BKM TECHNOLOGY PARTNERS

SecurPro

Pipeline Protection System

Leak Detection and Location

PROTECT **SECURE** **DEFEND**

Technology for the Detection & Location of Leaks and Illicit Tappings

Overview

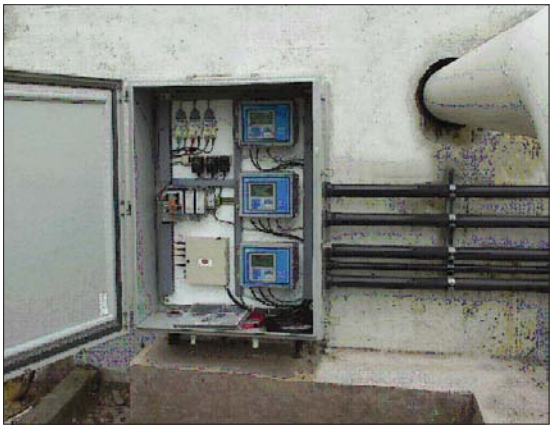
Leaks and thieves cause billions of dollars of unrecoverable losses of petroleum resources every year. It is estimated that up to 10% of the refined products in developing countries disappear, either as contaminants despoiling the environment or as losses to thieves and vandals.

BKM Technology Partners combines non-invasive hardware sensors and flow meters on pipelines to detect anomalies in flow caused by leaks or illegal tappings with integrated patent pending software tools to isolate the location of the leak or illegal tapping to within six meters of the sources. Non-invasive sensors allow for low cost 24 x 7 monitoring, and advanced modeling of data provides for accurate analysis of the leaks or tappings so that appropriate action can be taken at the right time and right place.

Detection of Leaks

In the event of a pipeline leak, a sudden drop in pressure radiates a sonic wave both upstream and downstream from the source at the speed of sound in the liquid. This wave creates a pressure transient which results in a sudden drop in the then current value of the liquid's pressure propagation velocity (Vs). Vs is measured at each of the upstream and downstream Site Stations (metering points) an average of ten times per second. The decrease in Vs is detected and time stamped with the arrival of the shock waves' leading edges. Since all site stations have synchronized time clocks, the relative arrival times of the shock wave at each site station is easily determined.

Detection of leaks or tappings occurs at near real time because it is based on thresholds. The normal state of the pipeline flow is calibrated in the Master Control Station, and variances to the norm show up as blips on the screen. The accuracy of the location function is dependent on the resolution of time stamping and the pressure wave velocity of the liquid. Since the sampling resolution is 0.1 seconds, and assuming a velocity of 1500 meters per second, in real time, the leak without SecurPro would be within ±150 meters. SecurPro is designed to locate the leak within six to seven meters



Maintenance and Durability of the Flow Meters & Ultrasonic Sensors

Ultrasonic sensors have little maintenance requirements. They have no moving parts and are installed outside the pipeline using metal banding. They have been installed under water in specialized water proof metal housing, underground and in areas of 80% and higher moisture saturation. They have low power consumption needs and can be powered with a small solar array and standard 12 volt storage battery.

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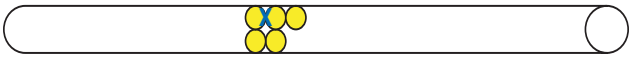
Technology for the Detection & Location of Leaks and Illicit Tappings

SecurPro–Locating a Leak Within Six to Seven Meters

While threshold alerts are effective for immediate leak detection, pattern matching allows the system to isolate the location with a far greater precision. Each transmission from the flow meters has a signature which is matched against a norm to determine if there is a leak, tap, etc. Since each sample will have slightly different positions relative to the sample set, the location can then be determined with a fine degree of accuracy by mapping the time duration between the corresponding two sensors (flow meters) for each sample set.

Leaks caused by tappers are always turned on and off – not a typical pattern for a naturally occurring leak. A leak due to mechanical failure occurs one time and then there is a constant change in mass balance, whereas leaks made from theft occur, product is taken, and then the illegal valves are turned off. An illegal tapping behaves more like pipeline junction points.

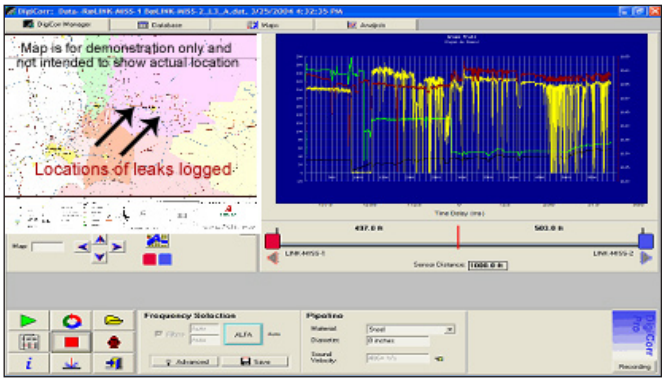
As an example with the SecurPro technology – a leak occurs at one point 500 meters from sensor A, and then at another point in time, 670 meters from Sensor A, and over a period of time, the data sets are 500, 670, 450, 300. When plotted on a location map it appears as several dots that are all close to some point on the pipeline. By creating a statistical model of this data, the most probable location is selected (x), with the other possible locations being eliminated via probability analysis.



Precision in location requires the constant collection and monitoring of the changes in the pressure wave, statistically massaging the data, and comparing the results with historical data and known locations of valves etc.

After collection and modeling of the data, the location is converted to latitude and longitude so that it can be juxtaposed on a GIS map. An example of the feedback from an alarm state demonstrates the graphical data and its transposition onto a map. Red indicates flow from the originating plant, Yellow is flow received. Black and Green are the sonic velocity of the gasoline in the pipeline, whose velocity is measured in meters per second and are changed by the opening and closing of tapping locations.

The map data can then be used to isolate the location to investigate using other techniques such as ground penetrating radar, vapor detection, or human surveillance.



Ultrasonic sensors have very little maintenance requirements. They have no moving parts and are installed outside the pipeline using metal banding, thereby requiring no invasive sensors. They have been installed under water in specialized water proof metal housing, underground and in areas of 80% and higher moisture saturation. They have low power consumption needs, less than 5 watts, and have been successfully powered with small solar arrays and standard 12 volt solar battery.

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