guidance

Energy Set-Points

Nearly every piece of equipment has a control system. Plant engineers and managers must ensure they are programmed properly. This guidance document is meant to help the brewer determine and evaluate energy set-points.

Many energy-consuming systems have programmable set points; from simple air-conditioning thermostats to more complex computer-controlled brewing process systems. Some breweries set air pressures, temperatures and flow rates well above the acceptable levels to be cautious, but this increases energy consumption. It is critically important to manage set points in order to prevent the need for additional work.

Additionally, understanding where the energy is used is also critically important. Installing meters at strategic locations will allow monitoring and tracking of energy usage and improve knowledge and insights.

Continuously managing set points is another important task. Set points are normally established for an application, process or practice on an individual basis with very little concern for other activities in the location. In most cases set points are established without documentation explaining the reasoning for the set point and ramifications if the set point is raised or lower.

To ensure that energy set points are optimized, more documentation on the set point should be developed. This documentation should include:

- Explanations and reasoning for set levels,
- Ramifications of moving the set point,
- And a time frame for reviewing the set point to ensure that it is operating at an optimal level.

Critical energy set points vital for safety, product quality, and productivity should be checked daily or in some cases, on each shift. Set points that are non-critical such as room temperature for comfort, water temperatures, etc. should be checked weekly or monthly.

Establish a simple management program. The control mechanism can occur electronically, manually, or a combination of both. Develop a table that identifies the location, equipment or process, energy use (heat, cooling, pressure etc.), whether critical or non-critical, review period (every shift, daily, weekly or monthly), max/min deviations from set point, last date checked, and name of person that checked the set point.

Step 1: Team assignment

Install a small team, consisting of the plant energy manager or technician, electricity or control engineer, a utility engineer and a production line manager. The team is assigned with the following tasks:

- Taking inventory of all equipment set points and controls.
- Yearly evaluation per line item if these set points are still correct or need to be changed.
- Communicating of adjustments to appropriate personnel.

Step 2: Inventory of equipment set points and controls

The team should start with an extensive inventory of all relevant set points and controls. Remember, this is a large assignment that will probably take more than 3 months to complete.

The team will use equipment lists and supplier info to get an overview of all relevant equipment and their set points and control settings. For each item the information per setting needs to be extended and documented in the following example table. To determine if a setting is critical or non-critical, the following criteria for critical set points can be reviewed.

- Does the setting influence product quality?
- Does the setting influence the energy use of the equipment/facility?
- Does the setting influence employee safety or health?

Create inventory action items:

- Review each set point and control limits regularly (at least every six month), and judge the accuracy of the settings. Determine whether set points can be optimized or if control limits can be narrowed?
- Determine if there are any new equipment or instrumentation available that will allow for the set point to be adjusted to lower energy use.
- Make a cost/benefit analysis to evaluate suggested improvements.
- Set up a design of experiments for those parameters that need more details on the possible setting adjustments and for which experiments are necessary.
- When set points to be adjusted are determined, inform management and colleagues and explain actions.
- Adjust the spreadsheet with the latest settings including the date of the change and responsible employee.
- Check any equipment operating with new settings for at least one week for any irregularities.
- Make sure this set point change is communicated to the right personnel and include documentation explaining the change for any questions that may arise in the future.

Step 3: Continuous management of set points

Develop a change management program to ensure that the energy manager or technician is involved in any energy set point being considered. For this a special procedure must be developed.

When Step 2 is complete and all critical items are known, a procedure should be set to ensure that every set point change is verified and approved by the set point team, responsible energy manager, and/or technician. The procedure should align with the plant quality system.

Continuous management action items:

- The employee wishing to change a set point should develop and file a document describing the set point change and reasoning.
- The form should be submitted to the plant quality team.
- The quality manager should inform the team about the desired change.
- The team should determine the energy impacts of the change and offer solutions if the set point change causes energy use to increase.

Step 4: Energy Monitoring System

Breweries should consider utilizing an Energy Monitoring System (EMS) to gain more knowledge on the amount and timing of energy use by major systems in the facility.

Setting up an Energy Monitoring System first involves making an energy balance to see where the main energy users are and which energy users may need a dedicated meter.

Format set point control

Location	Equipment or process	Energy used	Critical / non-critical	Review period	Min/max deviation	Last checked	Name of employee

To estimate equipment energy usage note the installed electrical power, the operating hours for that equipment and (if needed) a correction factor to correct for less than full load situations. By multiplying the installed power X operating hours X correction factor, you will get the annual energy use.

For fuel use in boilers, the annual fuel use converted to kWh should be filled in the last column so a rough energy balance is created.

Table 2 energy balance template

Main category	Equipment	Installed power	Operating hours	Correction factor	Annual Energy use (kWh)

The sum of all energy users should be consistent with the plants total energy use. There will always be a small amount 'non classified', which usually is the energy use from computers, printers and small other equipment.

Based on this rough energy balance priorities need to be made for fine tuning the data perhaps with selected metering.

Step 5: Fine-tuning of energy balance

Fine-tuning of the energy balance can be done initially without using expensive metering equipment. Meters should only be purchased and used for information gathering that is critically important and not possible to retrieve with other solutions:

- Prioritize the energy categories. Identify the main energy consuming categories from the energy balance. Put first priority to the biggest energy users.
- Determine per category, of which equipment parameters can be measured, that relate to their energy use. Some examples:
  - ✓ Loading and unloading of compressors
  - ✓ The average frequency of an inverted motor
  - ✓ Flows and temperatures of hot water through heat exchangers
  - ✓ Brew Kettle steam flows, durations, wort cooling temperatures
  - ✓ Monitoring on/off sequence of lights, conveyors, filling machines
  - ✓ Flash pasteurizers inlet and outlet temperatures
  - ✓ Refrigeration inlet and outlet temperatures
- Determine how to get from these parameters to the actual energy use of this equipment.
  - ✓ The loading/unloading sequence gives the load factor of the compressors, which can be used in the energy calculations.
  - ✓ The average frequency of certain inverted motors gives that load factor as well
  - ✓ On/Off sequences give more accurate operating hours
  - ✓ With flows and temperatures, the heat transfer (without transportation losses) can be calculated
- Based on these parameters, determine the best way to retrieve, measure, or read the output of these parameters on a regularly basis. For example:
- Loading and unloading of compressors can be retrieved from the compressors log files. Download this data weekly and document it.
- Flows and temperatures can be read once per shift and per product and documented in a special log.
- On/Off sequence of filling machines can usually be retrieved from the equipment logs.
- On/Off sequence of lights, conveyors etc. can usually easily be retrieved by putting a counter at the electrical cabinet of the equipment. Cooperating with an electrical engineer might be necessary.
- Frequencies can be read from the inverter display. Some inverters have the ability to log data, for others a reading (and logging) per shift might be necessary to obtain an average value.
- Establish a database with all these data and log data weekly. Data can then be used to make trends.
- Trend analysis should be done once per month in a special 'set point team' meeting.
- Based on the average values, the energy balance for the selected equipment can be fine-tuned.
- The energy balance should be set with averages for at least half a year to take production fluctuations and climate influences in account.
- Decide which data is still necessary to retrieve and cannot be utilized by other measurements or readings.
- Remember that the main energy consumers deserve the most attention - there is no need to install or purchase meters for very small energy consumers.

Key variables

Key Variables / Parameters	Key Variables / Parameters to Monitor	Typical Ranges	Parameters influenced by this key variable and to be checked when key parameter is changed	Comments
Boiler discharge pressure	System steam pressure, discharge boiler pressure	80 psi to 150 psi	CIP, brew kettle, mash tun, pasteurizers, and bottle washer temperatures	Review vendor specifications to determine satisfactory operation range for each boiler
Boiler blow down	Times boiler is blow-down occurs each day	Depends on Water Chemistry Some plants, have set number of times per day	Condensate return, Boiler supply water, fuel usage	Blow-down is determined by water chemistry and operating history. Each plant will need to review with their water chemistry vendor the appropriate amount of times to blow-down each day
	Amount of water discharged during day.	4-8% of Boiler Feed water flow rate	Condensate return, Boiler supply water, fuel usage	
	Water chemistry levels	60 psi to 300 psi, TDS 3,500 ppm, Alkalinity 700 ppm & TSS 15 ppm	Condensate return, supply water, fuel usage	
Boiler efficiency	Stack temperature Fuel input Steam output	Coal boilers: 75% to 85% Oil Boilers: 72% to 82% Gas Boilers: 72% to 80%	Fuel usage	Boiler efficiency is checked and adjusted by trained boiler control specialist. Automatic control systems can monitor the parameters necessary to maintain boiler efficiency
Low pressure compressed air system	Fuel usage			See accompanying spreadsheet to calculate theoretical fuel use
Hvac - office areas	Office thermostat	68° F to 77° F	Employee's working conditions	
Hvac - production areas filler rooms	Room temperature		Foaming, filling speed, condensation on bottles or cans	
Hvac - production areas cold rooms	Room temperature	39° F to 50° F	Check the quality requirements of the concentrates. This is mentioned on the labels	
Control / electrical cabinets	Cabinet internal thermostat	65° F to 70° F		Temperature to depend entirely on equipment specifications and operating environment. Typical range shown for reference

Chilled Water Supply/ Return	Discharge Water Temperature and Return Water Temperature	Differential between CHWS and CHWR = 10 degrees		Chilled water differential temperature should be as low as possible to reduce energy consumption. Equipment age, type, plant location and water supply can influence the chilled water system and should be taken into consideration when determining optimal chilled water set points
Discharge Pressure	Discharge Pressure at each unit or system discharge pressure and outside ambient or wet bulb temperature (Optimal discharge pressure set point will change depending on outside conditions)	150 psi to 195 psi		Optimal discharge pressure matches wet bulb temperature to determine most efficient discharge pressure to operate and turns on or off cooling fans and pumps to maintain the optimal pressure
Building heating	Temperature	65°° F – 72° F	Employee's working conditions	
Air Conditioners	Temperature	72° F – 78° F	Employee's working conditions	Use the highest T possible, to have the lowest energy use
Pasteurizers	Temperature		Speed of machine, quality requirements demand pasteurizing at certain T for certain period. Lowering T may increase the time.	
CIP	Temperature	85° C/185° F – 90° C /194° F	Speed of CIP process, quality requirements demands CIP at certain T for certain period. Lowering T may increase the time	
	Time	Varies depending on application	Speed of machine, quality requirements demands CIP at certain T for certain period. Lowering T may increase the time	