

Analyzing the Color of Transformer Oil Using Spectrophotometric Instrumentation

An engineer working for a power utility company is asked to check whether the electrical transformers in the field are working properly. Rather than looking closely at the transformers' hardware or performing a test run of the machine, the engineer first looks at the color and clarity of the transformer oil being used. Why? Because the color of the transformer oil can tell the engineer a great deal about how well the transformer is currently operating and detect even the smallest signs of trouble before the device is powered on. [Oil tests](#) are a fast, simple, and inexpensive method for detecting operational problems in a transformer; it's similar to checking a car engine's oil every month or so to ensure that the engine is working properly.

Many power utility companies frequently test the color and quality of the transformer oils they use because high-quality oils can protect their transformers from damage. In fact, transformer oil tests detect an estimated 70% of incipient failures in transformers.¹ Using UV-Vis spectrophotometry, engineers and on-site operations managers can quickly test the color of transformer oil to ensure that it meets exacting standards. By performing these tests periodically, either on-site or under lab conditions, power utility companies and other industries that rely on transformers can ensure that all of their equipment is operating at peak efficiency.

Color is a Sign of Oil Age and Purity

Transformer oil (or insulating oil) is used to keep an electrical power transformer cool during normal operations. Because the voltage used in electrical transformers is so high, the resulting heat can damage the transformer's core and winding.² The oil serves as a protective liquid barrier for the transformer's core, allowing electricity to pass through without overheating the core. These oils also prevent oxidation of the winding's cellulose insulation by limiting the exposure of oxygen in the system. However, although transformer oil plays a major role in the function of an electrical transformer, the oil can also damage equipment if it's not filtered properly or changed frequently enough.

Darkened coloration is the first sign that transformer oil needs to be changed or filtered. As the oil ages, it slowly changes from a pale yellow, transparent color to a deep brown, nearly opaque shade. Most transformer oils need to be filtered or changed at least every six months in order to prevent damage to the transformer, and testing the color of the oil is one of the easiest methods to determine exactly how old the oil is and whether it will still work effectively. Generally, oil that is yellow, orange, or even somewhat red in color is fresher and will work as intended. As oil ages, it transforms to a brown or black color and its efficacy diminishes. If engineers or on-site managers fail to detect these important color changes, the transformer may be more prone to problems like arcing, corona discharge, overheating, or decreased insulation strength.³ This is why testing for color is an essential step to maintaining a fully-operational electrical transformer.

Without careful oil color analysis, a transformer may experience one of the many problems listed above, which in turn could disrupt normal operations and lead to greater maintenance costs. It is usually much less expensive to periodically test for oil color consistency than it is to repair a transformer after it has failed due to overheating or arcing. Moreover, it takes time to repair the equipment after it has already been damaged, which may lead to delays in service. By testing your transformer oil color and standardizing your color measurement protocol, you may be able to prevent these problems before they become more costly.

Full article with photos available here:

<https://www.hunterlab.com/blog/color-chemical-industry/analyzing-the-color-of-transformer-oil-using-spectrophotometric-instrumentation/>