CASE STUDY:

Chelsea Technologies Group

Chelsea Technologies Group (CTG) specializes in the design and manufacture of sensors and systems for a wide range of markets, including: oceanographic, maritime, environmental, defense, homeland security and industrial process control.

CHALLENGE

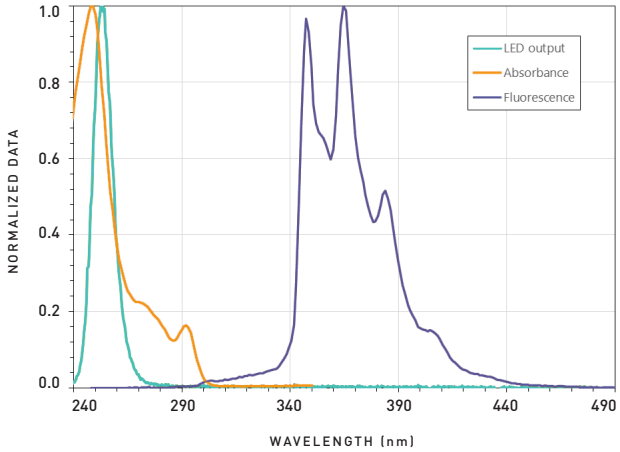
The International Maritime Organization (IMO) has continued to tighten regulations on sulfur content in marine fuel in order to reduce sulfur dioxide (SOx) emissions from ships. When the global limit drops to 0.5% in 2020, the shipping industry will face a difficult decision— switch to expensive low sulfur fuel (with an economic impact estimated at tens of billions of dollars annually) or implement relatively lower cost exhaust cleaning systems.

Exhaust cleaning systems use gas scrubbers to reduce emissions. In addition to SOx, emissions from marine diesel engines contain particulate matter and polycyclic aromatic hydrocarbons (PAHs). Wet scrubbers clean a wide range of pollutants out of the exhaust gas, including SOx and PAHs. One of the principal challenges associated with wet scrubbing is handling the wash water discharge since PAHs are harmful to both people and the environment. Therefore, after scrubbing, the wash water is treated and monitored for PAHs prior to being discharged into the sea. This reduces the possibility of pollution shift from air to water, which would negate the environmental benefits of exhaust gas cleaning.

Low concentration levels of PAHs such as phenanthrene can be measured using fluorescence spectroscopy at 255 nm excitation. In fluorescence spectroscopy, the emission intensity (signal) is directly proportional to the concentration of the fluorescent compound over a wide range of concentrations. The emission intensity is also directly dependent on the intensity of excitation, so the higher the intensity of the light source at 255 nm, the more sensitive the detection.

TIGHTENING IMO REGULATIONS ON SULFUR CONTENT IN FUEL ARE DRIVING THE IMPLEMENTATION OF EXHAUST CLEANING SYSTEMS IN SHIPS AND MONITORING OF PAHs IN THE WASH WATER DISCHARGE.

FIGURE 1



Absorbance and fluorescence spectrum of phenanthrene, with an overlay of the Crystal IS 255 nm Optan LED spectrum

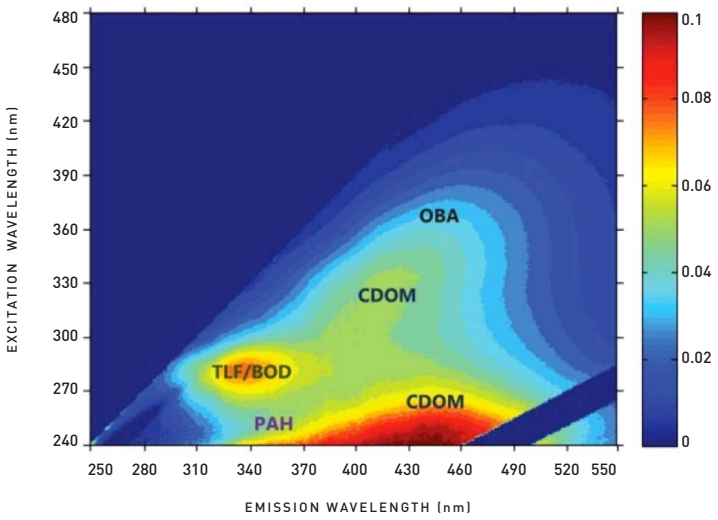
Fluorometers operating in the deep UV wavelengths have traditionally used xenon flash or deuterium lamps. These sources have more complex circuitry and a higher cost of ownership in relation to solid-state light sources like LEDs. However, the adoption of UVC LEDs in fluorescence applications has been hampered by low light output and short lifetime of early commercial devices, which leads to poor sensitivity in the application. When developing their high performing UviLux sensor, CTG looked to Crystal IS for high light output, long lifetime UVC LEDs.

SOLUTION

CTG's newly developed UviLux is a highly sensitive fluorometer to monitor PAHs including phenanthrene. The UviLux uses a UV LED from Crystal IS as the fluorescence excitation source and a miniature photomultiplier as the detector with specific optical filtration providing the 'tuning' required to target various measurement parameters. In addition to PAHs, the UviLux fluorometer can be configured to measure parameters such as Coloured Dissolved Organic Matter (CDOM), Tryptophan-like fluorescence (TLF), Biological Oxygen Demand (BOD) and Optical Brightening Agents (OBA), as illustrated on the next page.

"THE EXCELLENT LONG-TERM STABILITY OF CRYSTAL IS UV LEDS DEMONSTRATED THROUGH OUR EXTENSIVE IN-HOUSE TESTING NOT ONLY HELPS TO EXTEND OUR SENSORS' LIFETIME, BUT, MORE IMPORTANTLY, THEIR CALIBRATION INTERVAL, WHICH HELPS TO REDUCE 'THROUGH LIFE' COSTS FOR OUR CUSTOMERS."

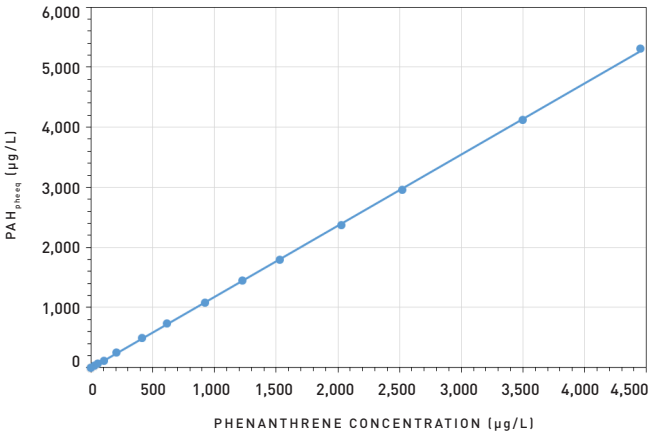
FIGURE 2



Fluorescence excitation-emission matrix of a natural freshwater sample, indicating PAH, TLF/BOD, CDOM and OBA

A key application for the UviLux fluorescence sensor is in CTG's Sea Sentry system for exhaust gas wash water monitoring. The Sea Sentry system allows CTG customers to meet IMO environmental regulations around monitoring wash water for PAHs (defined as phenanthrene fluorescence equivalence), pH, Turbidity and Temperature. CTG's Sea Sentry is a 'turnkey' system that provides all four parameters for integration within an exhaust gas cleaning system. The UviLux PAH+ sensor used in this application incorporates a Crystal IS 255 nm Optan LED to target phenanthrene fluorescence with industry-leading sensitivity. The UviLux PAH+ sensor also provides a simultaneous measurement of UV sample absorbance. By combining absorbance and turbidity measurements, a correction is made for attenuation effects in the sample, which can be problematic in wash water with high color and/or turbidity. CTG has demonstrated that with their absorbance and turbidity correction algorithm, PAHs can be monitored over the required range of 0 - 4500 µg/L phenanthrene equivalence, in water turbidity up to 1000 Formazin Turbidity Units (FNU).

FIGURE 3



UviLux PAH+ sensor dose-response curve to phenanthrene, demonstrating the excellent linearity (R2 = 0.99998) that can be achieved across the full range from 0 - 4500 µg/L, with integrated absorbance correction

Dr John Attridge, CTG's Technical Director, said: "The excellent long-term stability of Crystal IS UV LEDs demonstrated through our extensive in-house testing not only helps to extend our sensors' lifetime, but, more importantly, their calibration interval, which helps to reduce 'through life' costs for our customers."

Crystal IS ADVANTAGE

LEDs offer instantaneous response, low power consumption and design freedom over traditional light sources. In addition, Crystal IS deep UV LEDs provide:

>High light output for trace detection in the parts per trillion levels

>Long lifetime that extends calibration and maintenance periods

>Excellent reliability that prolongs sensor lifetime

Crystal IS™
High Performance UVC LEDs

70 Cohoes Avenue
Green Island, NY 12183
U.S.A.

www.cisuvc.com
518.271.7375
sales@cisuvc.com