DOCKETED	
Docket Number:	21-AAER-01
Project Title:	Appliance Efficiency Regulations for Dipper Wells
TN #:	259266
Document Title:	CA IOUs Draft Dipper Well Test Method
Description:	Draft dipper well test method submitted by the CA IOUs during workgroup activities.
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Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	9/24/2024 11:18:22 AM
Docketed Date:	9/24/2024

Draft Dipper Well Test Method

Scope

The purpose of this test method is to determine the typical daily water and energy consumption of various types of commercial utensil rinsing equipment. Utensil rinsing equipment shall be characterized into two different categories based on products currently available on the market:

- Continuous flow – this includes standard dipper wells with a manually adjustable faucet and an overflow drain.
- Intermittent flow – this can be subdivided into 3 product categories which do not rely on continuous flow of water.
    - On-demand mechanical flow – the flow is controlled by pressing a utensil against a mechanical valve that shuts the flow on and off.
    - On-demand automatic flow – the flow is automatically controlled by a sensor that triggers the inlet of fresh water and draining of the stagnant water.
    - Heated manual dump – bacteria growth is inhibited by heating the well water above 140F and the water is manually dumped by the operator.

Methodology

Setup

The daily water and energy consumption shall be determined for a typical use of a dipper well, which is assumed to consist of an 8-hour operating period and 120 items served over a period of 2 hours[3]. The unit tested shall be installed according to manufacturer's installation instructions. Water shall be supplied at a temperature of 70±2 degrees F[4] at a pressure of 60±2[5] psi, unless otherwise specified by the owner's manual. Any deviations to water temperature and pressure shall be documented. Higher water temperatures shall have their energy consumption calculated based on 65% water heating thermal efficiency. [6]

Water Consumption

Flowrate Measurement

Flowrates shall be measured by either an inline water meter or a catch and weigh method per ASTM F2324-13(2019) and reported in gallons per minute (GPM):

- Continuous Flow Dipper Wells – the faucet shall be opened fully[7] and measured for at least one minute after the flow has been stabilized.
- Intermittent Flow On-Demand Mechanical Flow – averaged over ten 10-second uses.

[3] This is a starting assumption, additional research and potentially user surveys are recommended.
[4] It would simplify the test method to test with cold water only. Typical cold water temperatures are 60 degrees F on average in California, but 70 degrees F is easier to achieve throughout the year by blending hot water.
[5] Typical commercial building water pressure ranges between 20 and 60 psi. By specifying the GPM rate for continuous flow dipper wells with an adjustable faucet the pressure does not need to be tested at multiple points.
[6] Added clause to accommodate the calculation of a hot water dipper well without the extra testing. 65% thermal efficiency includes recirculation system losses in addition to water heater thermal efficiency, this is the formula and value used in ASTM F1696 for door type dishwashers.
[7] Flow rate is measured at maximum flow as future steps use a percent of maximum flow rate for active and inactive periods.

- Intermittent Flow On-Demand Automatic Flow – averaged over a period of an hour of use which consists of addition of one teaspoon of whole milk to the well per minute.
- Intermittent Flow Heated Manual Dump – measure the volume of the container filled to the fill line assuming the container gets fully refilled twice per hour for active periods and once per every 2 hours during inactive.

Water Consumption Reporting

Water consumption shall be calculated for an 8-hour period consisting of 6 hours of inactivity and 2 hours of active operation. The 2 hours of active operation shall mimic rinsing of one soiled utensil per minute. This water consumption shall be reported in gallons per day using the following methodology:

Q = total water consumption, in gallons per day (superscript indicates dipper well type)
q = water flow rate, in gallons per minute
V = water volume of the dipper well filled to the fill line, in gallons

Continuous Flow Dipper Wells – 75% of maximum flow rate during 2 hours of active operation and 25% of maximum flow rate during 6 hours of inactivity.

$$Q_{continuous} = [(q_{max} \times 0.75 \times 2) + (q_{max} \times 0.25 \times 6)] \times 60$$

Intermittent Flow On-Demand Mechanical Flow – 2 hours of active operation with one utensil washed per minute equals 120 utensils washed per day. 120 utensils washed for 10 seconds per day equals to 20 minutes of continuous flow during active operation. This type of device needs to be flushed for a minute at the beginning of each day and does not use water during inactive periods. The total water consumption for this device shall be calculated for 21 minutes of flow per day.

$$Q_{IF\ MF} = q_{max} \times 21$$

Intermittent Flow On-Demand Automatic Flow – average flowrate during 2 hours of active operation using the whole milk addition methodology described during flowrate measurement. Average flowrate during 6 hours of inactive operation with no milk addition to measure any idle water consumption or stir cycles.

$$Q_{IF\ AF} = [(q_{active} \times 2) + (q_{inactive} \times 6)] \times 60$$

Intermittent Flow Heated Manual Dump – 2 hours of active operation with 2 container refill per hour. 6 hours of inactive operation with 1 container refill per 2 hours.

$$Q_{IF\ MD} = \left[\frac{V \times 2}{0.5} + \frac{V \times 6}{2}\right]$$

Energy Consumption

Not all dipper wells have associated energy consumptions. **Continuous flow and intermittent flow on-demand mechanical flow** dipper wells can be connected to hot water sources. In order to calculate the energy used to heat water, maximum energy consumption for those two types of dipper wells can be determined by calculating water heating energy per day in Btu/h assuming a 140°F supply temperature by calculating water heating energy per day in Btu/h. Water heating energy consumption calculations shall be conducted for those types of dipper wells using the daily water consumption and assuming a temperature rise of 70 degree F (140 degrees F to 70 degrees F) and a thermal efficiency of 65%. Maximum energy consumption shall be reported in kBtu/day.

Water Heating Calculation[8]

Calculate and report the primary hot water energy use during the active and inactive dipper well test based on:

$$E_{DHW} = \frac{Q_w c_p \rho \Delta T}{\eta}$$

Where:

E_{DHW} = the calculated domestic hot water energy throughout the day
Q_w = the quantity of hot water consumed by the dipper well throughout the day
c_p = the specific heat of water, Btu/lb*°F = 1. 00 Btu/lb*°F
ρ = the density of water, lb/gal = 8. 33 lb/gal
η = the assumed system efficiency of the commercial hot water system using a standard efficiency gas water heater and pipe recirculation system losses, % = 65 %
ΔT = the temperature rise of hot water °F = $T_{hot} - T_{cold}$
T_{hot} = the temperature of the hot water supplied to the dipper well
T_{cold} = assumed cold water supply temperature for cold water dipper wells, °F = 70°F

Intermittent flow on-demand automatic flow dipper wells use electrical components for controls, sensors, pumps, and valve actuation. These devices shall be connected to an electric meter with a minimum resolution of 5 Wh and shall be monitored during the water consumption test including the 2 hours of active operation and 6 hours of inactive operation. Energy shall be reported in kWh per day.

E = total energy consumption in kWh per day, superscript indicates dipper well type
e = energy consumption rate in W, superscript indicates the type of test

$$E_{IF\ AF} = (e_{active} \times 2) + (e_{inactive} \times 6)$$

Intermittent flow heated manual dump dipper wells use heating elements to reduce bacteria growth. Energy is used to preheat cold water that is filled in the well as well as reheat the water after cold utensils are placed in the well. These devices shall be connected to an electric meter with a minimum resolution of 5 Wh and shall be tested for water preheat, idle, and utensil

[8] Per ASTM F1696, *Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machine*, Section 11.6.5 using dipper well instead of dishwashing machine. This method assumes a gas water heater.

heating. Energy shall be reported in kWh per day as the sum of the energies from the water preheat, maintenance and utensil heating tests.

> Energy per day = water preheat energy + water maintenance energy + utensil heating energy

$$E_{IF\ MD} = E_{preheat\ total} + E_{inactive} + E_{active}$$

Water Preheat

The well shall be filled with 70±2F water to the fill line. The device shall be turned on; energy and time shall be recorded until the elements cycle off. Energy usage in Wh shall be averaged over 3 tests. Water preheat energy shall be multiplied by the number of refills per day and reported in kWh.

> Water preheat energy = water preheat test x number of refills per day

$$E_{preheat\ total} = E_{preheat\ test} \times N_{refills}$$

Water Maintenance

Once the unit is preheated to the desired temperature and the elements cycle off, energy consumption shall be monitored for a period of 3 hours. Energy rate shall be reported in W and multiplied by the number of inactive hours of operation minus the preheat time during the inactive period. This energy shall be reported in kWh/day.

> Water maintenance energy = water maintenance energy rate x (inactive hours of operation – (preheat time x refills during inactive period))

$$E_{inactive} = e_{inactive} \times \left[t_{inactive} - \left(t_{preheat} \times N_{refills}\right)\right]$$

Utensil Heating Test

Ten ice cream scoop utensils shall be used for this test. The utensil shall be unibody 3±0. 2 fl oz aluminum scoop 7±1” in length known in the industry as a #12 scoop. The ice cream scoops shall be held in a refrigerator at 32-40F for at least 8 hours prior testing. The dipper well shall be preheated prior to testing. Energy consumption test shall start after the dipper well has been preheated and prior to the first scoop being placed into the well. A scoop shall be removed from the refrigerator and placed into the preheated dipper well for a period of 1 minute, then placed back into the refrigerator. As soon as the first scoop is removed from the dipper well, another cold scoop shall be placed into the dipper well. This process shall be repeated for 30 minutes and an energy rate in W shall be reported for this test. Utensil heating energy shall be reported for the number of hours of the active hours of operation excluding preheat time during active hours of operation in kWh/day.

> Utensil heating energy = utensil heating energy rate x (active hours of operation – (preheat time x refills during active period))

$$E_{active} = e_{active} \times \left[t_{active} - \left(t_{preheat} \times N_{refills}\right)\right]$$