1.6.7. PENETRANTS WITH CASCADE LUMINESCENCE IN LUMINESCENT TESTING METHOD

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Paper is devoted to creation of high-sensitive luminescent penetrants for liquid penetrant testing method. Colored and luminescent penetrants in combination with respective cleaning agents and developers are applied in aviation, machine-building, nuclear power and other branches of industry for detection of surface defects during testing of parts and end products.

One of the main properties of penetrants consists in their ability to ensure high sensitivity during testing, i.e. ability to detect, where possible, defects of minimal size. In particular, this requirement is met for the account of selection of efficient luminophores. Moreover, such luminophores must possess with sufficient light intensity on developer sorbents and have high quantum yield of luminescence in solutions.

In order to increase sensitivity of luminescent penetrants, i.e. to increase light intensity in defects, it is possible to use mechanism acting in so-called "multi-fluorophores" systems. In this case, penetrant contains, in particular, two luminophores operating under principle of "cascade luminescence" for the account of intermolecular electronic excitation energy transfer. Herewith, luminophore-donor absorbs light in the radiation domain of UV-lamp used for inspection of parts during testing (λ_{max} = 366 nm). Luminophore-acceptor, in addition to absorbtion of the UV-lamp radiation, absorbs also radiation of luminophore-donor and radiates in the domain being the most sensitive for human eye (yellow-green region of spectrum), thus increasing the method sensitivity.

When single luminophore is used, on the one part, a lot of light is lost in order to achieve the required fluorescence area; it is due to the incomplete overlaying of radiation spectra of lamp and absorption spectrum of luminophore; on the other part, radiation region optimal for human eye is not achieved, because Stokes-shift of luminophores does not exceed, as a rule, 100 nm.

Furthermore, for higher reliability of defects detection, it is necessary, as far as possible, for both luminophores in the penetrant composition to have equal chromatographic mobility and solvability in solvents used in a penetrant and developer (values R_f for both luminophores measured under thin-layer chromatography method must be close to each other).

During development of high sensitive penetrants, we are using dye having absorption maximum at 375 nm and luminescence maximum in the range of 440 – 450 nm as a luminophore-donor. Luminophore-acceptor, in its turn, has absorption maximum at 440 – 450 nm and luminescence maximum within the range of 520 – 530 nm (region being most sensitive for human eye).

Using above disclosed approaches, domestic penetrants with extra high sensitivity asre developed. Moreover, for the account of due selection of solvents, these penetrants possess with reduced toxicity and fire hazard. Penetrants composition includes coumarin of blue-violet fluorescence as a luminophore-donor and one or several coumarins of yellow-green fluorescence as a luminophore-acceptor.

Developed penetrants have I class of sensitivity under GOST 18442 and 3 class of sensitivity under DIN EN ISO 3452-3, respectively.