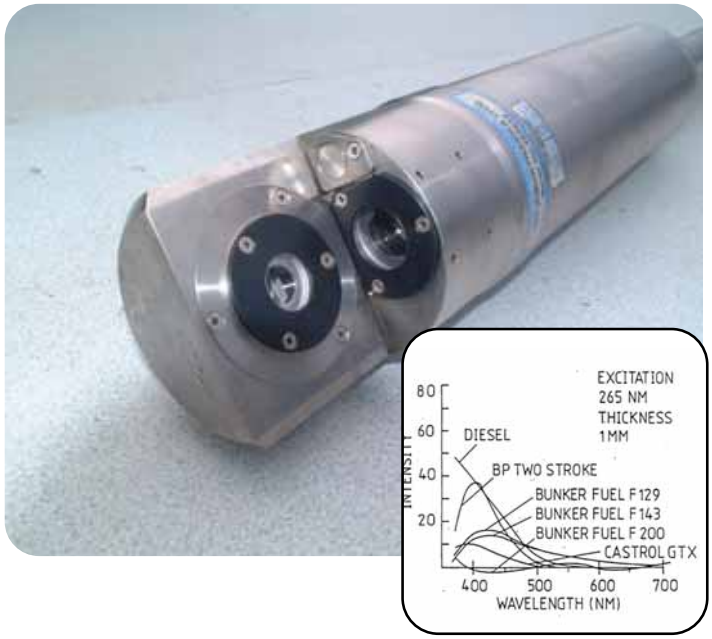
RG TECHNICAL REPORT

Robertson Geologging Ltd.
(USA)tel: (281) 807 6209 (UK) tel: +44 1492 582323
email: sales@geologging.com web: www..geologging.com

Hydrocarbon detection with new Ultra-violet Fluorimeter Sonde UVFS

Robertson Geologging Ltd., supported by Greg Hileman of USGS Nashville, carried out trials of a new borehole UV fluorescence probe (UVFP) at Fort Campbell US Army airbase in June 2003. Our object was to evaluate the potential of the UVFS probe to detect hydrocarbon contamination in water wells. The test wells included a highly contaminated example close to a fuel storage tank, lightly contaminated boreholes containing both water and vapour and a remote borehole believed to be free of man-made contamination. The UVFS probe produced repeatable logs from each borehole and proved to have adequate sensitivity to detect variations of hydrocarbon concentrations both in water and in vapour.



Principle:

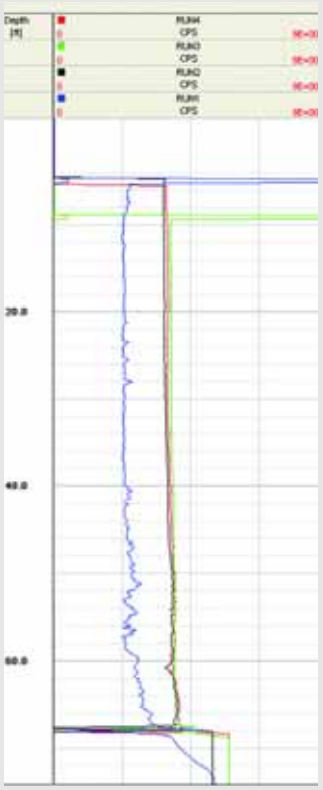
Most crude and refined petroleum products fluoresce in the UV when excited by ultra-violet radiation of an appropriate short wavelength. This fluorescence arises from organic impurities in the oil, the major types being polyaromatic and heterocyclic hydrocarbons. The mixture of such impurities and its fluorescent spectrum fingerprint a particular sample of oil.

The UVFP uses a powerful xenon lightsource pulsed at 4ppsec. The lamp emits UV radiation at a peak wavelength of 239nm. This UV beam is collimated and focussed through a window in the probe onto a small volume of the surrounding fluid or vapour. Fluorescence from oil in this volume is detected by a sensitive photomultiplier. An optical filter centred on 360nm is used to discriminate hydrocarbon fluorescence from that produced by organic decay (gelbstoff). The probe contains electronics to stabilise against drift through lamp aging or temperature.

Since the probe responds to concentrations of impurities of unknown compositions it is not possible to calibrate it in the accepted sense for general hydrocarbon concentration. Instead, the probe is standardised against a known concentration of carbazole, a pure organic compound with a similar fluorescent fingerprint to common oils. Logs from the standardised probe can then be calibrated against laboratory analysis data from water samples taken from the particular well.

The probe is 90mm diameter and rated to 600m depth. It produces a single channel of 24-bit digital data which represents the total intensity of UV radiation detected by the photomultiplier. The UVFP is compatible with all RG current RG logging units and winches/cables.

Well 1 (ref. EXT43)
WL 68', TD 92', screened 62' to TD

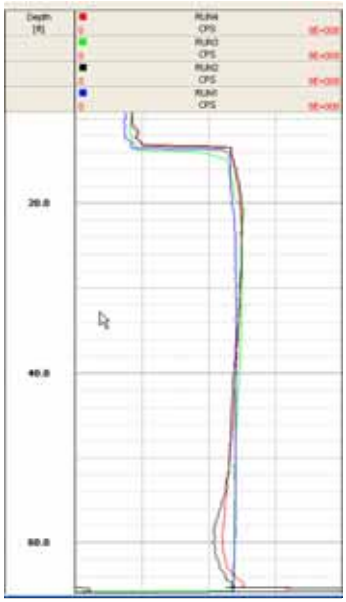


Located adjacent to a fuel storage tank, Well 1 contained both water and vapour and was described as "highly contaminated". A strong fuel smell was evident when the well was first opened. The probe body was coated with free oil on withdrawal.

Down and up logs clearly showed the vapour/water interface at 68' with the higher concentration of hydrocarbon in the water. There was a 25% difference in vapour concentration between the first down run and later runs. The higher concentration during later runs is thought to result from contamination of the optics by a thick layer of oil on the water surface. The strong 'kick' in the probe response at the water surface lends credence to this as this feature was not observed in other wells.

Well 3 (ref. EXT17)
WL 13.2', TD 71.4', screened 21' to 71'

Well 3 was located adjacent to the apron of the airfield and was again described as "contaminated". The well contained mainly water.

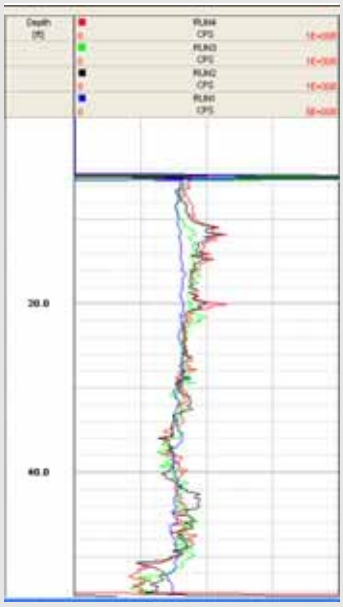


The first 'up run of the probe was aborted after the probe optics became blocked with mud at the bottom of the well. After cleaning, four subsequent logging runs, two in each direction, showed a consistent probe response. The uv intensity value of around 4.8E8 cps was similar to that in the water near the bottom of the known heavily contaminated Well1 and was probably representative of fuel-saturated water.

Both up-direction logs showed a reduced response on starting the log at the bottom of the well. Tests logging a stationary probe, for 10 minutes in 'time-mode' eliminated probe drift or any artifact of switching the probe 'on' as the cause of this. It is believed that the effect was due to mud settlement in the well during the 5-10 minutes that the probe remained stationary near the bottom between logging runs.

Well 2 (ref unknown)
WL 56.2', TD 57.5', screened 30' (approx) to TD

Well 2 was located some 150 yds from Well 1 in a direction away from the fuel storage facility. It was described as "clean". However, an oil film was evident on the probe after logging. The well contained vapour almost to TD.



Four logging runs were made, two in each direction. Runs 2, 3 and 4 gave consistent results with good repeatibility of features. The agreement was particularly remarkable given the major disturbance of the vapour column by the 90mm probe moving in a 100mm borehole.

The first run 1 down again was anomalous, with the UV response appearing some 5x greater than in later runs. The response was similar to Run 1 in Well 1 and clearly indicated fuel-saturated vapour, the result of the well being shut-in for a long period prior to logging. The failure to return close to saturation levels during subsequent runs suggested that the contamination of the surrounding soil was much lower than in Well 1 and that a longer time would be needed to equilibrate.

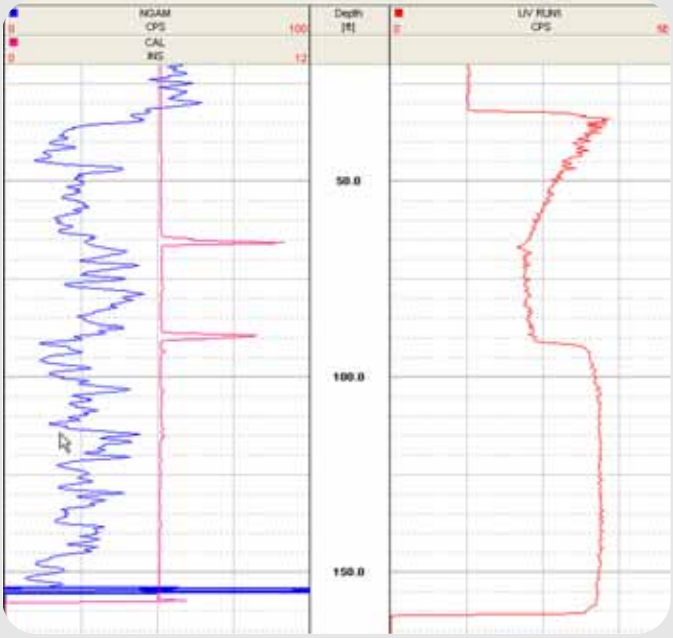
Well 4 (ref. unknown)
WL 32', TD 161', partial 6" casing

Well 4 was located off the main site near a firing range and was remote from any fuel storage facility. However, natural hydrocarbons are present in marine shales in this area.

In addition to a the UV log, calliper and natural-gamma runs were made in this borehole. The optics of the UV probe were blocked by mud at the bottom of the borehole at the end of the first run down and no up log was attempted.

The calliper showed two washouts at 66' and 89' and a casing shoe at 47'. Below the 89' washout, the UV response indicated a constant level of hydrocarbon. Between 89' and the upper washout at 66', the hydrocarbon level was constant but lower. Between water level and the upper washout, the hydrocarbon level decreased at a constant rate with depth.

Thie hydrocarbon profile suggests an internal flow in the well with hydrocarbon-contaminated water entering at the upper washout or fracture and leaving at the lower one. Below 89ft, there is no flow and the well acts as sump collecting denser hydrocarbon. Further logs including a heat-pulse flowmeter would have been invaluable here to test this hypothesis.



Summary

The UVFM probe has shown adequate sensitivity and stability to be of use in water-well hydrocarbon contamination studies both in water and in air. Its response varies according to the fluid and contaminant type. The probe provides a relative measure of hydrocarbon concentration in a given well. Where quantitative data is required, the UV logs may be calibrated against laboratory analyses of water samples taken from the same borehole.

Further tests are in progress to evaluate the use of the probe in detecting thief zones in coal-bed methane (CBM) wells and in cross-borehole tests with fluorescent tracer dyes for ground-water studies.