Average Oil Temperature Rise in Distribution Transformers

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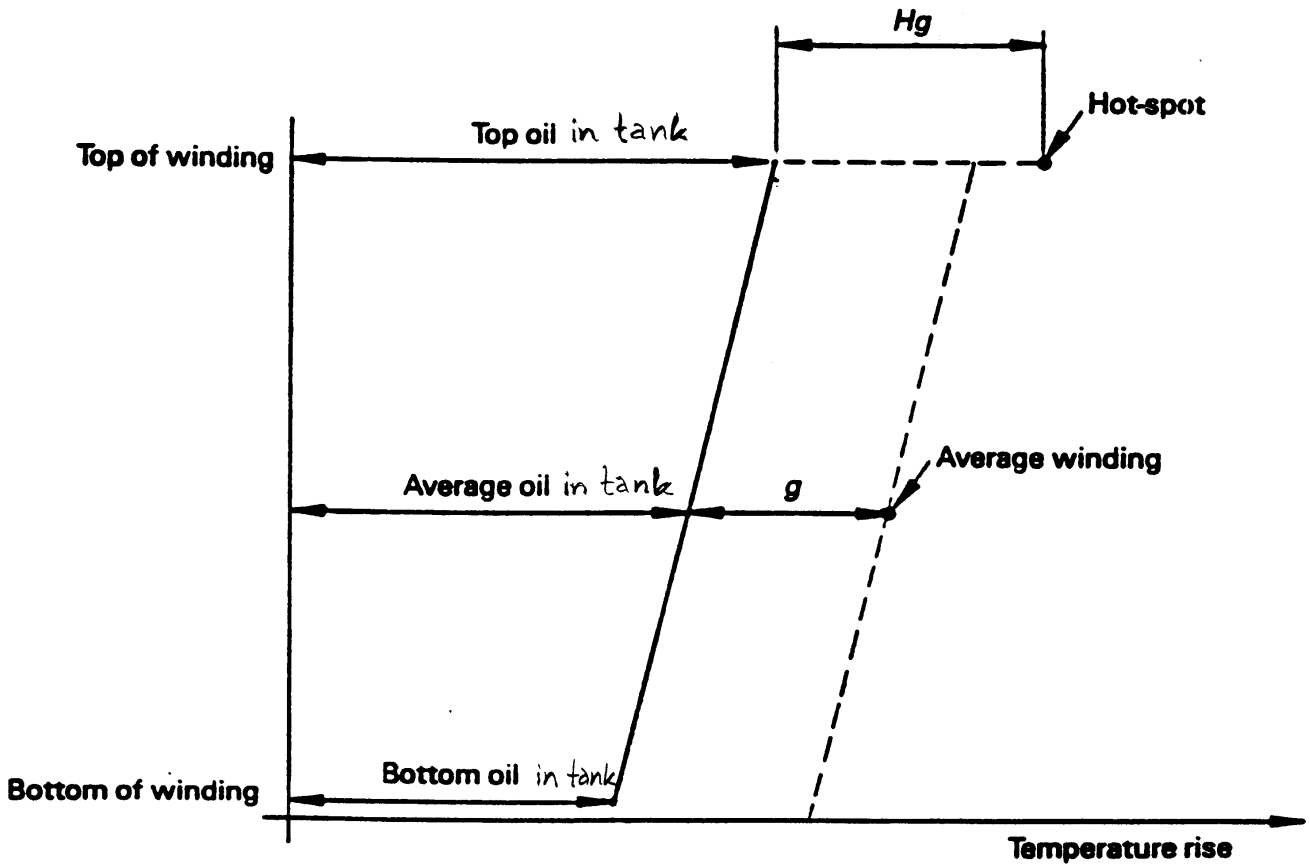
Background

- **It is necessary to obtain a proper value for the Average Oil Temperature Rise in the heat run test:**



Background, cont.

- It is difficult to properly define the Average Oil Temperature Rise in a Distribution Transformer in a heat run test, because Bottom Oil Temperature Rise is not directly measured (as in transformers with an external oil circulation)

- The guidance given by C57.12.90-1999:

  ”Where the bottom liquid temperature cannot be measured directly, the temperature difference may be taken to be the difference between the surface temperature of the liquid inlet and outlet”

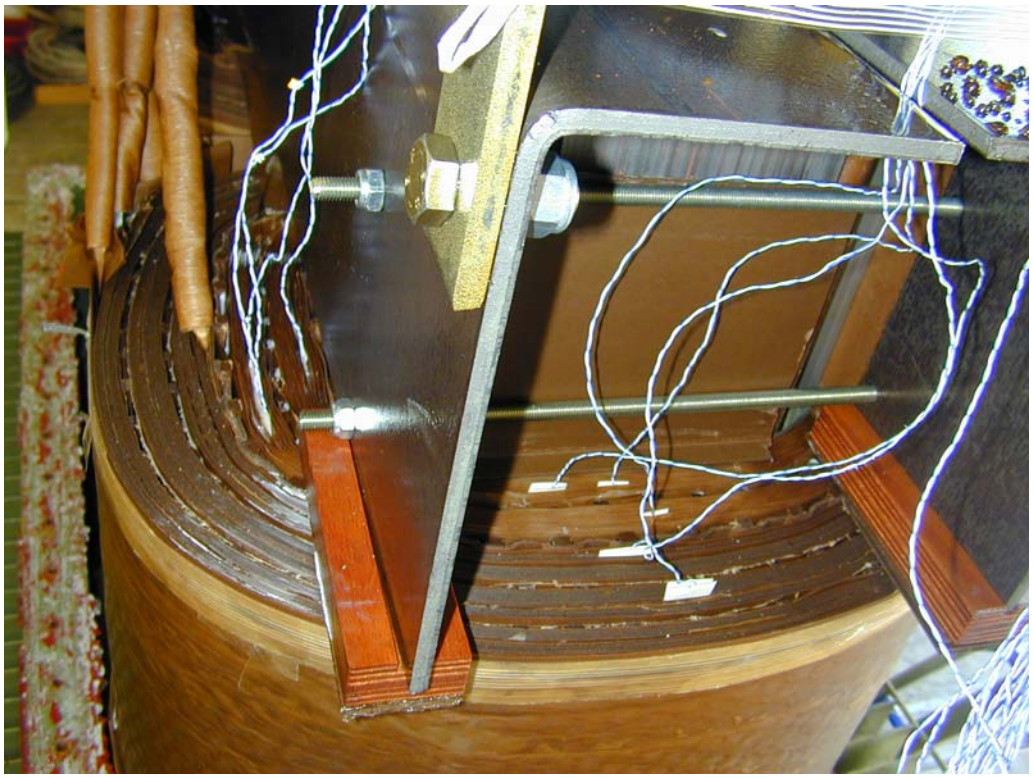
- Extensive tests were made on a 2500 kVA distribution transformer

2500 kVA case: The Transformer

- 3-phase unit, 20.5+-2x2.5% / 0.71 kV, Dy11, in corrugated tank

2500 kVA case: Sensors in wdgs

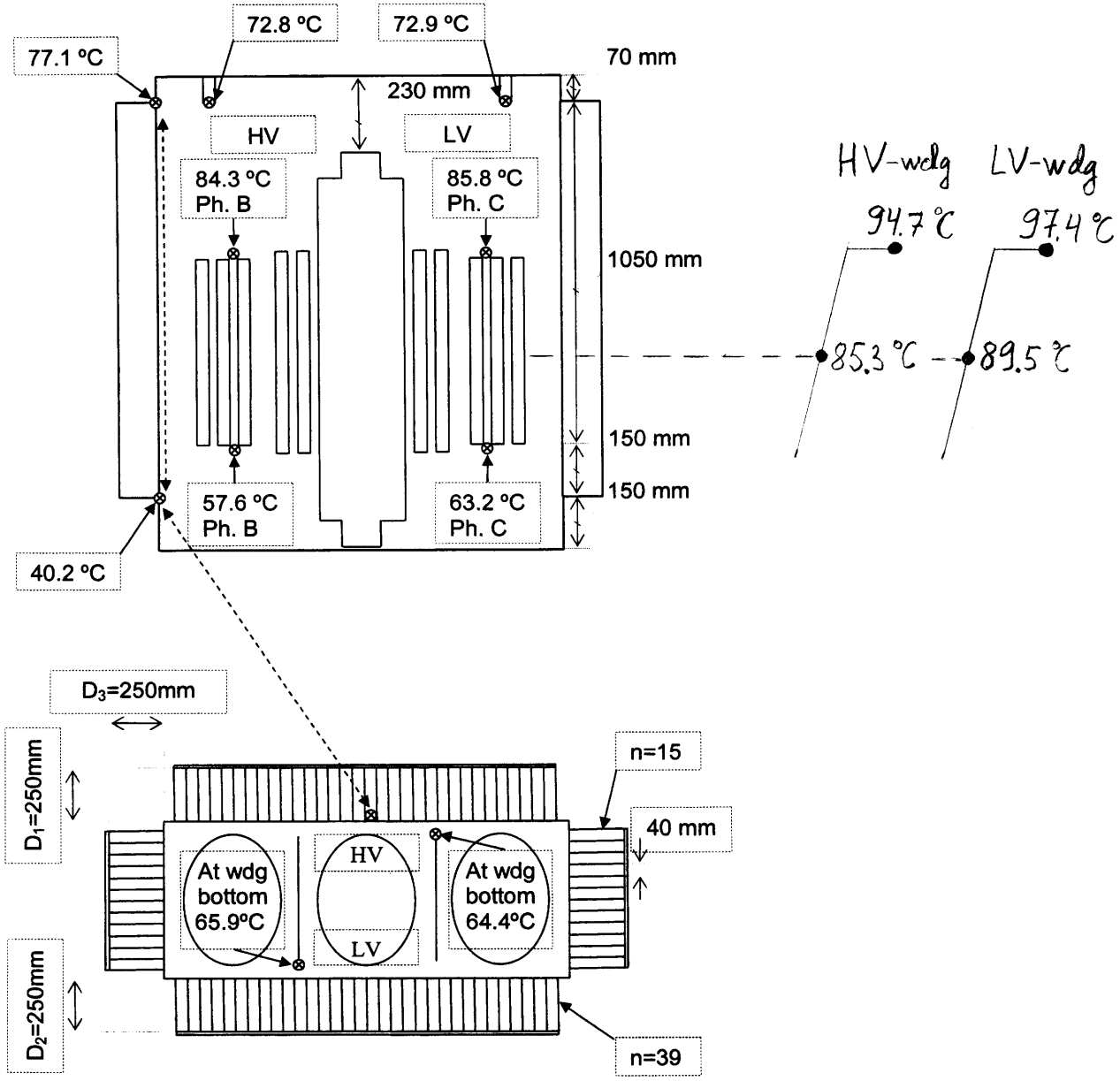
- 9 sensors embedded in the top of the LV-wdg and 6 sensors in the top of the HV-wdg to record hot-spot



2500 kVA case: Sensors recording oil temperatures

- 2 sensors on tank outside (on the tank surface at top and bottom of the cooling ribs)
- 2 sensors in the two oil pockets
- 15 sensors in the oil circulation inside the tank

2500 kVA case: Temperatures at 1.0 pu / Amb. 24.8 °C



2500 kVA case based on IEEE C57.12.90-1999

- Top oil in pocket = 72.8 °C
- ”Surface temperature of the liquid outlet” = 77.1 °C
- ”Surface temperature of the liquid inlet” = 40.2 °C

According to the standard the average oil temperature will now be = 72.8 – 0.5 x (77.1 – 40.2) = 54.4 °C, i.e. the average winding – to – average oil gradients would be:

- LV-wdg: g_{LV} = 35.1 K (hot-spot – to – top oil in pocket = 24.5 K)
- HV-wdg: g_{HV} = 30.9 K (hot-spot – to – top oil in pocket = 21.8 K)

Unreasonable hot-spot factors < 1.0:

- LV-wdg: H = 24.5 / 35.1 = 0.70
- HV-wdg: H = 21.8 / 30.9 = 0.71

2500 MVA case based on Internal Bottom Oil Temperatures

- Top oil in pocket = 72.8 °C
- Internal bottom oil temperature 0.25x(57.6+63.2+65.9+64.4) = 62.8 °C

The average oil temperature will now be = 0.5 x (72.8 + 62.8) = 67.8 °C, i.e. the average winding – to – average oil gradients would be:

- LV-wdg: g_{LV} = 21.7 K (calculated = 18.6 K)
- HV-wdg: g_{HV} = 17.5 K (calculated = 15.5 K)

Reasonable hot-spot factors > 1.0:

- LV-wdg: H = 24.5 / 21.7 = 1.13
- HV-wdg: H = 21.8 / 17.5 = 1.25