

Shell Form Comments

new definitions are confusing

The current definition is easier to understand.

the older definition better as it is more clear and per my thinking of shell

The present definitions together have the advantage to clearly express the basic difference of core- and shell-form transformers. This is more difficult to see with the proposed changes.

The shell form definition is now too complicated and confusing. Needs to be simple for beginners to understand.

“partially surround” is not necessary

‘Axial-along’ is confusing.

Remove any reference to direction of coil, since coils may be arranged in any direction.

Use of the word “horizontal” in the shell-form definition is ambiguous without defining the orientation of the overall transformer components

The proposed definitions apply only to power transformers and not to distribution transformers that may be of either core or shell type construction. These distribution transformers in some cases have full width strip conductors, which when wound do not have “axial” placement relative to other windings. Therefore a distribution transformer, even when fully surrounded with core steel which has a full width strip winding could not be a shell-type transformer as the windings are not arranged axially.

The new definition seems to apply only to a large power transformer (e.g. 500 or 1000 MVA). However, the distribution transformers with wound cores (e.g. 500 kVA) can also be regarded as shell form. The small distribution units are shell form since the core is built around the windings. The windings are also arranged concentrically but with a shell form construction.

A core type transformer has two magnetic circuits whereas the shell type transformer has one magnetic circuit.

Agree with key features of shell form: horizontal core, axially arranged windings

Why do the legs of a shell form have to be horizontal?

Wording about yokes and “partially surrounded” is similar for both designs and makes more difficult distinguishing real difference vs common features.

Leave out the word “axially”

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Rejected - because of the limitation to axial arrangement and interleaving.

The shell form new definition includes “axially” arranged coil that is a key requirement for shell form. It is interesting that the axial coils may also be called “sandwiched” (IEEE SH15156) which provides a better visualization for many people. You might consider adding “(sandwiched)” after axially in the new definition.

This definition is focused on larger power transformer construction. It is correct only for that construction where 'pancake' coils can be interleaved to build phase packets that are oriented vertically with horizontal core legs. However, in many distribution transformers, the coils are wound concentrically with the phase building horizontally outward. When a wound core is employed, for three phase transformers, there are two large 'loops' and two small 'loops' giving a five-legged core. There are distribution transformers with stacked cores, but when 'wye-wye' designs are made, two outer shunt legs may be added again making a five-leg core. Single phase distribution can be either core form or shell form, but the basic concentric coils are wound and either a single coil with two core 'loops' or two coils with two stacked legs may be typical.

I think only large power shell transformer would fit in proposed definition. E.g. typical single phase distribution transformer is a shell type transformer but would not fit in the proposed definition.

This is for power transformers. Wound core Distribution transformers have a number of different core / winding arrangements.

Keep it simple as these definitions do not cover all possibilities.

The user of core legs and yokes doesn't seem to fit this definition. I can't quite picture more than one "leg". There is a common leg through the windings and core laminating that surround them and between phases. I don't get that from the proposed definition.

These definitions do not well define wound-core designs. they may be satisfactory for Class II power transformers but doubt that they adequately cover Class I or Distribution.

I would propose that we would consider a simpler, not a more complicated, definition.

As a reference, I went back to the Westinghouse, Electrical Transmission and Distribution Reference Book (Second edition 1943) and found these definitions.

On page 408, it states the following:

"Transformers are constructed in either core-form or shell-form. The core-form consists of a single-ring magnetic circuit encircled by windings. The shell-form consists of windings forming a common ring encircled by two or more rings of magnetic material."

And again, these are defined in the 1968 edition of the Standard Handbook for Electrical Engineers from Section 11, Page 12.

"When the magnetic circuit takes the form of a single ring encircled by two or more groups of primary and secondary windings distributed around the periphery of the ring, the transformer is termed a core-form transformer. When the primary and secondary windings take the form of a common ring which is encircled by two or more rings of magnetic material distributed around its periphery, the transformer is termed a shell-form transformer."

The phrase "windings (coils) are arranged axially in multiple interleaved groups" describes a specific design concept; this is correct. Any number of winding concepts may be used with a shell-form transformer.

The phrase "yokes that partially surround the windings (coils)" ignores the external legs that lay outside the coils.

Windings are not always axial. They can be axial or radial.

Shell-form definition seems to specifically describe the coil winding's orientation is along the core legs.

"...arranged axially in multiple interleaved groups along one or more horizontal magnetic circuit.." is not clear and needs a sketch.

Proposed new definitions

- Shell form A transformer in which the windings (coils) surround part of a magnetically closed circuit (core) axially stacked.
- Shell form: "...groups along on one or more radial magnetic circuit..."
- Shell form: A transformer in which the windings (coils) are arranged axially in multiple interleaved groups along one or more horizontal magnetic circuit (core) legs with yokes that partially surround the windings (coils).
- Shell form: A transformer with windings (coils) arranged axially in multiple interleaved groups along horizontal magnetic circuit (core) legs with yokes that surround the windings (coils).
- Shell form: A transformer in which the windings (coils) are arranged along one or more (core) legs inside a magnetic circuit (core) which forms a shell consisting of yokes and legs **surrounded by one or more horizontal magnetic circuits (limbs and yokes).**
- Shell form: A transformer in which the windings (coils) are arranged axially in multiple interleaved groups along square horizontal legs.
- Shell form: A transformer in which the windings (coils) are arranged axially in multiple interleaved groups along one or more horizontal **core segments, magnetic circuit (core) legs with yokes that partially surround**

~~the windings (coils)~~ with a core arrangement such that the magnetic circuit completely surrounds each winding.

- Shell form: A transformer in which the windings (coils) are arranged axially in multiple interleaved groups ~~legs with yokes that partially surround the windings (coils).~~ **surrounded by one or more horizontal magnetic circuits (core limbs and core yokes)**
- Shell form: A transformer in which the center openings of the windings (coils) are oriented horizontally and are arranged in multiple interleaved groups along one or more horizontal magnetic circuit (core) legs with yokes that partially surround the windings (coils).
- Shell form: A transformer where the positive sequence and zero sequence impedances are the same.
- Shell form: has 2 more legs than coils, with the 2 legs without coils partially enclosing the coil(s), hence "shell" type. Examples could be a 3-phase transformer with 3 coils and a 5-legged core and a single-phase transformer with 1 coil and 3 legs.
- Shell form: A transformer which has transformer steel core comprised of "legs" and "yokes" that connect "legs" to form continuous magnetic circuit which surrounds windings (coils).

Westinghouse, Electrical Transmission and Distribution Reference Book (Second edition 1943), pg 408:
The shell-form consists of windings forming a common ring encircled by two or more rings of magnetic material.

Standard Handbook for Electrical Engineers, section 11 pg12:
When the primary and secondary windings take the form of a common ring which is encircled by two or more rings of magnetic material distributed around its periphery, the transformer is termed a shell-form transformer.