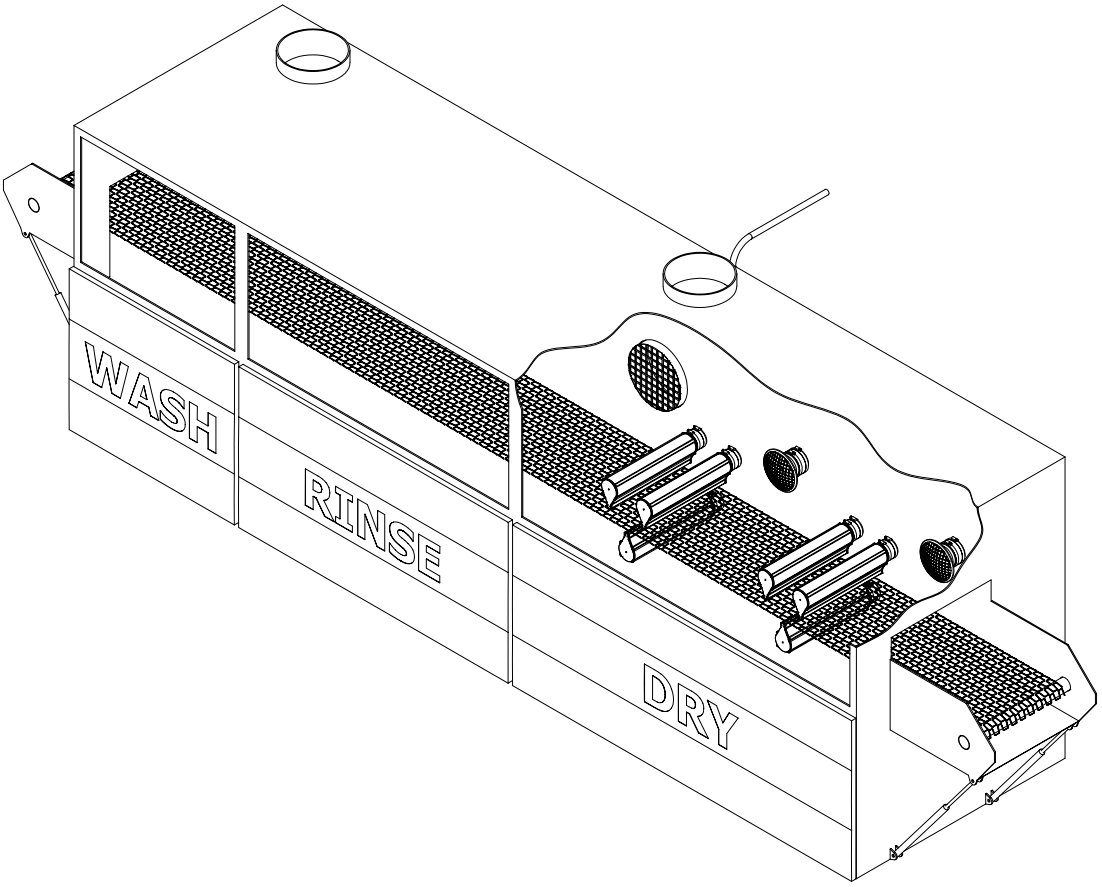
Sonic Installation Manual

High Temperature
Air Re-Circulation System



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High Temperature
Air Re-Circulation System

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1 Introduction

Sonic centrifugal blowers have been utilized within in-line, conveyorized aqueous parts cleaners for many years with tremendous success. The benefits of re-circulating the air from the drying zone back to the inlet of the Sonic blower to increase air knife discharge temperatures has been proven to greatly increase drying capacity. This document is intended to identify the benefits of using a re-circulating air circuit within an in-line or batch cleaner and to illustrate the configuration and hardware necessary to optimize the drying performance and system efficiency. This document will cover the following:

- Application Guidelines
- Re-circulation Instructions
- Exhaust / Make-up Airflow
- Cooling Water schematics

2 Traditional Air Knife Drying Systems

2.1 Operating Principal

Historically, the air knife drying zone or drying cycle of an aqueous parts cleaner draws factory air into fans or blowers, discharges the air through air knives or nozzles onto the parts at high velocity to remove moisture, and then large amounts of plant air is exhausted to prevent hot and moist air from exiting the cleaner which would increase the heat load in the factory and reduce worker safety and comfort.

2.2 Disadvantages of Traditional Single Pass, Non Air Re-Circulating Designs in Air Knife Systems

- Multiple blower / motor units for high production rate or complex part geometries.
- Routinely use in-line air duct heaters to increase blower / air knife air temperature.
- Increased length of drying zones or additional drying modules.
- Often requires compressed air blow-off to supplement undersized blowers / air knives.
- A typical exhaust air requirement for an aqueous cleaner is 1.25 to 1.5 times the total blower/air knife input volume. This commonly results in exhaust ventilation specifications of 2,000 – 3,000 cfm (945 to 1,420 lps) for each cleaner with a corresponding HVAC energy cost.

To achieve the best drying results requires that blowers, heaters, and exhaust ventilation horsepower is at the highest possible levels without air re-circulation.

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3 Sonic Air Re-circulation System

3.1 The Sonic Solution

Since 1990, Sonic has been providing air knife drying equipment and establishing drying standards for the in-line parts cleaning industry. Sonic is an expert in drying technology and equipment innovation. With continuously increasing production rates, part complexity and the increasingly stringent drying standards, the short-term solution is more blowers and more horsepower.

However, the energy costs associated with the "more horsepower" approach have become the source of a major increase in manufacturing costs. Sonic will now show how a properly designed air re-circulation system can dramatically improve drying performance while reducing overall equipment costs and the manufacturing process costs that are required to run them.

3.2 What is Sonic Air Re-Circulation?

A Sonic re-circulating air circuit is defined as the process of reclaiming air from the air knife drying zone and reusing this air through the blower to achieve increased air temperatures and therefore increased drying performance. By re-circulating up to 100% of the volume of air from the air knife drying zone, Sonics' normal heat of compression temperature rise can be accelerated by 2-3 times the temperature rise of a single pass, non re-circulating, air knife system. A Sonic centrifugal blower develops a single pass heat of compression (T1/T2) of 40° to 60°F (22°C to 33°C), depending on the static blower pressure and the blower efficiency at the operating flow rate. Re-circulating, the already heated air can produce a total temperature rise versus the ambient plant temperature of up to 100°F (56°C) or more. The primary objective of Sonic blowers and air knives is to create high impingement air velocities on the surface of parts for drying but, where high temperature air re-circulation can be used, the residual 5% surface moisture that is often difficult to remove can now be done without the use of additional blowers.

3.3 Important Considerations & Benefits

- The re-circulated air can be balanced with plant & make-up air to achieve any air knife temperature desired.
- The part being dried will increase in temperature as re-circulated air is heated.
- The surface temperature of the outer housing of the aqueous cleaner may increase and materials of construction may have to be changed to accommodate the higher temperature.
- The exhaust / make-up air for the cleaner can be significantly reduced by as much as 90% of the total air knife zone volume.
- The exhaust air pathways will have to be changed to ensure that a small percentage of air exchange takes place in the re-circulated air knife zone, thereby preventing a saturated air stream condition.

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Although there is some additional hardware required to implement the air re-circulation system, Sonic can assist with recommendations to ensure the selection of the proper items.

3.4 Additional Installation Requirements

The application of a recirculation circuit should never be used if the product being dried has anything other than rinse water on the product. Recirculation of air with rust inhibitors or other additives will result in frequent air / water separator maintenance and will cause a buildup of material in the blower air stream.

The blower cooling unit should only be cooled with water or water / glycol solution. The use of D.I. water or water with aggressive additives may cause cooling circuit failure or clogging.

4 Component Layout

Figure 1 and Figure 2 illustrate a conceptual representation of a cleaner design optimized for drying efficiency and minimal heat loss. Although this design is similar to many already used within the industry, the main improvements are seen by maximizing the benefits of re-circulating the blower air and managing the integrated support resources (i.e. water, air, etc.).

Balancing the exhaust / make-up air for the cleaner together with the proper positioning of the blower air intakes will allow for an accurate selection of air knife temperature(s). Although the example shown in this manual is of (2) Sonic blowers in one cleaner, high temperature air re-circulation will result in fewer or lower horsepower blowers than was required for single pass non re-circulation systems. Two 15 hp (11.2 kW) blowers will now do what (2) 20 hp (15 kW) or (2) 15 hp (11.2 kW) & (1) 10 hp (7.5 kW) might have previously been required for complete drying.

Figure 3 and Figure 4 illustrate the configuration of a typical Sonic centrifugal blower when used in an in-line cleaner utilizing an air re-circulation system. The blower size, airflow rate and motor horsepower, are based on the desired drying performance. Contact Sonic Air Systems for engineering assistance and design support for each cleaner. The example cleaner shown uses two air knives to dry the upper surface of the product and a single air knife to dry the bottom surface of the product. Therefore, the air supply is split into three lines using a multi-port manifold as shown. An in-line air / water separator is used between the return air supply and the blower inlet. This separator is necessary to assure that no water or debris pass to the blower. Any liquid stream entering the blower will eventually cause a shaft seal failure. The in-line separator has a 10-micron polyester filter media that acts as a coalescing element for the most effective moisture removal. Although moisture latent air passes through the separator, a 10% exhaust / make-up air pulled into the drying zone prevents a saturated condition. Furthermore, the centrifugal action of Sonics' high-speed impeller together with the heat of each compression cycle helps deliver dry air back to the air knives.

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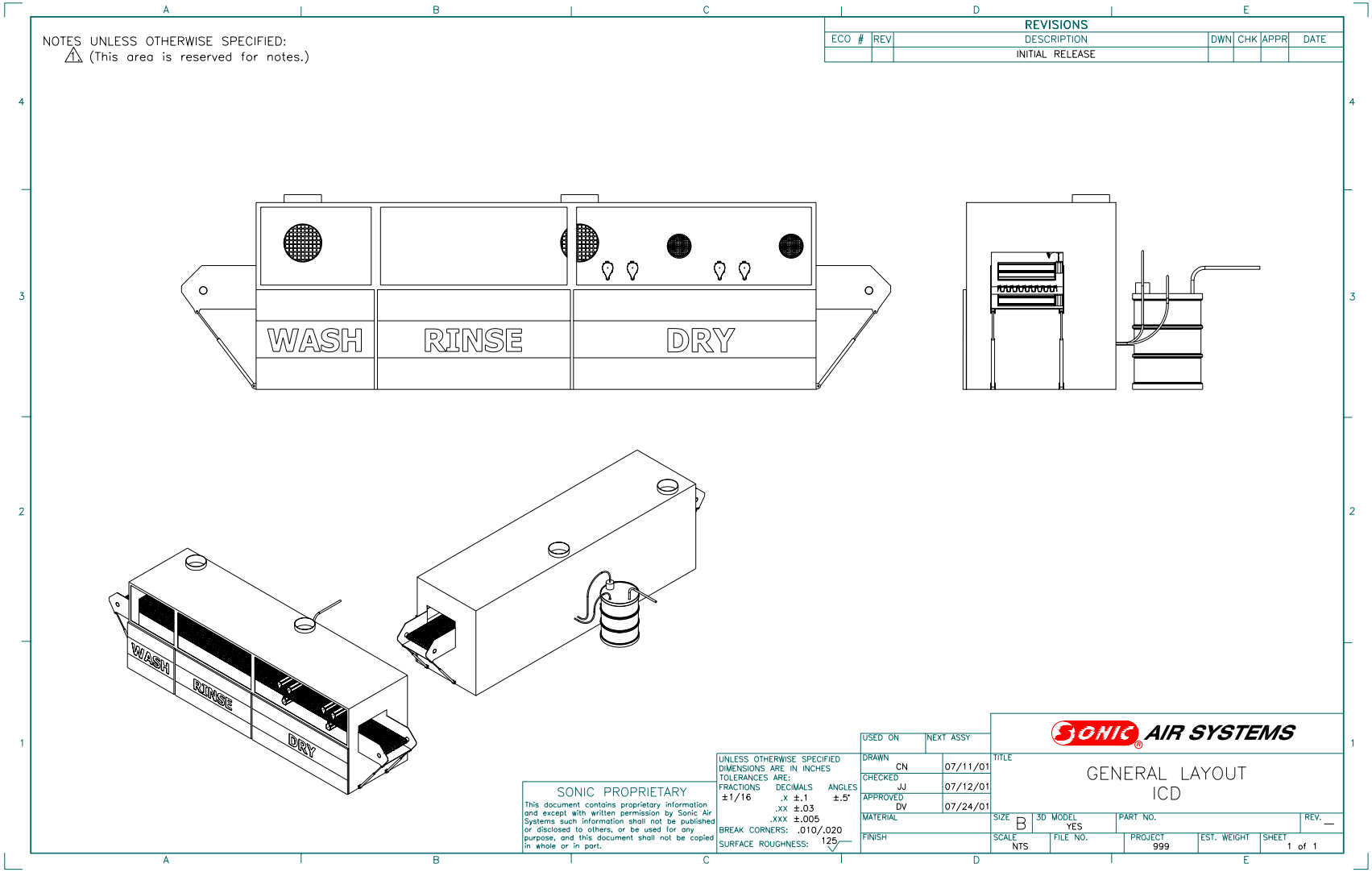


Figure 1 - General Layout

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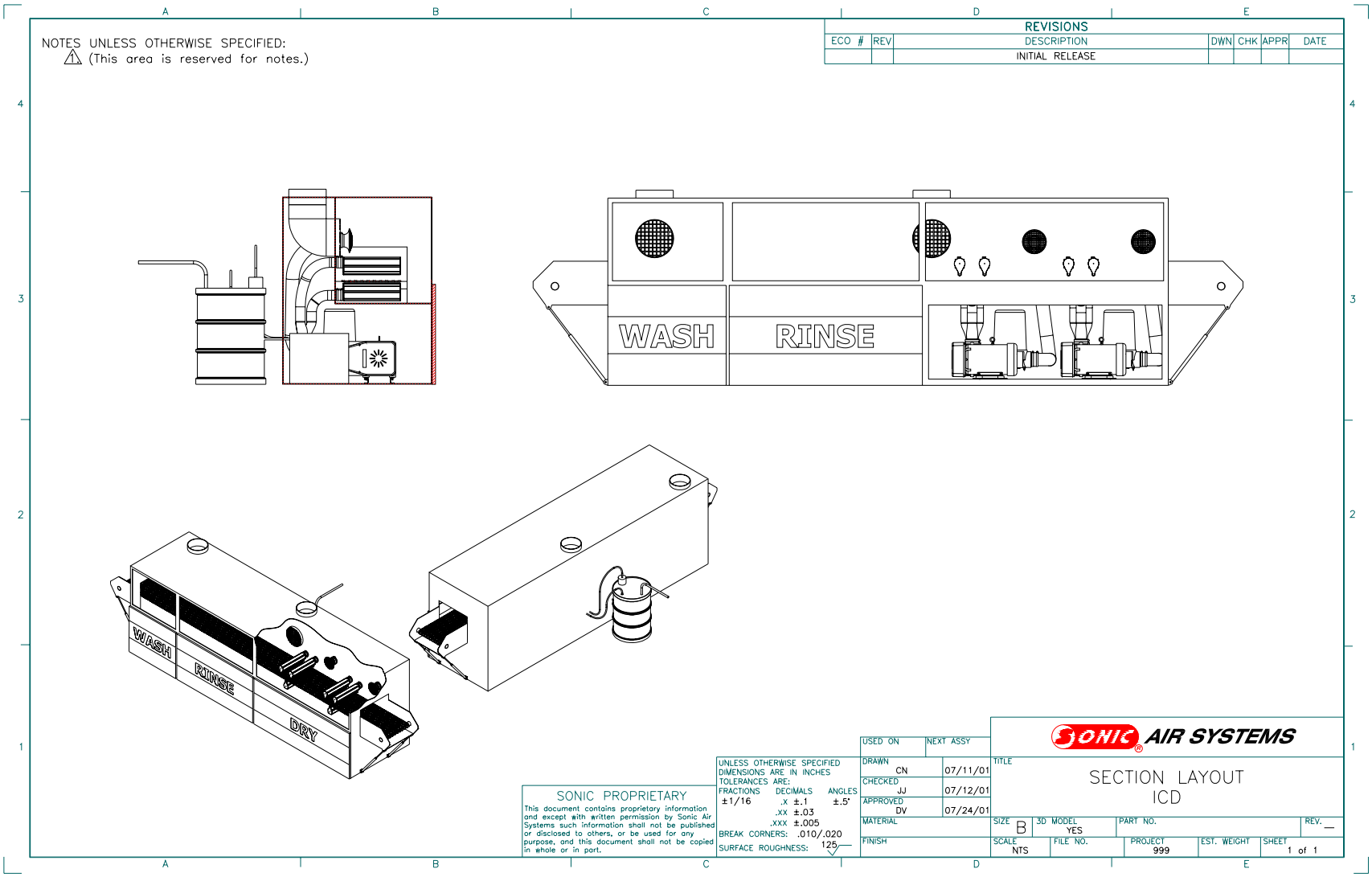


Figure 2 - Section Layout

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4.1 Internal Components

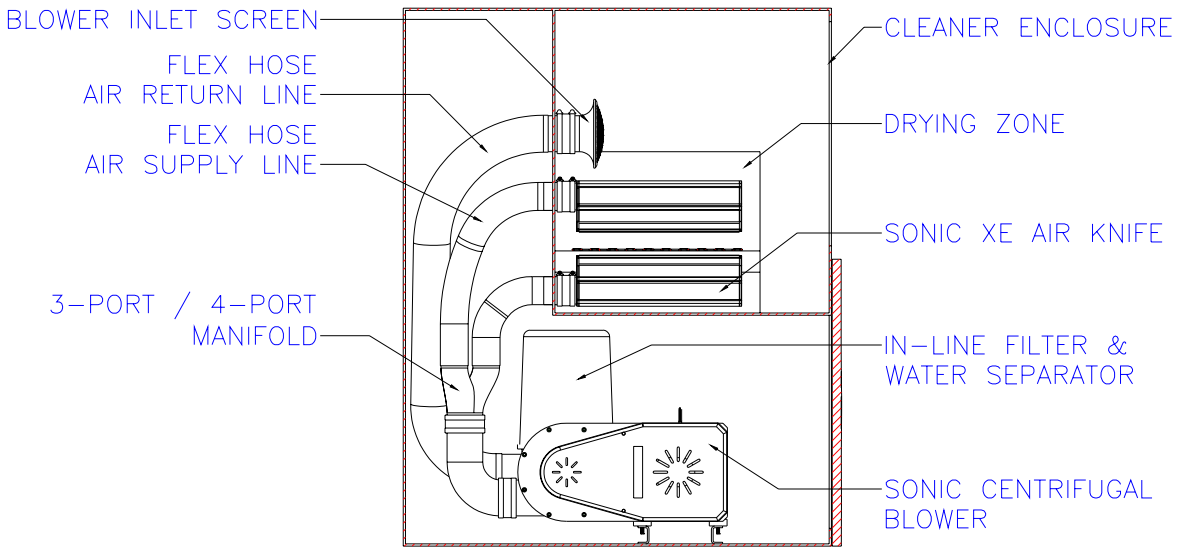


Figure 3 - Blower Section View

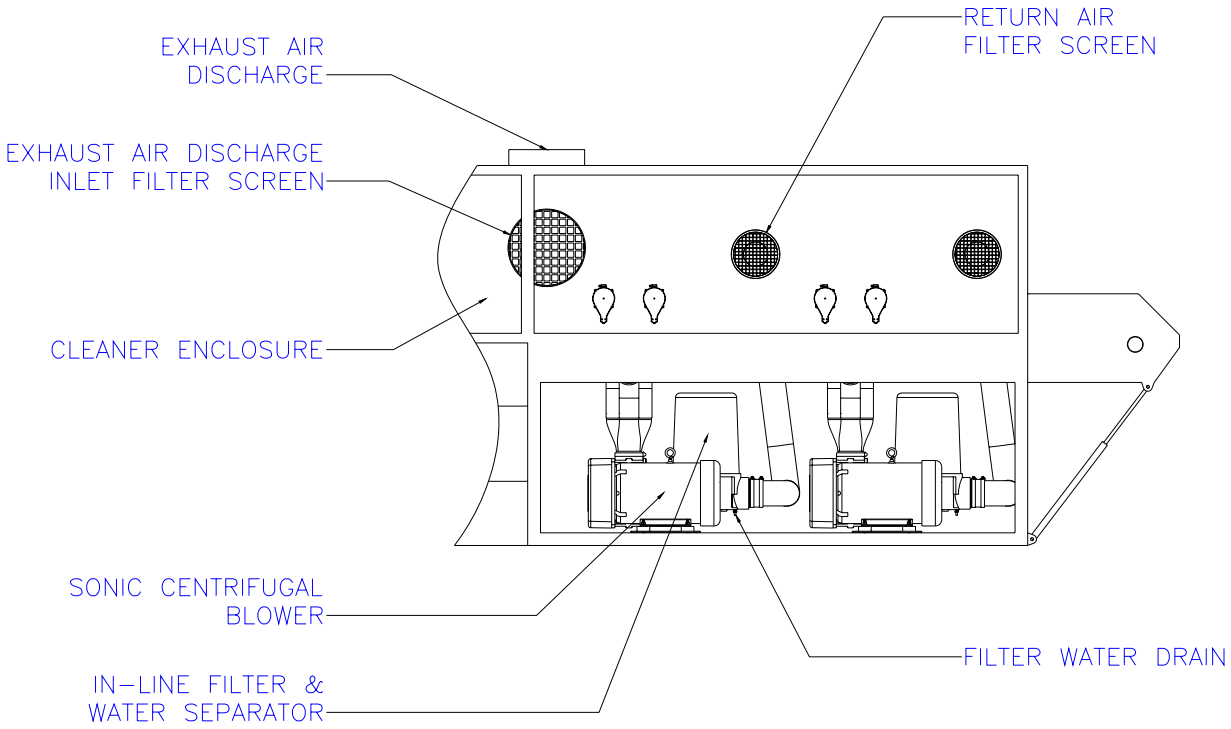


Figure 4 - Front Internal View

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4.2 Sonic Centrifugal Blower Unit w/ Water-Cooling Circuit

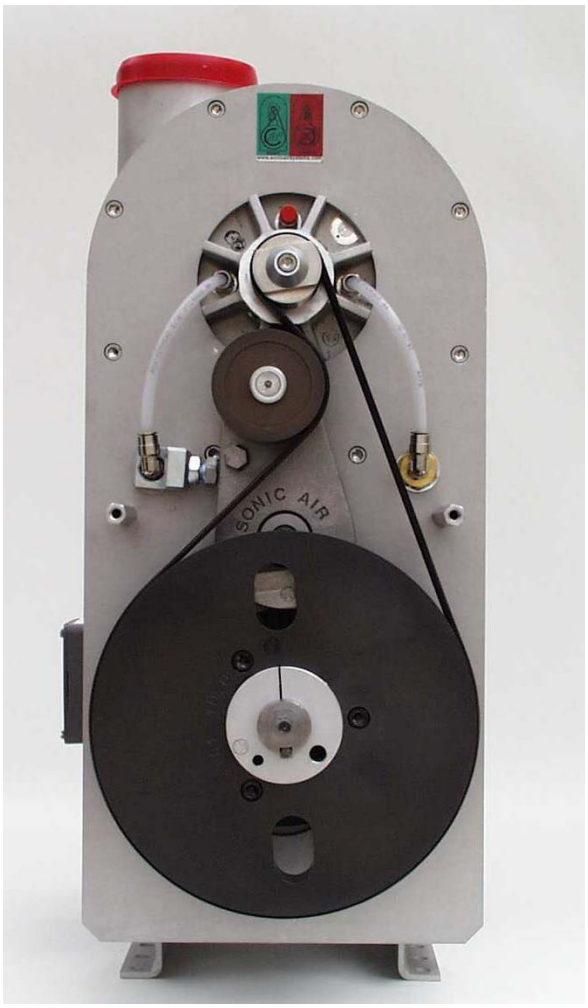


Figure 5 - Sonic Centrifugal Blower w/Water-Cooling

Figure 1 and Figure 2 show the example aqueous cleaner with two Sonic 100 centrifugal blowers that are designed to produce approximately 800 cfm (380 lps) at 2 psig (0.14 bar) each. Figure 5 shows a Sonic 100 centrifugal blower with the water-cooling circuit (Photo is taken with the belt guard removed). If the inlet air is piped directly to the blower inlet, and the temperature is over 125°F (52°C), a water-cooled blower head must be used to protect the shaft bearings. The Sonic water-cooling circuit routinely allows blowers to handle inlet temperatures in excess of 350°F (177°C). For the average air knife zone re-circulation loop, the inlet temperature to the blower would be less than 175°F (80°C), well below the maximum design temperature of 400°F (205°C).

In any event, the warranty of water-cooled blowers is the same as standard blowers and the bearing longevity is not compromised when operated as instructed by Sonic. Please note that Sonic blowers in the air re-circulation system must always be mounted in the #6 or #10 positions (See Figure 6) ONLY to prevent water build-up in the blower housing during shut down.

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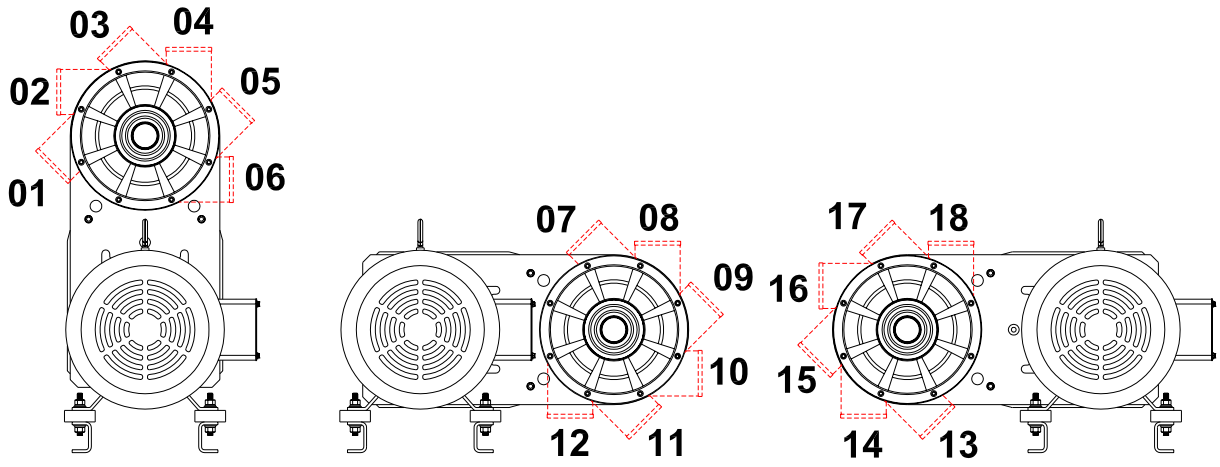


Figure 6 - Blower Rotations

Although the cooling water flow supply rate will depend on the blower operating specifications, the common design point in all applications is that the water exiting the blower cooling circuit should never exceed 100°F (38°C). Typical water demand will range from 0.25 gpm (1.0 lpm) at 20 psi (1.4 bar) to 0.75 gpm (2.9 lpm) at 40 psi (2.75 bar) when using tap water (approximately 65°F (18°C)) and will be significantly lower if chilled water is used. The water-cooling circuit in Figure 9 shows a self-contained blower / water reservoir but, central plant cooling water is always a preferred source.

If the water-cooling circuit is not flowing when the blowers are operating above 125°F (52°C) inlet air temperature, the life expectancy of the blower bearings will drop 25% for every 10°F (6°C) over the 125°F (52°F). Sonic blowers can be equipped with thermocouple sensors to measure the temperature of the blower bearings. The thermocouple information can then be monitored with a controller to determine if the water-cooling is operating or to offer advance warning of other routine blower service requirements. Belt replacement, filter/separator cleaning or bearing servicing can all be detected through the thermocouple readings.

4.3 Sonic In-Line Water Separation

Figure 7 shows the in-line air/water separator, which is designed to mount adjacent to the blower inlet and has a 10-micron filtration together with water drain lines. This is best used where there are space constraints, high dirt or debris loads, where water volumes in the re-circulation air could be high and with re-circulation air temperatures below 200°F (94°C). The canister (mounted on top) is carbon steel and has a cast aluminum base with 4" O.D. (102 mm) hose connectors.

Figure 8 shows the in-line filter / screen which is designed for use when the re-circulated air from the drying zone travels vertically up through the filter screen. With this assembly mounted above the drying zone, the fine mesh S.S. de-mister screen will diffuse small concentrated amounts of liquid and this design is best where air re-circulation temperatures exceed 200°F (94°C). Temperatures between 200°F to 400°F (94°C to 205°C) can be achieved in the re-circulation loop by adding closed coil heater elements to the inside walls of the drying zone.

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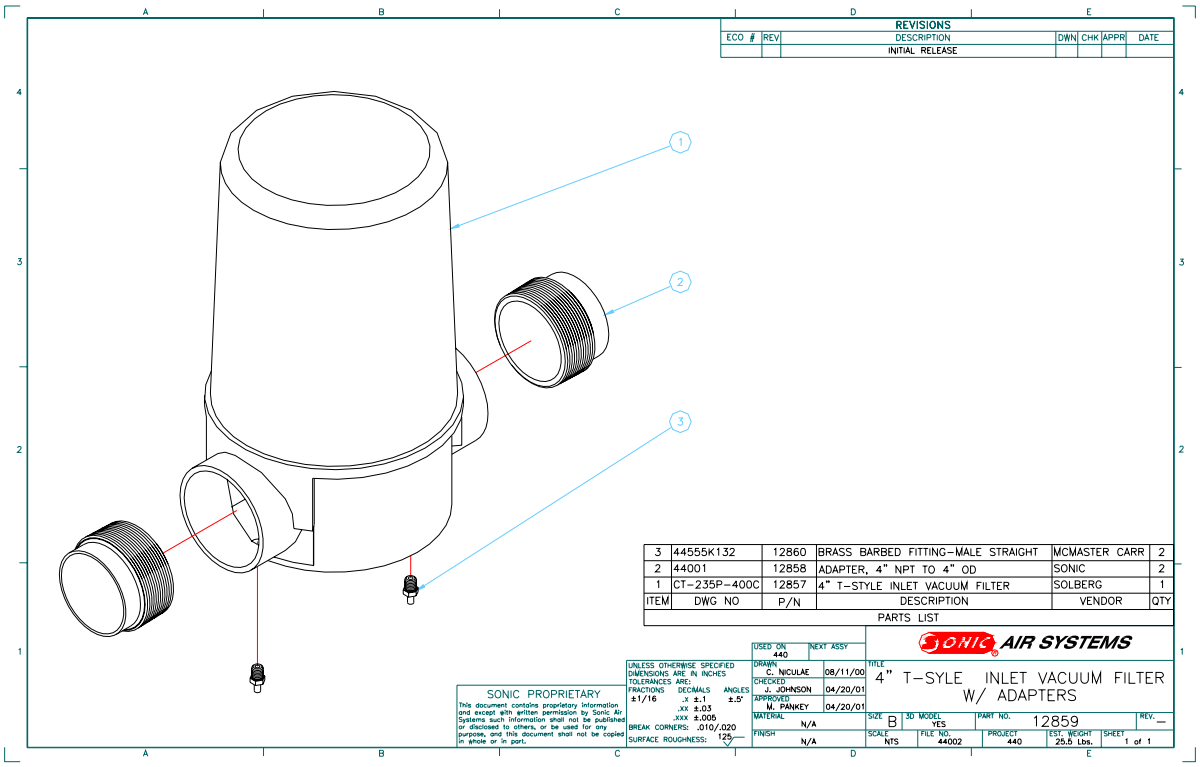


Figure 7 – Sonic Air/Water Separator & Filter

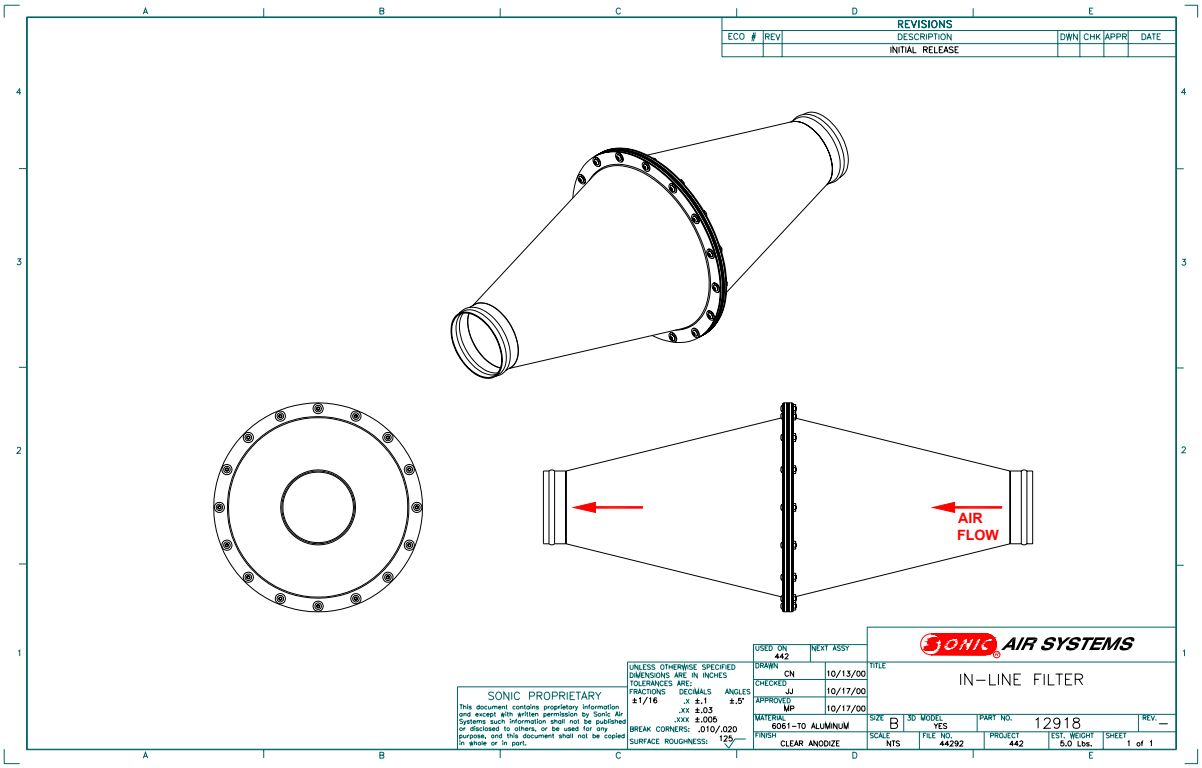


Figure 8 - Sonic In-Line Filter/Screen

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4.4 Water-Cooling Circuit

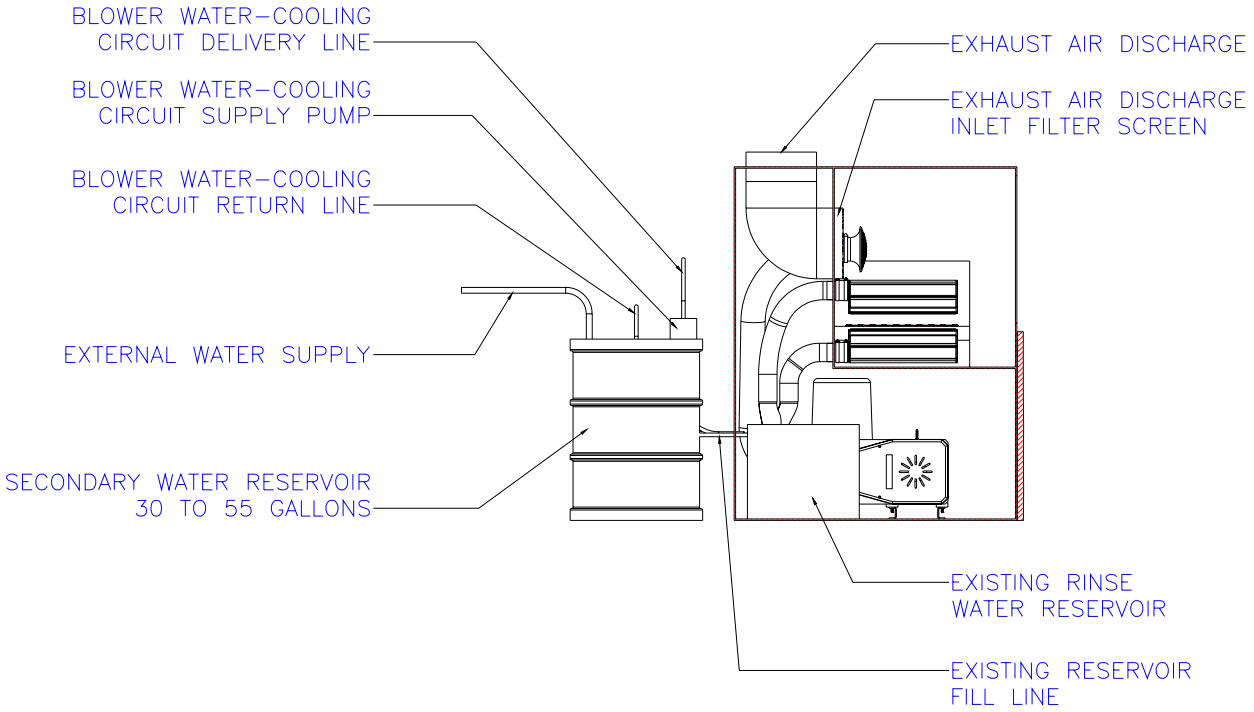


Figure 9 – On-Demand Water Supply Schematic

Most aqueous parts cleaning systems use on-demand fresh water replenishment with a solenoid valve activated by float controls. The plant water supply feeds fresh make-up water into the cleaning system's rinse tanks to accommodate system evaporation. Unless plant cooling tower water is readily available, Sonic recommends that a blower water reservoir (30-55 gallon (115 to 210 liter) drum) be added to the make-up water supply circuit to provide the cooling water for the blower unit(s) (See Figure 9). The size and capacity of the Sonic blower water reservoir is dependent on the heat load of the blowers. The external plant water supply feeds the Sonic blower water reservoir directly. Typically this is city or plant water that is pressurized and therefore does not need a pump. A level monitor in the blower water reservoir and a flow control valve will control the external fill line. The fill line to the existing water reservoir (rinse tanks) is gravity feed from the blower water reservoir. A level monitor in the rinse tanks and a flow control valve controls this fill line. The blower cooling water must have a dedicated small centrifugal pump from the blower water reservoir through the individual Sonic blower's water-cooling jackets and then gravity drain back to the top of the blower water reservoir. The flow rate is dependent on the heat load of the blowers but is typically only 0.25 to 0.75 gallons (1.0 to 2.9 liters) per minute per blower.

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4.5 Exhaust/Make-Up Air Diagram

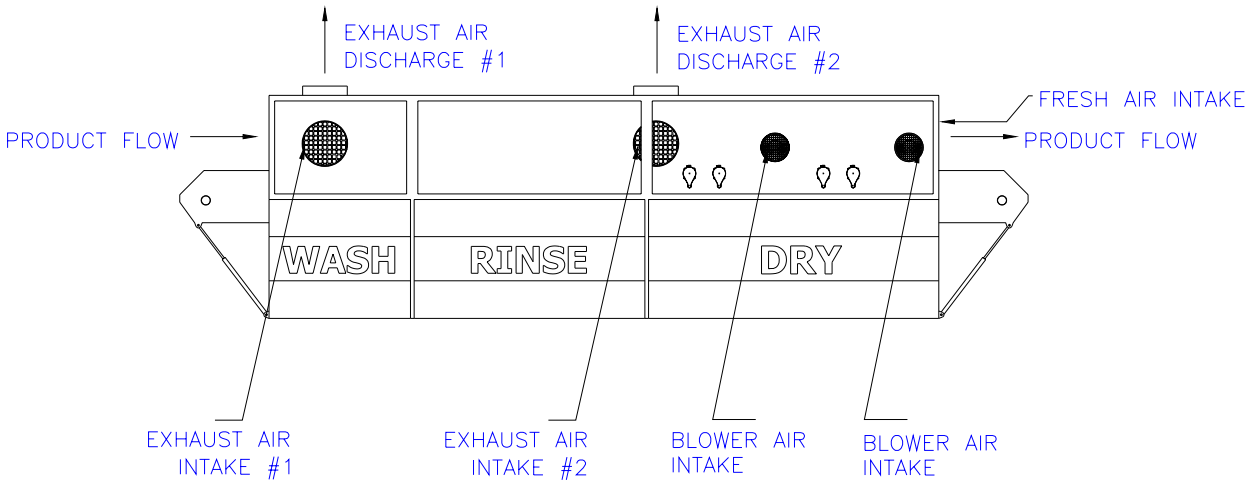


Figure 10 – Exhaust/Make-Up Air Diagram

The most important element of a successful air re-circulation system is often a properly designed exhaust / make-up air system. The correct amount of exhaust air from the right locations of the load and unload sides of the cleaner will ensure good temperature profiles, prevent re-wetting of otherwise dry parts and prevent contaminating the blower with dirty water and debris. A correctly sized exhaust / make-up air system will reduce plant HVAC loads by up to 3,000 CFM (1,420 lps) per cleaner and contribute to better parts drying quality for less blower horsepower.

Improper setup or design can actually reduce the effectiveness of the drying process or even apply moisture back on the product. Please refer to Figure 10 that illustrates the proper location and orientation of the exhaust air discharges as well as the proper location of the blower return intake air. Improvements in the drying process are affected by the following:

- Product Flow – The exhaust system should be balanced to create an airflow that is counter to the direction of the product flow at the unload side. This will pull dry air from the unload side of the washer to the air knife zone the moisture from the dry zone back into the wash and rinse zones, which will increase the drying performance and maintain the reclamation of the water in the system.
- Location of Exhaust Air Discharge – The discharges should be located to create an airflow that is counter to the product flow and that contains the moisture and steam within the cleaner. Discharge #1 is located near the entrance to the cleaner. This position assures that the moist air and steam is contained and that the airflow direction is counter to the product flow. Discharge #2 is located at the beginning of the air knife drying zone to assure that moist air is contained after the rinse cycle and to pull fresh air from the exit of the cleaner. The balance of the discharges is important to create the correct counter air flow, to minimize the heat load to the building and to achieve the desired air knife zone temperatures.
- Blower Air Intake Location – The blower intake is located in the drying zone after and above the air knives. This assures that only hot moist air is recirculated through the

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blowers. It is important to minimize the possibility of liquid entering the blower recirculation circuit even with the protection of the water separator and filter.

- Temperature Control – The temperature of the blower air can be controlled using the exhaust air discharges. Discharge #2 can be used to pull air from the exit of the cleaner that mixes the blower air with fresh air.

By using this configuration, the exhaust air load is reduced from 1.25 to 1.5 times the total blower airflow rate (or 2,000 – 3,000 cfm (945 to 1,420 lps)) to approximately 0.10 to 0.15 times the total blower airflow rate (200 to 450 cfm (95 to 215 lps).

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