



Qualification Process Solutions

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Heat Addition Using Direct Steam Injection

The following calculations are used to estimate the amount of steam used for direct steam heating and the amount of condensate generated.

General Information

- 1 calorie of energy is required per gram of water to raise the temperature of the water 1 °C.
- 15 BTUs of energy are required per gallon of water to raise the temperature of the water 1 °C.
- 1 gallon of water weighs 8.33 lbs.
- The amount of energy released during the steam to condensate phase change is 970.3 BTU/lb. Assumes process occurs at atmospheric pressure.

Calculations

- Determine the temperature rise of the water in °C.
- Select a starting volume.
- Use energy and temperature relationship (above) to calculate total BTUs required to meet final condition.
- Convert BTUs to Lbs of steam using conversion.
- Using available plant utilities calculate time to reach final condition.
- Calculate final volume.

Example

Starting Temperature	25	°C		
Final Temperature	90	°C		
Temperature Difference	65	°C		
Starting Volume	200	gallons		
Calculate Heat Required to Increase Temperature	$65 \times 200 \times 15 =$	195,000	BTUs	
Convert BTUs to Lbs of Steam	$195,000 / 970.3 =$	201	Lbs	
Determine Time to Heat using 50 Lbs / hr steam	$201 / 50 =$	4	hours	
Calculate Total Condensate Generated	$201 / 8.33 =$	24	gallons	