Halloween

Penetrant Professor

from

Met-L-Chek®

Hydrophilic Emulsifier & Refractive Index

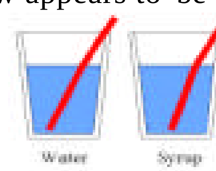
ASTM E-1417 and other specifications pertaining to the operation and maintenance of post emulsifiable penetrant inspection systems require that the concentration of the hydrophilic emulsifier be monitored. This is done using a refractometer and comparing the reading to that of a chart. A calibrated refractometer must be used, and the chart must be derived from actual samples of the emulsifier. Met-L-Chek offers 2 calibrated refractometers, **RHBN-32ATC** & **ZGRB-32ATC**, that give accurate readings for the chart supplied with E-58D. Uncalibrated instruments can give readings that are either too high or too low, resulting in concentrations that may be outside of the limits of the specification.

ASTM E-1417, paragraph 7.8.2.6 reads as follows:.. "Concentration of the emulsifier solution shall be checked at the intervals specified in Table 1 using a refractometer...

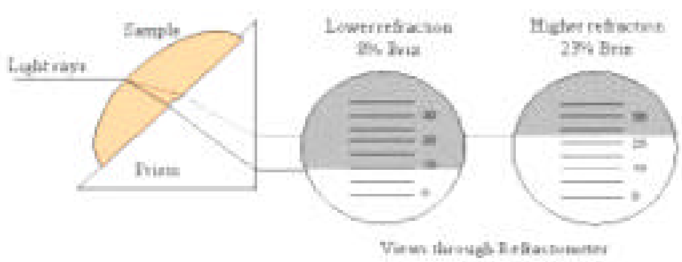
Refractometer values obtained shall be compared to actual values obtained from known concentrations of emulsifier. For immersion applications, the concentration, as percent of volume, shall be no higher than that specified by the penetrant system supplier and shall not exceed that for which the system was qualified. For spray applications, the concentration shall not exceed 5 %."

Refraction of light is the bending of light rays at the interface of dissimilar substances. When light is passed from a lower refractive substance into a higher refractive substance the light rays bend toward the perpendicular to the surface. When light is passed from a higher refractive substance into a lower refractive substance the light rays bend away from the perpendicular to the surface.

Refraction is easily demonstrated by placing a straw in a glass of water. As light passes from the air into the water it is bent and the straw appears bent. If corn syrup is added to the water increasing the solution density the refraction is greater and the straw appears to be bent even more.



Refractometers are instruments that measure the bending of light as it crosses an interface between dissimilar substances and converts the bending light rays into a useful scale. It must be remembered that refractometers measure the refraction of light relative to some standard and some substance. The results for one emulsifier will not necessarily be the same for a different emulsifier.



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CASR

2007

In a previous meeting of the CASR study group, the results of a study of penetrant indication fade under various intensity levels of UV-A illumination were presented. However, the fade results were presented with the initial indication brightness obtained by each of four UV-A intensities normalized to 100%. While interesting, the normalization did not allow one to assess the comparative brightness of the indications under the different intensities and at the different times of exposure. At the suggestion of Met-L-Chek, this study was redone so that this important information could be seen, and the results were presented in a telephone conference on September 11, 2007. Without going into the details of the study, which was competently done using two cracked specimens, the results are shown in figures labeled 12 and 14, below.

What one can see here is that the indications do fade from the more intense UV-A illumination, as expected, and as widely acknowledged. However, if one compares the brightness of the indications, illumination intensities higher than 1000 µW/cm^2 produce brighter indications that last until the fading reduces the indication brightness to the same level as 1000 µW/cm^2 would produce. This does not happen as fast as the conventional (and untested) wisdom might expect. For almost any intensity up to 20,000 µW/cm^2, the indications are brighter than what 1000 µW/cm^2 would produce up to almost a 20 minute continuous exposure.

This information augments the previously reported results, and is far more useful in deliberations concerning applicable specifications that prescribe limits on the UV-A intensity and the time of exposure of the indication to the illumination.

In addition to these results, the study also presented the theoretical brightness of a crack that was illuminated with 800, 1000, and 1200 W/cm^2 of UV-A. However, this information was theoretical and did not take into account the fact that there are two countervailing processes simultaneously affecting the indication brightness as time passes. The first effect is that the brightness decreases with increasing exposure to the UV-A, and the rate of decrease is faster with higher intensities. The second is that the brightness is increasing as the indication continues to develop and more of the penetrant exudes into the developer. The theoretical brightness values shown in the report only took into account the increase in brightness due to increasing illumination intensity. From the results shown, one could conclude that the higher intensities were desirable because they resulted in brighter indications. Closer attention to the process has already shown that the brightness of an indication produced by 1000 µW/cm^2 increases over time as more of the penetrant in the defect exudes into the developer, and this effect counters any fading of the brightness due to exposure to the UV-A. The unanswered question is whether the fading of the indication over time counters this increase when higher illumination intensities are used. This phenomenon is probably only of concern when the intensities are fairly low and close to the same value (such as 800, 1000, and 1200 µW/cm^2), since higher intensities (such as 5000 µW/cm^2) completely dominate what is happening and dwarf the increase due to further development of the indication. Future work might address this question.

The
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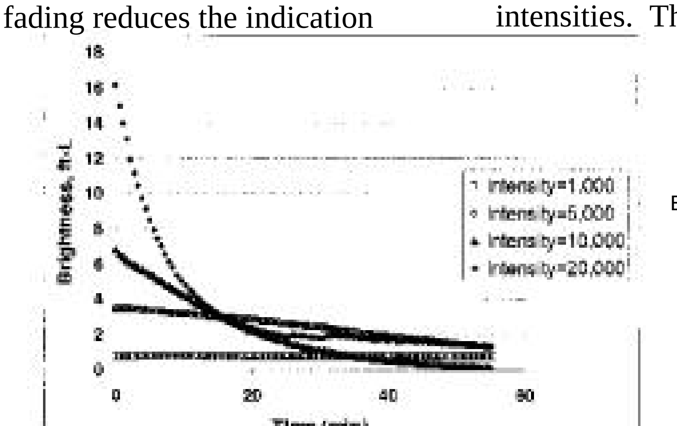

Figure 12: Change in corrected indication brightness over time for a single 0.040" long lcf crack (sample 02-484) repeatedly processed and exposed to different intensities of UV-A radiation.

Center for NDT Evaluation Iowa State Univ.

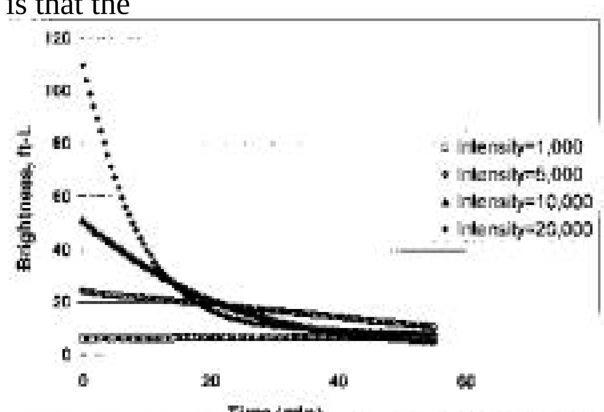

Figure 14: Change in indication brightness over time for a single 0.069" long lcf crack (sample 02-475) repeatedly processed and exposed to different intensities of UV-A radiation.