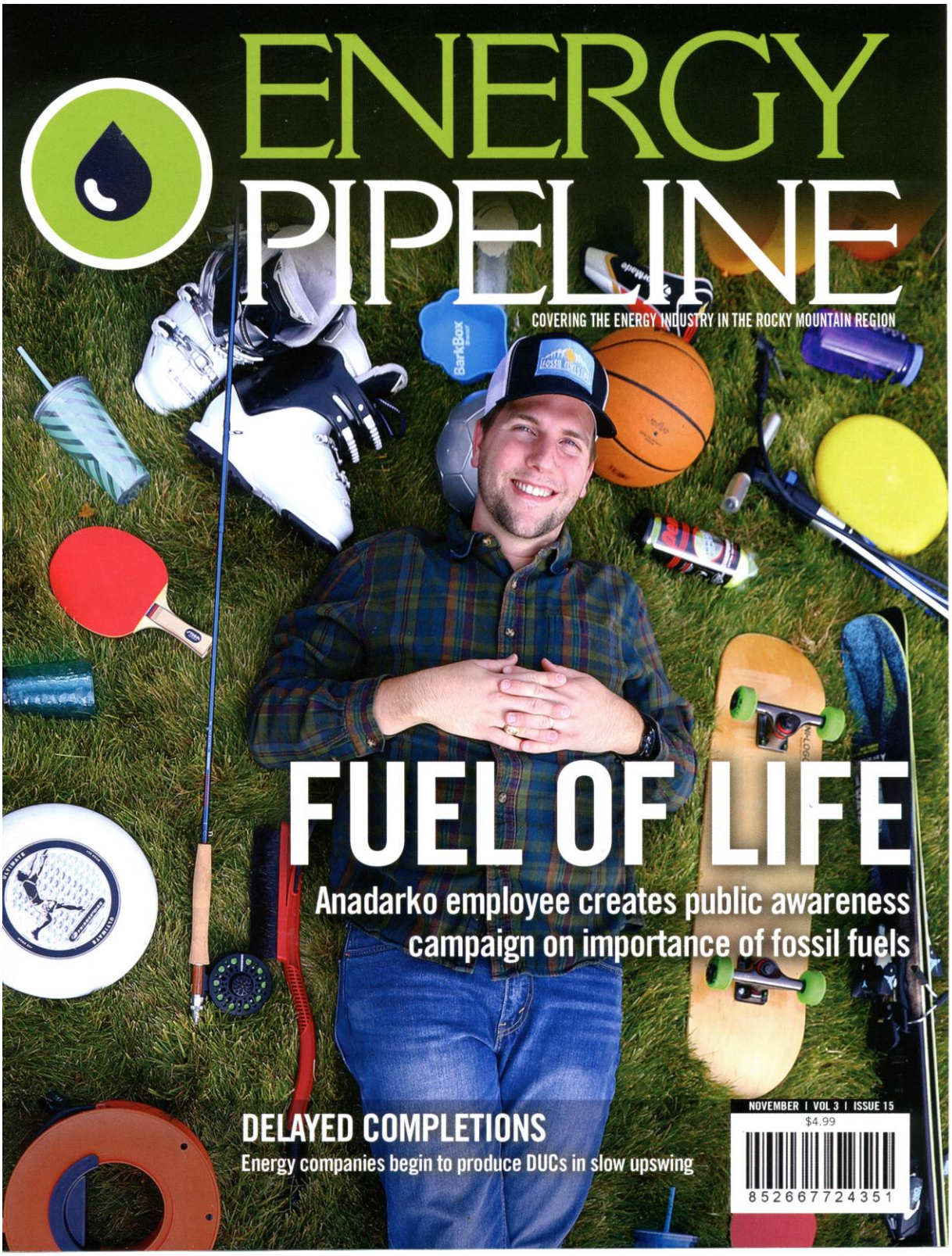
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Environmental conditions can cause pigments to change colors

BY GARY BEERS • FOR ENERGY PIPELINE

For over 50 years, **GARY BEERS**, has worked in numerous fields of environmental science as a consultant, regulator and educator. This career included senior management position with major consulting, nonprofit and public organizations. He has founded several successful firms to capture emerging resource management markets. One of his latest ventures, EnviroScienceINFO, provides content for public media.

The amazing chameleon (Figure 1) has the marvelous ability to see the color patterns of their environment and can closely match these designs by changing the color patterns in their skins. Recent advances in pigment technology have produced "smart pigments" that change color in response to specific changes in local environmental conditions. These emerging products are finding valuable applications at aerospace, power, and manufacturing, and oil/gas facilities.

INTELLIPIGMENT TAPE CHANGES COLOR TO INDICATE HYDROGEN LEAKS

A specialty tape containing proprietary color-changing pigments can be wrapped around pipe fittings, flanges, valves, and storage/transportation vessels and will immediately change to black at locations where hydrogen gas is detected. Under a grant from NASA, researchers at the University of Central Florida develop a color-changing (chemochromatic) tape starting with a powder patented by Japanese researchers that changed color in the presence of hydrogen. The critical improvements by the Florida researchers involved adjusting the chemistry so that the color change was immediate and visible to the naked eye (NASA Technology, Spin-Off, 2016). This research project received numerous awards including "NASA Commercial Invention of the Year" in 2016. The technology is licensed to HySense Technology which sells a product, Intellipigment tape, for detecting hydrogen gas leaks.

The advantage of this chemochromatic tape is obvious and can save time and lives. Previously, workers would use electrochemical and combustible gas sensors to identify the presence of possible leaks in areas where many hydrogen transfer lines were present, but locating the specific leak of the colorless, odorless gas was time-consuming. However, with the lines wrapped, the location of the leak would be immediately located by the worker since the tape at the site of the leak would change from a tan color to a black color.

SMART PAINT SIGNALS WHEN EQUIPMENT IS TOO HOT TO HANDLE

A paint for use in coatings and packaging changes color when exposed to high temperatures – thus, delivering a visual warning to workers handling material or equipment with the potential to malfunction, explode, or cause burns when overheated. The coatings turn different shades of color from red to blue in response to a range of temperatures, beginning at 95 degree F. (New Jersey Institute of Technology, Press Release, 2014). Further, this material can indicate how long a substance has been exposure to high temperature high enough to comprise its functionality.

Key applications include:

• thermal-coated tools indicating when they have become dangerously too hot to handle.

• warning to firefighters of the intensity of the fire on the other side of a door coated with thermal paint.

These researchers are working on related "smart paint" technologies that would signal whether an item has been damaged by force, shock, or exposure to dangerous chemicals – such as carcinogens

SMART PAINT DETECTS STRUCTURAL DAMAGE

There are paints that will transmit damage to a structure. Carbon nanotubes (which can carry electrical current and are powered by a battery) and fly ash are combined into a cement-like coating that can be sprayed onto any surface. When structural defects start to occur, the paint starts to bend and a change in conductivity is wirelessly transmitted to a remote computer (Smart Paint Could Make Bridges, Mines Safer. CNET, Tech Culture, January 2012).

There are valuable applications of this smart paint for monitoring the structural status of storage vessels and pipelines in oil/gas field operations, especially where the equipment is located at remote locations or where access is difficult.

SMART PAINT CAPTURES ATMOSPHERIC POLLUTANTS

An interesting emerging technology involves embedding tiny particles of silver which capture atmospheric pollutants (Oi! You've Missed a bit. The Economist Online, February 2012)

In related developing applications,

• smart paints are able to change color in response to various gaseous mixtures of petroleum organic chemicals (i.e., benzene, xylene) at various temperatures) (Smart Pigments with Reactive Nanocolors Printed on Paper and Flexibles, 2009 International Conference onNanotechnology for the Forest Products Industry).

• self-propelled tiny "microbots" with smart paint coatings can travel in wastewater and adsorb lead from a level of 1,000 parts per billion down to 50 parts per billion in an hour (InnovOil, Tech Radar, Innovation in the Oil and Gas Sectors, May 2016).

News Briefs

HALLIBURTON COMPANY & U.S. SILICA HOLDINGS, INC.

HOUSTON — Halliburton Company and U.S. Silica Holdings, Inc. in October announced the companies have moved a record-breaking unit train carrying nearly 19,000 tons of U.S. Silica frac sand from Ottawa, Ill., to Elmendorf, Texas. The train, the largest frac sand unit of its kind shipped to date in North America, arrived Oct. 13 via the BNSF railroad. Unit trains reduce transit time from mine to transload facility.

"Utilizing sand unit trains enables Halliburton to respond to customers' needs on a shorter timeline and deliver cost efficient sand on location to drive the lowest cost per BOE," said Richard Gonzalez, vice president of Production Enhancement for Halliburton. "Our extensive infrastructure along with a great working relationship with U.S. Silica highlights our strength in collaborating and engineering solutions to maximize asset value for customers."

"Unit train delivery, leveraging our combined logistical assets, is the most efficient and cost effective way to deliver high volumes of sand in the time constraints required," said Don Weinheimer, senior vice president and president of Oil and Gas for U.S. Silica. "Unit train capability is increasingly critical to our customers success as sand demand per well continues to ramp up."

The unit train, which originated at U.S. Silica's largest plant in Ottawa, Ill., took five days to build and was loaded with 30/50 and 40/70 U.S. Silica frac sand. It was received at the Halliburton Elmendorf South Texas Sand Plant, which can handle two 115 car unit trains simultaneously and can hold 40,000 tons in its eight silos. The facility is located within the Alamo Junction Rail Park in Elmendorf, about seven miles from the company's South Texas Operations Center in southern Bexar County.