## Miscibility & compatibility

According to IEC 60296, mineral oils are generally considered miscible and compatible if the properties in the mixture are not worse than those of the oils alone.

Oils are rated as physically miscible if a homogeneous phase is created after mixing and no precipitations, cloudiness or phase formations occur.

Mineral oil-based insulating oils of the same classification, group and cold start temperature (LCSET) are considered compatible. No additional testing is required in mixtures up to 10%.

In the event of deviations from the points mentioned above, any mixtures must be classified accordingly, taking into account the classification according to IEC 60296 (type A or type B). Influencing parameters are, for example, the sulfur content, the oxidation stability, the additive content and the straygassing behavior.

## Mixture of insulating oils in delivery condition

(e.g. in the event of a supplier and / or product change in first fill, usually ex tank truck in storage tank)
Practical experience shows that there are generally no problems, not even if insulating oils of different classifications are mixed with one another in delivery condition.

## Mixing of insulating oils in delivery condition with oils in operation in transformers and aggregates

(e.g. in the event of a supplier and / or brand product in the service fill, ex tank truck, drum or IBC in transformer)
Also in this cases it can be seen that there are generally no problems when a small proportion of unused oil is topped up during operation, i.e. the top-up amount corresponds to less than 5% of the operating oil amount, whereby the operating oil itself should still has a "good" rating according to IEC 60422. In practice, larger refill quantities, especially for oils that are more heavily aged, can lead to sludge precipitation

In the case of miscibility inquiries aimed at refilling transformers, the following must be observed beforehand in order to be able to make the best possible statement:

- What oil is in the transformer that needs to be topped up?
- Which standard did this oil correspond at the first fill? (if necessary have data sheets provided)
- Have additives been added to the oil after first fill?
- Is there an analysis available regarding current state of aging of the oil?

## Miscibility tests in case of doubts

In IEC 60422: 2013 5.12. procedures for checking the miscibility of insulating oils in operation are explicitly described:

*„The oils are to be mixed in the same ratio that is expected in the asset. If this ratio is unknown, however, they should be mixed in a ratio of 50:50.*
*For the characterization of pure oils and oil mixtures, at least the following test methods are considered necessary:*

- *Foaming*
- *Oxidation stability acc. 61125 including acidity, sludge and DDF after aging. The test time should correspond to the oil type classification in IEC 60296.*
- *Corrosive sulfur and / or potential corrosiveness after aging according to IEC 61125*

*There is limited experience with the use of oil that contains pour point improvers, which are used to supplement oils with naturally low pour points. Laboratory tests, however, suggest that the low-temperature behavior is unlikely to be significantly impaired.*
*Compatibility tests are particularly necessary for oils that contain additives. Again, it is recommended to consult the oil supplier or the equipment manufacturer."*