Typical leakage values

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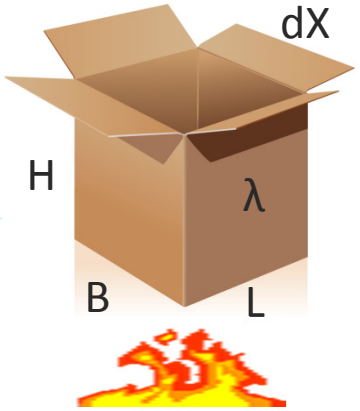

A = Area

ΔT = temperature difference

dX = thickness of box

λ = material insulation property

h = convection factor

$$\frac{A * \Delta T}{\frac{dX}{\lambda} + \frac{1}{h}}$$

Leakage in W/K

Leakage in a steel cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,002 [m]
λ = 46 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{0{,}200043}$$

Box 0,5m² , ΔT=10°C ⇒ 25W/K
Box 0,5m² , ΔT=20°C ⇒ 50W/K
Box 0,5m² , ΔT=30°C ⇒ 75W/K

Box 1m² , ΔT=10°C ⇒ 50W/K
Box 1m² , ΔT=20°C ⇒ 100W/K
Box 1m² , ΔT=30°C ⇒ 150W/K

Box 2m² , ΔT=10°C ⇒ 100W/K
Box 2m² , ΔT=20°C ⇒ 200W/K
Box 2m² , ΔT=30°C ⇒ 300W/K

For h we normally calculate between 5-20. 5 = low convection, 20 = high convection

Leakage in a aluminum-alloy cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,002 [m]
λ = 190 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{0{,}200011}$$

Box 0,5m² , ΔT=10°C ⇒ 25W/K
Box 0,5m² , ΔT=20°C ⇒ 50W/K
Box 0,5m² , ΔT=30°C ⇒ 75W/K

Box 1m² , ΔT=10°C ⇒ 50W/K
Box 1m² , ΔT=20°C ⇒ 100W/K
Box 1m² , ΔT=30°C ⇒ 150W/K

Box 2m² , ΔT=10°C ⇒ 100W/K
Box 2m² , ΔT=20°C ⇒ 200W/K
Box 2m² , ΔT=30°C ⇒ 300W/K

For h we normally calculate between 5-20. 5 = low convection, 20 = high convection
We realize that for high λ's the difference is very small or none for leakage values

Leakage in a plexi-glass cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,002 [m]
λ = 1,9 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{0{,}201053}$$

Box 0,5m² , ΔT=10°C ⇒ 25W/K
Box 0,5m² , ΔT=20°C ⇒ 50W/K
Box 0,5m² , ΔT=30°C ⇒ 75W/K

Box 1m² , ΔT=10°C ⇒ 50W/K
Box 1m² , ΔT=20°C ⇒ 100W/K
Box 1m² , ΔT=30°C ⇒ 150W/K

Box 2m² , ΔT=10°C ⇒ 100W/K
Box 2m² , ΔT=20°C ⇒ 200W/K
Box 2m² , ΔT=30°C ⇒ 300W/K

Still the λ's are high why the difference is very small or none for leakage values

Leakage in a 10mm LDPE insulated cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,01 [m]
λ = 0,04 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{0{,}45}$$

Box 0,5m² , ΔT=10°C ⇒ 11W/K
Box 0,5m² , ΔT=20°C ⇒ 22W/K
Box 0,5m² , ΔT=30°C ⇒ 33W/K

Box 1m² , ΔT=10°C ⇒ 22W/K
Box 1m² , ΔT=20°C ⇒ 44W/K
Box 1m² , ΔT=30°C ⇒ 66W/K

Box 2m² , ΔT=10°C ⇒ 44W/K
Box 2m² , ΔT=20°C ⇒ 88W/K
Box 2m² , ΔT=30°C ⇒ 133W/K

Leakage in a 20mm LDPE insulated cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,02 [m]
λ = 0,04 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{0{,}45}$$

Box 0,5m² , ΔT=10°C ⇒ 7W/K
Box 0,5m² , ΔT=20°C ⇒ 14W/K
Box 0,5m² , ΔT=30°C ⇒ 21W/K

Box 1m² , ΔT=10°C ⇒ 14W/K
Box 1m² , ΔT=20°C ⇒ 28W/K
Box 1m² , ΔT=30°C ⇒ 43W/K

Box 2m² , ΔT=10°C ⇒ 28W/K
Box 2m² , ΔT=20°C ⇒ 57W/K
Box 2m² , ΔT=30°C ⇒ 86W/K

Leakage in a 10mm PUR insulated cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,01 [m]
λ = 0,025 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{0,6}$$

Box 0,5m² , ΔT=10°C ⇒ 8,3W/K
Box 0,5m² , ΔT=20°C ⇒ 16,7W/K
Box 0,5m² , ΔT=30°C ⇒ 25W/K

Box 1m² , ΔT=10°C ⇒ 16,7W/K
Box 1m² , ΔT=20°C ⇒ 33,3W/K
Box 1m² , ΔT=30°C ⇒ 50W/K

Box 2m² , ΔT=10°C ⇒ 33,3W/K
Box 2m² , ΔT=20°C ⇒ 66,7W/K
Box 2m² , ΔT=30°C ⇒ 100W/K

Leakage in a 20mm PUR insulated cabinet

A = area [m^2]
ΔT = temperature difference [-]
dX = 0,02 [m]
λ = 0,025 [W/mK]
h = 5 [W/m^2K]

$$\frac{A*\Delta T}{\frac{dX}{\lambda}+\frac{1}{h}} \Rightarrow \frac{A*\Delta T}{1}$$

Box 0,5m² , ΔT=10°C ⇒ 5W/K
Box 0,5m² , ΔT=20°C ⇒ 10W/K
Box 0,5m² , ΔT=30°C ⇒ 15W/K

Box 1m² , ΔT=10°C ⇒ 10W/K
Box 1m² , ΔT=20°C ⇒ 20W/K
Box 1m² , ΔT=30°C ⇒ 30W/K

Box 2m² , ΔT=10°C ⇒ 20W/K
Box 2m² , ΔT=20°C ⇒ 40W/K
Box 2m² , ΔT=30°C ⇒ 60W/K

Conclusions

- At high λ's (above at least 2) the leakage factor is almost not affected
- Insulation is key to get a good function of an installation
- Convection factor h has a big influence for poorly insulated cabinets

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