



① $u_{pp} + (u_{max} - u_{pp}) \left(1 - e^{-t/\tau}\right)$

② $u_{pp} e^{-t/\tau}$

③ $\int_0^T (u_{max} - u_{pp}) e^{-t/\tau} dt$

$= (u_{max} - u_{pp}) \left(\tau + T e^{-T/\tau} \right)$

④ $\int_0^T u_{pp} e^{-t/\tau} dt = u_{pp} (-\tau) e^{-t/\tau} \Big|_0^T$

②a $u_{pp} = u_{pp} + (u_{max} - u_{pp}) \left(1 - e^{-ST/\tau}\right)$
 $= u_{pp} + u_{max} \left(1 - e^{-ST/\tau}\right) - u_{pp} + u_{pp} e^{-ST/\tau}$
 $= u_{max} - u_{pp} \left(1 - e^{-ST/\tau}\right)$

Fläche rising

$u_{pp} \cdot ST + (u_{max} - u_{pp}) \left(ST + \tau e^{-ST/\tau} - \tau \right)$

Fläche falling

$u_{pp} (-\tau) \cdot \left(e^{-ST/\tau} - 1 \right)$
 $= u_{pp} \tau \left(1 - e^{-ST/\tau} \right)$

Summe Fläche

$u_{pp} ST + (u_{max} - u_{pp}) \left(ST + \tau e^{-ST/\tau} - \tau \right)$
 $+ u_{pp} \tau \left(1 - e^{-ST/\tau} \right)$

(2)

$$= u_{pn} (ST - ST e^{-ST/\tau} + T) + u_{max} (ST + T e^{-ST/\tau} - T) + u_{pp} \tau (1 - e^{-(S-1)T/\tau})$$

$$u_{pn} = u_{pp} e^{-(S-1)T/\tau}$$

$$= u_{pp} (-T e^{-ST/\tau} + T e^{-(S-1)T/\tau} + T e^{-(S-1)T/\tau} + u_{max} (ST + T e^{-ST/\tau} - T) + u_{pp} (\tau - T e^{-(S-1)T/\tau})$$

$$= u_{pp} (-T e^{-T/\tau} + T e^{-(S-1)T/\tau} + T - T e^{-(S-1)T/\tau}) + u_{max} (ST + T e^{-ST/\tau} - T)$$

$$= u_{pp} (-T e^{-T/\tau} + T) + u_{max} (ST + T e^{-ST/\tau} - T)$$

$$\boxed{\text{Fläche} / \tau = 3 u_{max}}$$

$$\Rightarrow \text{Fläche} = 3 \tau u_{max}$$

$$\Rightarrow u_{pp} (-T e^{-T/\tau} + T) = u_{max} (ST - ST e^{-ST/\tau} + T) = u_{max} (T e^{-ST/\tau} + T)$$

$$\Rightarrow u_{pp} = u_{max} \frac{(e^{-ST/\tau} + 1)}{(e^{-T/\tau} + 1)} = u_{max} \frac{1 - e^{-ST/\tau}}{1 - e^{-T/\tau}}$$