Paint Heater Calculations

1. Introduction

Use this instruction sheet to calculate the necessary wattage needed to heat coating material to the required temperature.

The heating capacity of any electric heater is limited by the total wattage of its heating elements.

2. The Rule of Thumb

The required heater capacity can be estimated by the use of a simple rule of thumb.

1000 watts will raise the temperature of an organic solvent type coating 100 °F at a flow rate of 6 gallons per hour. Water based materials require approximately double this wattage.

Example

If a lacquer is to be sprayed from a number 20 nozzle at 150 °F, here is the way to calculate heater capacity by the rule of thumb.

NOTE: This formula does not provide for heat required to melt or vaporize but only for changing the temperature of a material already in the liquid state.

NOTE: Flow rate is determined by nozzle size — a 06 nozzle flow is 0.06 gallons per minute; a 09 nozzle flow is 0.09 gallons of water per minute, etc.

Rule of Thumb Formula:	Flow rate per hour (nozzle size x 60) 1	**x**	Temp. Rise °F (Spray temp. — room temp.) 1	**x**	1000 watts	=	Minimum wattage
Rule of Thumb Calculation:	0.20 x 60 6	**x**	150 °F–70 °F 100 °F	**x**	1000 watts	=	1600 watts

3. Definitions and Formulas

Table 1 lists the definitions and formulas you will need to complete the paint heater calculations.

Table 1 Definitions and Formulas

	Definition	Formula
W_h	Heat required (watts)	$W_{tr} + W_{hl}$
W_{tr}	The heat (watts) required to raise the temperature of the coating material to the correct spraying temperature. Temperature rise is the difference between operating temperature and room temperature.	$$\frac{3 \times \text{Temp. Rise °F} \times \text{Heat Factor} \times \text{Spray Rate GPH}}{10}$$ **NOTE:** Refer to Table 2 for typical heat factors **NOTE:** Spray Rate is usually taken as maximum rate of spray rather than average hourly usage. Refer to the *Sample Calculations* examples B and D.
W_{hl}	The heat (watts) required to balance the heat losses from the various equipment components such as the pump and the heated fluid lines.	Heat loss from pumping system + Heat loss from hoses

4. Typical Heat Factors

Table 2 lists the typical heat factors of a variety of coatings and liquids.

Table 2 Typical Heat Factors

Coating/Liquid	Pounds/Gallon	Specific Heat	Heat Factor
Alcohol	6.70	0.60	4.00
Aliphatic Solvent	6.30	0.52	3.30
Aromatic Solvent	7.30	0.47	3.40
Enamel	8.00	0.42	3.40
Iron Oxide Primer	10.00	0.42	4.20
Kerosene	6.70	0.50	3.40
Ketone Solvent	6.70	0.57	3.80
Lacquer	7.60	0.50	3.80
Oil SAE10	7.20	0.51	3.70
Paraffin (Molten)	7.50	0.71	5.30
Polyester Resin	9.40	0.41	3.90
Red Lead Primer	25.00	0.13	3.30
Varnish	8.00	0.50	4.00
Water	8.30	1.00	8.30
Water Emulsion	10.70	0.56	6.00
Heat Factor = Specific Heat x Pounds/Gallon			

5. Approximate Heat Losses

Allow heat losses of 200 watts for the pumping system, and 4 watts/ft of uninsulated metal covered hose and 6 watts/ft for uninsulated metal tubing ($^{3}/_{8}$ in. diameter). These allowances are based on operating at temperatures 100 °F above room temperature. If higher temperature differences are encountered, the allowances should be increased proportionally.

For example, if the ambient temperature is 150 °F below the operating temperature, the heat loss factors would be increased 50%. Heat losses from uninsulated lines can be reduced about 50% by using a hose cover. Heat losses listed are based on losses from equipment into still air.

6. Sample Calculations

Use the following four examples to help you determine your necessary heater requirements.

Example A

Determine the heater capacity for a continuous operation in which two 30 nozzles spray iron oxide primer at 170 °F with a room temperature of 70 °F. Four 25 ft lengths of 842XXX hose are used.

To calculate the heating capacity (W_h), use the formula

$W_{tr} + W_{hl} = W_h$

W_{tr} Formula	$\frac{3 \times \text{Temp Rise °F} \times \text{Heat Factor} \times \text{Spray Rate}}{10}$ **NOTE:** Spray Rate = hourly flow rate of two 0.30 nozzles	=	watts
W_{tr} Calculation	$\frac{3 \times 100\ °F \times 4.2 \times (2 \times 0.30 \times 60)}{10}$	=	4500 watts

W_{hl} Formula	Heat loss from pumping system	+	Heat loss from hoses	=	watts
W_{hl} Calculation	200	+	4 x 25 x 4	=	600 watts

W_{tr}	+	W_{hl}	=	W_h
4500 watts	+	600 watts	=	5100 watts

NOTE: Recommendation — three 1700-watt heaters.

Example B

What heater capacity would be needed if the system in Example A were to spray intermittently one minute on and one minute off?

Where the spray cycle is of short duration, as in this example, the average hourly flow rate may be used to determine the heater size. The average flow rate in this operation is only half that in Example A and therefore W_{tr} = 2250 watts instead of 4500 watts.

The heat losses from the pumping system and hoses remain the same.

To calculate the heating capacity (W_h), use the formula

$W_{tr} + W_{hl} = W_h$

W_{tr} Formula	$\frac{3 \times \text{Temp Rise °F} \times \text{Heat Factor} \times \text{Spray Rate}}{10}$ **NOTE:** Spray Rate = hourly flow rate of two 0.30 nozzles	=	watts
W_{tr} Calculation	$\frac{3 \times 100\ °F \times 4.2 \times (2 \times 0.30 \times 30)}{10}$	=	2250 watts

W_{hl} Formula	Heat loss from pumping system	+	Heat loss from hoses	=	watts
W_{hl} Calculation	200	+	4 x 25 x 4	=	600 watts

W_{tr}	**+**	**W_{hl}**	**=**	**W_h**
2250 watts	+	600 watts	=	2850 watts
NOTE: Recommendation — two 1700-watt heaters.				

Example C

Determine the heater capacity needed if the system in Example A were to spray intermittently fifteen minutes on and thirty minutes off.

This system would spray even less material per hour than the system in Example B. However, the heater capacity would be the same as for continuous operation. Even with the heater turned off, the latent heat stored in the equipment would be sufficient to maintain the spray temperature within 10 °F for an interval which perhaps a half gallon of material could be sprayed.

In this example, two 30 nozzles would spray this much material in less than one minute. After the latent heat was thus used, the heater would have to supply the entire heat to sustain the temperature throughout the balance of the spray period. If only the two HA heaters recommended in Example B were used in this operation, the temperature would probably hold within 10 °F for three for four minutes and gradually drop to perhaps 150 °F as the spray operation continued.

Example D

Determine the heater capacity needed by the system in example A if the material is molten paraffin and the spray temperature is 320 °F. Assume that the paraffin is supplied from a heated pressure tank at 250 °F.

To calculate the heating capacity (W_h), use the formula

$W_{tr} + W_{hl} = W_h$

W_{tr} Formula	$\frac{3 \times \text{Temp Rise °F} \times \text{Heat Factor} \times \text{Spray Rate}}{10}$ **NOTE:** Spray Rate = hourly flow rate of two 0.30 nozzles	=	watts
W_{tr} Calculation	$\frac{3 \times 70\ °F \times 5.3 \times (2 \times 0.30 \times 60)}{10}$	=	4000 watts

W_{hl} Formula	Difference of operating and room temperatures	x	Heat loss from pumping system	+	Heat loss from hoses	=	watts
W_{hl} Calculation	$\frac{200}{100}$	x	200	+	4 x 25 x 4	=	1500 watts

W_{tr}	+	W_{hl}	=	W_h
4000 watts	+	1500 watts	=	5500 watts
NOTE: Recommendation — three 1700-watt heaters.				

NOTE: The heat loss from the hoses could be cut by about 50% if hose covers were used.

$0.50 \times \frac{250}{100} \times (4 \times 25 \times 4) = 500$ watts