

Alternative Technologies

SC A2 Question 2.2:

What is the experience of reliability in service of alternative transformer technologies, especially for demanding applications? Is there any significant difference from the reliability of conventional oil-immersed transformers?

M. STOESSL - AT

G. LEBER - AT



Types of insulation fluids and advantages of ester

Mineral Oil

- Produced from crude oil
- Hydrocarbon compounds
 - Paraffinic, naphthenic, aromatic, olefin
- Advantages
 - Well known, tried and tested
 - Inexpensive (still)



“Synthetic” Ester

- Derived from chemicals
- Product of alcohol with synthetic or natural acids
 - E.g. pentaerythritol tetra fatty acid



“Natural” Ester

- Made of plant seed oils
 - Soya
 - Canola (rapeseed)
 - Sunflower
 - Others



Esters have higher fire safety factors

- Higher flash and fire point
- Fire point over 300°C
 - K class rating (IEC 61039)
- Lower gas conversion factor
 - Tank rupture prevention improvement up to 20%

Esters are environmentally friendly

- Readily / Fully biodegradable
 - In accordance with OECD 301 / IEC 61039



Esters can extend the lifetime of the transformer

- Slower decrease in the degree of polymerization
- Higher capacity to absorb moisture than mineral oil without compromising on dielectric properties
- Higher temperature limits and/or higher insulation life expectancy

Experience of reliability in service of alternative transformer technologies



Siemens Energy's reference list excerpt covers the entire transformer/reactor portfolio

Shipment Year	Fluid Type	Country	f [Hz]	Rated Power [MVA]	Rated Voltage		Cooling Type
					OS [kV]	US [kV]	
2004	Synthetic ester	SWE	50	135	238	13,5	KFWF
2006	Natural ester	BRA	60	50	69	13,8	KNAN
2008	Natural ester	GER	50	40	110	21	KNAN
2009	Synthetic ester	SWE	50	100	235	13,5	KFWF
2011	Synthetic ester	SWE	50	200/100/100	154	13,8	KFWF
2013	Natural ester	GER	50	300/180	420	115	KDAF/KNAN
2014	Synthetic ester	MEX	60	60/48/36	230	23	KNAN/KNAF
2015	Synthetic ester	GBR	50	240	400	132	KDWF
2015	Synthetic ester	SWE	50	120/60/60	433 $\sqrt{3}$	16,8	KDWF
2015	Synthetic ester	UAE	50	125	132	34,5	KNAF
2015	Synthetic ester	RUS	50	160	115	11	KDAF
2016	Synthetic ester	USA	60	100/100/10	335 $\sqrt{3}$	136 $\sqrt{3}$	KDAF
2017	Synthetic ester	USA	60	300	345	136 / 13,8	KDAN/KDAF
2017	Synthetic ester	USA	60	300	138	138 $\pm 25^\circ$	KDAN/KDAF
2017	Synthetic ester	GBR	50	310	220	33	KNAN
2017	Natural ester	BEL/NED	50	80	150	6,9	KNAN/KNAF
2017	Natural ester	USA	60	125	345 $\sqrt{3}$	13,8	KDWF
2018	Synthetic ester	USA	60	575	345	345 $\pm 40^\circ$	KDAN/KNAN
2018	Synthetic ester	USA	60	400	345	138	KDAN/KNAN
2018	Synthetic ester	GER	50	20	155	155	KNAN
2019	Synthetic ester	USA	60	150	345	138	KNAN/KNAF

Benefit of alternative insulation

Important Criteria for Evaluation of Transformers with Ester

