SLOVENSKI STANDARD

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Trifazni oljni distribucijski transformatorji, 50 Hz, od 50 kVA do 2 500 kVA in najviġja napetost naprave do 36 kV ï 3. del: Ugotavljanje moļnostne zmogljivosti transformatorja, obremenjenega z nesinusnimi tokovi

Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV -- Part 3: Determination of the power rating of a transformer loaded with non-sinusoidal currents

Ölgefüllte Drehstrom-Verteilungstransformatoren 50 Hz, 50 kVA bis 2 500 kVA, mit einer höchsten Spannung für Betriebsmittel bis 36 kV - Teil 3: Bestimmung der Bemessungsleistung eines Transformators bei nichtsinusförmigen Lastströmen

Transformateurs triphasés de distribution immergés dans l'huile, 50 Hz, de 50 kVA a 2 500 kVA, de tension la plus élevée pour le matériel ne dépassant pas 36 kV -- Partie 3: Détermination de la caractéristique de puissance d'un transformateur avec des courants de charge non sinusoidaux

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EUROPEAN STANDARD

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English version

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the Harmonization Document HD 428.4 S1:1994, prepared by the Technical Committee CENELEC TC 14, Power transformers, was submitted to the formal vote for conversion into a European Standard and was approved by CENELEC as EN 50464-3 on 2007-02-01.

The following date was fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2008-02-01

The EN 50464 series consists of the following parts, under the general title “Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2 500 kVA with highest voltage for equipment not exceeding 36 kV” :

Part 1	General requirements
Part 2-1	Distribution transformers with cable boxes on the high-voltage and/or low-voltage side – General requirements
Part 2-2	Distribution transformers with cable boxes on the high-voltage and/or low-voltage side – Cable boxes type 1 for use on distribution transformers meeting the requirements of EN 50464-2-1
Part 2-3	Distribution transformers with cable boxes on the high-voltage and/or low-voltage side – Cable boxes type 2 for use on distribution transformers meeting the requirements of EN 50464-2-1
Part 3	Determination of the power rating of a transformer loaded with non-sinusoidal currents
Part 4	Requirements and tests concerning pressurised corrugated tanks

Contents

1 Scope

This European Standard gives to the user guidance to determine the loadability of an oil-immersed distribution transformer, as defined in and covered by EN 50464-1, in the case of load current with harmonic factors exceeding the maximum values allowed.

NOTE In general this document is also applicable to dry-type distribution transformers as defined in and covered by HD 538.

2 Normative references

For the purposes of this document, the normative references of EN 50464-1 apply.

3 Application

For normal electrical energy distribution, the allowable total harmonic factor [1)] and even harmonic factor of the load current are assumed to be limited to 5 % and 1 % respectively.

For electrical distribution with higher harmonic factors, it has to be taken into account that the load loss increases and, by consequence, the temperature rises in the transformer exceed those corresponding to sinusoidal currents having the same r.m.s. value.

NOTE If the transformer is intended for converter operation or the harmonic factor is higher than 5%, the matter shall be discussed between purchaser and manufacturer.

4 Equivalent power rating

The equivalent power rating is related to sinusoidal current which causes the same losses as those occurring with the non-sinusoidal current imposed.

The equivalent power rating is equal to the power based on the r.m.s. value of the non-sinusoidal current multiplied by the factor *K*.

The rated power of the transformer to be used shall be equal to or higher than the equivalent power rating.

In case a transformer in service is subsequently loaded with harmonic currents, a derating factor 1/*K* shall be applied to the rated power.

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1) The harmonic factor H, in percentage, is defined by:

$$H\% = 100\left[\sum_{n=2}^{n=N}\left(\frac{I_n}{I_1}\right)^2\right]^{\frac{1}{2}}$$

5 Calculation of the factor *K* to obtain the equivalent power rating

The factor *K* is given by the following formula [2]:

$$K = \left[1 + \frac{e}{1+e} \left(\frac{I_1}{I} \right)^2 \sum_{n=2}^{n=N} n^q \left(\frac{I_n}{I_1} \right)^2 \right]^{\frac{1}{2}}$$

where

e = the eddy current loss due to sinusoidal current at fundamental frequency (e.g. 50 Hz), divided by the loss due to a d.c. current equal to the r.m.s. value of the sinusoidal current, both at reference temperature;

n = harmonic order;

I = the r.m.s. value of the sinusoidal current and, in the other case, of non-sinusoidal current, containing all harmonics, given by

$$I = \left(\sum_{n=1}^{n=N} I_n^{\,2} \right)^{\frac{1}{2}} = I_1 \left[\sum_{n=1}^{n=N} \left(\frac{I_n}{I_1} \right)^2 \right]^{\frac{1}{2}}$$

I_n = the n_{th} harmonic current (amplitude or r.m.s. value);

I_1 = the fundamental current (amplitude or r.m.s. value);

q = an exponential constant [3].

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[2] In the formula it is assumed that both power ratings are based on the same r.m.s. value of the load current.

[3] The exponent q is dependent on the type of windings and on the frequency. However as an approximation and as a guidance, the following constant values may be used:

– 1,7 for transformers with round or rectangular wire in both the low and high voltage windings;

– 1,5 for transformers having low voltage foil windings.

Other values, based on measurements and possibly frequency dependent, may be applied by agreement between purchaser and manufacturer.