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A comparative between IEEE and EN in the transformer derating when supplying nonsinusoidal load current. A practical case.

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ABSTRACT

Nowadays, power quality is a challenge for the distribution companies since the new energy policies are directed to a distributed generation system with power electronic based technologies. The reduction of distribution transformers capability when supplying nonsinusoidal load currents has a major impact within capacity reduction in distribution networks produced by technical losses. IEEE Std C57.110-2018, EN- 50464-3 and EN-50541-2 define procedures to derate transformers when supplying nonsinusoidal load currents. The aim of this paper is to compare these procedures through a real case distribution transformer that suffers problems due to high levels of current distortion.

REAL CASE INFORMATION

A thermal protection in a plastic production factory opens during normal load of only one of the distribution transformers.

No problems were found on the thermal protection. This lead to think that the transformer could be affected by a level of harmonic above the designed. In order to verify this, an analysis of the derating of the transformer with IEEE and UNE standards was carried out.

Available information for transformer T1:

- Rated power: 2,500 kVA
- Primary winding voltage: 12,000V
- Primary winding resistance: 0.449 Ω
- Secondary winding voltage: 380 V
- Secondary winding resistance: 0.00015 Ω
- Connection: Dyn11
- Rated Load Losses: 18,900 W
- Rated No Load Losses: 4,300 W
- Cooling system: ONAN

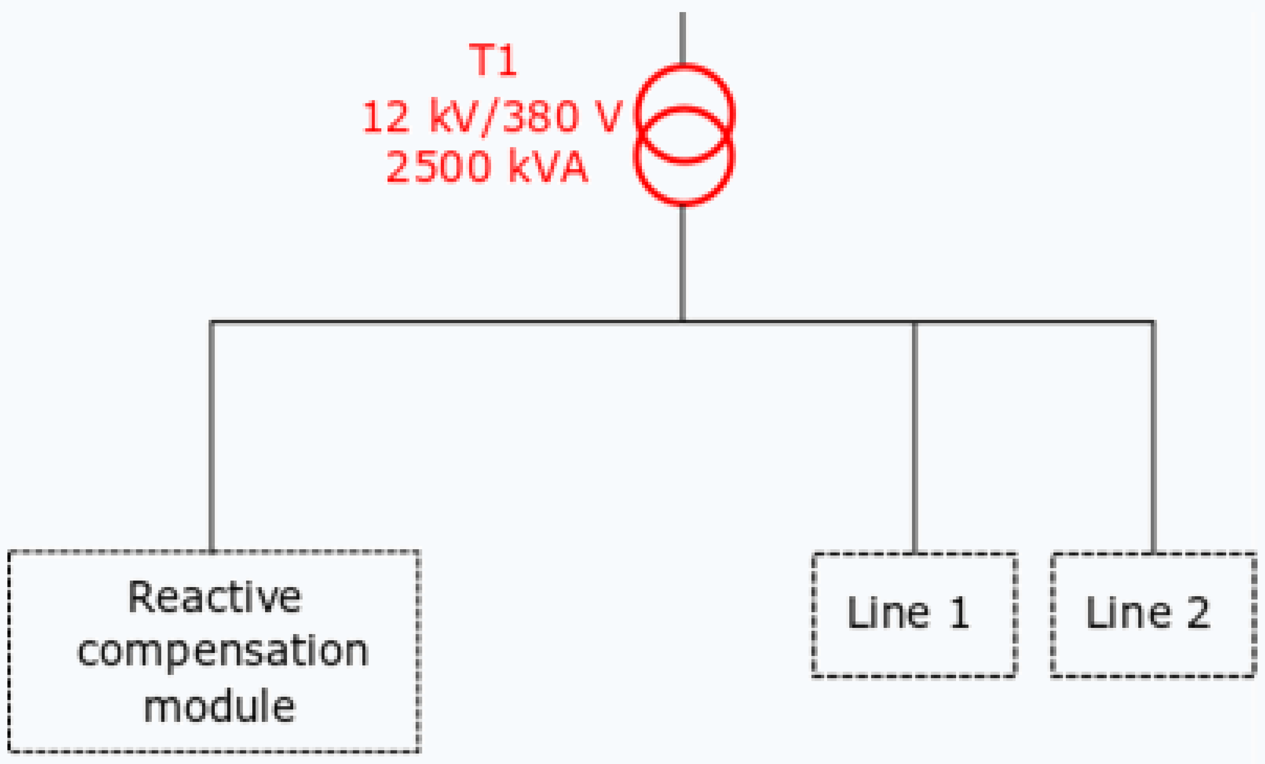

Fig. 1 Single-line diagram of the transformer T1 loads

TRANSFORMER DERATING ANALYSIS

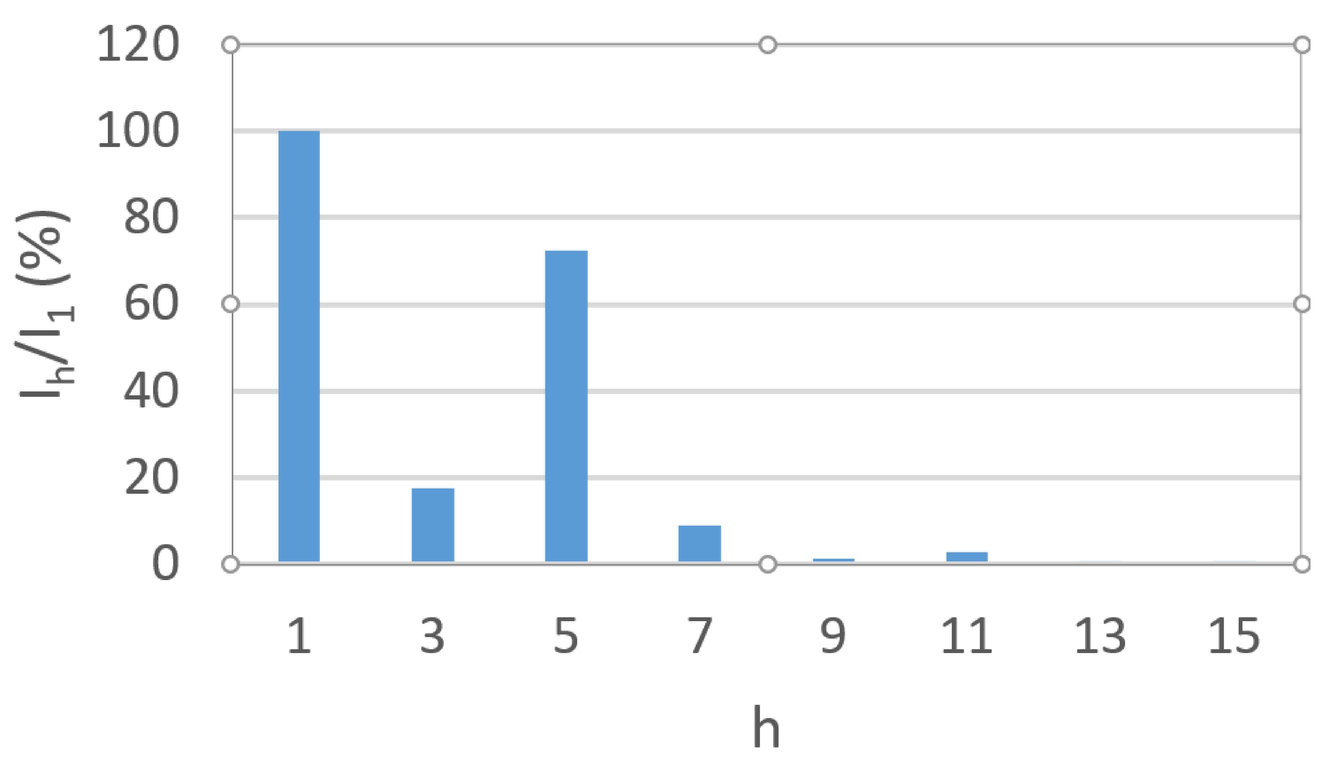

Fig. 2 Harmonic content of the current

Table. 1 Application of ***IEEE Std C57.110-2018***

IEEE Std C57.110-2018	
Total stray losses	$P_{TSL_R} = 5{,}899\ W$
Rated Eddy-current losses	$P_{EC_R} = 1{,}769.7\ W$
Stray losses not in windings	$P_{OSL_R} = 4{,}129.3\ W$
Harmonic factor for Eddy current	$F_{HL} = 9.53$
Harmonic factor other stray losses	$F_{HL_{STL}} = 1.92$
Máximun current per unit	$I_{max}(p.u) = 0.707$
Old rated power	$2{,}500\ kVA$
NEW RATED POWER	$\mathbf{1{,}767\ kVA}$

Table. 2 Application of ***EN-50464-3***

EN-50464-3	
Eddy-current losses (PSCAD simulation)	$P_{EC} = 1{,}450\ W$
Losses with dc current power supply (PSCAD simulation)	$P_{dc} = 3{,}100\ W$
Parameter e	$e = 0.468$
Conservative value	$q = 1.7$
Factor K	$K = 1.71$
Correction factor 1/k	1/K = 0.58
Old rated power	$2{,}500\ kVA$
NEW RATED POWER	$\mathbf{1{,}456\ kVA}$

CONCLUSIONS

Two standardized methods for derating of distribution transformers that are operating in nonsinusoidal conditions have been analyzed. Both methods provide relatively similar results but with different levels of complexity due to the requested input data.

The results obtained with EN procedure are more conservative than the IEEE procedure, with a diference of 12 %. This fact is understandable since the EN procedure is simpler than IEEE procedure and make the calculation neglecting the stray losses.

In summary, the most appropriate standard to derate the transformers is the IEEE procedure if the necessary input data is available. In the case that the input data is poor is more appropriate the use of EN procedure.

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