Calculation of an Auto transformer

Number of turns per Volt

$n / V = 10^4 / (4{,}44 * B * F_q * 0{,}9 * f)$

B = magnetic induction [T or Wb/m^2]

F_q = Core limb [cm^2]

f = operating frequency [Hz]

n = number of turns per volt

0,9 = filling factor

For your calculation, take the following data:

B = 1,3T

$F_q = 11{,}52\ cm^2$

F = 50 Hz

$n / V = 10^4 / (4{,}44 * 1{,}3 * 11{,}52 * 0{,}9 * 50) = 3{,}34\ n / V$

Power of a normal transformer:

$F_q = B * \sqrt{P}$ ➔ $P = (F_q / B)^2$

$P = (11{,}52cm^2 / 1{,}3T)^2 = 78{,}5W$

Power of a auto transformer for a calculate power of normal transformer:

$P_{auto\ transformer} = P_{normal\ transformer} / \{1 – (U_2 / U_1)\} = 78{,}5W \{1 - (110V / 220V)\} = 157W$

Calculate of the winding:

$n_1 = n * U_1 = 3{,}34\ n/V * 220V \approx 735$ windings (734,8 windings)

$n_2 = n_1 * U_2 / U_1 = 735 * 110 / 220 \approx 368$ windings (367,5 windings)

n_2 = tapping of n_1. In this special case it is a centre tapping.

Calculation of the wire diameter:

$d = 2 * \sqrt{I / (\pi * S)}$

d = wire diameter [mm]

I = output current [A]

S = current density [A/mm]

For good using S = 2,5 A/mm

$I = P / U_2$ = 157W / 110V = 1,42A

$d = 2 * \sqrt{1{,}42A / (\pi * 2{,}5A/mm)}$ = 0,36mm