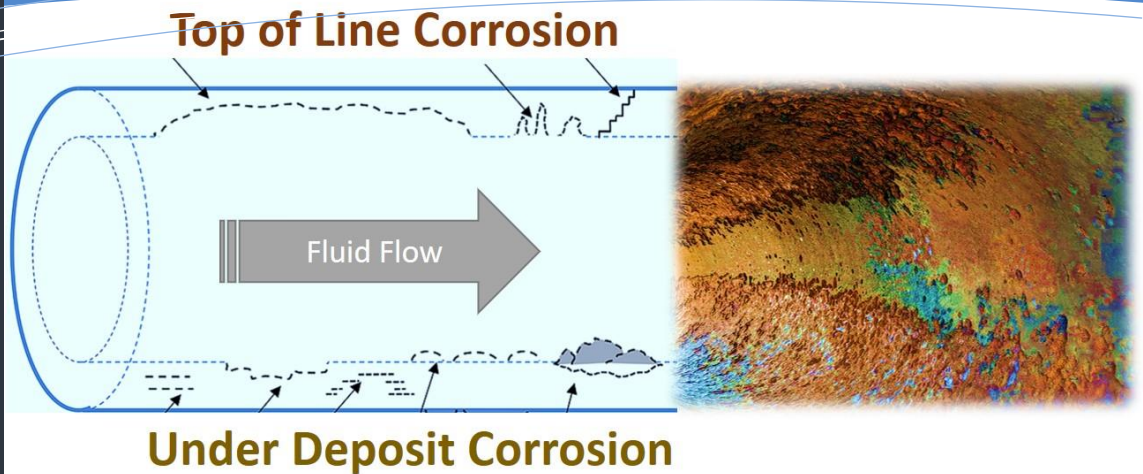


AVANTE HOLISTIC AND INTEGRATED PIPELINE INTEGRITY MONITORING SYSTEM FOR OIL & GAS TRANSMISSION

- PIPELINE WALL THICKNESS THINNING IS USED FOR CORROSION MONITORING
- STRAIN AND DEFORMATION ANALYSIS IS USED FOR GEOHAZARD MONITORING

AVANTE Holistic Pipeline Integrity Monitoring System (PIMS) for Oil and Gas Transmission:

- Corrosion inside the oil and gas transmission pipeline contributes to most of the failures and leaks events. The rates and mechanism of corrosion are different for different oil and gas sources. The slow thinning happened differently and at different rates for the top and bottom of the pipeline and non-uniformly along the pipeline. AVANTE PIMS is designed to optimize the with multiple monitoring points for holistic and cost effective results.
- Geohazards such as soil erosion, earth sliding, and earthquakes all causes the embedded pipeline to move and deform. AVANTE PIMS incorporates multiple strain monitoring sensors for reporting cumulative strain for slow and unexpected large bending and deformation to provide timely alerts for remedial actions.
- The data from all sensor modules are gathered in suitable period and duration, they are collected in a separate controller and processor that are powered by AC, battery and preferably backed with recharging from solar when other power sources are not available. The data are communicated in high speed with one of cellular, satcom, Wi-Fi, LoRAN, wireless mesh network, etc. to central monitoring center server for 24/7/365 monitoring and in case of exceptions, to provide real-time alerts.



AVANTE Holistic Pipeline Integrity Monitoring System (PIMS) for Oil and Gas Transmission:

- **Corrosion of the pipeline** used in oil and gas transmission, particularly the internal corrosion is one of the major causes of failure and leakage that cause contamination of the environment. Corrosive factors are particularly significant on the top side of the pipelines, called top-of-line-Corrosion (TOLC) are different from that of the bottom that are caused by under deposit corrosion (UDC) as illustrated in the above illustration and image.
 - It is the slow thinning and the RATE OF THINNING caused by corrosion to provide the predictive capability for replacement of remedial actions in chemically modified the oil and gas characteristics before feeding into transmission.
 - AVANTE pipeline monitoring system is used for corrosion thinning of the transmission pipeline even without knowing the original wall thickness. Typical accuracy or resolution depends on the overall thickness and are in most cases better than 0.01mm.
 - In addition to the top-bottom-side positions, additional sensor probes can also be placed along the pipelines for more capability in catching the coating degradation points whereby provide more predictability. AVANTE Pipeline thickness measurement module is designed to have capability of multiple channels for up to 8 or more probes with switching mechanism to provide that capability.
- The geohazards such as soil erosion, land slide, earthquakes and other related geohazards can **move, bend, deform the pipeline** to cause immediate or subsequent rupture and leaks.
 - Strain gages with multiple directions are can be mounted onto the surface of the transmission pipeline with high strength adhesive with adequate flexibility as not to crack with bending. The strain data along one or more directions are measured periodically depending the geohazard potential.
 - The magnitude of bending and their relative rate of change are important factors in providing alerts. The excessive strain as prescribed can trigger an alert to the controlling organization including the suitable local and/or relevant government agencies for possible onsite inspection and/or remediation.
- Temperature sensors help to provide supplementary data when the changes are sudden and/or extreme.



AVANTE patent-pending Integrated Pipeline Integrity Monitoring System (PIMS) incorporates strain analysis in providing timely alters for preventive remediation actions disasters

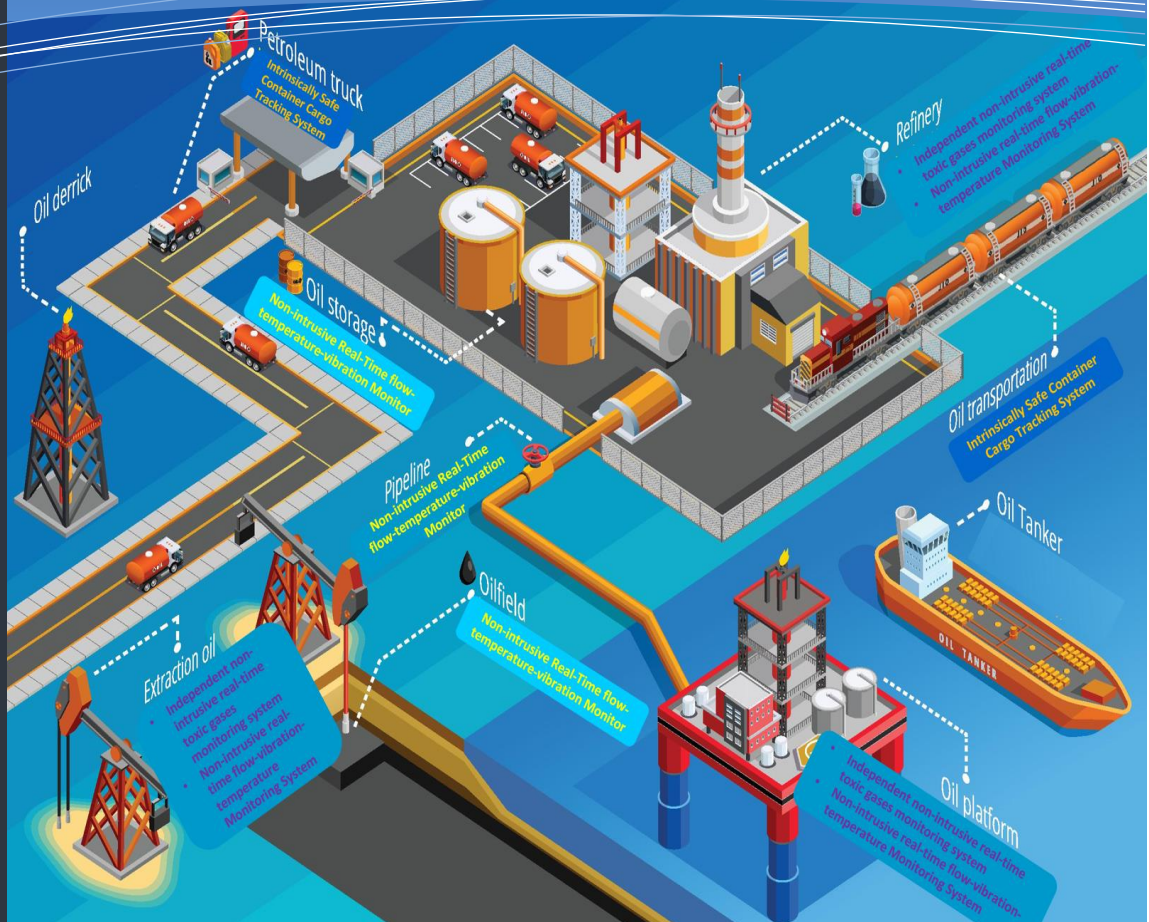


AVANTE HOLISTIC PIPELINE INTEGRITY MONITORING SYSTEM FOR OIL & GAS SUPPLY CHAIN VISIBILITY AND MANAGEMENT

- NON-INTRUSIVE AND COMPREHENSIVE DIGITAL SENSORS INSTALLED AT THE CHOKE POINTS AND ALONG THE OIL AND GAS TRANSMISSION PIPELINE FOR USE IN PROVIDING COMPLETE VISIBILITY AND HOLISTIC SAFETY AND SECURITY MANAGEMENT

AVANTE Holistic Pipeline Integrity Monitoring System (PIMS) for Oil and Gas Supply Chain Visibility and Management:

- AVANTE Pipeline Integrity Monitoring System incorporates multiple modules of sensors that are installed externally and non-intrusively for quantitative and/or relative measurements of factors along the pipelines that affects functioning. They can be installed in all of the choke points along the supply chain linkage in achieving the full visibility of the supply chain for more secure and effective management.
- Changes in relative flow rate; flow paths, present-absent of flow; coupling with vibration and temperature data can be used in documenting all movements along the supply chain.
- Theft and tampering can be controlled and prevented with the ability of the vibration analysis for distinguishing excavation and geohazards from drilling, cutting and other tampering.
- The data collected for almost all of the events that may cause the supply chain disruption are captured and are communicated in high speed with one of cellular, satcom, Wi-Fi, LoRAN, wireless mesh network, etc. to central monitoring center server for 24/7/365 monitoring and in case of exceptions, to provide real-time alerts.
- AVANTE PIMS sensor modules are designed to be self-monitoring and self-powered for 24/7/365 autonomous data gathering and analysis.



AVANTE patent pending holistic and integrated Pipeline Integrity Monitoring System (PIMS) is non-intrusively installed onto the surface of the pipeline at judicial locations and choke points provides quantitative data, trending characteristics of the relevant pipeline measurable data, to provide predictive and/or preventative capability for pipeline failures and errors.

AVANTE Holistic Pipeline Integrity Monitoring System (PIMS) for Oil and Gas Supply Chain Visibility and Management:

Pipelines are integral part of the oil and gas supply chain. They are used extensively from up-stream in crude transmission to refinery and depots; mid-stream from refinery to distribution depots and shipping, and to downstream from depots to tankers and end users.

Pipeline transmission of oil and gas are the most cost-effective means in transport the goods in the oil and gas industry. These important assets are susceptible to natural causes of slow but certain corrosion, geohazards, human errors in excavation and operations, intentional tampering destruction and theft. The losses caused by leakages in the US alone reaches more US\$300 million in 2018 alone.

Traditional SCADA systems embedded inside the pipelines provides accurate flow and other data information but only in those far in between transmission points. They do not provide adequate granularity and visibility along the thousands of miles of pipelines.

AVANTE patent-pending Pipeline Integrity Monitoring System incorporates quantitative sensor modules that can be cost effectively and non-intrusively installed on the surface of the pipeline to monitor all of the potential hazards that can damage the pipelines both internally and externally, human errors and intentional tampering and theft. They also designed to be easily installable self-contained, self-powered and self-monitoring units along the pipelines and at all of the critical choke points for a full supply chain visibility safety and security.