ENGINEERING NOTE

ENCLOSURES

Enclosure Sizing for Electrical/Electronic Components

Due to the installation site it may be necessary to place the electrical/electronic equipment inside of a sheet metal enclosure to protect the components from damage due to moisture or dirt, or to prevent contact with live electrical parts.

Components such as transformers, variable frequency controllers, DC controllers, etc., will generate a finite amount of heat and because the enclosure has a thermal insulating characteristic, this heat will contribute to a rise in temperature inside the enclosure. Since each component within the enclosure has a maximum allowable operating temperature, it is important to design the system such that this limit will not be exceeded under normal operating conditions.

The amount of heat that will be dissipated by a non-ventilated sheet metal enclosure is directly proportional to the amount of exposed effective surface area. Since a cabinet will dissipate most of its heat through its exposed vertical surfaces due to convection air currents, the vertical area of the cabinet is the primary determining factor for effective surface area. When determining the effective surface area of a totally enclosed cabinet:

- Do not include the bottom surface area.
- Do not include any vertical area, such as the back or the side, that is closer than six (6) inches to a wall or other surface.
- Use only one-half of the top surface area. Dust and debris accumulating on the top surface over time reduces the ability of the top surface to dissipate heat.

This assumes that the enclosure will not be exposed to direct sunlight, which will result in radiative heat transfer to the enclosure.

Additionally to ensure proper heat distribution throughout the enclosure, hence optimum heat transfer, it is recommended to circulate the air within the enclosure by means of an internal fan (approximately 100 CFM) if a major generator of heat such as an AC or DC controller is installed in the cabinet. Enclosures with only relays, contactors, etc., generally do not require an internal fan.

Altitude is also a factor. Heat dissipation from the enclosure will decrease with an increase in altitude. As a rule, decrease the heat dissipation capacity of the enclosure by 3% for each additional 1,000 feet above 3,300 feet.

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A standard enamel painted, gasketed enclosure made of 12 or 14 gauge sheet metal installed in a typical factory will dissipate 1.5 watts per square foot of exposed effective surface area for a 1°C gradient from inside to outside of the enclosure, i.e. 1.5 Watts/ft^2 • °C (ΔT).

Procedure for Enclosure Sizing

1. Determine total heat generated by the components within the enclosure using units of Watts. Most manufactures list worst case heat generation data in their literature.
2. Determine the maximum allowable operating temperature of the components and use this value as the highest allowable temperature inside the enclosure. If there are different maximum temperature for different components, take the lowest of these.
3. Estimate the maximum ambient temperature that will exist where the enclosure will be located. Be sure to consider whether or not the building is air conditioned during the summer.
4. Subtract the estimated maximum ambient temperature from the maximum allowable enclosure internal temperature. This is the maximum allowable temperature rise or Δ T.
5. Multiply the maximum allowable temperature rise Δ determined in Step 4 by 1.5 Watts/ft^2 • °C to obtain the required heat dissipation in Watts/ft^2.
6. Divide the total heat generated by all components as determined in Step 1 by the required heat dissipation determined in Step 5 to obtain the required exposed surface area.
7. Select an enclosure of appropriate dimensions and calculate the effective surface area; the area which will be exposed to free air in the room. Increase or decrease the dimensions until the calculated exposed surface area satisfies the requirement established in Step 6.

Typical Heat Losses

Although the AC or DC controller is the major offender when it comes to heat loss, other components produce appreciable heat also. Below is a list of commonly used components with their associated heat loss:

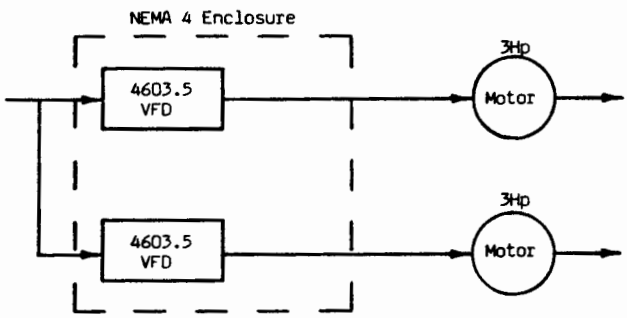
Component		Heat Loss
1 0/ Transformer		.07xVA rating
3 0/ Transformer		.03xVA rating
Contactors:	Size 1 & 2	10W
	Size 3,4,4.5	20W
	Size 5,6	40W
Starters:	Size 00,0,1	12W
Relays:	#00-4 pole	12W
	#00-8 pole	24W
	Standard 115V (KUP)	2W
	Reference relays (ice cube)	1W
Resistors		I^2R

Add an extra 10% for miscellaneous components.

Example:

You wish to place two (2) Movitrac 4603.5 variable speed controllers in a washdown environment where the ambient air temperature can reach a maximum of 80°F (26.7°C). Assume the additional components (relays, contactors, etc.) inside the enclosure will generate 50W.

Because this is a washdown environment, you will want to select a NEMA 4 rated enclosure.



1. Total heat generated.
   a. From the Movitrac 4603.5 specifications, the heat generated for each controller was determined to be 210 Watts.
   b. Total heat generated =2 x 210W + 50W = 470W
2. Maximum allowable temperature inside of enclosure: 50°C
3. Ambient temperature: 26.7°C.
4. $\Delta T = 50°C - 26.7°C = 23.3°C$
5. Required heat dissipation: $1.5W/ft^2 \cdot °C \times 23.3°C = 35\ W/ft^2$
6. Surface area required: $470W \div 35\ W/ft^2 = 13.4ft^2$
7. Select a wall mounted enclosure 30"W x 36"H x 10"D. The effective surface area will be the front, both sides, and one-half the top

   Effective surface area = $(36"x36") + 2(10"x36") + 1/2(10"x30") = 1950in^2$

   Converting to ft^2 $A = 1950in^2 \div 144in^2/ft^2 = 13.5ft^2$

   Thus the selected enclosure will meet the surface area requirement.

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If the enclosure size required is larger than desired than an auxiliary means of cooling the cabinet must be considered. Fans or blowers can help in keeping the enclosure size to a minimum. However, if the enclosure internal temperature must be maintained at or below ambient temperature, or if humidity must be removed, or if there can be no free exchange of outside air into the enclosure, then an air conditioner or heat exchanger must be utilized.

Air conditioners should be sized to overcome only the internal heat load and not oversized. Also, if possible, the internal temperature should be maintained close to the ambient temperature. This will eliminate possible "sweating" of the cabinet due to excessively cool internal temperatures. Oversizing the air conditioner will result in frequent cycling on and off and possibly decreasing its life. If the internal temperature must be maintained below the ambient temperature, insulating the cabinet will decrease the air conditioning requirement as well as eliminating external condensation.

For those installation sites that are cold and damp and the equipment within the enclosure may be off for an extended period of time, space heaters are often incorporated to minimize condensation and moisture build-up within the cabinet. If used, select space heating to produce about one-half of the heat dissipation capacity of the enclosure.