Zagazig J. Agric. Res., Vol. 37 No. (2) 2010 397 - 419

MANUFACTURE AND EVALUATION OF DOUBLE PASS COOLER FOR AQUATIC FEED PELLETS

El-Kinawy, W. S.[1], M.S. El-Shal[2], M.A.I. Arnaout[2] and Maisa M. Megahed[1]

1. **Agricultural Engineering Research Institute, A.R.C., Doki, Giza, Egypt.**
2. **Agricultural Engineering Dept., Faculty of Agriculture, Zagazig University, Egypt.**

Accepted 4/5/2010

ABSTRACT: **Cooling is one of the most important post-processing operations in the production of extruded aquatic feed pellets. In this study a simple design of double pass cooler was manufacturing for sinking pellets and the effect of different operating parameters on the final quality of extruded sinking aquatic feed (auger speed, air velocity and feeding rate) were investigated. The cooler parameters that were studied included three different air velocity in upper cylinder of 2.9, 4.6 and 5.8m/s, and 3.7, 5.3 and 8.2 m/s in bottom cylinder, four different auger rotating speeds of (45, 60, 75 and 90 rpm.), and three different cooler feeding rate of (250, 350 and 450 kg/h).**

The results showed that the highest cooling efficiency was 83.66%, the lowest out-put pellets temperature and output moisture content were 27.3°C and 9.93%, respectively at parameters of 5.8 and 8.2 m/s air velocity in upper cylinder and bottom cylinder respectively, 45 rpm. auger speed, and 250 kg feeding rate. The best pellets durability was 98.91 at air velocity of 2.9 and 3.7 m/s in upper cylinder and bottom cylinder respectively, 45rpm auger speed, and 450 kg feeding rate. Specific energy was 4.866 kW.h/ton and 0.00% total mash losses at air velocity of 2.9 and 8.2 m/s in upper cylinder and bottom cylinder respectively, 45 rpm auger speed, and 450 kg feeding rate.

Key words: Double pass cooler, aquatic feed pellets, manufacture, auger speed, temperature, moisture content.

INTRODUCTION

Maier *et al.* (1989) studied the production of pellets by extrusion. Ground feed ingredients were extruded through dies ranging in diameter from 4 to 12 mm. After extrusion, the pellets were cooled before being placed in storage. Also, stored pellets needed to be ventilated occasionally to prevent spoilage. They concluded that knowledge of the thermal properties (specific heat, thermal conductivity, and thermal diffusivity) of the pellets is needed in the efficient design and selection of coolers and ventilation equipment for poultry litter pellets.

Robinson (1984) reported that in the conventional extrusion process for feed production, pelleted products exit the die at about 60-85°C and 12-17.5% moisture. During cooling, air is forced through the pellets to quickly reduce the temperature and to remove a specific amount of moisture from the material and in general, for long-term storage, the final moisture content of the pellets should be less than 12-13%.

Turner (1995) studied that in the pellet milling process, pellets leave the die at temperatures of 60-95°C and moisture contents of 12-18%. Pellets are cooled, mostly using forced air, immediately after the die to within 5°C of ambient temperature, and to within 0.5% of the original moisture content of the feed ahead of the conditioner.

Maier *et al.* (1992) established that the most important operating and design parameters for a pellet cooling system are bed depth and air-to-pellet mass flow ratio. Fundamentally, both are airflow resistance parameters. They added that the cooling time might range from about 4 to 15 min.

Fasina *et al.* (1997) reported that cooling and drying is one of the unit operations involved in the production of Lucerne pellets. Optimization of this unit operation is essential due to its substantial impact on pellet quality and production costs. A heat and mass transfer program was developed for the cooling and drying of Lucerne pellets. The program, when applied to a single-pass cross flow cooler, showed that pellet size (or diameter), air temperature and ratio of pellet flow rate to airflow rate significantly affected the cooling and drying of the pellets. No significant effect of initial pellet temperature (within the range of 90 to 110°C) was found on the rate of pellet cooling although the location (or time) of complete cooling of the pellets increased with increase in initial pellet temperature.

Jennifer (2004) storage and handling properties of the pellets made from poultry litter are affected by moisture content between (6 to 22%) and relative humidity between (45% to 80%) of the storage environment. The force required to rupture the pellets varied from 350N at 6.0% moisture to 50N at 22.0% moisture W.b. Temperature of the pellets exiting the die increased to 85 °C ± 2 °C after pelleting, the pellets were cooled in an environmental chamber set at 22°C and 4% relative humidity

Ray *et al.* (2004) studied airflow resistance during cooling of pelleted products of four sizes and shapes (circular cross-sections with 4.0, 6.7 and 19.4 mm diameters, and rectangular cross section with 33.2 x 34.9 mm dimensions). The effect of "loose" and "packed" fill were tested for each product size except for the cubes, which was tested at loose fill only. The pressure drop was higher for the packed fill, but the similar trends for variation of airflow with pressure drop was observed for both conditions. Three bin shapes (round, square, rectangular) containing equal airflow areas were also tested, and no significant effect of the same on airflow resistance was detected.

Kaddour and Alavis (2007) in this study a simple design one rotating bass cooler was manufacturing, some different operating parameters were testing. Lowest possible air velocity is desired to reduce pellet losses with output air. On the other hand, lower air velocity reduced the degree of drying and cooling, leading to higher molding and mash percentage. For two months storage, the least possible air velocity that led to zero molding for low density floating feed was 3.76 m/s at 10 rpm. turning speed and 100 cooler angles. Also at these settings pellet losses and mash percentage were acceptable (only 0.8% and 1.6%, respectively). This corresponded to output temperature of 28.50C, cooling efficiency of 72.8% and output moisture of 8.3%. Similarly, for medium density sinking feed, the best operating parameters were 3.76 m/s air velocity, 15 RPM. turning speed and 100 cooler angles. This corresponded to output temperature of 27.30C, cooling efficiency of 73.9% and output moisture of 8.9%, and resulted in 0.5% losses, 1.7% mash percentage and 0% molding after two months of storage.

The objectives of this study are:

1. Manufacturing a simple design of double pass cooler for aquatic feed pellets.
2. Studying the effect of different operating parameters (auger speed, air velocity, feeding rate) on the final quality pellets.

MATERIALS AND METHODS

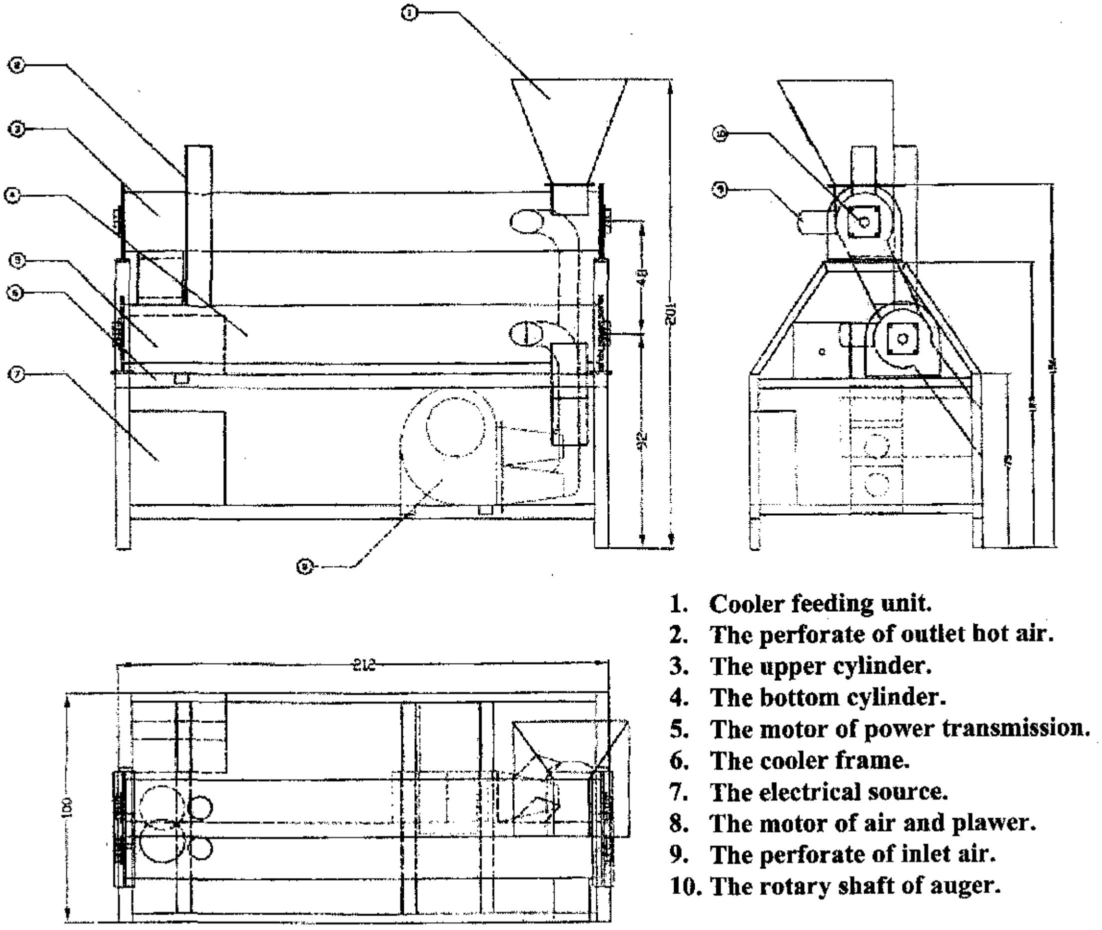
Components of the Double Pass Cooler

The cooler rested on a frame with an adjustable base, and consisted of feeding unit, two cooler barrels, an air-comprising unit and a power transmission unit (Fig. 1a and 1b).

Frame: The cooler frame, manufactured to supporting the two barrels, was made from steel bars of 4x6x0.5 cm it has dimension of 124 cm highest and 100 cm width. The frame supported on four wheels has diameter of 20cm.

Feeding unit: The feeding hopper has conical shape; it has inlet dimensions of 50x50 cm, outlet dimensions of 15x23 cm. and45 cm highest. It has holding capacity range between (20-30) kg of aquatic feed depends on the pellets density.

Double pass barrels: The cooler barrels are the cooling room of cooling system, the extruded pellets move through it with cooling air to decrease the pellets moisture and temperature. Etch barrel has dimension of 200cm length, 25cm diameter, 0.3cm thickness, the upper barrel has four perforates, the first under the feeding unit has dimension of 15x23 cm for pellets input, the second connected with the bottom barrel from the another end by glass cylinder has diameter of 19 cm and 19 cm length, the third from 24cm of the barrel end at the top has10 cm diameter and 19cm. length to exit the hot air. The fourth for cooled air input it has diameter of 10cm.The bottom barrel has four perforated too, the first connected with the upper barrel has diameter of 19cm, the second for hot air out put from 24cm of the barrel end at the top has10 cm diameter and 70cm length, the third to exit the pellets out the cooler after cooling operation it has dimension of 15x23cm, the fourth for cooled air input at feeding side it has diameter of 10cm. Etch barrel set on the frame from the both ends by a vertical pallet has 32 cm diameter, and1 cm thickness.



1. Cooler feeding unit.
2. The perforate of outlet hot air.
3. The upper cylinder.
4. The bottom cylinder.
5. The motor of power transmission.
6. The cooler frame.
7. The electrical source.
8. The motor of air and plawer.
9. The perforate of inlet air.
10. The rotary shaft of auger.

Fig. 1a. The double pass cooler machine

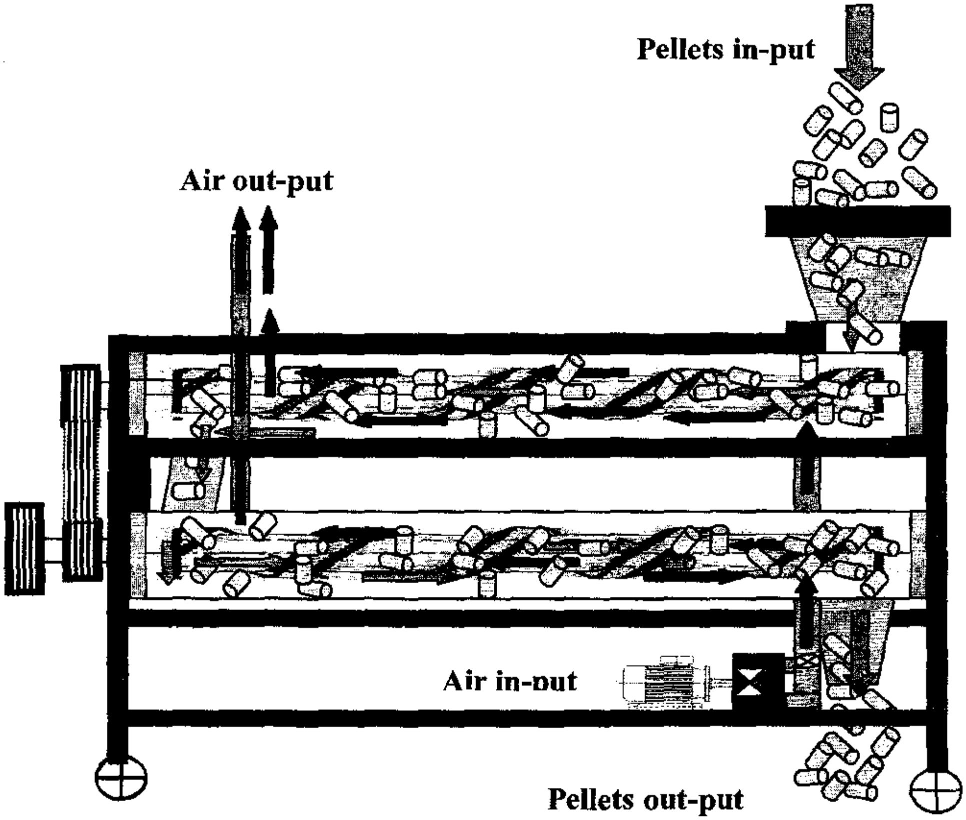


Fig. 1b. The moving direction of air and pellets inside the cooler

Turning auger: The cooler augers were anchored on the rotary shaft of the cooler inside the barrel, it designed to transfer and turning the extruded pellets from the beginning of the barrel to the end in etch stage. The auger shaft dimensions were 230 cm length, 5 cm diameter ends to 4 cm and 15 cm pitch and was supported on two rollers on the a vertical pallet on frame. The auger consisted on two rows of holes has 0.5 cm diameter.

Air Compressing system: It consisted of compressing fan and an air chamber divides to two parts their one at the beginning of the upper barrel, and the other at the beginning of the bottom barrel of cooler. The compressing fan had a diameter of 25 cm, and was powered by a (2.18) kW (4 hp) motor. The air velocity through the pellets at the two barrels' has controlled by gate.

Power transmission: The cooler power transmission unit consist of an electric motor 1.47 kW (2 hp). The motor output shaft speed was from 60 to 3000 rpm., and power was transmitted from gear on shaft of the motor to gear on the shaft of the auger at the bottom barrel and to gear on the shaft of the auger at the upper by a chains.

Evaluation of Cooler Performance

Aquatic feed pellets were produced on a single screw extruder using dies with 4.00 mm diameter circular opening. The average dimensions of sinking pellets were 4.0 mm diameter and 5.0 mm length. The cooler performance was evaluated based on the following measurements: cooling efficiency (%), output pellet moisture content (%), out put pellet temperature (C^o), mash losses percentage in the final product (%), pellet loss (%), specific energy, and pellets durability.

Pellets temperature out-put

The pellets temperature were monitored using thermocouples.

Cooling efficiency

The air temperature and relative humidity during the cooling study ranged between 28-29° C and 55.3-60.7%, respectively. The cooling efficiency was calculated using the following relation –

$$\text{Cooling efficiency}(\%)=\frac{T_1-T_2}{T_1}\text{x}100 \quad (1)$$

(Kadduor and Alvis (2007))

Where, T_1 and T_2 are the pellet input and output temperatures respectively (C^o).

Pellets moisture content %

Pellet moisture contents were determined using the oven drying method (140^{o} C for 2 h) and expressed on a wet basis.

Pellet losses

Pellet losses with air output were evaluated by letting the air from the output tube pass through a porous collection bag. The mass of material in the bag was measured and expressed as a percentage of the total mass of pellets that passed through the cooler.

$$\text{pellets losses}(\%) = \frac{W_p}{W_t} \times 100 \text{ -------- } (2)$$

(Kadduor and Alvis (2007))

Where: W_P: pellets losses (kg) and Wt: sample mass (kg)

Mash losses

Mash losses in the final product was a measure and expressed as a percentage of the total mass of pellets that passed through the cooler.

$$\text{mash losses } (\%) = \frac{Wm}{W_t} \times 100 \cdots \quad (3)$$

(Kadduor and Alvis (2007))

Pellets durability

Pellets durability after cooling was determined using durability turning box at 50 rpm.. The pellets sample of 500g inside the box and operating 10 minute, after treatment, the sample sieve and weight. It was calculated from the following relation:

$$\text{Pellets durability} = \frac{Wa}{Wb} x\,100 \qquad (\%)$$

Where: W_a : broken pellets (g) and W_b : sample mass (g)

Specific Energy

In order to measure the energy requirement for operating the designed mixer unit, a super clamp meter-300 k was used for measuring the current strength and potential difference before and during experiments. The consumed power was calculated according to the following formula (Ibrahim, 1982):

$$\text{Total consumed power} = \frac{\sqrt{3}\ \ I\ \ V\ \eta\ \ \cos\theta}{1000}(\text{KW})$$

Where I= Line current strength in amperes, V = Potential difference (Voltage) being equal to 380 V, Cos θ = Power factor (being equal to 0.84), $\sqrt{3}$ = Coefficient current three phase (being equal 1.73), η = Mechanical efficiency, assumed (90 %) constant.

The specific energy requirement in (kW.h/ton) was calculated by the following equation:

$$Energy\ consumed = \frac{P}{Q}(KW.h/ton)$$

Where P = The consumed power to mixing ration, KW

Q = Machinery line productivity, ton/h.

RESULTS AND DISCUTION

Effect of Operational Factors on Pellets Output Temperature

Pellet output temperature after cooling is a very important parameter, not only as a measure of cooling performance, but also from the point of view of packaging and stability during handling and long term storage.

Auger speed

Fig. 2 showed that the effect of auger speed on the out put sinking pellets temperature, at air velocity profile of 2.9 and 3.7 m/s, and auger speed of 45, 90 rpm. which it ranged between (34.56 and 42.77°C), (34.49 and 42.47°C) and (35.22 and 42.83° C) at feeding rate (250, 350 and 450 kg/hr) respectively.

The increase in auger speed leading to the decrease in pellets retention time inside the cooler, and decreased the time of heat transfer process between hot pellets and air that led to pellets exit fast out the cooler barrel with higher out put pellets temperature .

Air velocity

Fig. 2 showed that the effect of air velocity on the output sinking pellets temperature, at air velocity profiles of (2.9, 3.7 m/s) to (5.7, 8.2 m/s) and at auger speed of 45 rpm. which it ranged between (34.56 to 27.3°C), (34.49 to 27.26°C) and (35.22 to 28.31° C) at feeding rate (250, 350 and 450 kg/hr) respectively.

Air velocity greatly affects the rate of heat transfer from the hot pellets to the cooling air, with higher velocity the volume of air increased that leading to a greater heat transfer coefficient , so high air velocity led to fast temperature removing thus lower out put pellets temperature thus.

Feeding rate

Fig. 2 showed that the effect of feeding rate on the out put sinking pellets temperature which it ranged between (27.3 and 28.31o C), (24.65and 26.58o C) at feeding rate of 250 and 450 kg/h respectively at air velocity profile of (5.7, 8.2 m/s) and auger speed 45 rpm.. The increase in feeding rate leading to increased the heat quantity of pellets in the cooler

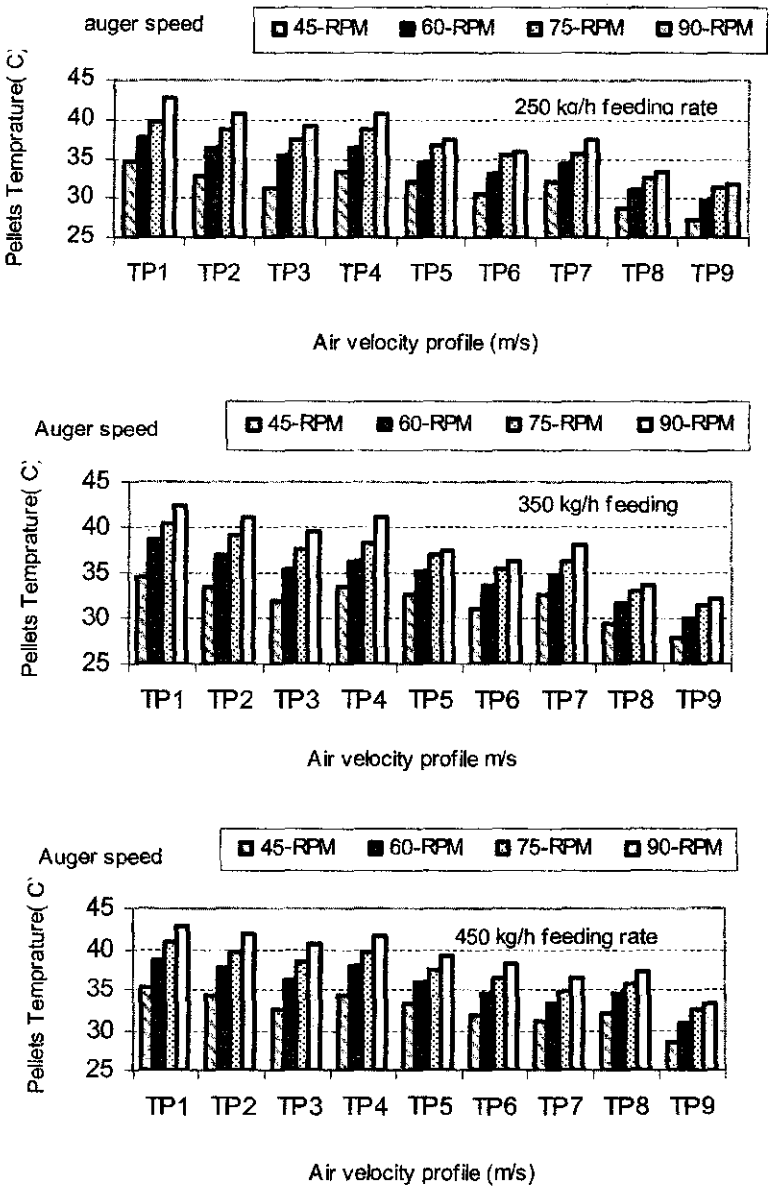


Fig. 2. The effect of air speed profile and cooler speed on sinking pellets out-put temperature at 250, 350 and 450kg/h feeding rate.

temperature and the decrease of pellets contact surface area with air inside the cooler , so the increase in feeding rate with the same of air velocity and auger speed led to decrease in the temperature removing of pellets and higher out put pellets temperature.

Effect of Operational Factors on Cooling Efficiency

Cooling efficiency is a very important measurement to evaluate any cooling system and it takes into accounts both the inlet and outlet temperatures of the pellets.

Auger speed

Fig. 3 showed that the effect of auger speed on the cooling efficiency for air velocity profile of (5.7, 8.2 m/s), the auger speed of 45 rpm. and auger speed of 90 rpm. which it ranged between (66.59% and 61.13), (66.02 and 60.64) and (65.35 and 59.28) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The increase in auger speed from 45 to 90 rpm. leading to the decrease in pellets retention time inside the cooler, and decreased the time of heat transfer process between hot pellets and air that lead to pellets exit fast out the cooler barrel with higher out put pellets temperature and lowest Cooling efficiency.

Air velocity

Fig. 3 showed that the effect of air velocity on the cooling efficiency at air velocity profiles of (2.9, 3.7 m/s) to (5.7, 8.2 m/s) for the auger speed of 45 RPM. which it ranged between (57.69% to 66.58%), (57.78% to 66.02%) and (56.89% to 65.34%) for sinking pellets.

Air velocity greatly affects the rate of heat transfer from the hot pellets to the cooling air, with higher velocity the volume of air increased that leading to a greater heat transfer coefficient, so high air velocity lead to lead to fast temperature removing thus lower out put pellets temperature and highest Cooling efficiency.

Feeding rate

Fig. 3 showed that the effect of feeding rate on the cooling efficiency for sinking pellets which it was (66.59%) and (73.64%) at feeding rate of (250 and 450 Kg/h) respectively for air velocity profile of (5.7and 8.2 m/s) and auger speed 45 rpm. The increase in feeding rate leading to increased the heat

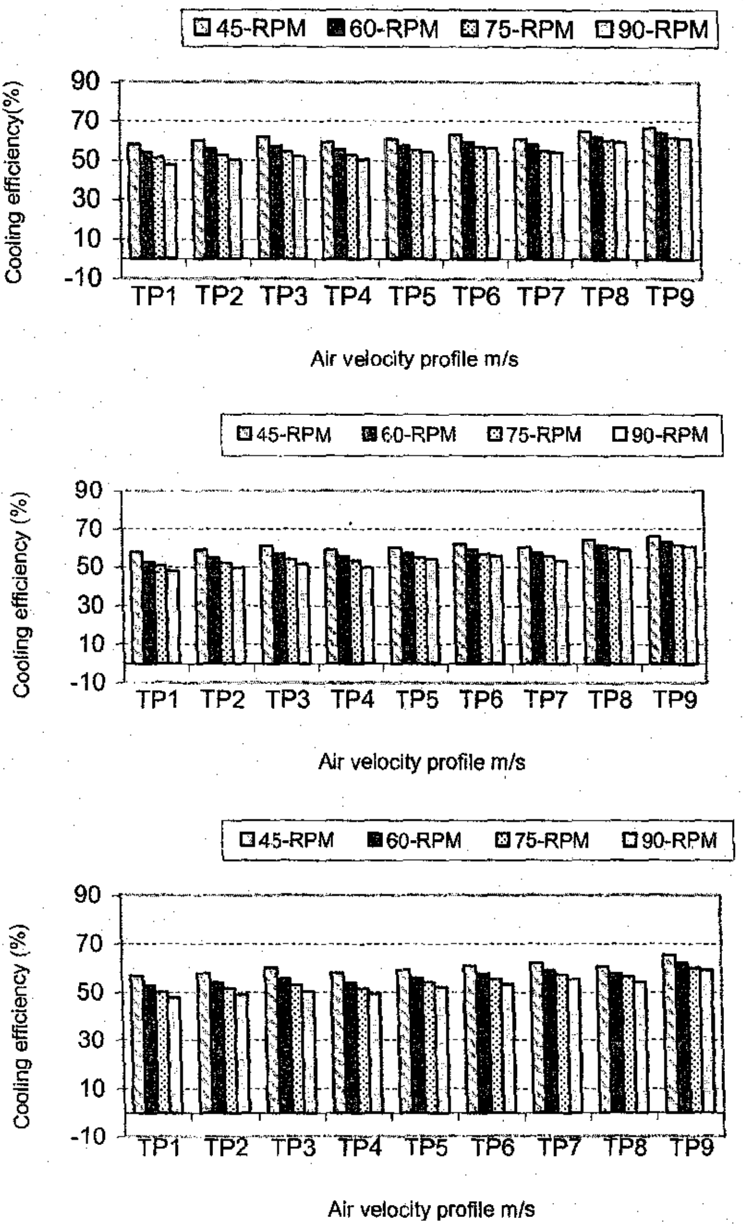


Fig. 3. The effect of air speed profile and cooler speed on sinking cooling efficiency at 250, 350 and 450 kg\h-feeding rate

quantity of pellets in the cooler and decreased the pellets contact surface area with air inside the cooler, so the increase in feeding rate lead to decrease in the temperature removing of pellets and higher out put pellets temperature and lowest cooling efficiency.

Effect of Operational Factors on Pellets Moisture Content

A primary outcome of the cooling process is removal of moisture from the pellets leading to lower water activity, inhibition of mold growth, and long-term storage.

Auger speed

Fig. 4 showed that the effect of auger speed on pellets moisture content at air velocity profile of (2.9, 3.7 m/s), the auger speed of 45 and 90 rpm. Which it ranged between (14.54% and 20.17%), (15.92% and 21.58%) and (16.81% and 22.47%) for sinking pellets.

The increase in auger speed leading to the decrease in pellets retention time inside the cooler, and decreased the time of heat transfer process between hot pellets and air that lead to pellets exit fast out the cooler barrel with higher out put pellets temperature and moisture.

Air velocity

Fig. 4 indicated the effect of auger speed on the out put sinking pellets moisture at air velocity profiles of TP1 (2.9, 3.7 m/s) and TP3 (5.7, 8.2 m/s) and the lowest auger speed of 45 rpm. which it ranged between (14.54% and 11.78%), (15.92% and 12.96%) and (16.81% and 13.85%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

At air velocity profiles of TP4 (4.6, 3.7 m/s) and TP6 (4.6, 8.2 m/s) it ranged between (13.67% and 10.68%), (14.93% and 12.08%) and (15.82% and 12.97%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

At air velocity profiles of TP7 (5.7, 3.7 m/s) and TP9 (5.7, 8.2 m/s) it ranged between (12.37% and 9.93%), (13.99% and 11.14%) and (14.88% and 12.03%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The decrease in pellets output moisture by the increase in the air velocity, could be due to the increase in air quantity by high speed of air, thus lead to fast moisture removing of pellets output . Air velocity greatly affects the rate of heat and moisture transfer from the hot pellets to the

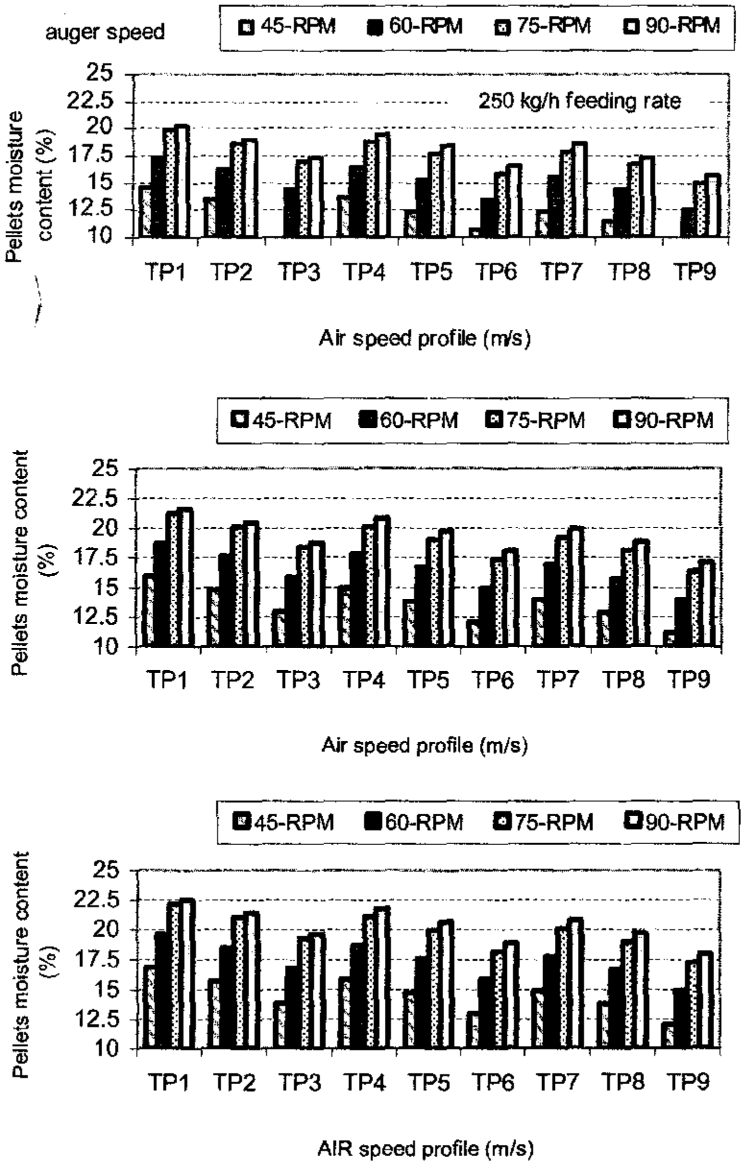


Fig. 4. **The effect of air speed profile and cooler speed on sinking pellets output moisture content at 250 , 350 and 450kg\h feeding rate**

cooling air, with higher velocity the volume of air increased that leading to a greater heat and moisture transfer coefficient, so high air velocity lead to lead to fast temperature and moisture removing thus lower out put pellets temperature and moisture.

Feeding rate:

Fig. 4 indicated the effect of feeding rate on the out put sinking pellets moisture content after double bass which it was (14.54%), (17.43%) at feeding rate of (250 and 450Kg/h) respectively, air velocity profile of (2.9and 3.7 m/s) and auger speed 45 rpm

The increase in feeding rate leading to increased the heat and moisture quantity of pellets in the cooler and decrease the contact surface area between pellets and air inside the cooler, so the increase in feeding rate with the same of air velocity and auger speed lead to decrease in the temperature and moisture removing from pellets and thus higher out put pellets temperature and moisture.

Effect of Operational Factors on Pellets and Mash Losses

Auger speed

Fig. 5 showed the effect of auger speed on the sinking mash losses at air velocity profile of Tp_1 (2.9, 3.7 m/s) and at the auger speed of 45 rpm, and 90 rpm. which it ranged between (0.24% and 1.1%), (1.6 and 2.46) and (2.53 and 3.39) at feeding rate (250, 350 and 450 Kg/hr) respectively

The increase in mash formula percentage in plant packing by increasing the cooler screw speed , could be due to, the decrease in pellets retention time in cooler barrels , that lead to less effect of air velocity for mash removing by decrease the pellets retention time in cooler barrels.

However, for sinking pellets losses was (1.24% and 0.4%), (1.11 and 0.35) and (0.84 and 0) at feeding rate (250, 350 and 450 Kg/hr) respectively. It means that the increase in auger speed would lead to faster transit of pellets through the cooler and reduced retention time.

The decrease in pellets losses with air output by increasing the auger speed for sinking pellets just at air velocity profile (TP9) of (5.7m/s upper with 8.2m/s bottom) could be due to the decrease in pellets retention time in cooler barrels.

Air velocity

Fig. 5 showed the effect of air velocity on the sinking mash losses

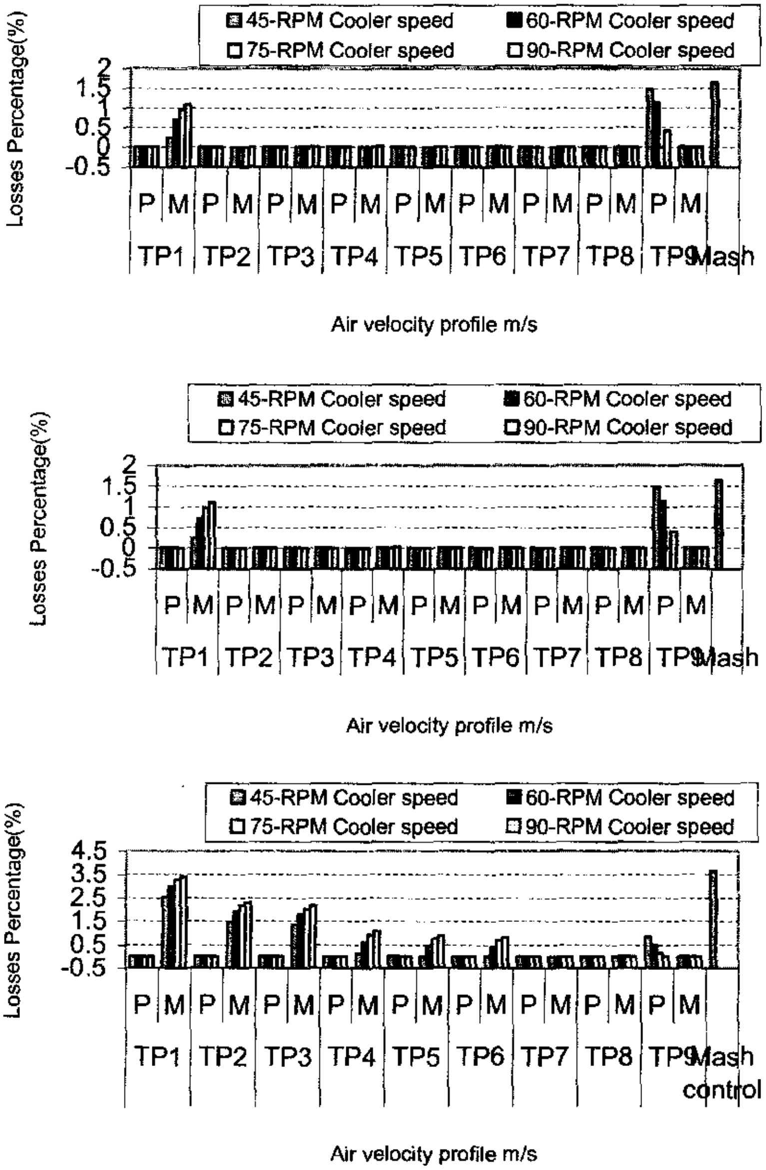


Fig. 5. The effect of air speed profile and cooler speed on sinking pellets and mash losses percentage at 250, 350 and 450 kg\h feeding rate

at the lowest auger speed of 45 rpm. and air velocity profile of Tp_1 (2.9, 3.7 m/s) and air profile speed of Tp_9 (5.7,8.2 m/s) which it ranged between (0.24% and 0%), (1.6% and 0%) and (0.84% and 0%) at feeding rate (250, 350 and 450 Kg/hr) respectively

The decrease in mash formula in pellets package for sinking treatments, with high air velocity profile could be the mash formula has very low density, allow the air to pick it up out the cooler with air.

However, for sinking pellets losses ranged between (0% and 1.47%), (1.6% and 0%) and (0% and 2.53%) at feeding rate (250, 350 and 450 Kg/hr) respectively

Feeding rate

Fig. 5 showed the effect of feeding rate on the sinking mash losses at the lowest auger speed of 45 rpm. and air velocity profile of Tp_1 (2.9, 3.7 m/s) and air profile speed of Tp_9 (5.7, 8.2 m/s) which it was (0.24%, 1.6 and 2.53%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The increase in mach losses and the decrease in pellets losses by the increase in feeding rate could be due to the increasing in pellets capacity in cooler barrel in time unit and the decrease in the area between pellets that lead to decrease air velocity by increasing the resistance of air to pick up the mach out the cooler from the screw center.

Effect of Operational Factors on Durability

Pellets durability is one of the most important parameters of pellets quality control measurement; it indicates pellets resistance for handling.

Auger speed

Fig. 6 indicated the effect of auger speed on the out put sinking pellets durability at air velocity profile of (2.7, 3.9 m/s) and auger speed of 45 rpm, and 90 rpm. which it ranged between (97.32% and 92.94%), (97.95% and 93.57%) and (98.91% and 94.53%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The decrease in pellets durability by increasing auger speed from could be due to the decrease in pellets retention time inside the cooler, that lead the pellets exit fast out the cooler, and the high rotating speed of screw lead to make cracking of pellets.

Air velocity

Fig. 6 indicated the effect of auger speed on the out put sinking pellets durability after double pass at the auger speed of 45 rpm. and

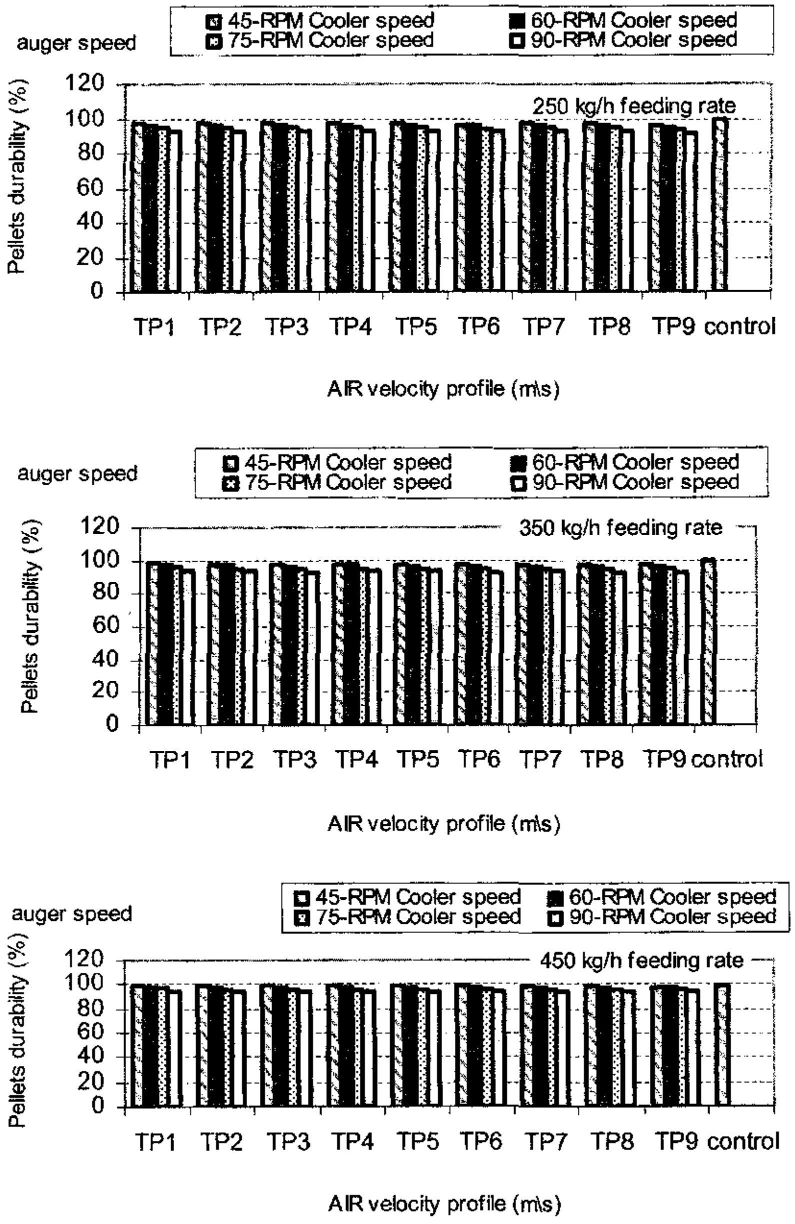


Fig. 6. The effect of air speed profile and cooler speed on sinking pellets durability at 250, 350 and 450 kg/h feeding rate

air velocity profiles of (2.9, 3.7 m/s) and (5.7, 8.2 m/s) which it ranged between (97.32% and 96.75%), (97.95% and 97.38%) and (98.91% and 98.68%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

However, at air velocity profiles of (4.6, 3.7 m/s) and (4.6, 8.2 m/s) and at the auger speed of 45 rpm. which it ranged between (97.11% and 96.54%), (97.74% and 97.17%) and (98.7% and 98.13%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

However, at air velocity profiles of (5.7, 3.7 m/s) and (5.7, 8.2 m/s) and at the auger speed of 45 rpm. which it ranged between (96.92% and 96.35%), (97.55% and 96.89%) and (98.51% and 97.94%) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The decrease in pellets durability by increasing of air velocity for all profiles could be due to the increase in auger speed and the high air velocity may be caused increase the cracked and breakage pellets percentage thus decreased the pellets resistance for handling after cooling.

Feeding rate

Fig. 6 showed the effect of feeding rate on the out put sinking pellets durability at air velocity profile of (2.9, 3.7 m/s) and auger speed 45 rpm. it was (97.32%), and (96.33%) at feeding rate of (250 and 450 Kg/h) respectively.

While at air velocity, profile of (5.7, 8.2 m/s) and auger speed 90 RPM. which it ranged between (92.94% and 94.53%), (86.94% and 88.4) at feeding rate of (250 and 450 Kg/h) respectively.

The increase in pellets durability by the increase in feeding rate for all air velocity profiles could be due to the decreased in air velocity inside barrels of cooler between the pellets thus decreased the effect of the high air velocity which that may be caused increase the cracked and breakage pellets percentage and thus increased durability.

Effect of Operational Factors on Specific Energy

Reducing the energy requirements is important goal of any industry; it depends on the equipments power consumed and machines productivity

Auger speed

Fig. 7 indicated the effect of auger speed on specific energy for sinking pellets at air velocity profile of (2.7, 3.9 m/s) and auger

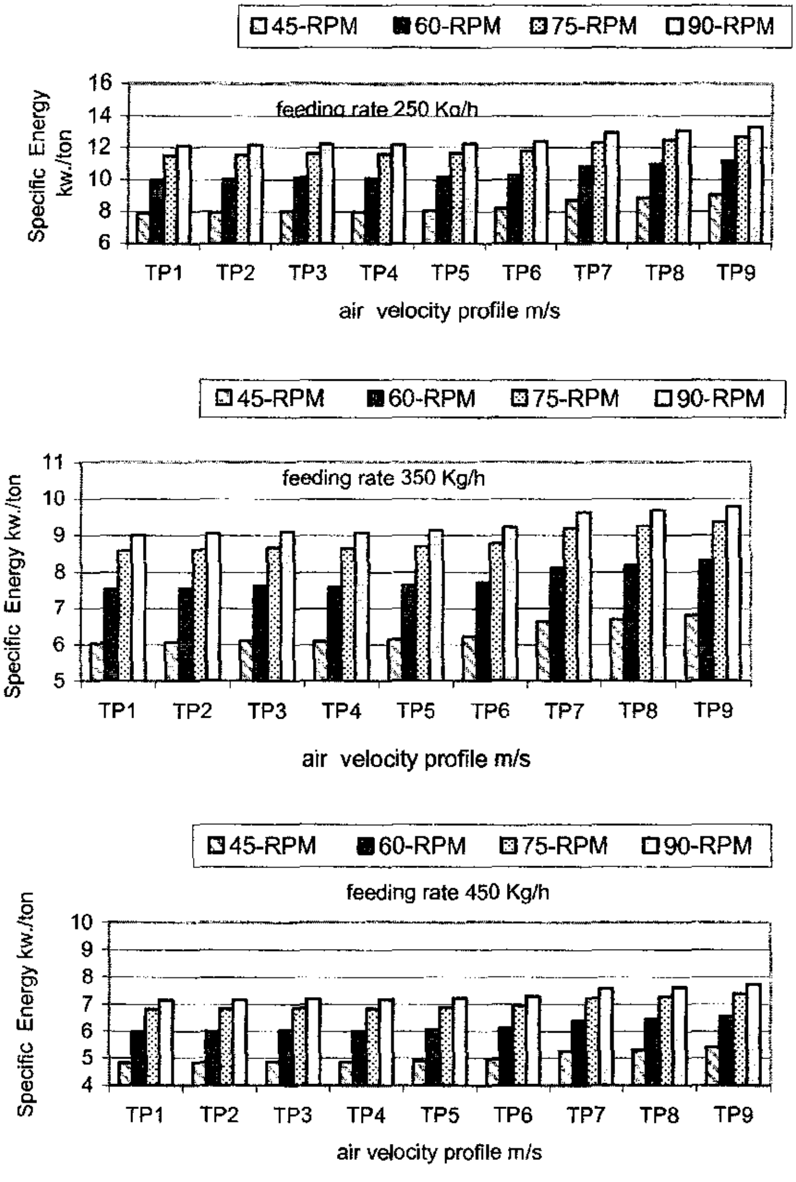


Fig. 7. The effect of air speed profile and cooler speed on specific energy at 250, 350 and 450 kg/h feeding rate

speed of 45 rpm. And 90 rpm. which it ranged between (8.02 and 12.21), (6.11 and 9.09) and (4.87 and 7.19) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The increase in the specific energy by the increase in auger speed for all air velocity profiles at the same of feeding rate and air velocity profile could be due to the increase in productivity with high auger speeds.

Air velocity

Fig. 7 indicated the effect of auger speed on specific energy for sinking pellets at the lowest auger speed of 45 rpm. and air velocity profiles of (2.9, 3.7 m/s) and (5.7, 8.2 m/s) which it ranged between (7.89 and 9.05), (6.03 and 6.8) and (4.8 and 5.39) at feeding rate (250, 350 and 450 Kg/hr) respectively.

The increase in the specific energy by the increase in air velocity for all air velocity profiles at the same of feeding rate, auger speed and productivity could be due to the increase in power consumption by the air motor with the high auger speeds.

Feeding rate

Fig. 7 showed the effect of feeding rate on specific energy for sinking pellets at air velocity profile of (2.9, 3.7 m/s) and auger speed 45 rpm. which it ranged between (7.89 kW.h/mg), (7.73 kW.h/mg) at feeding rate of (250 and 450 Kg/h) respectively.

While at air velocity, profile of (5.7, 8.2 m/s) and auger speed 90 rpm. it ranged between (13.27 kW.h/mg), (13.07 kW.h/mg) at feeding rate of (250 and 450 Kg/h) respectively.

The increase in the specific energy by the increase in feeding rate at the same of air velocity profile and auger speed for all air velocity profiles and auger speeds could be due to the increase in productivity with high auger speeds.

REFERENCES

Fasina, O., S. Sokhansanj and B. Tyler. 1997. "Optimizing the drying and cooling of alfalfa pellets", ASAE Annual International Meeting, Minneapolis, Minnesota, USA, 10-14 August, 1997. Paper-American- Society-of-Agricultural- Engineers. No. 976004, 8 pp.

Jennifer, M. 2004. Physical characteristics of pellets from poultry litter. ASAE/CSAE annual international meeting sponsored by ASAE/CSAE.

Fairmont. Chateau laurier, The Westin, Givernment center. Ottawa, Otario, Canada 1-4 Agust 2004.

Kaddour, U.A. and Alavis. 2007. Manufacture and evaluation of a single pass rotary cooler for aquatic feed pellets. Mansoura University journal of Agricultural Sciences, 32 (11): 8955 – 8973.

Maier, D.E. and F.W. Bakker-Arkema. 1989. The drying and cooling of feed pellets – an evaluation of single and double deck horizontal coolers. Adv. Feed Technol., 1(1): 62-74.

Maier, D.E., R.L. Kelley and F.W. Bakker-Arkema. 1992. In-line, chilled air pellet cooling. Feed Manage., 43 (1): 28-32.

Ray, S.J., L.O. Pordesimo and L.R. Wilhelm. 2004. Airflow resistance of some pelleted feed. Trans. ASAE., 47 (2): 513-519.

Robinson, R. 1984. Pellet cooling. In Manufacture of Animal Feed, (D. A. Beaven, ed.) pp. 54-55, Turret-Wheatland Ltd., Rickmansworth, U.K.

Turner, R. 1995. Bottomline in feed processing: achieving optimum pellet quality. Feed Manage., 46 (12) : 30-33.

تصنيع وتقييم مبرد ثنائي الاتجاه لأعلاف الأسماك المنتجة بنظام البثق

وليد الشحات القناوى[١] – محمد سعد الدين الشال[٢]
مراد على إبراهيم أرناؤوط[٢] – مائسه منير مجاهد[١]

١– معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – وزارة الزراعة واستصلاح الأراضى.

٢– قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق.

تبريد الأعلاف السمكية بنظام البثق يعد من أهم العمليات التي تؤثر علي جودة الأعلاف المنتجة بما يمثل ٥ – ١٠% من جملة العوامل الميكانيكية الأخرى، بالإضافة إلي أهمية عملية التبريد لزيادة كفاءة التخزين (الحفاظ على جودة الأعلاف وقيمتها الغذائية – زيادة فترة التخزين)، ونظرا لارتفاع أسعار الوحدات المستوردة من المبردات وارتفاع

طاقاتها الكهربية المستهلكة فإن البحث يهدف إلى تصنيع وتقييم مبرد بسيط ثنائي الاتجاه لتبريد أعلاف الأسماك ودراسة تأثير عوامل التشغيل المختلفة علي أداء وكفاءة التبريد للمبرد.

وكانت عوامل الدراسة كالآتي:

١- سرعات للبريمة داخل كل أسطوانة (٩٠،٧٥،٦٠،٤٥ لفة /دقيقة).

٢- سرعات للهواء داخل الأسطوانة العلوية (٢,٩ ، ٤,٦ ، ٥,٧ م/ث) وداخل الأسطوانة السفلى (٣,٧ ، ٥,٣ ، ٨,٢ م/س).

٣- معدلات التغذية (٢٥٠ ، ٣٥٠ ، ٤٥٠ كجم/ساعة).

ومن خلال القياسات التالية تم تقييم أداء المبرد وتأثير عوامل الدراسة علي جودة الأعلاف المنتجة، درجة حرارة العلف قبل وبعد التبريد ، ونسبة الرطوبة قبل وبعد التبريد، وكفاءة التبريد، متانة العلف بعد عملية التبريد ، نسبة العلف السائبة والمكسورة في شكائر التعبئة، ونسبة الفاقد من الأعلاف مع الهواء الخارج من وحدة التبريد، والطاقة المستهلكة لإتمام عملية التبريد.

وقد أشارت النتائج المتحصل عليها إلى أن أعلي كفاءة تبريد كانت ٨٣,٦٦% وأقل درجة حرارة للعلف الخارج من المبرد ٢٧,٣٠°م وكذلك أقل محتوي رطوبى للعلف ٩,٩٣% كانت عند سرعة بريمة ٤٥ لفة / دقيقة وسرعة هواء في الاسطوانة العليا ٥,٧ م/ث، والاسطوانة السفلي ٨,٢ م/ث و معدل تغذية ٢٥٠ كجم/ساعة. كانت أعلي قيمة لمتانة العلف ٩٨,٩١% عند سرعة هواء في الاسطوانة العليا ٢,٩ م/ث، والاسطوانة السفلي ٣,٧ م/ث وسرعة بريمة ٤٥ لفة / دقيقة، ومعدل تغذية ٤٥٠ كحم / ساعة، وأقل قيمة للطاقة النوعية كانت ٤,٨٦٦ كيلوات.ساعة / طن عند سرعة هواء في الاسطوانة العليا ٢,٩ م/ث ، والاسطوانة السفلي ٨,٢ م/ث عند سرعة بريمة ٤٥ لفة / دقيقة، ومعدل تغذية ٤٥٠ كحم / ساعة.

ويوصي البحث بأهمية دراسة هذا النظام لاستخدامه في مختلف أنواع الأعلاف الحيوانية نظرا لبساطة التصميم وارتفاع الكفاءة وانخفاض تكاليف تشغيله عن المبردات الأخرى.