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Constructing a Walk-in Dehydrator for Drying Hops

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Introduction

Hops (*Humulus lupulus*) are an herbaceous perennial primarily grown in the United States and Germany. The United States has 40 percent of the world hops production acreage. The female hop flowers (cones) are used for bittering and flavoring in brewing beer (USDA-ARS 2020). The craft brewing industry has grown in the United States, making up more than 25 percent of the $116 billion U.S. beer market (Brewers Association 2019). As the interest in local craft beer continues to grow, so does the demand for locally-sourced ingredients. This has resulted in increased interest in growing hops for local markets. Acreage of hops in the United States reached a record high of 58,641 acres in 2020 (Campbell 2018 and USDA 2020).

One of the most important parts of hops production is the handling and processing of the cones after harvest. Freshly harvested hops contain 80 percent moisture content (calculated dry weight divided by initial weight) and can quickly lose quality and aromatic compounds if not immediately used in brewing as a wet hop, or dried for long-term storage (Campbell 2018 and Moorehead 2017). Hops should be dried immediately once harvested.

There are many methods to dry hops and which method is selected should depend on the quantity of hops that will be dried, the space available and the available budget. An oast house or hop kiln, which is a building designed for drying hops, is commonly used for large-scale hops drying. These kilns can be found in most major hop-growing areas and consist of a rectangular one or two-story building with one or more kilns. The hops are spread out in thin layers on perforated drying floors and are dried by hot air rising from a heat source below. Other options for growers to dry hops on a

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moderate scale are to use sheds or barns that use ambient heat or on a small-scale using a dehydrator or home oven. General rules apply for drying hops regardless of the scale or method: hops are dried at 38-60 °C (100-140 °F) to a moisture content of 5-6 percent moisture, which factors in that the hops gain moisture back during cooling, resulting in a final ideal moisture content of 8-10 percent (Brown 2013). After drying, the hops are cooled, bagged, and are ready to be sold.

Small-scale hops production is of growing interest in Arkansas. Due to the smaller amount of hops harvested in a small-scale operation, an option for drying hops is to convert a small shed or storage building into a walk-in dehydrator. The University of Arkansas System Division of Agriculture (UA System) is conducting research on hops production in Arkansas at the UA System Fruit Research Station in Clarksville, Arkansas. A metal shipping container at this site was converted into a three-shed, multipurpose storage unit (**Figure 1**). We converted one of the sheds of this shipping container into a walk-in dehydrator. The primary components needed to convert the shed into a dehydrator include insulation, shelving, heat and fan units, thermometers, and a dehumidifier. In this factsheet, we will discuss general considerations of the steps and estimated costs for small-scale hops producers to build a hops dehydrator.

Figure 1. Shipping container used as three sheds with one shed selected to convert into a hops walk-in dehydrator at the University of Arkansas System Division of Agriculture Fruit Research Station (Clarksville, AR)

The following step-by-step guide is based on our experience using a space with the dimensions 8-ft L x 8-ft W x 7.5-ft H that had existing doors and previously had no electricity. A professional electrician installed electricity to the building. The materials needed for the conversion and insulation of the building include:

Materials Needed:

- Fiberglass Reinforced Plastic (FRP) board wall panel
- Polystyrene foam board insulation
- Construction adhesive
- Plywood
- Electric gable vent fan
- Metal shelves
- Ceiling mounted heater (750/1500 watt)
- Mounted fan (6-in, 110V)
- Temperature controller
- Thermometer/hygrometer
- Dehumidifier

Step 1: Estimate Space Needed

You should determine the maximum amount of fresh hops you plan to harvest on a daily and weekly basis to determine how much space you may need for the given time frame.

- At peak harvest, the hopyard at the Fruit Research Station produced 21 pounds in a single day's harvest.
- For our 8-ft L x 8-ft W x 7.5-ft H shed, we could dry a maximum 126-160 lbs. of hops per week. In general we harvested two to three times per week so we remained below our maximum capacity.

Step 2: Select a Location

Hops must be dried quickly once harvested. Therefore, some considerations when selecting a location for your walk-in dehydrator are as follows (Campbell 2010):

Location

- Close to hopyard
- Elevated for good water drainage
- Partial to fully shaded is ideal to prevent high temperatures in the dehydrator
  - *A tarp can be used to fully cover structures exposed to the sun*
  - *Our example is in full sun due to limited availability of potential space at the Fruit Research Station*

Size

- Ceiling height at least 6 ft with room for a person to walk into the dehydrator

Access to electricity

- Most of the equipment will require power

Light exposure

- Limit windows that allow heat loss and light which degrade hops quality

Ventilation and drainage

- Ventilation required to regulate temperature inside dehydrator
- Set up dehumidifier to drain to the exterior

Step 3: Measure Interior Space

Once you have selected a location and building for your walk-in dehydrator, measure the interior dimensions of the space you plan to use (**Figure 2**).

These measurements will determine the amount of material needed for insulation, flooring, and how much room you will have for shelving and equipment.

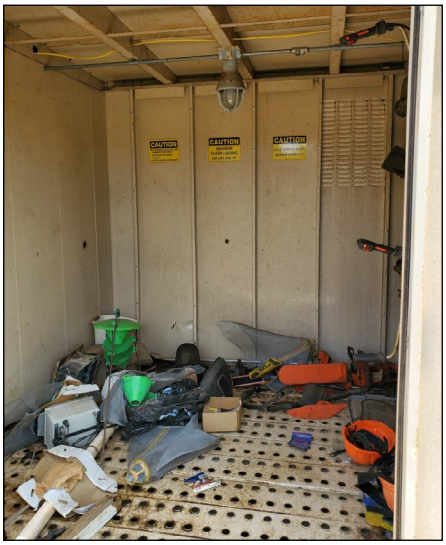

Figure 2. Interior of the shed in the shipping container before being converted into a walk-in dehydrator (Clarksville, AR)

Insulation is important because it helps the building maintain temperature during drying.

Step 4: Cut Opening for Exterior or Gable Vent Fan

If it is not already installed, installation of an exterior or gable vent is important to vent excess hot air and maintain the preferred temperature (**Figure 3**). Installing it first will help get an accurate estimate of the amount of insulation needed for the walls, since the area covered by the fan will not be insulated.

Figure 3. Exterior of the gable vent fan installed for the walk-in dehydrator (Clarksville, AR)

Step 5: Prepare Materials for Installation

FRP board and polystyrene foam board can be used to insulate the walls and ceiling of the space. If your space has slick floors, we recommend covering them with plywood as a safety precaution due to the possibility of condensation build-up on the floors.

Cut the FRP wall panel board, polystyrene foam insulation boards, and plywood to fully cover the walls and ceiling of the space (**Figure 4**).

Figure 4. Fruit Research Station staff James McClellan (left) and Emory Johnson (right) cutting polystyrene foam board for insulation (Clarksville, AR).

NOTE: *You will need to consider the area removed for the gable vent fan when cutting your materials.*

Step 6: Install Insulation Materials

Insulation will improve the efficiency of the drying process, and spending time and money ensuring your space is properly insulated is a good investment. Since the space we used is a metal shipping container, we used polystyrene foam board and FRP board as they are both moisture resistant and commonly used when insulating buildings.

- First, install the polystyrene foam board on the walls and ceiling and secure panels with construction adhesive.
- Next, install the FRP board on top of the polystyrene foam board, also securing with construction adhesive (**Figure 5**).

NOTE*: Consider if the floor or ceiling of your space needs insulation.*

Figure 5. Insulation layers of fiberglass reinforced plastic (FRP) over polystyrene foam board in the walk-in dehydrator (Clarksville, AR).

Step 7: Install the Gable Vent Fan

The gable vent fan with thermostat control regulates the temperature in the shed by removing excess hot air during drying. Install the fan in the area you previously cut based on the instructions for your specific fan (**Figure 6**).

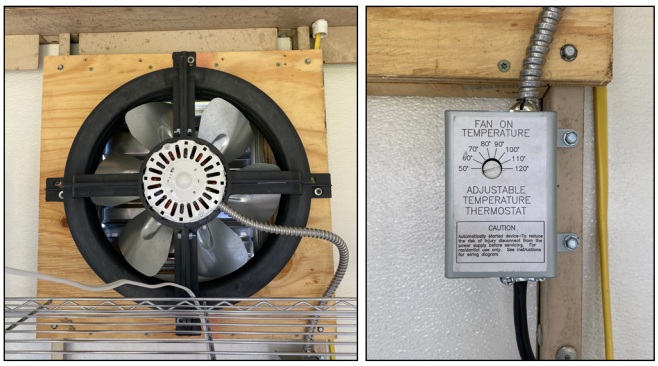

Figure 6. Close-up of the gable vent fan (left) and thermostat controller (right) in the walk-in dehydrator (Clarksville, AR).

Step 8: Install Plywood Flooring (optional)

Figure 7. Plywood floors installed in the walk-in dehydrator (Clarksville, AR).

Use construction adhesive to secure plywood to the floor and make sure there are no gaps between panels. Plywood should meet the insulated walls on all sides. Gaps may allow insects or rodents to enter the space and also reduces energy efficiency (**Figure 7**).

Step 9: Connect Electricity to the Building and Install Electrical Outlets

If building does not have a power source, the equipment used in the dehydration process will require access to power. For the size of our space, we installed two 120-volt duplex outlets at a height of 4 feet from the floor (**Figure 8**).

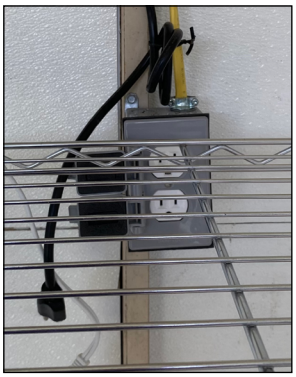

Figure 8. One of the two 120-volt duplex outlets installed in walk-in dehydrator (Clarksville, AR).

***NOTE**: A professional was hired for the installation of electricity to the storage container. Seek additional information or a professional as required by local regulations.*

Step 10: Install Temperature Regulation Equipment and Shelving

Heater

- A heater is important as it will help maintain a constant temperature in the space required for drying.
- Ceiling-mounted heater units allow for more room on the floor or for shelving and other equipment. We used a ceiling-mounted heater with 750/1500 watt capacity (**Figure 9**).
- Small space heaters are another option for heating the space.

Figure 9. Ceiling mounted heater used in walk-in dehydrator (Clarksville, AR).

Fan

- A ceiling mounted fan allows more room on the floor for shelving and other equipment. We used a 6-in size, 110-Volt capacity fan (**Figure 10**).
- The oscillating fan helps with air movement to ensure hot air is evenly distributed throughout the space.

Figure 10. Clip-on oscillating fan installed in walk-in dehydrator (Clarksville, AR).

Thermometer and Hygrometer

- The thermometer measures the temperature and the hygrometer measures the humidity of the space. Both of these are important to ensure the efficiency of the drying process as high humidity will slow drying.
- Units can be mounted inside or outside of the dehydrator depending on the model.
- If mounted indoors, place both units close to the door so that the temperature can be monitored from the door quickly without releasing too much heat (**Figure 11**).
- A wireless model allows for taking readings on a mobile device without opening the dehydrator.

Figure 11. Temperature and humidity reader installed on a wire shelf in walk-in dehydrator (Clarksville, AR).

Dehumidifier

- A dehumidifier sized for the space is required to remove humidity from the dehydrator and reduce the time needed for drying. For our space, we installed a single unit with 50-pint capacity (**Figure 12**).
- The unit should be placed where drainage is easily accessible. In our building, we placed the unit close to the door so the drainage hose could lead outside (**Figure 13**).

Figure 12. A 50-pint dehumidifier set up in the walk-in dehydrator (Clarksville, AR).

Figure 13. Placement of dehumidifier next to the door with drainage hose leading outside of the building (Clarksville, AR).

Shelving

- Metal shelving allows for airflow through the hops once they are placed on the shelves.
- The size and number of shelves that can be installed will depend on the size of the space (**Figure 14**).

Figure 14. Wire shelving set up in walk-in dehydrator (Clarksville, AR).

- The minimum vertical space between shelves should be 12 inches to allow for airflow and easy loading of the hops. We place the hops in paper bags for drying but other types of reusable trays or boxes that do not constrict airflow could also be used. If trays or boxes are used, it is recommended to cover the hops with hardware netting to prevent the cones from moving around, as they become very light when dried.

Step 11: Test the Walk-in Dehydrator

- Before harvest begins, the dehydrator should be tested to ensure it can maintain the desired temperature for a minimum of 24 hours.
- To prevent quality loss, it's recommended that drying not last more than three days (Moorehead 2017).
- We filled each paper bag with 5-6 ounces of wet hops and place the bag on its side. This amount allows for the hops to be spread out in a single layer, which helps improve drying time. In our experience, if the bag has more than 7 ounces, the drying is less efficient.
- In our space, it takes 16-24 hours to dry 14-16 lbs. of wet hops at one time using 4 shelves (**Figure 15**).
- Ideal moisture content for dried hops is 8-10 percent.
- Refer to FSA6156: Hops Production in Arkansas, for more details on hop ripeness and calculating percent moisture content.

Figure 15. Freshly harvested hops placed on shelves to dry in the converted walk-in dehydrator at the Fruit Research Station (Clarksville, AR).

The space required, location, and design of a walk-in dehydrator should be taken into consideration early on in the planning process. Cost will also factor into the ultimate design, and we present our estimated costs for consideration. Several factors will affect the final cost of converting a space into a walk-in dehydrator, such as: building size, electrical wiring and labor costs, available supplies, and location. Based on the size and conditions of the pre-existing shipping container we used, the total for the conversion of the space into a walk-in dehydrator was $1,440.75 (**Table 1**).

Table 1. Costs associated with converting an 8-ft x 8-ft x 7.5-ft section of the shipping container into a walk-in dehydrator

Item	Unit Price[Y] ($)	Quantity	Subtotal ($)
Insulation Materials			
Fiberglass Reinforced Plastic (FRP) Board Wall Panels (4-ft x 8-ft)	32.97	10	329.70
Polystyrene Foam Board Insulation (1-in x 4-ft x 8-ft)	16.25	10	162.20
Liquid Nails® Multi-Purpose Construction Adhesive (9 fl oz)	6.98	3	20.94
Plywood (3/4-in x 4-ft x 8-ft)	54.68	3	164.04
Shelving			
47.7-in W x 72-in H (18-in diameter) 5-tier Steel Shelving Unit	79.98	4	319.92
Equipment			
Electric Gable Vent Fan (18-in diameter)	88.98	1	88.98
Ceiling Mounted Heater	46.99	1	46.99
Mounted Fan	40.00	1	40.00
Temperature Controller Thermostat	35.00	1	35.00
Wireless Thermometer/Hygrometer	49.99	1	49.99
Calibration Kit for Wireless Thermometer/Hygrometer	7.99	1	7.99
Dehumidifier (50 pint)	175.00	1	175.00
Total			**1,440.75**

[Y]Prices as of Spring 2021 purchased from local and online sources

Conclusion

This guide provides the primary components, steps, and costs needed to convert a shed to a dehydrator for small-scale hops producers. These steps and costs are based on our experience and are intended only as an example of one way to construct a walk-in dehydrator. A virtual tour of our hops dehydrator is available on You-Tube on the UAEX Fruit and Vegetable Channel (UAEX Fruit and Vegetable, 2021).

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