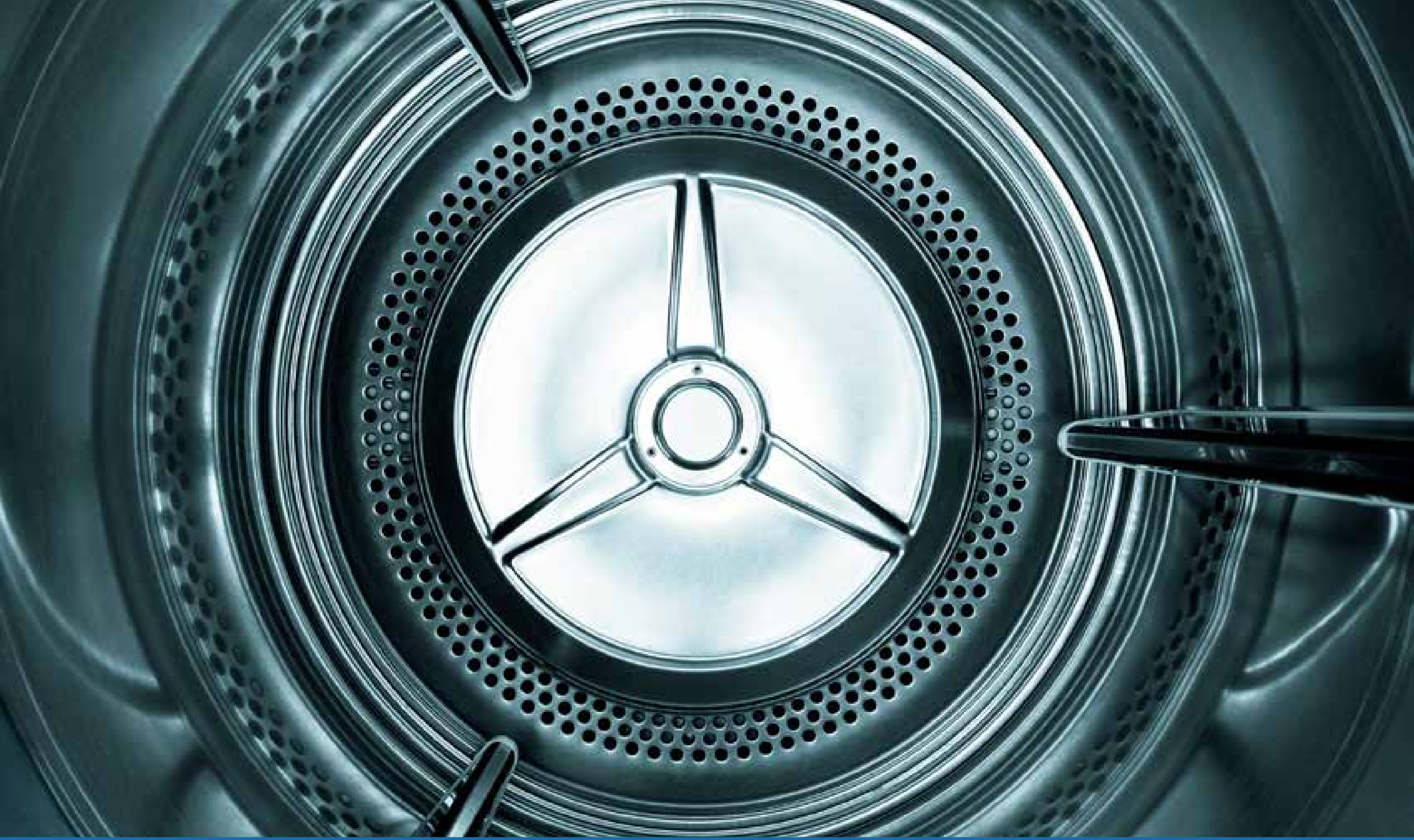

DRYERS

Operation, Efficiency, and Safety

Dryers remove moisture by moving heated air through the linen. Dryers are also called tumblers or conditioners. A dryer or tumbler is used to fully dry linen. A conditioner is a dryer which is used primarily for conditioning linen prior to further finishing.

Dryer related fires are all too common in the institutional laundry industry. There are as many as 2,000 reported fires in healthcare laundries each year, and the majority of those are dryer related. An inefficient dryer indicates the strong possibility of a fire hazard. If a dryer requires more than normal drying times, there is also a strong possibility of an increased risk of a dryer related fire. It is significant to note that many of the steps necessary to increase dryer efficiency will also reduce the risk of dryer fires.

Dryer Operation

The major components of a standard dryer are:

1. **Cabinet and frame**—Encloses the dryer and provide support structure, protective cover, and beauty.
2. **Heating unit**—Heats the incoming air. The most common heating units are gas burners and steam coils. Less common are oil burners and thermal oil heated units. Electrically heated coils are very rare on industrial grade dryers. Incoming air first flows through the heating unit where it is heated to increase the drying rate of the linen.
3. **Air flow containment vessel**—Provides the channel through which the air flows. The air-tight construction of the containment vessel is extremely important to the efficiency of the dryer operation. A leaky containment vessel will allow air to be drawn into the air-flow downstream from the heating unit. The result is two-fold. First, it cools the air going through the linen which increases drying time. Second, it reduces the air flow through the heating unit which may cause over heating of the heating chamber.
4. **Dryer basket**—Holds the linen. The dryer basket is perforated and sits in the path of the air-flow. The air passes through the basket, picking up moisture from the linen. The basket rotates to keep the linen tumbling to facilitate air-flow through the linen and evenly distribute the heat throughout the linen load.
5. **Air seals**—Play a vital role by blocking the path around the dryer basket, forcing the air through the dryer basket and the linen load. Note in the illustration below that there are two air seals, one on each side of the basket.

   Air seals may be the most forgotten critical components of any dryer. Air seals wear out or become torn, allowing air to bypass the dryer basket, decreasing efficiency, increasing drying time, raising energy costs, and reducing dryer production capacity.

   The air seals are subject to constant wear as the basket turns, and pins and other objects can protrude through the holes in the dryer basked and damage the air seals. Some designs provide a more complete seal and may be more efficient because the air flow enters the dryer basket from the bottom, underneath the load of linen, which forces the air up through the linen.
6. **Air blower**—Exhausts the air out of the dryer. The air blower will always be located on the exhaust end of the dryer. This design puts the air blower in a position where it pulls air through the dryer and pushes it out the exhaust. There should be a safety switch which will automatically shut down the dryer in the event that the exhaust motor fails.

   Dryers have two primary motors. The largest motor, the blower, has already been mentioned. A second drive motor provides power to turn the dryer basket. Dryers should be equipped with a safety device that will shut off the heating unit in the event that the drive motor fails. Heating a basket load of linen without tumbling creates a dangerous fire hazard. This safety device is not standard on all dryers. Some large dryers may have a third motor for the burner system.
7. **Lint filtering system**—Removes lint from the drying system. Dryers produce lint which must be filtered out before the dryer air is exhausted to the outside. Lint filters may be built into the dryer, in which case, they are usually placed up stream from the blower. Or, separate lint filters external to the dryer can be used. External lint filters can be located by the dryer, in a separate location, or even outside. Dryer controls control the dryer operation for time, temperature, cool down cycle, reversing mode, etc. The controls may be manual or computerized . Computerized controls come with a wide variety of options.

Dryer Controls

There are two main controls for all dryers, a heat control and a timer control. On manual controls, there should be two timers, one for drying time and one for cool-down time. On manually-operated controls, the operator must set the drying temperature, drying time, and cool-down time. On computerized models, the parameters for time and temperature are programmed for various types of linen. The operator simply selects the correct formula number for each load and the computer automatically runs the correct drying temperature and times.

Thermal Sensors

There are two or more thermal sensors on dryers. One is located in the heating chamber. Steam heated dryers may not have a thermal sensor in the heating chamber, but all gas heated dryers do. If the heating chamber overheats for any reason, such as lack of adequate airflow, the thermal sensor shuts off the heat. This thermal sensor is primarily a safety device which prevents overheating of the heating chamber, the hottest part of a dryer during operation. The second thermal sensor is located in the exhaust flow immediately after the dryer basket. This is the main thermal sensor and is responsible for controlling drying temperature. It measures the temperature of the airflow exiting the dryer basket.

For gas heated dryers, when the exhaust air reaches the present temperature selected by the operator, the thermal sensor sends the signal to the controller which shuts off the burner. When the air temperature drops, the controller turns the burner back on. The temperature controller cycles the heating unit on and off until the linen is dry. More efficient gas dryers are equipped with a modulating controller. As the temperature of the exhaust air rises, the controller reduces the burner flame to maintain air temperature. Modulating the flame maintains a more consistent temperature, faster drying, and more efficient energy consumption than simply cycling the burner off and on. Some computerized dryers allow programming of the heated air temperature as well as the exhaust air temperature. Controlling the heated air temperature maintains a more consistent drying temperature throughout the drying cycle and also helps protect heat sensitive linens.

Steam or thermal oil heated dryers heat incoming air by drawing inlet air through a heat exchanger, which is a set of coils heated by steam or thermal oil. There are no temperature controls on the heat exchanger itself. Instead, temperature is controlled by an air damper. At the beginning of a wet load, all of the incoming air passes through the coils. As the load dries and the exhaust air temperature rises, a damper moves to mix unheated outside air with the heated air from the steam coils. The damper controls the temperature by changing the amount of air bypassing the steam coils. At the end of the drying cycle and for cool down, the damper completely closes off air passage through the coils and sends only unheated air to the dryer.

Most steam heated dryers are designed to operate efficiently at 125 to 150 psi of steam pressure. A steam pressure of 125 psi should produce coil surface temperatures of 3500 F. Low steam pressure will reduce the efficiency of the dryers and dramatically increase drying times. If steam pressure gauges indicate 125 psi, but coil surface temperatures are well below 350°F, there is usually something wrong with the system (steam traps, coils, etc.) or the quality of the steam. Steam heated dryers and thermal oil heated dryers require a warm up period and a cool down period. Opening the steam valve full blast on cold coils can damage them. Once the coils reach operating temperatures, the steam valve is opened all the way and left open until the end of operations for that day.

Thermal oil heated units warm up gradually as the oil heating boiler warms up. Proper cool down steps are critical with thermal oil heated dryers to prevent damage to the inside of the heat exchanger tubing and to prevent premature breakdown of the thermal oil.

Moisture Sensing

An option for automatic sensing of moisture content is available on many dryers. With this option, the potential for over drying of linen is reduced. There are two systems. One system measures the temperature drop of the air as it passes through the linen in the dryer basket. Thermal sensors measure the temperature of the air just before it enters and immediately after it exits the dryer basket. As hot air passes through the wet linen, it transfers heat to the linen and picks up moisture which cools the air. Dry linen absorbs very little heat from the air. When the temperature drop reaches a preset minimum, then the computer assumes the linen is dry and ends the drying cycle and starts the cool down cycle. A second system uses a moisture sensing device, which measures the amount of moisture in the exhaust air. As the linen dries, the moisture content of the exhaust air drops. Once the moisture content reaches the desired level, the computer ends the drying cycle. At this writing, this second system is less common due to problems with the reliability of the moisture sensing unit. Another common option is an energy conservation system which automatically re-circulates part of the hot exhaust air as the linen gets dryer. Improvements and modifications to different energy conservation systems for dryers are being introduced almost continuously. Some air re-circulation systems do produce energy savings on dryers of 200 pounds and larger. However, some air re-circulation systems on smaller dryers from 170 pounds and under have not proven as effective and a few have even created problems with dryer operation.

Reversing and Non-reversing Modes

Dryers should always be purchased with the option for both reversing and non-reversing operation. In reversing operation, the dryer basket rotation reverses direction 3 to 4 times per minute. Reversing mode is used for drying large items such as blankets and spreads. The periodic reversing of the rotation of the basket reduces tangling, improves drying time, and decreases wrinkling. In non-reversing mode, large linen items, like blankets, wrap into a tight ball. The inside of the ball will not dry because air cannot penetrate the ball. Non-reversing mode should always be used for drying small items, such as towels, washcloths, diapers, gowns, etc. The reversing mode on small items actually increases drying time by up to 20% over non-reversing mode. It is important to note that dryers operate more efficiently drying small linen items in non-reversing mode.

Conditioning Linen

Conditioning linen is a process of removing only some of the moisture from extracted linen in order to speed up later processes, such as ironing, steam cabinet finishing, pressing, etc. Conditioning should only be used when the moisture content of the extracted linen exceeds the ability of the finishing equipment to fully dry the linen at full production speed. When conditioning linen, only enough moisture should be removed to allow the ironer or other equipment to operate at normal capacity.

Generally, the moisture content of conditioned linen should not be less than 35%, or the quality of finishing may be affected. In the laundry industry, dryers which are installed primarily for conditioning linen are called conditioners even though there are no mechanical differences. The exception is a dryer which is installed for the sole purpose of breaking up cakes of linen from a press extractor. In a post sort operation, linen from a press extractor must be broken apart to facilitate sorting. In some cases, moisture removal is not required. In this case, a dryer may be installed without a heating unit or even a blower. It simply consists of a frame, dryer basket, and drive motor, and is used only for breaking apart linen cakes from the press extractor.

Lint Filters

Lint filters are required for all dryers. Lint filters may be built into the dryer or external to the dryer. There are two major types, dry and wet.

Dry Lint Filters

Dry type lint filters use some type of a filtering device, usually a fine mesh screen, which must be cleaned on a regular basis during the operation of the dryer. As lint builds up on the filter screen, it gradually reduces the airflow through the filter, reducing the efficiency of the dryer. There are automatic lint filters which use a variety of self-cleaning designs. Most self-cleaning systems remove the lint built up on the filter screen automatically at the end of each dryer load. Some automatic systems use a vacuuming system which continuously cleans the filter screen even while the dryer is running. The continuously self-cleaning filter is generally more efficient because lint build up on the filter screen is reduced even while the dryer is running. Self-cleaning filters usually deposit the lint into a storage bin or bag for later removal. Automatic, self-cleaning lint filters save time because they reduce the labor required to clean the filter, and they save energy because a clean filter does not restrict the air-flow.

Wet Lint Filters

Wet type lint filters use water to filter the lint out of the dryer exhaust. Typically, the exhaust air passes through a water shower. The lint is trapped by the water. The water is collected and passes through a cloth bag, which removes the lint from the water. The water can be re-circulated. When the cloth bag is full of wet lint, the wet lint is discarded. Wet type filters are more efficient than dry type filters for two reasons. First, wet type filters remove more of the lint from the dryer exhaust than dry type. Second, wet type filters do not restrict the airflow from the dryer because there are no lint screens to block the airflow.

There are disadvantages. Wet type filters cost more money, can be messier, and require more maintenance than dry type. Also, wet type filters can freeze if not protected from cold weather.

Dryer Efficiency and Risk of Dryer Fires

Dryer inefficiency and the risk of dryer related fires come from two areas: operational and mechanical.

Operational Hazards

Operator error is the most common cause of dryer related fires. There are three common practices which reduce dryer efficiency and increase the risk of dryer related fires.

1. ***Over drying linen***

   Over drying linen is one of the most common unsafe and inefficient practices in the industry. Continuing to run the heat cycle after the load is dry damages linen and increases the risk of spontaneous combustion. Completely dry linen reabsorbs moisture out of the air, so drying linen to a crisp point is a waste of time and utilities. Run test loads to determine the maximum time required to dry each type of linen load. Make a list of each type of load with the drying time required and post the list by the dryers. Drying times are shorter during dry seasons than humid seasons.

2. ***Failure to run a cool down cycle***

   Failure to run a cool down cycle at the end of the drying cycle is a common cause of dryer fires. Hot linen can spontaneously burst into flames, not only while it is in the dyer, but even hours after it has been unloaded from the dryer. Many laundry fires have started this way, long after the last person has left the laundry for the day. Be sure that all loads run on a cool down cycle for at least 4 to 5 minutes, or until linen has cooled to at least below 140°F before unloading from the dryer .

3. ***Not unloading dryers***

   Leaving linen in the dryer after it is dried is another frequent cause of dryer fires. Once a dryer stops, air movement through the linen stops. A hot spot in the linen can generate spontaneous combustion. Always be sure that dryers are unloaded immediately after the dryer stops. At the end of the day, all dryer loads, even if not finished, should be emptied from the dryers. A common time for dryer fires is right at the beginning of the day when dryers are started after linen has been left in the dryer overnight.

Mechanical Hazards

Dryers dry linen by moving air through the wet linen. As air enters a dryer, it first passes through a heating component, such as a gas burner or a steam coil. Dryers are designed with a heating component balanced for a given airflow. As air moves through the dryer, it picks up heat from the heating component and transfers it to the linen. The air then passes through the blower and out the exhaust ducts. At some point in the exhaust stream, the air passes through a lint filter. Any restriction of the airflow not only reduces the efficiency of a dryer, it creates a dangerous fire hazard. If the airflow is restricted, several things happen.

1. ***Restricted airflow increases the drying time.***

   Excessive drying time may be the most obvious symptom and usually your first clue that something is wrong. Normal drying times vary between makes and models. The following drying times are for general comparison purposes only. The vendor can provide specific information for your dryers. Gas dryers with load sizes of 170 pounds and smaller can normally dry a full load of terry towels in less than 40 minutes. Steam dryers may take longer, depending on steam pressure. Most gas dryers 200 pounds and up should dry a full load of terry towels in no more than 18 to 20 minutes. Some can dry in less time, depending on the dryer model and moisture content of linen and relative humidity of the air.

2. ***As the airflow slows, the heating compartment gets hotter.***

   In steam and thermal oil heated dryers, the maximum temperature is limited. In a gas burner, however, the heating compartment will continue to grow hotter. Dryers are equipped with safety devices which shut off the gas burner in the event they overheat, provided that the safety devices function properly. Otherwise, melt down and/or a fire can occur.

3. ***Since slower moving air is exposed to the heat source longer, it is much hotter when it reaches the linen.***

   This is true for all dryers, steam or gas. The temperature of the air can reach a level which can damage the linen and can even cause combustion. Dryers have thermocouple devices which should shut off the heat source if the air gets too hot. One note of caution: if these thermocouple devices malfunction, even an otherwise properly functioning dryer can overheat, scorching the linen or igniting a fire.

4. ***As the hot air leaves the dryer, it enters the ductwork.***

   If there is any lint build up in the duct work, the hotter than normal air can heat the lint to its combustion point, causing a fire in the exhaust ducts.

5. ***Slow moving air allows lint to settle inside the exhaust ductwork.***

   Assuming there are no burs or exposed metal edges inside the exhaust duct to catch lint, any lint build up at all in the exhaust ducts is a key indication of a problem with airflow. Lint build-up in exhaust ducts further restricts the airflow while it creates a new fire hazard.

Causes & Solutions for Air-Flow Problems

Restricted airflow has numerous causes.

1. ***Inadequate make up air***

   Dryers consume huge quantities of air. In an enclosed area, dryers can become "air starved." Air starved means a dryer cannot draw in enough air to provide adequate airflow through the dryer. If dryers are located in a closed-in area, they must be supplied with an outside air source. Otherwise, be sure the dryer area has an adequate air supply. If open windows are a source of air, be sure screens are installed in the windows. Dryers can be purchased with an option for connecting to outside make up air.

2. ***Clogged lint filters***

   Clogged lint collectors may be the most frequent cause of restricted airflow. Keep lint collector screens clean. If a lint collector screen becomes clogged with material which cannot be removed, replace the screen.

3. ***Excessive back pressure***

   Excessive backpressure results from (a) exhaust ducts which do not have a large enough cross sectional area, (b) the exhaust ducts are too long, or (c) there are too many bends in the exhaust ducts. Dryer manufacturers provide recommendations for the size, maximum length, and maximum number of bends for the exhaust ducts. Properly constructed exhaust ducts keep backpressure at a minimum. They also do not collect lint. Lint builds-up in an exhaust duct is a clear sign of a problem. Periodic cleaning of the insides of the exhaust ducts treats the symptoms, but does not correct the problem.

   Possible solutions include:

   (a) If possible, reduce the length of the exhaust runs by relocating the dryers closer to the outside exhaust point or by using a different external exhaust point closer to the dryers. For example, if the exhaust runs to the roof from the first floor of a multi-story building, try rerouting the exhaust to the nearest exterior wall.

   (b) Reroute the exhaust line to eliminate as many bends as possible and use more gradual curves instead of short radius 90-degree bends.

   (c) Replace the exhaust ducts with ones which have a larger cross section.

   (d) Add an exhaust booster fan in the exhaust line. Be sure all ductwork is clear and external exhaust openings are not blocked. Most manufacturers recommend a maximum of .5" positive water column backpressure. Many smaller dryers have weighted backpressure dampers which will trip a switch to shut off the dryer if backpressure exceeds a preset limit. Do not tamper with nor disable this switch. Excessive backpressure can cause carbon monoxide accumulation.

4. ***Undersized lint filters***

   Properly sizing lint filters is critical to the operation of dryers. Dryers exhaust huge amounts of air. Performance varies between models, but as an approximation, a typical 150-pound dryer exhausts 2,500 cfm of air. A 200-pound dryer exhausts 5,000 cfm or more, and a 400-pound dryer exhausts 6,500 to 8,000 cfm. When sizing lint collectors, the rated cfm capacity of the lint collector must be more than the total cfm of all the dryers to be connected to it. Using a lint collector undersized for the total cubic feet of exhausted air volume restricts airflow. As a rule, do not connect small dryers to the same lint collector with large dryers. Not only will this create excessive backpressure on the smaller dryers, but exhaust from the larger dryers can blow back into the laundry through the smaller dryers.

5. ***Clogged dryer basket***

   Plastics and other trash can clog the holes in the dryer basket, reducing and eventually blocking the airflow. These materials should be removed from the inside of dryers on a daily basis. If they are allowed to remain in the dryer basket, they can become extremely difficult to remove. Restricted airflow slows production, increases utility costs, and can be a dangerous fire hazard. In some cases, it may also create a hazardous environment for employees from dryer exhaust blowing back into the laundry.

Safety

There are other safety concerns for dryer operation. All dryers must have a functional safety door interlock. On all large dryers of 200-pounds capacity or more, the safety door interlock locks the dryer door and prevents the dryer door from being opened until the dryer has been turned off and the basket has stopped turning. On most small dryers, the safety door interlock does not prevent the door from opening while the basket is turning. Instead, the safety door interlock simply turns the dryer off if the door is opened while the dryer is in operation. However, it can take a few moments for the dryer basket to come to a complete stop after the door is opened. It is an unsafe practice to open the dryer door while the basket is still turning. The dryer should always be turned off and the basket allowed to come to a complete stop before opening the dryer door. Do not use the safety door interlock as the off switch. The safety door interlock on all dryers should be checked daily.

STANDARDS

It is a violation of OSHA rules to operate a dryer with a faulty or disconnected safety door interlock.

It is simple to check the safety door interlock. Push the start button with the door open. The start button should not respond, and the dryer should not start up.

It is a violation of OSHA rules to operate machinery without proper guards and covers in place

All guards and protective covers must be in place over any moving parts and exposed electrical power components during normal operation of equipment. On tilting dryers, an added precaution should be in place in the form of a guardrail or some guarding device to keep people out from under the dryer when it is in a raised position during normal operations.

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Dryers: Operation, Efficiency, and Safety

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