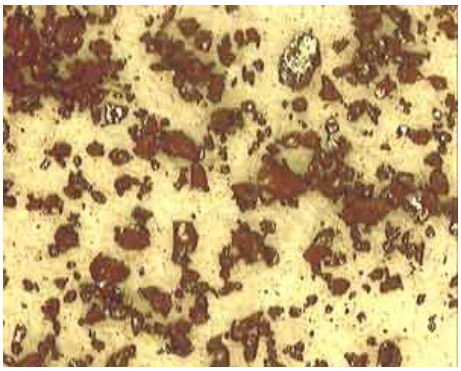
Magnetic Particles

As mentioned previously, the particles that are used for magnetic particle inspection are a key ingredient as they form the indications that alert the inspector to defects. Particles start out as tiny milled (a machining process) pieces of iron or iron oxide. A pigment (somewhat like paint) is bonded to their surfaces to give the particles color. The metal used for the particles has high magnetic permeability and low retentivity. High magnetic permeability is important because it makes the particles attract easily to small magnetic leakage fields from discontinuities, such as flaws. Low retentivity is important because the particles themselves never become strongly magnetized so they do not stick to each other or the surface of the part. Particles are available in a dry mix or a wet solution.

Dry Magnetic Particles

Dry magnetic particles can typically be purchased in red, black, gray, yellow and several other colors so that a high level of contrast between the particles and the part being inspected can be achieved. The size of the magnetic particles is also very important. Dry magnetic particle products are produced to include a range of particle sizes. The fine particles are around 50 mm (0.002 inch) in size, and are about three times smaller in diameter and more than 20 times lighter than the coarse particles (150 mm or 0.006 inch). This make them more sensitive to the leakage fields from very small discontinuities. However, dry testing particles cannot be made exclusively of the fine particles. Coarser particles are needed to bridge large discontinuities and to reduce the powder's dusty nature. Additionally, small particles easily adhere to surface contamination, such as remnant dirt or moisture, and get trapped in surface roughness features. It should also be recognized that finer particles will be more easily blown away by the wind; therefore, windy conditions can reduce the sensitivity of an inspection. Also, reclaiming the dry particles is not recommended because the small particles are less likely to be recaptured and the "once used" mix will result in less sensitive inspections.

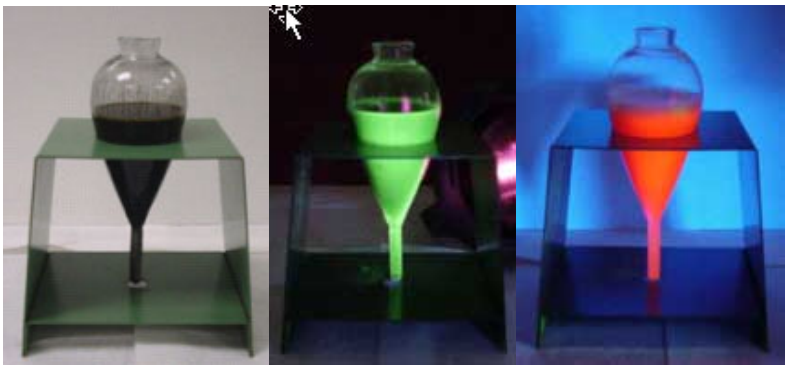


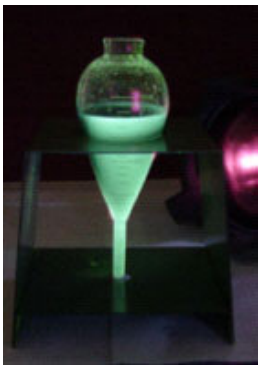
The particle shape is also important. Long, slender particles tend align themselves along the lines of magnetic force. However, research has shown that if dry powder consists only of long, slender particles, the application process would be less than desirable. Elongated particles come from the dispenser in clumps and lack the ability to flow freely and form the desired "cloud" of particles floating on the component. Therefore, globular particles are added that are shorter. The mix of globular and elongated particles result in a dry powder that flows well and maintains good sensitivity. Most dry particle mixes have particles with L/D ratios between one and two.

Wet Magnetic Particles

Magnetic particles are also supplied in a wet suspension such as water or oil. The wet magnetic particle testing method is generally more sensitive than the dry because the suspension provides the particles with more mobility and makes it possible for smaller particles to be used since dust and adherence to surface contamination is reduced or eliminated. The wet method also makes it easy to apply the particles uniformly to a relatively large area.

Wet method magnetic particles products differ from dry powder products in a number of ways. One way is that both visible and fluorescent particles are available. Most nonfluorescent particles are ferromagnetic iron oxides, which are either black or brown in color. Fluorescent particles are coated with pigments that fluoresce when exposed to ultraviolet light. Particles that fluoresce green-yellow are most common to take advantage of the peak color sensitivity of the eye but other fluorescent colors are also available. (For more information on the color sensitivity of the eye...see the material on penetrant inspection.)





The particles used with the wet method are smaller in size than those used in the dry method for the reasons mentioned above. The particles are typically 10 mm (0.0004 inch) and smaller and the synthetic iron oxides have particle diameters around 0.1 mm (0.000004 inch). This very small size is a result of the process used to form the particles and is not particularly desirable, as the particles are almost too fine to settle out of suspension. However, due to their slight residual magnetism, the oxide particles are present mostly in clusters that settle out of suspension much faster than the individual particles. This makes it possible to see and measure the concentration of the particles for process control purposes. Wet particles are also a mix of long slender and globular particles.

The carrier solutions can be water or oil-based. Water-based carriers form quicker indications, are generally less expensive, present little or no fire hazard, give off no petrochemical fumes, and are easier to clean from the part. Water-based solutions are usually formulated with a corrosion inhibitor to offer some corrosion protection. However, oil-based carrier solutions offer superior corrosion and hydrogen embrittlement protection to those materials that are prone to attack by these mechanisms.

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