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ARE AIR CURTAINS EFFECTIVE?

No doubt they are!

Various studies and research conducted show that Air Curtains are effective in creating a barrier to keep the inside air well conditioned.

It has been determined that the cooling power loss (Q) kW from an open cold storage/conditioned doorway, because of infiltration of air, can be calculated using the following expression by Mann/Hofer.

$$Q = (0.48 + 0.004\Delta T)\, A\, (h_w - h_c \sqrt{Hp_c} \sqrt{1 - \frac{P_w}{P_c}}$$

Where,

ΔT = temperature differential across doorway (°C)

A = area of doorway (m^2)

h_w = enthalpy of air on warm side of doorway (kJ/kg)

h_c = enthalpy of air on cold side of doorway (kJ/kg)

ρ_c = density of air on cold side of doorway (kg/m^3)

ρ_w = density of air on warm side of doorway (kg/m^3)

H = height of doorway (m)

As an example a cold store with a 2.35m high x 1.8m wide doorway has a cold store temperature of minus 22°C with 70% relative humidity. The loading bay area adjacent to the cold store is typically at +7°C, 70% Rh. This equates to a cooling load of 69kW which has to be made up by the cold store refrigeration equipment.

Research has been carried out with FRPERC, University of Bristol, where tests were carried out with a cold store air curtain fitted over the doorway of a cold store. The infiltration of air into the cold store was measured using a CO_2 tracer gas method for different door opening times with and without the air curtain operating. From these tests the effectiveness of the air curtain in preventing infiltration of air was as high as 76.9%, where effectiveness E can be described by the following equation:

$$E = \frac{Q_b - Q_a}{Q_b}$$

Where,

E is the Energy Effectiveness,

Q_a is the Energy Exchange through an Open Doorway With an Air Curtain fitted plus the power consumed by the Air Curtain,

Q_b is the Energy Exchange through an Open Doorway WITHOUT an Air Curtain fitted,

The closer the Energy Effectiveness is to 1 (unity) the better the energy effectiveness

with, 1 = Ultimate Barrier (equivalent to a closed door, if $Q_a = 0$)

0 = Bad (equivalent to an open doorway with no air curtain, if $Q_a = 1$)

In this case example, the cooling load of 69kW would be reduced to 15.9kW (*i.e.* 69kW x 0.231) with a decrease in electricity costs and a reduction in health and safety hazards from ice formation and fog in the doorway.

Reference studies done by HEVAC members, BSRIA (UK) and by TNO (Netherlands).

The above example proves the enormous savings which can be achieved by installing the air curtains on the doorway. However, it is equally important to choose the right velocity at the right height

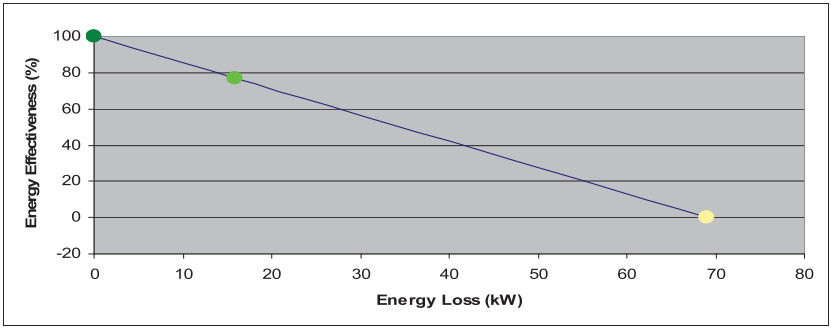
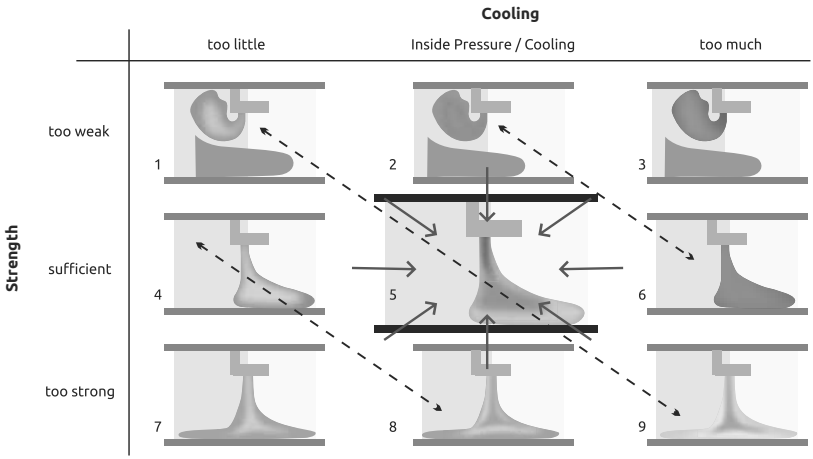


Fig. 7

to achieve the desired result. An Air curtain, if not chosen properly, will accelerate the loss of conditioned air. The same can be seen in figure 9, which is a descriptive model, between the strength of the air stream of the air curtain and the cooling in the chamber.

Further, the air curtain effectiveness can be seen with the help of following figure...



Air Curtain Strength and Cooling Control Protective

Fig. 8

Clockwise from top left:

Fig. 1 shows the effect on the conditioned space without an air curtain and illustrates convective heat losses,

Fig. 2 shows the effect when an air curtain is used with too high an airflow velocity,

Fig. 3 shows the effect when an air curtain is used with incorrect outlet angle,

Fig. 4 shows the effectiveness of a correctly installed and selected air curtain

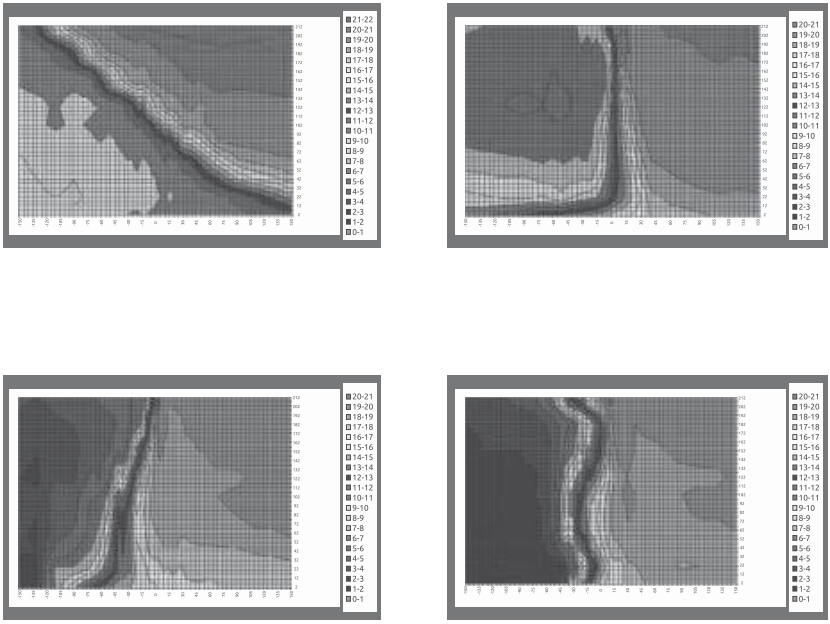


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Fig. 9