Pellet cooler functions

Adjustments can be made to improve the cooling system

by Fred Fairchild

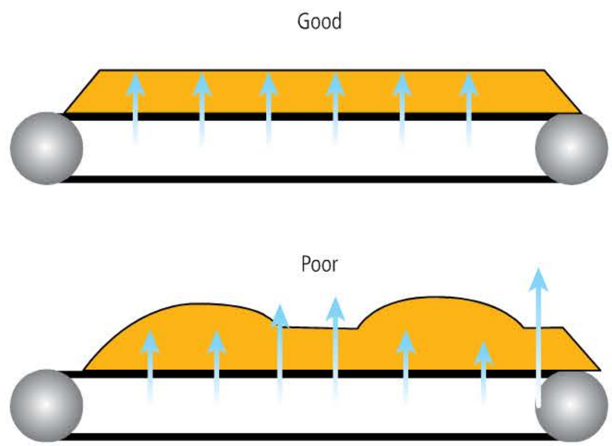
Pellet cooling is a dynamic process that involves simultaneous heat and mass transfer between the pellets and the cooling air. Pellet cooling occurs as a result of both evaporative cooling and convective cooling. Evaporative cooling is the transfer of water from the pellets to the air which results in both moisture reduction and cooling in the pellets. Convective cooling also occurs and depends on the temperature difference between the pellets and the air, the amount of pellet surface area, and the heat transfer coefficient.

Pellet cooling system performance is affected by many variables. The first are variables found in the air being used and include the air temperature and relative humidity, and the amount of air passing through the cooler. Pellet variables include the pellet temperature, moisture content, pellet size and density, fines present, and pellet quantity and quality. Cooler variables include product bed depth, uniformity of bed depth and system design.

The cooling system must meet several requirements. It must be designed to effectively cool a range of products by removing enough heat and moisture for further handling or storage of the pellets. But, it must also be able to do these tasks while avoiding overdrying of the pellets. Removal of more moisture than required results in removing extra mass (weight) that results in losing selling weight. The cooling system itself must be reliable and provide gentle handling of the pellets that minimizes creation of fines in the process. In some situations, counter-flow coolers may be equipped with heat exchangers on the entering air to heat it so greater product drying may be accomplished.

Regardless of the cooler type — horizontal, vertical or counter-flow — it is very important that the bed depth be uniform where air passes through the product to keep the air flowing equally through all the product (see Figure 1, right).

Figure 1: Bad depth/uniformity



COOLER SYSTEM DESIGN

Assume that it is desired to cool 25 tons per hour of pellets. If we use 400 cubic feet per minute (CFM) of air per ton to do the cooling, the amount of air needed is 25 x 400 = 10,000 CFM. The quantity of air used and the cross section area of the cooler and connecting duct work determine the velocity of the air. The velocity is determined by the formula Q = VA. Q = Quantity of Air (CFM), V = Velocity of the air in feet per minute (FPM), A = Cross-section area of the duct work in Square Feet.

Assume you are using a Bliss Industries model 10-202-6 Op-Flo counter-flow pellet cooler to cool the 25 tons per of pellets requiring 10,000 cfm of air.

The body of the cooler is round and is 86 inches in diameter. The cross section area of the body is 40.2 square feet. ($A = \pi \times r^2$) Diameter = 2r. Radius r = Diameter/2. Radius (r) for the cooler body = 86in./2 = r = 43in.; we need to convert this into feet = 43 in/(12 in. per foot) = r = 3.58 ft. $\pi = 3.14$. The cooler area = $\pi \times 3.58^2$ = 40.2 square feet. Using the formula Q = V x A, we find the velocity (V) of the air passing through the cooler. V = 10,000 cfm/40.2 square feet = 249 feet per minute.

The exhaust port for the cooler is 10 inches x 36 inches. Area = Width x Length = 10 x 36 = 360 square inches. You convert this to square feet by dividing by 144 square inches in a square foot. A = 360/144 = 2.5 square feet. The velocity of the air through the exhaust port would be V = Q/A = 10,000 cfm/2.5 square feet = 4,000 feet per minute.

The same information may be used for any shaped cooler and exhaust outlet to determine the velocities of the air.

The ductwork beyond the cooler is best when of round construction to eliminate any corners in the ductwork. For the ductwork from the cooler described above, a rectangular to round transition should be installed to convert the ductwork to round. Again, you use the formula Q = V x A where Q = 10,000 cfm and V = 4000 fpm. A = Q/A = 10,000/4,000 = 2.5 square feet. Using the formula for a circle,

$A = \pi \times r^2$, $2.5 = 3.14\ r^2$, $r^2 = 2.5/3.14 = 0.796$, r = square root

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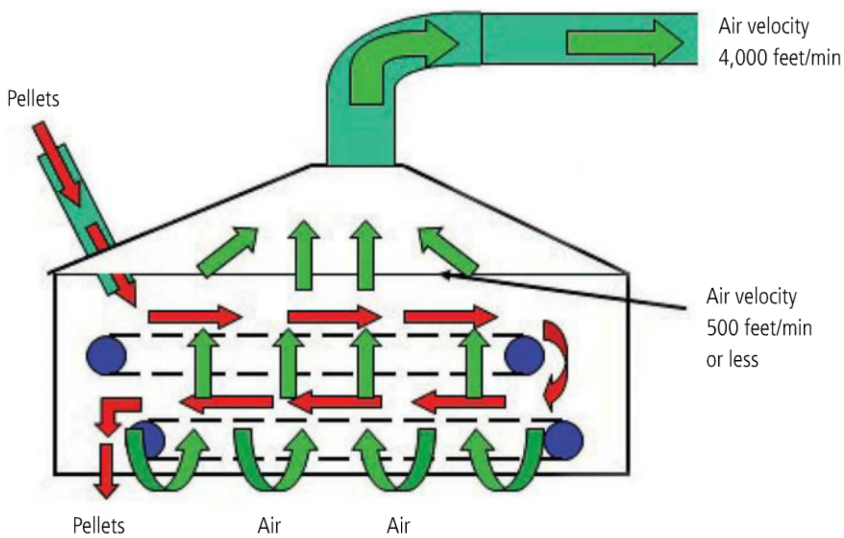
of 0.796, r = 0.892 feet x 12 inches/foot = 10.7 inches. The required diameter of the ductwork is 2r or 21.4 inches. The round ductwork needs to be 21 inches in diameter or less to maintain the air velocity in the ductwork of at least 4,000 feet per minute.

The ductwork is then connected to a cyclone style separator(s) to separate any particles in the air from the air and return them to the pelleting system. These should be of the tall slim high efficiency design. If one cyclone cannot handle the amount of air from the cooling system, two or more may be connected in parallel to handle the needed air volume. These collectors operate under negative pressure and require air locks on their bottom particle outlets to allow particles out, but keeping air from entering. The discharge ductwork from the collector exhaust(s) is then collected back into same size ductwork used prior to the collectors.

Leaving the collectors, the ductwork is then connected to the fan for the system. This fan pulls the air into the cooler through its air inlets, through the pellet beds, out the exhaust, through the collector and into the fan. The fan should have a blade that is a backwardly curved de-

Horizontal cooler



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sign to allow for variations in suction pressure required to pull the air through the system. At the outlet of the fan, the ductwork is continued for a short distance before discharging the air into the open atmosphere.

Since the air from the cooler is very moist and warm, all ductwork, collectors and fans should be wrapped in insulation to avoid excessive cooling of the air in the ductwork system resulting in the formation of condensation in the ductwork. It is best that the warm air reach the discharge into the open air before condensation occurs.

If air velocity in the ductwork drops below the desired velocity under certain operating conditions, a branch with a damper should be installed just beyond the cooler exhaust to allow for adding room air to the ductwork area to maintain the minimum velocity required. Although I have recommended a minimum velocity of 4,000 feet per minute, some companies design their systems to operate at velocities of 3,200-3,500 feet per minute. If different velocities are used in the system ductwork, the ductwork must still be sized to handle the required air volume at the specified velocity.

The following chart looks at adjustments that might be made to improve the performance of the cooling system and its equipment. WG

Trouble Shooting Cooler Operation and Performance – What Should I Do?

PROBLEM	RECOMMENDATION
Temperature is OK, Moisture is too high	Reduce air flow, Increase bed depth
Temperature is high and Moisture is high	Increase bed depth, Increase air flow
Temperature is OK, Moisture is too low	Reduce bed depth, Increase air flow
Temperature is low, but moisture is high	Increase bed depth, Reduce air flow
Temperature is low, Moisture is low	Reduce air flow

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