

Dotz Nano's Carbon Dots (CD)

Ground Breaking Tracing and Tagging Solution for Oil Industry Applications

Dotz's CDs are water soluble, resistant to photo-bleaching and non-toxic.

These unique properties make them ideal for applications hitherto impacted by the potential risk of harmful chemicals in the Upstream Oil & Gas Exploration & Production market.

Additionally, Dotz's patented process for introducing and extracting CDs as taggants in crude oil and oil-based derivative products makes them ideally suited for security or product integrity devices for use in the Downstream shipping, transportation and points-of-sale.

✓ CDs Advantages Over Fluorescent Organic Dyes & Heavy Metal Quantum Dots

- Tuneable emission spectra (Blue, Cyan, Aqua Green and Red)
- Detectable signal brightness even at extremely low level concentrations
- Stable in all downhole environments
- Photo stability
- Biological stability
- Temperature stability
- Pressure stability
- No naturally occurring chemical presence in formations
- No damage to the reservoir formation (tested & approved by COREX in laboratory conditions that replicate subsurface applications)
- Low cost - less expensive than graphene or carbon-fibre alternatives, and comparable with fluorescent dyes
- Non-toxic - therefore usable in any concentrations without damage to the environment or hazard to health



Wec BrandDesign



www.dotznano.com



Tracing and Tagging Solution for Oil Industry Applications

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Subsurface Oil Industry Applications - Upstream

UP

CDs can be used in subsurface applications as a means of detecting reservoir and formation damage, hydrocarbon flow paths and water dilution effects.

In both drilling and production activities CDs can be used as an inexpensive and non-toxic alternative to fluorescence dyes or radioactive taggants for injected fluids in either frac or inflow / water flood operations.

Drilling Applications

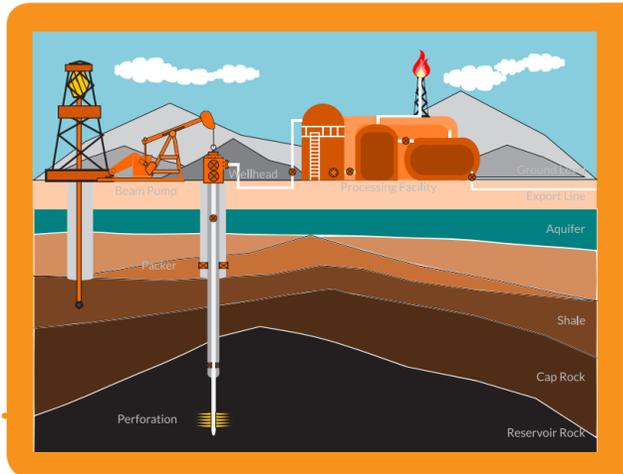
The **two main applications** for use of tracer technologies in the drilling environment are with drilling muds and formation fluids.

- **Drilling Fluid Invasion Detection** - testing the thickness and invasion of drilling mud (mudcake) to the rock formation

- **Formation Damage Control** - testing the reservoir rock properties in a variety of laboratory-simulated pre-completion and pre-production scenarios

- 1 Determination of drilling fluid (mud) invasion in core samples and formation fluid samples and help identify and quantify:
 - Sw, Rw and hydrocarbon saturations
 - Contamination of downhole formation fluids

- 2 Determination of formation damage effects of any injected fluids or moveable fluids in the reservoir system:
 - As drilling muds
 - As part of completion processes
 - As part of reservoir production
 - Injected as part of Secondary and Tertiary production phases

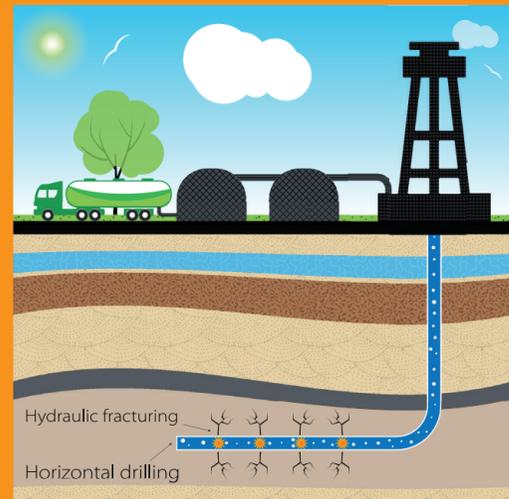


Completion Applications

- **Hydraulic Frac Fluid Flowback** - measurement of injected frac fluid flowback water, testing for dilution from formation water breakthrough
- **Hydraulic Frac Fluid Pollution** - detection of frac fluids in ground water aquifers

CD tags can be added to the injected frac water used for cracking of tight reservoir rock or shales and for the transportation of proppant that hold the fractures open.

Emission spectrum of any specific CD signature used can be detected in flowback water at the wellsite using portable lab kit, and dilution effects from produced formation water can be measured accurately.



Reservoir Solutions

- **Inflow Measurement** - measuring reservoir production performance.
- **Inter-well Performance** - measuring travel paths and flow dynamics for injected water multi-well reservoirs.

After initial reservoir pressure depletes in an oil well, secondary recovery phases are used, injecting water, steam or gas into the formation, to drive the oil to the surface.

Tracers are the only sure way of measuring where injected water goes within the reservoir, tracking flow paths and detecting unflushed areas. Using CDs with unique spectral signatures enables accurate measuring of the tagged fluids produced from each completion point within the production wells, and so help show flow dynamics within the reservoir and identify reservoir optimisation targets.

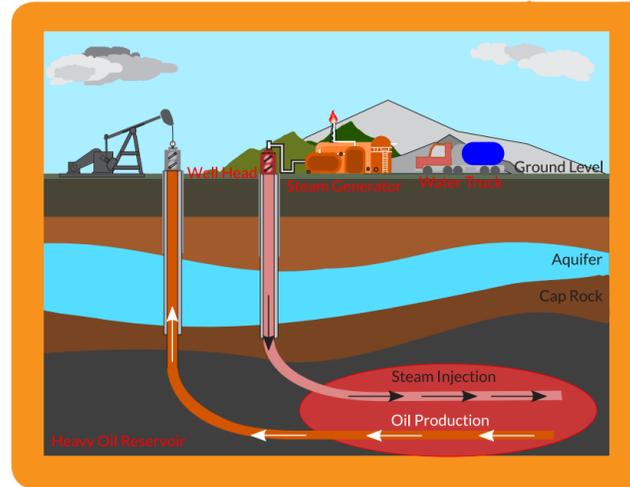
Tagging fluids injected into the wells with specific and unique CD signatures assists in the detection of the flow paths and identification of unflushed areas.

Measuring the UV spectral tuning of water produced from each completion point within the well(s) to help show flow dynamics within the reservoir and identify optimisation targets (IOR/EOR).

Improved Or Enhanced Oil Recovery (IOR/EOR) Projects based on tracer survey results can remodel the reservoir or reengineer wells and completions to optimise production.

HOW IT WORKS.....

- Emission spectrum of any specific CD signature used in injection fluids can be detected in tested flowback water measured at the wellsite using portable lab kit.
- Signature of injected water is unique, providing the capability of positively identifying source of water (injection well or completion point).
- Retrieved injected water from any given well in the reservoir reveals unique spectral signatures and concentrations of CD taggant when tested in the portable lab kit, helping to determine flow paths within the reservoir from injection points.
- 1ppm saturation of CDs visible under UV light to the naked eye but more diluted concentrations visible only via lab kit.



HOW IT WORKS.....

- A specific colour spectrum of CD taggant is introduced to the frac fluid at a diluted level.
- Given the volume of injected water used in the frac process (in excess of X gallons), concentrations of taggant can be reduced from ppm to ppb ratios without affecting dilution detection rates.
- Even minute dilution effects from mixing of produced formation water or breakthrough from water wet reservoir sections can be detected in samples of flowback water tested at the wellsite with portable lab kit.

Minute tracer levels may also be capable of detection in sampled ground water around the wellsite to determine whether breakthrough of frac fluids to water aquifers has taken place.

Given the unique spectral signature of the CD taggant, this is a 100% accurate way of detecting a frac fluid spill or migration event.

Oil Industry Applications - Midstream & Downstream

The primary use of CD taggants in the **Midstream** and **Downstream** areas of the market are for Product Integrity.

MID

Midstream.....

Security tagging crude oil & refined products through production, refining, shipping & transportation stages.

DOWN

Downstream.....

Ending with anti-counterfeiting measures at the storage, distribution and point-of-sale locations for the various derivative oil and gas products.

Unique Features.....

Dotz's innovative CDs has a number of unique features that enable it to tag or mark liquids in bulk quantities that can be then transferred to smaller packages if required:

- The quantity required for marking is extremely low (PPB levels)
- Non-toxic
- Tagging of bulk liquids in large volumes is highly cost effective
- With almost infinite encoding combinations a signature can be created for every client / batch / lot number

- Compatible with any bulk liquid
- Does not affect the properties and appearance of the tagged products
- Stable over time in harsh conditions
- Has a unique footprint that can thwart any attempt to replicate the taggant
- Can be detected in the field with a simple technique and inexpensive reader

Gasoline Supply Chain Overview.....

Dotz's encoded CDs can be inserted in anyone of the supply chain nodes:

