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Dead Tank
Ready for cooldown

3AP1 DT up to 170 kV with mixed gases for lowest temperature applications

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Secured power supply in rough environmental conditions

To secure global power supply over the long term, reliable equipment is essential. This naturally also applies to applications in rough environmental conditions. In particular, low temperatures affect the performance of high-voltage circuit-breakers.

The most common medium used for arc-extinguishing and high-voltage insulation is sulphur hexafluoride (SF_6). One major technical limitation of SF_6, however, is the condensation temperature, especially when this gas is used with significant overpressure. At rated lockout pressure and temperatures lower than approx. –30 °C liquefaction occurs and the remaining SF_6 gas densitiy would not be sufficient to ensure the full switching performance of the circuit-breaker.

An appropriate solution is the use of a mixture of SF_6 and tetrafluormethane (CF_4). The mixture of these two gases represents an optimum solution for covering the low-temperature applications without affecting switching performance. The mixture ensures a liquefaction-free insulation and arc-extinguishing medium as the SF_6 partial pressure is sufficiently reduced.

Based on the existing circuit-breaker design, the pure SF_6 filling will be replaced by a composition of

- 43 percent SF_6 and 57 percent CF_4 for applications down to –50 °C, and
- 25 percent SF_6 and 75 percent CF_4 for conditions down to –60 °C.

Additionally, the rated filling pressure is increased by 1.5 bar to 7.5 bar.

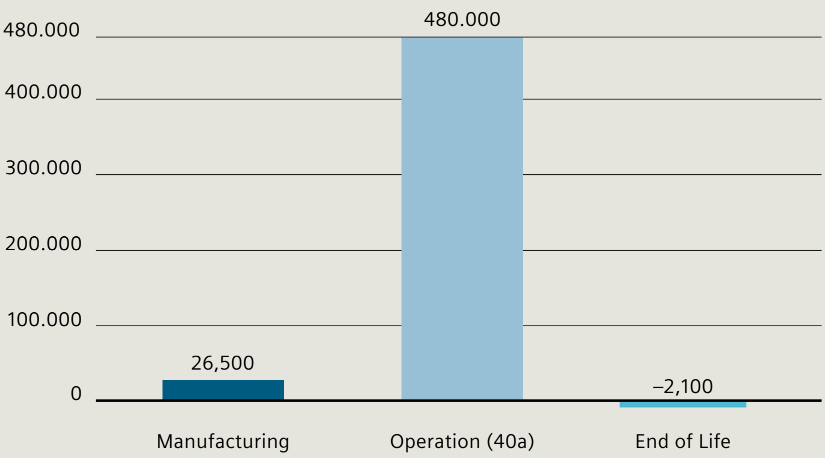
Consequently, the new low-temperature circuit-breaker with mixed gases offers mainly the same technical key ratings as the standard circuit-breaker that is used for low temperature conditions down to –30 °C.

The normal rated current, in particular, was certified for the same values as the standard breaker with pure SF_6 filling. For a 60 Hz application, the short-circuit current needs an insignificant line-to-ground of 3 nF (not required for 50 Hz). Usually, this capacitance value is available in power grid configurations with capacitive voltage dividers. Obviously, a circuit-breaker installation that provides this value within the grid configuration doesn’t need the external capacitors.This gives the customer the possibility to use standard equipment without any major modifications.

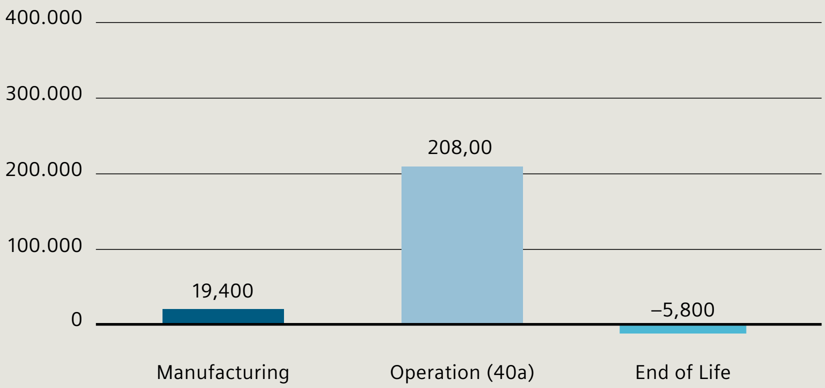
The new mixed gas solution is an alternative option to the proven devices with tank heaters for operation in harsh weather conditions with temperatures down to –60°C.

Global Warming Potential

3AP1 DT 145 kV* design 1995 with tank heaters



3AP1 DT 145 kV* enhanced design 2015 with mixed gas solution



* without current transformers

Rated voltage	kV	126	145 / 170
Number of interrupter units per pole		1	
Rated normal current, up to	A	3150	
Rated short-circuit breaking current, up to	kA	40	
Rated frequency	Hz	50	60
Rated power-frequency withstand voltage	kV	230	325
Rated lightning impulse withstand voltage	kV	550	750
Rated duration of short-circuit	s	3	
Rated peak withstand current (2.7 p.u.)	kA	108	
First-pole-to-clear-factor	p. u.	1.5	1.5/1.3
Capacitive voltage factor	p.u.	1.4	1.4/1.2
Temperature range	°C	–60 up to +55	–50 up to +55
Maintenance after		25 years	

All values in accordance with IEC; other values on request

CO_2 footprint

In terms of overall global warming potential (GWP), the mixed gas solution also offers advantages for a 100-year time horizon, because the GWP of CF_4 (7,400) is three times lower than that of SF_6 (22,800).

Additionally, the new dead tank offers a leakage rate of less than 0.1 percent per annum of gas losses for the complete circuit-breaker.

In comparison to other low-temperature applications with tank heaters, the mixed gas solution shows a markedly reduced CO_2 footprint.

Even within the same voltage range, **a reduction of the GWP by 56 percent** can be achieved by the enhanced design from 2015 and the use of mixed gases as shown in the diagrams.

During the manufacturing phase, optimized utilization of materials (e.g., a smaller base frame), as well as the use of mixed gases instead of permanent heating during operation in low-temperature areas, all aspects contribute to the improved GWP.

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