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Compacting and Baling Mill Run Peanut Hulls for Transport and Storage

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ABSTRACT

Mill run peanut hulls (Florunner) were compacted and baled with a modified 18.7 kW longitudinal press. Hull density was increased from 128 to 385 kg/m^3. The bale dimensions were designed for loading and transport on standard 12.2-m long flatbed trailers. Labor and energy costs for baling were approximately \$8 per tonne. Total costs for hulls delivered in truckload quantities were \$14 to \$18 per tonne. Bales of hulls stored for one year in both indoor and outdoor locations remained in satisfactory condition. Rain did not appear to penetrate the bales more than a few centimeters and internal temperatures did not exceed 79 C.

Key Words: peanut, hulls, compacting, baling, density, transporting, storing.

In past years many shelling plants have regarded peanut hulls as a waste product with little economic value. Several uses for peanut hulls have been proposed (1, 2) which have considerable potential for making hulls a valuable product. However, the density of mill run peanut hulls is only about one-third of that needed to obtain normal load weights, so transportation is expensive. Grinding or other processing will increase hull density but such operations are expensive and in uses such as for fuel, unground hulls are more desirable. The peanut industry has shown considerable interest in compacting and baling peanut hulls as a more economical method for transport and storage.

The National Peanut Research Laboratory in cooperation with the Dothan Oil Mill Company (DOMCO) and Walters Bale Press Company initiated an investigation to determine the feasibility of compacting and baling peanut hulls for transport and storage. This paper describes some results of this study.

Materials and Methods

Criteria used to determine bale dimensions and hull density requirements was based on transporting with a 12.2-m flatbed trailer in a two-high bale stack not to exceed 1.85 m and a minimum load weight of 18,000 kg. Using the standard 2.25-m trailer load width, the load volume was 49.8 m^3. To obtain the desired load weight, a hull density of approximately 370 kg/m^3 was needed.

Mill run peanut hulls were obtained from several shelling plants. Moisture content and bulk density averaged 11% (wb) and 128 kg/m^3, respectively. This indicated a compaction ratio of approximately 3 to 1 was needed to meet load configuration and weight requirements. Using a Carver laboratory press with a 15.24-cm-diameter compression cylinder, an approximate force of 3.4 kg/cm^2 produced a 3 to 1 compaction ratio in peanut hulls containing slightly less than 12% moisture content.

Mill run peanut hulls (Florunner) with an average density of 130 kg/m^3 and a moisture content of 11.5% were transported to a bale press manufacturer for preliminary baling tests. A standard longitudinal bale press capable of exerting a 25,000-kg force was used and several bales of hulls were produced that met density requirements and were very good in appearance. However, the bale dimensions were not suitable for a two-high stack on a flatbed trailer. Subsequently, the bale chamber of an 18.65-kW longitudinal bale press capable of exerting a 25,000/kg force was modified to produce bales 74-cm wide by 92-cm high by 150-cm long. These dimensions were calculated to meet a trailer loading configuration, 3 rows wide with 8 bales per row for 24 bales in a one-high stack or 48 bales in a two-high stack. The unit was set up at a shelling plant for operation under commercial conditions.

Mill run Florunner peanut hulls with an average density and moisture content of 126 kg/m^3 and 10.5%, respectively, were fed from the shelling plant hull collection system to the press. A three-man crew operated the press including removal of the bales from the press ejection area. Labor and energy requirements, production rates, and other data and observations were recorded. Thermocouples were inserted at the edge and center (Fig. 1) of the bales as they were made. Bales were stored in ambient air conditions in both indoor and outdoor locations. Bales were single stacked approximately 60 cm apart in both storage locations to permit free air circulation. Temperatures of the bales and ambient conditions were recorded every 4 hours for the 12-month storage period.

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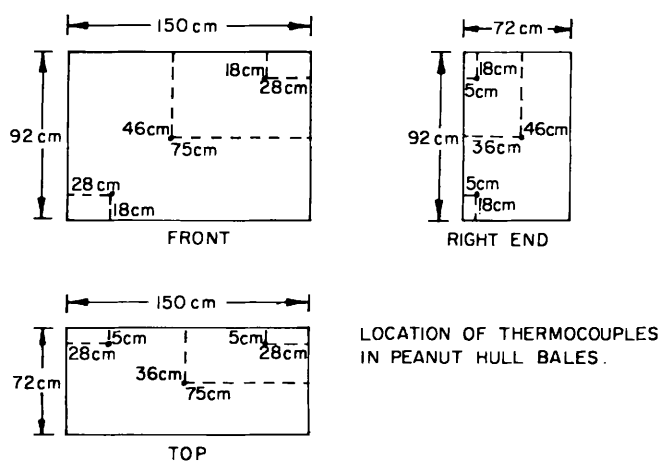

Fig. 1. Thermocouple locations in hull bale.

Results

Baling

Bales of peanut hulls produced by the baler were 74-cm wide by 92-cm high by 150-cm long. Bale appearance was considered very acceptable, although the top of the bale did not look as precise and compacted as the sides and bottom. Bale weights ranged from about 375 to 400 kg and there was a small but detectable difference in density between the top and bottom of the bale. Making a bale required the loading chamber of the baler to be charged several times. Neither the volume nor the weight of each charge was controlled, which probably caused the variation in bale weights. The variation in density was probably due to greater compaction of hulls and more fine hull particles at the bottom of the charge chamber.

Bale density averaged approximately 382 kg/m^3 which was adequate to obtain the 18,000-kg load weight on the 12.2-m flatbed trailer. However, if a greater bale density was needed a larger motor and hydraulic cylinder could be used on the press.

The average production rate of the press was four bales an hour, which was the approximate hull outturn from 7.5 tonnes of Florunner peanuts. Based on a three-man crew and an hourly wage of $3.25, direct labor costs were $6.22 per tonne. Energy costs @8 cents per kWh were 97 cents per tonne. End caps and bale tie costs were $2.56 per tonne. Indirect costs such as depreciation, interest on investment, maintenance, insurance, taxes, etc., must be added to these direct costs. The manufacturers' list price for the baler was $35,000 to $40,000 depending on accessories or modifications desired. Based on a 10-year baler life and shelling 13,617 tonnes of peanuts a year, depreciation costs would be almost $1.10 per tonne of baled hulls. Other indirect costs would probably equal this for a total baling cost of approximately $11.95 per tonne. However, equipping the baler with an automatic bale tie would eliminate the need for one crew member which would lower baling costs to about $10.50 per tonne.

Commercial transportation costs were quoted at $7.05 per tonne for a minimum load weight of 18,000 kg and a maximum distance of 165 km. Using inhouse trucks and drivers would reduce this cost from $2 to $3 per tonne. Depending on the baling and transportation methods used the delivered cost of hulls would range from $14 to $18 per tonne.

Storage

Bales of peanut hulls stored indoors did not undergo any noticeable change during the storage period. The hulls remained new and bright looking and the temperature in the bales did not exceed 34 C. The temperature at the center of the bales was usually one or two degrees higher than at the edge of the bales but the difference was not significant. There was a small loss of hulls from the bales as a result of periodic weighing but this did not affect the appearance of the bales.

The hulls in bales stored outdoors without cover showed rather rapid weathering and discoloration and there was a gradual deterioration in the appearance of the bales. Rain did not visibly appear to penetrate the bales more than a few centimeters but temperatures at the center of the bales (Fig. 2) indicated sufficient moisture transfer to produce internal heating from microbial activity. The heat buildup from microbial activity at the center of the bale was noticeable throughout the storage period but temperatures did not become high enough to cause concern about spontaneous combustion.

The fiberboard end caps on bales stored outdoors were weakened by rain and had a tendency to tear where the bale ties went around them. At the end of the storage period most of the end caps were providing only partial protection to the bales. As a result hulls flaked off the corners and in one instance was bad enough to loosen the top bale tie. Since the bales were stored singly the maximum amount of deterioration occurred. However, the bales could still be handled without difficulty and the hulls were useable for fuel or any other purpose where weathering and discoloration of hulls on the outside of the bales was not a consideration.

Discussion

The bales of peanut hulls were not subjected to excessive or severe handling treatment in these tests. In commercial operations it is very likely that more severe handling would be encountered, particularly in subjecting bale corners to impact forces during stacking. This could cause the corners of some bales to slough out. This could be a severe problem, and an end cap that covered the corners might be needed to prevent this.

Wire bale ties were not considered the most desirable type, particularly if the hulls were baled for fuel purposes. A few inquiries were made concerning bale ties of other types of materials, but no information was available on the kinds and amount of combusion gases that might be emitted. However, finding a satisfactory bale tie for a particular application should not be too difficult.

In this investigation, bales were stored approximately 60 cm apart. This permitted essentially unrestricted air circulation around them, but it also permitted faster deterioration of the bales stored outdoors without cover. In outdoor storage a close stack several bales high would have restricted air circulation which might increase the chance of spontaneous combustion. At the same time the top and outside stacks should protect the inner stacks from rain and thus prevent heat buildup from microbial activity. Bale deterioration should also be much less in a large stack and a plastic cover over the top of the stack

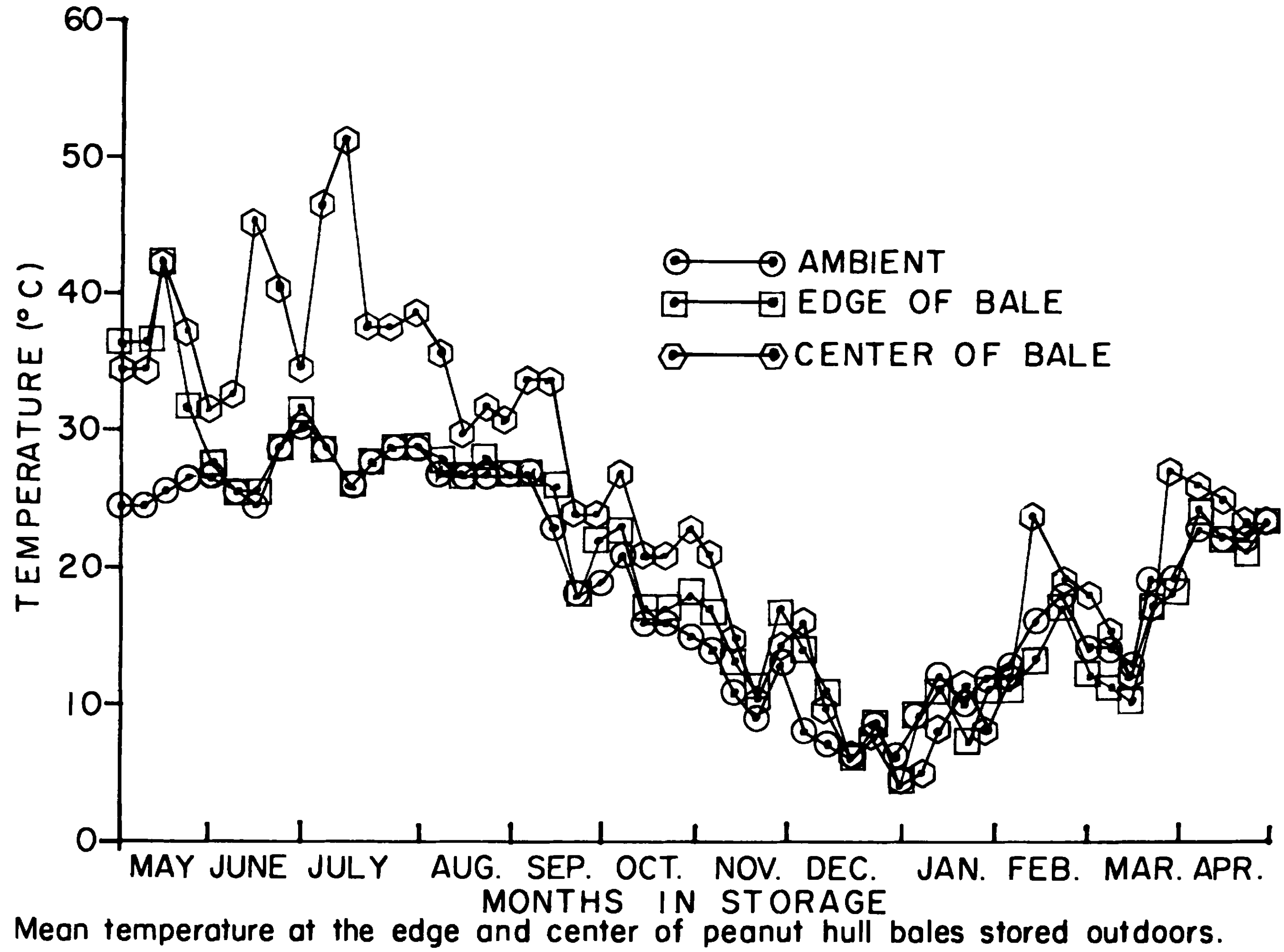

Fig. 2. Mean temperature at edge and center of hull bales stored outdoors.

should provide even greater protection. Further work is planned to investigate conditions and methods needed to protect and preserve hull appearance under outdoor storage conditions.

One of the most promising markets for mill run peanut hulls appears to be for use as a fuel. The heat value of peanut hulls has been determined to be 4365 calories per gram (7863 BTU per pound) (3). The average heat value for natural gas, coal and fuel oil is 5564, 6938 and 10,546 calories per gram (10,000, 12,500 and 19,000 BTU per pound), respectively (4). Based on heat value coal is the least expensive fuel of the three and currently costs about $60 per tonne. Peanut hulls would be a comparable value at a delivered price of $38 per tonne.

Conclusion

Compacting and baling mill run peanut hulls to obtain more economical transport and storage did not present any particular difficulty. Methods and equipment used in this investigation can be used in commercial applications. Each proposed installation must be considered individually to determine whether it would be an economically feasible method of hull disposal. However, the acceptable economic considerations of hull disposal would differ very widely from plant to plant, i.e., a plant that has no hull markets and is paying the average cost of $3 to $4 per tonne to dispose of hulls would probably consider compacting and baling to supply a no-profit market just to eliminate the disposal cost; and a plant that already has a market which permits them to sell hulls at a profit would probably require a market with a much greater profit potential before investing in compacting and baling equipment. Under these widely varying conditions the potential profit would be 0 to $20 per tonne if hulls were sold at a competitive price for fuel.

Acknowledgements

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