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Functional performance criteria for comparison of less flammable transformer oils with respect to fire and explosion risk

Power grids worldwide are expanding not only driven by ambitious clean energy, but also because of the rising hunger for reliable energy. Key components of these power grids are transformers, in all its forms and sizes. Transformers are traditionally filled with mineral oil, to serve as a coolant and dielectric insulator, but a rising trend is observed globally towards the adoption of less flammable, biodegradable transformer oil at ever increasing voltages and power ratings. The objective of this report is to discuss past, current and future attempts to quantify the fire and explosion risk in less flammable liquid filled high voltage transformers. Development of testing procedure standards that give a reliable assessment of the fire behavior of electro technical insulating liquid based on relevant physical characteristics of the fluids are currently under development, such as IEC 60695-8-3. However more effort is required in order to provide meaningful information concerning the relation between small scale tests and large scale tests and that between the tests and failure scenarios in real life applications. The experimental focus of this report, small scale comparative tests in the Cone Calorimeter, is limited to pool fires. Spray and vapour/gas cloud fires and explosions, even though of great importance, are not considered. In total 5 liquids were tested: mineral oil, silicone liquid, synthetic ester and 2 natural esters. The comparative tests display a wide range of fire properties for the respective liquids. The higher the fire point the longer it takes for a liquid to ignite. Polluting the samples with 3% mineral oil however affected the time to ignition especially for the natural esters. The heat release rate calculated from the cone experiments show analogies with the heat of combustion values tabelled, except for the silicone liquid where a crust formation on the liquid's surface impeded combustion. Great care should however be taken when scaling this small scale burning behaviour to use in fire safety applications