



Brewers Association Yeast Handling Systems



Prepared by the
Brewers Association Engineering Subcommittee

DOCUMENT PURPOSE AND SCOPE

The purpose of this document is to provide an overview and some detail of yeast handling systems, with specific focus on equipment and systems design and how to design-in the optimal environment by which yeast is propagated, stored and pitched.

This document will not include quality assurance topics, such as cell counting methodology, pitching rates, aeration and oxygenation rates and other process-specific topics. If the latter is desired, please consult the BA Resource Hub for the following resources:

[Bilge, Deniz. "Modern and Efficient Yeast Management" Craft Brewers Conference, 2015.](#)

[Pringle, Alastair. "Yeast: The Owner's Manual" Craft Brewers Conference, 2015.](#)

Yeast Handling Systems to be covered include:

- Safety Preface
- Yeast Propagation Systems
- Yeast Transfer Systems

SAFETY PREFACE

Yeast handling systems and the processes involved present safety issues that should be considered at the front-end of the design process. Hazard assessments should be performed while reviewing these designs to ensure the safety of your brewers and equipment. Further information about building safety into your design can be found in the following resource:

["Best Management Practice \(BMP\) for the Development of Safety Programs in Breweries. Volume 1. Hazard Assessment Principles," Prepared by the Brewers Association Safety Subcommittee.](#)

In addition, all materials used in propagation should be food safe. Such materials include media, wort, slurry, anti-foam and any other additives that will be included in the process. This article discusses the injection of compressed gases, CO₂ and O₂, into sealed containers; at all times, it is crucial to avoid over-pressure situations by installing a pressure relief valve or other ventilation device, and by utilizing regulators with accurate gauges set well below the working pressure limits of vessels. Special considerations should be taken when working with pure O₂ such as using spark-less tools, cleaning valves for O₂ service, and securing cylinder storage.

YEAST PROPAGATION SYSTEMS

Craft Brewers will use multiple strains of yeast to create myriad classic and esoteric styles of beer. Some strains of yeast are kept in-house and harvested over multiple generations, and some are propagated on an as-needed basis for one-off brews. Propagation is the process of growing yeast cells from either a single cell or starter yeast to a sufficient cell-count by which a batch of beer can be successfully fermented. Target cell counts for starters, step-up volumes and oxygenation rates are detailed in the following resource in the BA Resources Hub.

[Bilge, Deniz. "Propagating Healthy & Happy Yeast, The New Brewer, November/December 2018, pp. 115-118.](#)

1. **Rudimentary** – Small-scale breweries will utilize tried-and-true methods proven over the years by homebrewers, which don't have all the bells and whistles but are effective techniques when proper procedures are followed.
 - a. Glass Carboys – lead-free glass containers, cleaned and sanitized prior to the first step-up of wort and inoculation of yeast starter. Volumes vary, but most are between 5.0 – 6.5 US Gallons.
 - i. Bung & Airlock – A rubber bung is a beveled stopper with a ~0.5" hole in the center, which will allow for installation of a blow-off hose, used on a glass carboy to allow for CO₂ to escape and prevent outside air from ingress into the yeast starter. The blow-off hose should be submerged in a container of sanitizing solution.
 - ii. Funnels – Lab-specific funnels can be purchased for step-ups and transfers to converted kegs or tanks. These should be abrasion, heat and chemical resistant to ensure cleanability.
 - iii. Microscope and Hemocytometer – Even rudimentary systems should have the ability to track yeast cell growth and viability. Microscopes & hemocytometers can be purchased online or from your local lab supplies store, along with pipetting supplies and dyes for counting and viability assays.
 - iv. Oxygen bottle, O₂ regulator + oxygenation Stone – A simple, cost-effective way to oxygenate yeast propagate in a carboy is by diffusing sterile O₂ through a sintered stainless stone directly into the culture. Care should be taken to sterilize the stone by boiling or autoclaving, and periodically cleaning using a sonic cleaner. If pure Oxygen is not available, sterile and/or filtered air can be used and dosed in at a higher rate. If air is used, the brewer should consider an anti-foam to mitigate over-foaming during aeration and mixing.
2. **Converted Keg Systems** – Yeast propagation can be made easier by using converted kegs, which will allow the craft brewer to fill and transfer in a closed environment. The materials of construction of these kegs should be stainless steel and Buna or EPDM rubber, which are food-grade and compatible with CIP and sterilization prior to filling or pitching. Mixing and aeration of the yeast propagate is accomplished by bubbling sterile air or pure oxygen backwards through the outlet port of the keg and shaking contents by hand sufficiently to ensure thorough mixing of the slurry at least once a day. A mechanical mixer could be installed, or a magnetic stir bar with stir plate could be used to more consistently mix the contents while in propagation. Carbon Dioxide is vented out through the gas inlet of the keg coupler, which has had backflow prevention removed, and fitted with a hose into a bucket of sanitizer creating an airlock. Care should be taken to prevent over-foaming which can clog the vent outlet and over-pressurize the keg. If over-foaming becomes an issue, the brewer may choose to use anti-foam in the propagation or install a pressure relief valve.



Figure 1: Coopersmith’s converted keg for propagation and slurry storage

3. **Dedicated or Re-purposed Vessels** – Yeast can be propagated and slurry stored in vessels that were originally intended for other purposes. These stainless steel tanks will ideally be cylindro-conical, constructed of 304 or 316L Stainless Steel, adhere to 3A or EHEDG standards and have CIP and heat-sterilization capabilities. Recirculation ports on the manway or sidewall of the tank are also desirable as is a port for a removable oxygenation stone. Tanks that have shadow areas and/or threaded connection should be avoided, as they harbor wild yeast and bacteria that can cross-contaminate your starter. In addition, multiple cooling zones including a cone-zone are ideal to ensure thorough temperature control during propagation and also storage of yeast slurry.

[Couch, Matt. “Yeast Storage Solutions: Theory and Practice” Craft Brewers Conference, 2020.](#)

4. **Yeast Propagation and Storage Skids/Cellars** – Depending on your brewery’s size and scale of production, larger pre-engineered yeast handling equipment systems should be considered:
 - a. Step-up vessels, cylindro-conical, stainless steel, glycol jacketed, with the ability to be cleaned in-place and heat-sterilized, including all peripheral ports and piping/ potential dead-legs, fitted with integrated mixers or recirculation capabilities, inline aeration and inoculation ports, sight glasses in the mixing loop, plan for dissolved oxygen measurement and sterile sampling (inline or in-tank).



Figure 2: Yeast storage brink with top-mounted mixer at Maine Beer Company



Figure 3: Yeast storage and propagation skid at Great Lakes Brewing Company

- b. Pumps – Recirculation and pitching needs considered, pumps sized and installed accordingly, installed to facilitate easy priming and prevent cavitation, empty pipe protection, variable frequency drive, heat-sterilizable, and able to drain completely
- c. Instrumentation – Tank temperature probes and magnetic flowmeters with totalizers and/or tank load-cells should be included in an automated yeast handling system, as they allow the brewer to ensure yeast health by maintaining optimal temperatures and measuring pitch rates using the data provided. Additional mass-flow meters, inline dissolved oxygen meters, inline cell-counters and densitometers are generally cost-prohibitive for the small brewer, however if your brewery is kicking out multiple brews per day, the return on investment for this instrumentation will be realized quickly by reducing variability and errors.). A table-top dissolved oxygen meter can be used in place of an inline meter, noting that the timing of the sample is important to ensure a valid measurement.
- d. Drawings – Before fabrication or assembly of the skid/cellar can proceed, a complete, piping and instrumentation diagram (P&ID) and layout/ elevation drawing must be reviewed and approved by appropriate brewery staff. Complete understanding of these drawings is essential prior to moving forward with your project, as you will avoid missed pieces of equipment or instrumentation, as well as ensuring your gear will fit into the physical space provided.

YEAST TRANSFER SYSTEMS

A brewer can simply pour or siphon a yeast culture through a manway or funnel through a port prior to or during knockout, taking care to prevent airborne contaminants from entering the sanitary vessel; this method has the highest risk of contamination and human error. Preferably, the yeast will reside in an enclosed, sanitary environment until the time of pitching using the following methods and equipment:

1. **Cone-to-cone** – This process involves transferring a portion of yeast slurry from a finished beer sitting static in a primary fermenter to another empty & sanitized fermenter. The yeast can be transferred using gravity and top pressure or pumped (see below). Pitch volumes can be measured using a calibrated sight glass on the receive tank, or an inline flowmeter between the supply and receive tanks. This process, while simple, is inherently inaccurate as yeast that has flocculated and compacted in a primary fermenter's cone is stratified and the concentration unknown. Over time, a brewer can gather empirical data on their yeast strains to help increase the accuracy of the pitch, but it is always desirable to start with a homogenized slurry or propagate in order to better determine cell counts and pitch rates. More information on yeast cell counting can be found on the BA Resource Hub:

[Tretter, Kelly & Christiansen, Rob. "ASBC Lab in a Fishbowl," Craft Brewers Conference, 2017.](#)

2. **Gravity and top pressure** – This is the simplest method, which requires either compressed sterile air, CO₂ or Nitrogen to connect to an air-chuck or sanitary connection fitted with a steamable filter on the yeast vessel. The brewer must take care to make sure the pressure of the vessel (i.e. yeast propagator) exceeds the line pressure (i.e. fermenter), and that the top pressure is not excessively high and does not compromise yeast health. In addition, the pitching path should be able to be Cleaned in place and heat-sanitized, and backflow prevention should be considered in all cases. Backflow preventer valves should be made of sanitary materials, heat and chemical resistant, and be detailed in-between each use to ensure springs, shafts and seals don't get fouled.
3. **Centrifugal pump** – Common in most small craft breweries and relatively inexpensive and multi-purpose, a portable or fixed pump can be used to transfer yeast propagate from the propagator or slurry storage vessel to the fermenter. These pumps are made from sanitary materials such as 316 Stainless Steel and utilize high temperature pump seals made of EPDM or Viton, and also

may have seal-water to prevent airborne contaminants from entering the pitch stream. Inline flowmeters and/or load-cells installed on the tank are used to track the volume/volume pitch ratio to ensure wort is not over or under-pitched. Dedicated pumps are ideal and should be sized and installed appropriately.

4. **Positive displacement pumps** – Budget allowing, this type of pump is best suited for handling slurry. Diaphragm, peristaltic, rotary lobe and piston-style pumps deliver a known volume of yeast per stroke and ensure that the pitched yeast will be dosed at a known volume/volume ratio. As with centrifugal pumps, inline flowmeters and/or load-cells installed on the tank are used to track the volume/volume pitch ratio to avoid over or under-pitching. In order to CIP these pumps properly, a bypass loop should be built-in to ensure proper velocity (4.0 m/s).

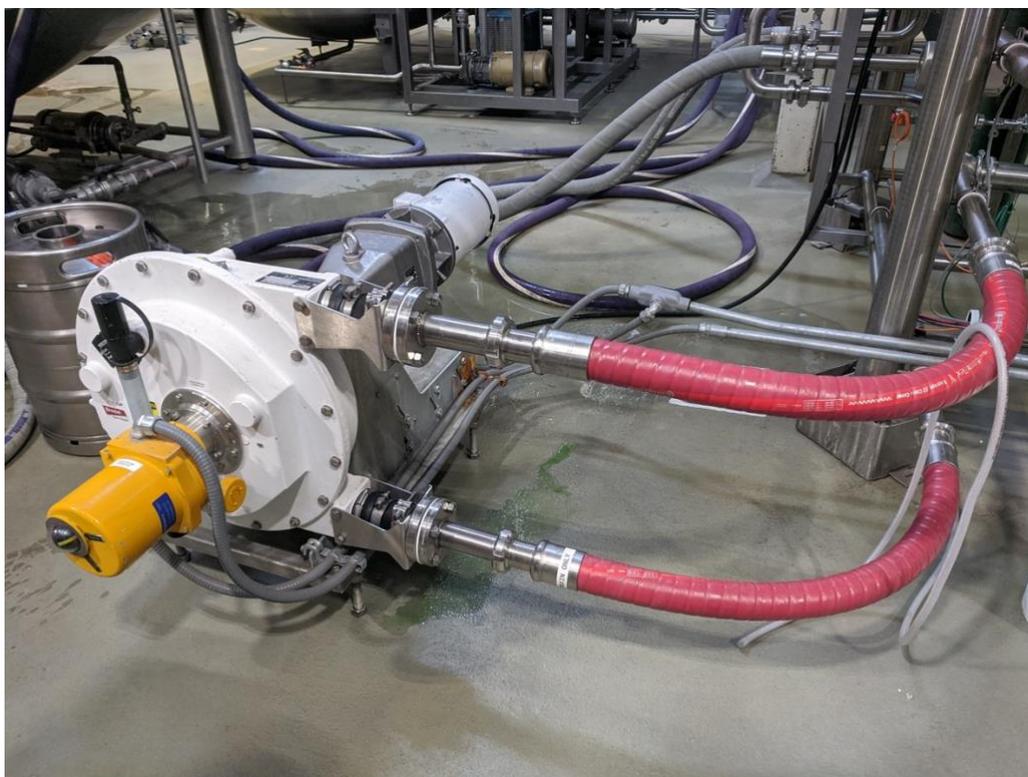


Figure 4: Peristaltic pump in use at Odell Brewing

5. **Special considerations** – When pitching yeast slurry, harvested yeast is much thicker and more viscous than thinner yeast propagate. Piping and pump systems should be designed to overcome the additional friction loss created by the slurry, and storage tanks should have a way to mix the slurry prior to pitching out. For piping pathways that are smaller diameter and have a circuitous path with lots of bends, a positive displacement pump is usually a good choice.