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REAL TIME MONITORING – THE KEY TO EFFECTIVE OIL SPILL PREVENTION AND RESPONSE

Chris R. Chase[1], Geraldo Lyra [2], Maurício Green [3]

Abstract

In the wake of the recent BP oil spill in the Gulf of Mexico, prevention and response issues have taken on heightened importance and more public visibility. By utilizing automated spill detection sensors, hydrocarbon releases can now be detected in real-time (analogous to a 'security camera' or 'smoke alarm', but for oil spills). Real-time detection and early-warning alert enables immediate response and containment of oil pollution, thereby reducing the volume of oil spilled and minimizing damage to environment, wildlife, waterways, and assets. This evolving technology provides environmental and operations personnel with a new weapon for preventing and combatting oil pollution, and a critical new tool for compliance with regulations that stipulate spill prevention, planning and response.

This paper details: 1) Development of a reliable, economical, optical, non contact, UV filter-fluorometer type, hydrocarbon pollution detection sensor system 2) Performance results from lab and field tests, 3) Case studies where this new technology is being used for spill prevention, early-containment, regulatory compliance, and realization of the numerous cost-benefits associated with minimizing oil spill risks.

Evolution of the sensor design reflects input from environmental specialists and regulatory agencies, as well as the needs and feedback expressed by early-adopters and existing users such as Shell, BP, SK, CalTex, Petrobras, CPC, Oxy, Exxon, Iberdrola, Aera, and others. Key system attributes include: 1) Near-zero maintenance, 2) High (micron-level) sensitivity for a comprehensive range of oils, i.e. detection of heavy crude-oil to lighter-fractions such as jet-fuel, and 3) System flexibility and adaptability for varied application requirements and installation environments (freshwater, marine, wet/dry industrial drainages, ports and harbors, coastal and offshore).

In addition to providing a technical overview of this new technology, this paper emphasizes installation examples. We feel that sharing real-world examples provides an informative 'roadmap', showing others who are interested how existing users are successfully implementing this technology for spill prevention and control. These examples encourage an open exchange of ideas and information, and demonstrate how any entity that produces, stores, uses or transports hydrocarbons can use and benefit from early warning spill detection to realize cost-benefits, strengthen compliance, and reduce response/remediation costs, environmental damages, and bad publicity inherent with oil spills.

1. Introduction

Social Responsibility is the administration form that is defined by the ethical and transparent relationship of the industries with all the publics and for the establishment of business goals that put forward the maintainable development of the society, preserving environmental and cultural resources for the future generations, respecting the diversity and promoting the reduction of the social inequalities. Slick Sleuth is a equipment fully aligned with the Social Responsibility because it enables an rapid and efficient response in case of accidentals, reducing or even avoiding environmental damages.

[1] BS, Intl. Business – Manager of Environmental Division, InterOcean Systems
[2] Mestre, Ciências Náuticas – Gerente Hazmat, HidroClean Proteção Ambiental
[3] Mestre, Ciências do Mar – Analista Ambiental, HidroClean Proteção Ambiental

Worldwide dependence on fossil fuels and oil derivative products are at historic highs for production, transportation, storage, and consumption. Oil spills are a global concern, and while major offshore spills garner attention-grabbing headlines, tanker spills and comparable large-magnitude offshore spill events statistically constitute just a fraction of oil pollution to the environment. In fact, land-based and inland-waterway spills result in much greater aggregate damage to the environment and cost to society than do marine spills (Etkins, 2010) [4], but draw considerably less public attention (recent Deepwater Horizon spill notwithstanding). According to the US National Academy of Sciences publication, "Oil in the Sea" (2002)[5]; "Nearly 85 percent of the [110 million liters] of petroleum that enter North American ocean waters each year as a result of human activities comes from land-based runoff…[while] less than 8 percent comes from tanker or pipeline spills". Similar statistics exist for Brazil and other industrialized countries around the world.

It's evident that both offshore and onshore spills are of growing public concern, particularly in the aftermath of the massive Deepwater Horizon incident. But while significant emphasis has been placed on prevention and response to spills at sea (spills from vessels have decreased in recent years), attention to, and prevention of, shore-based oil pollution sources has lagged far behind similar offshore efforts. *There seems to be more of a 'response mindset', as opposed to a 'prevention first' approach.* As such, the overall innovation of new processes, methodologies and technologies needed to protect the environment against land-based oil pollution are being severely outpaced by growth, demand, and omnipresence of oil.

Recent success in development and use of sensor technology for the prevention, detection, and early warning/containment of oil spills discussed in this paper is intended to help prevent and minimize the impact of inshore (freshwater) and near-shore (coastal/estuarine) oil spills, with particular emphasis on industrial uses, and expanded use in the offshore environment.

Prevention and early containment of spills benefits everyone: the public at large, stakeholders of watersheds and waterways, business interests (spills are expensive), the ecology of natural habitats, and the environment as a whole. Spill prevention and reduction through remote early detection provides a "win-win" solution and, when properly implemented, greatly reduces the risk of significant spills and cumulative harm to the environment caused by myriad small spills. Users of newly developed sensor technology are learning that real-time spill detection offers a powerful tool for preventing and containing spills that otherwise go undetected until it is too late.

A few factual tidbits based on statistics in the world provide perspective and can be extrapolated to other USA regions:

- **The US consumes ~21 million barrels per day (~25% of world's total)** (*US Dept of Energy*)
- **12,000 – 15,000 oil spills are *Reported* annually in USA** [*unreported* totals are obviously higher] (*Texas Water Resources Institute*)
- **More than half of reported spills in the US are inland incidents** (*various sources*)
- **25 Gallons of oil can spread a visible sheen over an area of one square mile** *(Metcalf and Eddy 2003)*[6]

	<7 Tonnes	7-700 Tonnes	>700 Tonnes	Total
OPERATIONS				
Loading / Discharging	3155	383	36	3574
Bunkering	560	32	0	593
Other Operations	1221	62	5	1305
ACCIDENTS				
Collisions	176	334	129	640
Groundings	236	265	161	662
Hull Failures	205	57	55	316
Equipment Failures	206	39	4	249
Fire & Explosions	87	33	32	152
Other/Unknown	1983	44	22	2049
TOTAL	7829	1249	444	9522

World Incidence of spills by cause, (<7 tonnes 1974-2009, 7-700 & >700 tonnes 1970-2009) – ITOPF - 2010

2. Goals of System Development

In developing an oil spill sensor, goals were established to create an early detection mechanism for spills or discharges, accidental or deliberate, for both freshwater and marine environments. Since its inception, the scope of the sensor's design has evolved to address an ever-widening range of applications and system features. However, the fundamental goals established at the outset remain at the core of the sensor design: 1) reliable detection of oil sheens and slicks on water surfaces, 2) non-contact sensor design, facilitating highly-sensitive oil detection without the instrument contacting the target water/effluent, 3) impervious to environmental conditions, 4) remote and autonomous operation, 5) operable in excess of 5-meter range above monitored surface (i.e. tidal range), 6) adaptable and scalable, 7) easy to install and operate, and 8) commercially viable, economical, low maintenance sensor package.

3. Principle of Detection - Ultraviolet (UV) Filter-Fluorometry

Oils are known to fluoresce, and the oil detection methodologies discussed herein involve detecting the presence of oil by means of exciting and measuring fluorescence. Fluorescence is an optical phenomenon in which a compound absorbs light at one wavelength and emits it at a longer wavelength (Bartman and Fletcher, 2002)[7]. When fluorescent compounds are excited, some of the energy is absorbed through the excitation of electrons to higher energy states. Once the light source is removed, the excited electrons fall back to their ground state, giving off light in the process. This process is very similar to what makes glow-in-the-dark materials possible, except it takes place in a much shorter time period. Because some rotational-vibrational energy (heat) is lost in the absorption-emission process, the wavelength of the emitted light is always longer than the wavelength of the absorbed light. Typically the absorbed light is in the ultraviolet (UV) range and the emitted light is in the visible range, with the longer-wavelengths often appearing violet or blue. As an example, oils typically absorb light between 300 and 400nm, and emit light in the 450 to 650nm range.

Fluorescence detection, or fluorometry, is by no means new sensing technology. Existing fluorometers use spectroscopy methods for fluorescence detection in the form of flow-through or in-water systems, comprised of sophisticated lab-quality instruments used for scientific research or as water analyzers. These fluorometers offer high sensitivity and multi-channel capabilities, but can also tend be quite expensive and/or impractical for use as remotely deployed field units or for use as a networked array of remote monitors. Flow-through and immersion techniques are also susceptible to bio fouling and oil staining on the sampling tube or optical mechanism and thus require significant maintenance. Likewise floating or submerged in-water sensors and probes have drawbacks such as problematic bio-fouling and troublesome installation and maintenance issues.

Newly developed UV filter-fluorometer sensors are based on the same fluorometric principles as spectrometers/fluorometers used in laboratory settings, however they are non-contact, remotely deployable, downward looking optical sensors, that may be installed high above target surfaces thus freeing them of maintenance, fouling effects and deployment limitations. These unique characteristics make them favorable for field installation and remote detection of oil on water surfaces. These field-deployable, UV-optical sensors incorporate a high-energy light source, filtered and sharply focused into a conical beam so only desired wavelengths of light are projected onto the target area. Any oil present in the target area will fluoresce and radiate light of characteristic wavelengths, which is processed by the UV-sensor's proprietary scanning optics and digital signal processing system, thus detecting the fluorescence characteristic of oil. The detection of oil using this method is predicated upon differential measurement, based on anomalous signal return within a target area when oil is present. If oil is present, the signal return is greater than normal ambient conditions, triggering an "oil detected" alarm state. If oil is present in varying amounts, the signal return is proportional to the level of fluorescence (indicative of oil) measured within the sampling area.

4. Technical System Development and Overview

Using the basic physical principles of fluorometry, and sensor objectives, the developmental stages began by studying the physical characteristics of oil and conducting laboratory experimentation with various light sources, optics, and detectors. Principal efforts focused on those oils and petroleum-based fluids, commonly referred to as PAH and BTEX compounds (Poly Aromatic Hydrocarbons and Benzene, Toluene, Ethylene, Xylene). The PAH and BTEX fluids chosen for study were selected because they are prevalent and of greatest concern to industrial users and government regulators. For example; crude oils, heavy fuel oils such as bunker and fuel oils #2/#4/#6, lube oils, motor oils, hydraulic oils, turbine oils, diesel, jet fuel, and kerosene were all tested, and all proved to be readily detected.

Numerous edible oils such as soybean, corn, olive and palm have also been examined, as well as water-soluble glycols, each of which can be detected to varying degrees.

There is inherent variability in fluorometric characteristics and how various hydrocarbons and oil types will respond to the detector when excited with UV light. Rather than attempting to analyze small differences and degrees of variability between every type of oil in every possible concentration and state (weathered, blended, etc.), priority was given to developing a field sensor capable of qualifying the presence of the widest possible range of oils with high reliability and detection probability; in other words a 'broad range' oil detector, which can operate in all types of environmental conditions. For users interested in the detectability of particular oils of concern, for example a unique type of industrial process oil, it's a simple exercise to test samples either in the lab or on site in the field, to verify high-probability of detection using the sensor, and is some cases optics can be optimized for that specific oil type.

Figure 2 below illustrates an example of characterizing oils when exposed to a broadband UV light source. The results are from tests performed during initial development of the instrument. These results illustrate representative curves and peaks, or 'spectral benchmarks' for oils' fluorescence-levels when irradiated with a UV source in a particular frequency range. For more thorough analysis of this topic see "Review of Oil Spill Remote Sensing" (Brown and Fingas, 2000)[8]

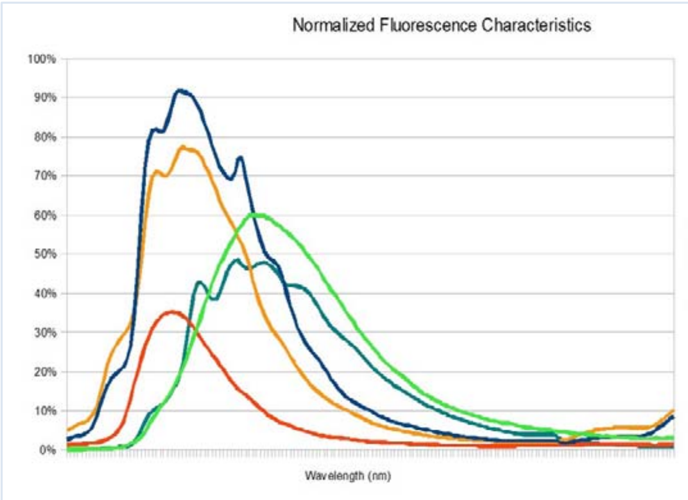

Figure 2. Relative fluorescence of various hydrocarbons

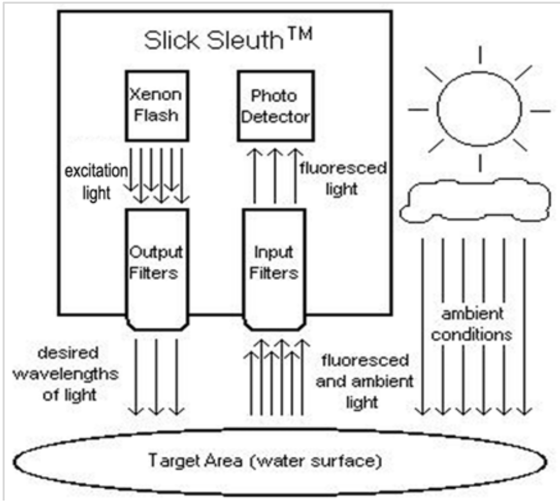

Figure 3. Basic operation of sensor

As the result of experimentation during research and development (R&D) stages, a high-powered Xenon strobe was selected for the sensor's integral light source, coupled with a suitable power supply. This flash and power supply has proven to be highly effective throughout the sensor's evolution. One key criterion for developing the flash assembly was enough output intensity to enable detection of small surface sheens from a distance of 5 meters above the target surface area. Today, ongoing R&D and advances in optics are yielding promising results for applications such as offshore platfroms, with ranges upwards of 20 meters (distance from sensor to surface) possible in the near-term.

Other integral components comprising the optical (UV-source) assembly are parabolic reflectors which focus the conical beam onto the target area below, and band pass filters which limit the energy output to the desired spectral range. On the detector side, band pass filters are coupled with proprietary photo detectors optimized for accurate detection of a wide range of oils. Figure 3 above depicts basic sensor configuration/operation.

The sensor system may be powered using available AC power, or can be operated using DC power with solar panels and rechargeable batteries. All sensor components are housed in a compact stainless steel weatherproof enclosure (roughly 20x30x40cm). An air-purge with valve fittings and vent may be added to satisfy installation requirements in explosive gas locations common in refineries and oil terminals, or alternatively the sensor may be housed within a suitable "explosion-proof" enclosure rated (ATEX, IEC, UL/cUL) for use in hazardous/explosive environments.

Remote communication of detection alarms is accomplished using contact relays, 4-20mA analog current output, RS232 and RS485 serial outputs, or a combination of above. Depending on application requirements and available infrastructure, these outputs are accessed via hardwire or wireless methodologies (Wi-Fi, RF, cellular, satellite), for real-time event notice to a central control room, "DCS", security post, cell phone and/or email address. Alarm output can also be used to automatically control a valve, or activate/deactivate a pump or skimmer, providing immediate, fully automated containment of a spill prior to any human intervention. This automated fail-safe method of detection and control is of particular value to refineries, power plants, and industrial sites where accidental oil spill events otherwise enter the storm water and cooling water discharge system. This method thus ensures that accidental spills are contained on site, personnel are alerted, and no oil reaches the environment. Figure 4 below depicts a detector coupled with a Programmable Logic Controller (PLC) and automated valve-closure. In this example, if oil is detected within the effluent discharge/control sump, oil is automatically contained until personnel arrive on scene.

Figure 4. Oil detector monitoring for compressor oil in a storm water sump at a natural gas pipeline compressor station. Real time alarm is sent to company headquarters and valve closes automatically upon detection of oil.

Figure 5. Oil detection sensor installed over discharge sewer at refinery. Real-time notification to facility personnel, night and day, around the clock, for all types of crude and refined oils.

5. Sensor Performance and Lessons Learned

While there are obviously huge advantages to detecting oil using *non-contact optical* methodology, one of the challenges using an optical sensor is that it must have a clear 'view' of the sampling area. If the optical path is blocked, the detectors' effectiveness is compromised. Testing and field experience have demonstrated that the UV light beam is unaffected by light haze or fog, but as a rule of thumb - if path interference is too thick for the human eye to penetrate, it will also affect optical sensor performance. A series of tests were conducted using dry ice and water containing an oily sheen. In this test, a visually impenetrable fog was generated, which effectively prevented the sensor from detecting oily sheen within the container. However, visually impenetrable fog is a far extreme, and this scenario has not occurred or presented any problems in the many field installations to date.

Similarly, partial path interference by physical blockage does not necessarily disable the sensor's ability to monitor and detect oil. For example in Figure 4 above, the sensor is installed such that its optical path into a containment sump below is partially blocked by a metal grate. Although signal return is attenuated in this example, the signal to noise ratio is the same as if no grate were present, and in this case the sensor looks right through the grate and can reliably differentiate between clean water and oil-polluted water within the sump. Several users have taken advantage of this capability; while others simply cut a small window in the grated-sump or man hole to provide the sensor a clear optical path to monitor for oil below (see Figure 5 above).

While the sensor is optimally mounted perpendicular to the surface below, it has been determined that there is an allowable tilt tolerance of about 15˚. This attribute is critical in certain applications, such as floating installations (refer to Figures 14 & 23), where a fixed perpendicular orientation is not viable. Interestingly, in one instance the sensor was tested at various forward looking tilt-angles. Figure 7 (below) depicts installation at a 60˚ angle, over the 'harbor wave' conditions generated in an oil spill equipment test tank in Japan. Oil was reliably detected at 60˚ and met expectations for the possibility of mounting the sensor on a moving vessel, however to date we're not aware of any users having field-deployed the sensor in such a manner, such as pointing forward on the bow of a moving vessel.

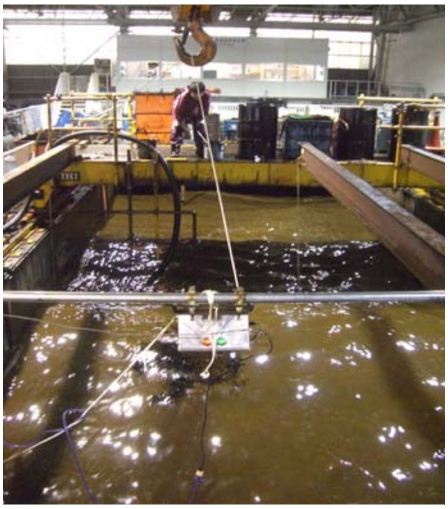

Figure 7. Sensor tilted outward at a 60-degree angle, detecting 'slop' oil on choppy wave-tank surface.

Figure 8. Oil detection sensor on a Navy fuel pier, monitoring for diesel oil on harbor surface in a port setting.

Naturally one of the biggest concerns of sensor operators is false detection, and there are a few substances that fluoresce in a manner similar to petroleum-based fluids. Fortunately items that might cause a false detection are few, and are not prevalent in typical installation environments. For example, white paper and white fabrics fluoresce (much as a white t-shirt glows under black light). In the case of some non-oil chemicals known to fluoresce, for example particular fluids containing rust inhibitors, varying the optical excitation frequency (optical filtering) has been successful in eliminating this potential source of false detection. More commonly, wildlife such as birds, algae, seaweed, sea foam, driftwood, debris and plastic bags may be present, but none have proven to be problematic sources of false detection. Nor do ambient conditions such as varying sunlight, waves, or water currents have any adverse affect on the ability of a UV filter-fluorometry type sensor to detect hydrocarbons on water surfaces. Indeed there have been no chronic false-detection issues reported by sensor users in the field with respect to naturally, or unnaturally, occurring environmental phenomena to date.

During sensor initialization, a "baseline" measurement is made. This baseline measurement establishes normal operating conditions, either with clean water 'background' or with a normal amount of oil present. The sensor also works well over dry or periodically wet/dry ground, so no water need be present. This one-time baseline measurement establishes normal ambient conditions as a 'zero-point'. This normalized-background contrasts greatly with anomalous fluorescence events indicative of oil. Varying water level, such as tides, or rising/falling storm water, cause the ambient baseline to shift up or down as the water periodically rises and subsides. To compensate for this background shift, the sensor uses an algorithm referred to as "adaptive baseline mode". In cyclical tidal settings, or applications where storm water surges occur randomly, the sensor utilizes this adaptive baseline mode in order to normalize these effects.

An interesting attribute discovered with respect to these UV-type sensors is the ability in many cases to detect oil dispersed in water, as well as fluorescing compounds such as glycols that are water soluble. For example, a user expressed interest in evaluating the sensor's ability to detect small concentrations of wire-drawing fluids used in their industrial manufacturing process. They were hopeful of detecting these potential pollutants at a concentration of 0.1%, because this was the concentration measured during clean up of their (very costly) accidental discharge. Each sample dispersed instantly in water when tested, and the results were extremely positive, with the sensor detecting each sample at concentrations of less than 0.1%, and one sample was repeatedly detected at a concentration of only 0.001%.

The sensor was initially designed to sample every 30 seconds to meet user requirements in harbor and coastal settings, however this proved to be impractical for installations where fast moving water currents could transport smaller spills past the sensor very rapidly. To overcome this rapidly moving water issue, tests were conducted using a flume with approximately 2-meters per second flow rate. Based on these results, and further development, the sensor is now user-programmable for variable sampling; from continuous 2 Hz sampling mode, in which the detector analyzes each sample, to a periodic sampling mode, in which the instrument takes a burst sample (typically 10 samples at 100msec interval, once every 5 seconds), and the detector analyzes an average of this periodic burst sample. This enables the detector to be programmed to sample continuously, or less frequently, as appropriate for specific application requirements and/or power budget.

6. Application Examples

As mentioned, initial development of this oil spill detection system was driven by users' requirements in ports and harbor settings, where sensors can be strategically placed to monitor fuel piers and bunkering facilities, marine terminals, shipyards, naval installations, storm water outfalls, etc. Interestingly, however, since the inception of this sensor technology, the largest number of user applications have proven to be oil, petrochemical, power generation and heavy-industrial facilities, most of which are located adjacent to rivers, estuaries and coastlines. End users in this sector include: refineries, terminals, tank farms, power plants, steel mill and heavy industrial facilities. This should not be surprising given the fact that any facility that stores, processes or utilizes large quantities of oil should be concerned with spill prevention and risk reduction. One way that entities and facility personnel may now choose to safeguard their operations against the risks of accidental spills is by installing early-warning sensor systems, in keeping with "Best Available Technologies" (BATs), "Best Management Practices" (BMPs) and "Best Engineering Practices" (BEPs), for real-time alert and early containment of spills.

There does seem to be higher awareness and stronger mandates for industrial facilities to protect against spills going undetected prior to discharge into the environment. The United States Environmental Protection Agency (US EPA), for example, mandates that a facility must maintain a Spill Prevention, Control and Countermeasure (SPCC) Plan that documents potential spill sources and risks, prevention and monitoring measures at the site, as well as contingency response equipment and capabilities. These regulations apply to all facilities with above-ground storage of any types of oil of more than 1,320 gallons aggregate, or any single tank larger than 660 gallons. US EPA estimates there are over 500,000 regulated facilities in the USA alone, nearly half of which consist of oil producers, refineries, pipelines/storage, bulk terminals, electric utilities, chemical plants, and manufacturers. The sensor technology discussed herein is certified to comply with US EPA standards for spill monitors at these facilities.

In addition to spill monitoring in harbors, or installing spill alarm safeguards along industrial spillways, a third major application involves use of remote spill detection sensors for protection of sensitive wildlife habitats and aquaculture/fish farms. For this application, detectors are installed beyond the perimeter of a sensitive habitat such as an estuary, wetlands, mangrove, bird sanctuary or shellfish bed. If a spill encroaches upon the boundary of a protected area, on an incoming tide, the remote spill detector will alert designated personnel. This in turn triggers contingency response actions in time to avert catastrophic damage and casualties to wildlife and natural resources. Response activities for sensitive habitats are often pre-planned and documented in Area Contingency Plans, to provide added protection for particularly valuable or vulnerable natural habitats. A spill alert notification in real time, day or night, allows responders to deploy oil containment booms and to implement pre-planned *time-critical* response activities.

The following examples demonstrate a number of progressive applications and system installations that have been implemented by users for pro-active spill prevention and early-warning response alert to oil spill events.

6.1. Safeguarding Wetlands in Oil Production Areas

Figures 9, 10 & 11. Remote spill detection system (4-units total) used to automatically control tidal gates and alert personnel to incursion of oil in wetlands/tidelands near production area. Oil producer collaborated with the State of California to safeguard the Bolsa Chica Wetlands, a tidal zone with many valuable indigenous species.

6.2. River and Inland Waterway Monitoring – Networked Systems

Figure12. Real-time monitoring at industrial outflow point, where discharge enters a river and then a municipal lake. Utilizes solar power and wireless (RF) alarm/data transmission for instantaneous alert to facility control room.

Figure 13. System array supplied through NATO for remote deployment on river flowing into Baku, Azerbaijan region. Wireless alarm/data network communicate to a dedicated base station, for real-time alert via email and text messaging..

6.3. Offshore Buoy Deployments for Protection of Desalination Plant Intakes and Aquaculture / Fish Farms

Figures 14 & 15. Catamaran buoy-mounted oil spill sensor for monitoring of desalination plant and power plant intakes. Systems currently installed in Middle East locations. Solar powered with remote telemetry alert.

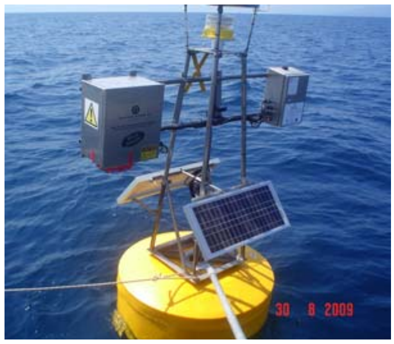

Figure 16. Oil spill sensor aboard water quality monitoring buoy near Greek fish farm area.

6.4. Monitoring for Oil in Effluent Discharge at Power Plants and Refineries

Figures 17, 18 & 19. Typical applications - sensors used for monitoring cooling water and storm water discharge for varying types of oils that could be spilled at refineries, power plants, and tank farms respectively. Alarm and data output sent in real-time to plants' 24-hr control room for instant notification and response. Note that Figure 17 (on left) depicts a unit housed in EXd-rated explosion-proof housing.

6.5. Implementation at Marine Oil Terminal Piers

Figure 20. Remote oil spill detection system deployed at tanker terminal for spill monitoring day and night during loading and offloading activities (note loading arm on pier in the background).

Figure 21. Array of spill detectors being deployed at this terminal, to monitor for both heavy-oils and lighter Benzene fractions. Sensors strategically placed at points along the piers. Local audio/visual alarms on pier plus wireless signal to control room.

6.6. Installation on Offshore Loading Buoys ("SBM"s)

Figures 22 & 23. Spill sensors mounted on the outer circumference of offshore tanker loading buoys. 2-sensors mounted on each buoy at 180° (i.e. on opposite sides of buoy). Oil-on-water alarms are sent to shore side operations personnel in control room via radio link, then relayed to bridge of tanker vessel to provide near-instantaneous alert of oil spill occurrences.

6.6. Installation at Airports and Municipal Storm Water Lift-Stations

Figure 24. Sensors mounted above storm water discharge canals, monitoring for jet fuel or incidental diesel/oil in runoff from airport tarmacs. Detection alerts airport personnel to shut control valve between discharge canals under airport property, before subsequent outflow to public waterways downstream.

Figure 25. US Army Corps of Engineers utilizes a network of sensors at critical pump stations (lift stations) to prevent potential oil spills in city drainages from getting into a major river where Salmon spawning occurs. Alarm signal automatically disables the pumps and remote alarm is received at the local 24-hour manned control center. 5-unit system has been in operation for several years.

7. Conclusion

The fundamental principle of detection upon which this sensor is based is not new science, however the methodology, development and application of technology described herein is new and innovative. Non-contact UV spill detectors are now being used successfully in various regions throughout the developed and developing world, demonstrating value and utility for a wide range of user applications. Numerous instances have been reported whereby the sensor has performed as intended and successfully detected potentially harmful spills. According to one such testimonial; “we received an alarm at the DCS [Distributed Control System – control center] in the middle of the night. On duty personnel were dispatched to investigate what was presumed to be a nuisance alarm, only to discover that an accidental release had occurred and was in process… The spill was contained and problem remedied”.

A notable milestone for this technology is certification for compliance with US EPA’s “Standard Test Procedures for Evaluating Leak Detection Methods”. Regulatory acceptance of new technologies, and corresponding adoption and use of that technology by industry in the real-world, is always a big step in the progression of introducing new technologies for environmental protection. In this manner facilities are encouraged to utilize such types of new technologies for automated detection, early warning, and in some cases automated unmanned containment.

During the course of development, many users have provided and continue to provide valuable feedback, helping define what is needed, and contributing to broader awareness and acceptance of remote spill sensor technology as a cost-effective tool and Best Management Practice. End users and new applications are driving further development of this technology, and R&D is ongoing to refine and continuously improve system performance and increased detection capabilities. One such internal effort at this time is to meet new demands in the offshore environment, and for protection of sensitive habitats like wetlands and mangroves in remote coastal areas.

A key component going forward will be to increase awareness of the availability and benefits of new sensor technologies, and to encourage the widespread use of remote spill alarms and related spill abatement technologies as integral components of spill prevention and response strategies. The future appears to be now for utilization of remote spill detection technology to aid in the prevention and early containment of oil spill pollution.

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