MAXIMIZING THE RECOVERY OF DRY KERNEL AND SHELL VIA A FOUR-STAGE WINNOWING COLUMN

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Palm kernel is a secondary product generated from palm oil mills. In a conventional kernel recovery plant, the separation of kernels and shells is carried out using a combination of a dry and wet separation system. The cracked mixture which consists of kernels and shells is separated partly by a winnowing column and partly through a hydro-cyclone or a clay bath. The commercial dry separation system uses either force or induced draught. The wet technique is considered less environmental-friendly as it requires a large volume of water and clay which contribute towards a high production volume of waste effluent.

With aims to maximize the recovery of dry kernels and shells, to improve kernel quality as well as to reduce the amount and impact of clay and water used for wet separation on the environment, MPOB in collaboration with Hur Far Engineering Works Sdn Bhd (HF) and FELDA Palm Industries Sdn Bhd (FPISB) has successfully developed an efficient kernel and shell separation system via a four-stage winnowing column (*Figure 1*). This invention follows the success story of the Rolek Palm Nut Cracker that has a consistently high cracking efficiency and produces a superior quality of the cracked mixture. The efficient and proper dry separation of kernels and shells from the cracked mixture can be achieved provided that the cracked mixture which is fed into the system has superior quality and particles of uniform size.

Figure 1. The four-stage winnowing column.

TECHNOLOGY

This invention relates to a specially designed winnowing system to improve the present separation efficiency of the cracked mixture from the mills. A dry separation system is used to separate a mixture of kernels and shells (cracked mixture) derived from the oil palm nuts after cracking.

The dry separation system consists of a series of equipment: a four-stage winnowing column, a cyclone, a blower fan, an air lock and an auger. Each column was designed with different parameters (*e.g.* air velocity, fan speed, column height, inlet and outlet levels, feeding ratio, *etc.*) in order to achieve the desired shell and kernel ratio separation at each outlet point. The four-stage winnowing column uses the air blowing principle instead of suction air whereby the air flow velocity is adjusted via the blower (damper) located at ground or an elevated level. This approach simplifies the process and ensures ease of control, as well as possesses the ability of eliminating the effluent generated from the wet separation system.

The system is also equipped with a unit of a small vibro clay bath to minimize the kernel losses by recovering the very fine kernel pieces generated from the screw press. The presence of this mini clay bath depends on the mill's requirement and the capability of the mill to recover the broken kernels generated from the screw press. If most of the broken kernels can be recovered at the polishing drum, then it is not necessary for the mini clay bath to be installed.

The process flow diagram of the system and a description of the process system are illustrated and summarized in *Figure 2* and *Table 1*.

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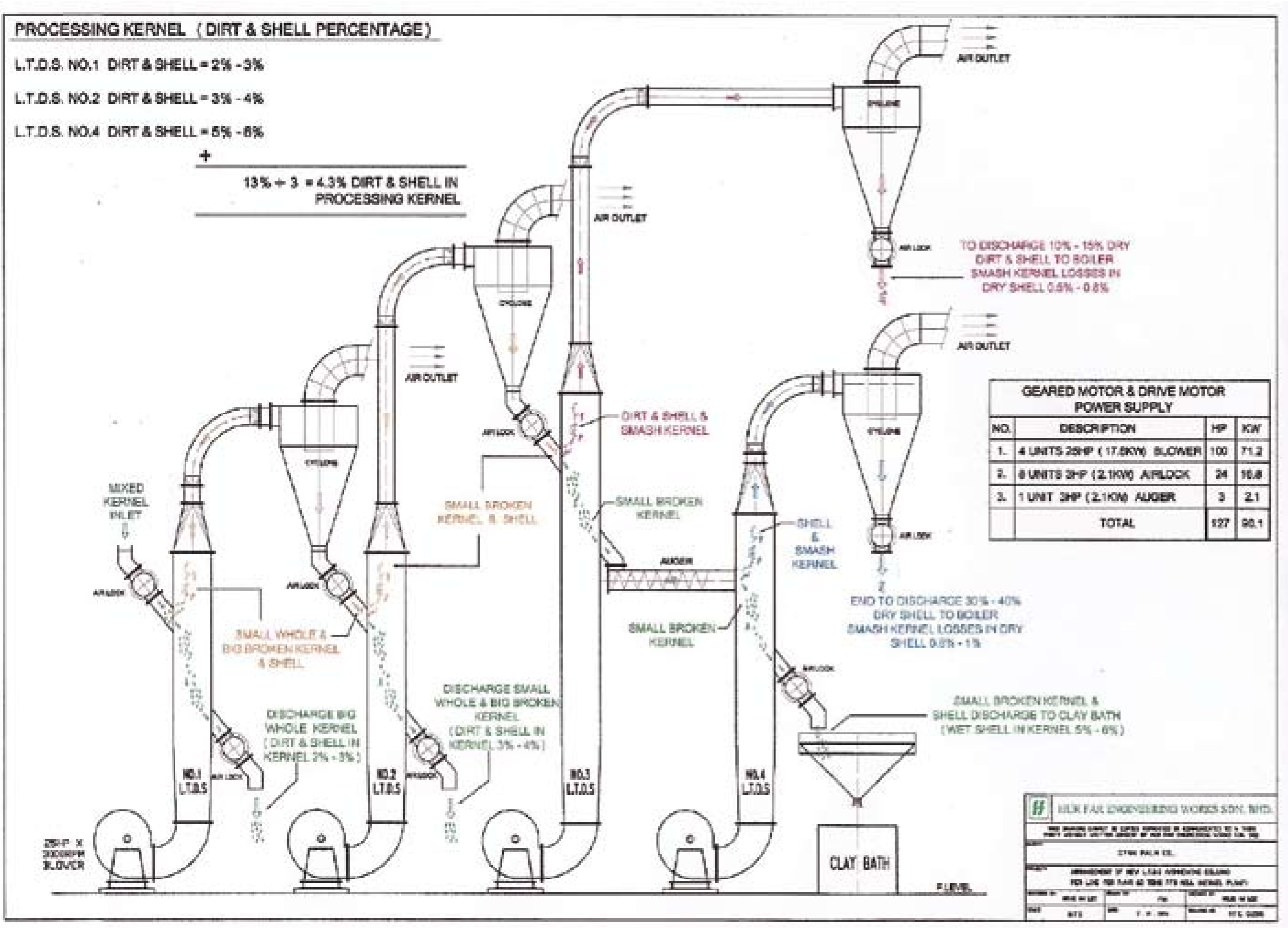

Figure 2. Process flow diagram of the four-stage winnowing column.

TABLE 1. PROCESS DESCRIPTION OF EACH WINNOWING STAGE

Stage/ Column	Process parameters and description
1	• Fan speed: 2950 rpm • Fan air inlet damper: 31 amps (3300 CFM) • % of recovery: whole kernels (15%-20%), dirt and thick shells (2%-3%) • Overhead products (shells and kernels) to Stage 2
2	• Fan velocity: 2740 rpm • Fan air inlet damper: 30 amps (3200 CFM) • % of recovery: small whole kernels (15%-20%), big broken kernels (8%), dirt and shells (3%-4%) • Overhead products (shells and small broken kernels) to Stage 3
3	• Fan speed: 2530 rpm • Fan inlet damper: 22 amps (2350 CFM) • % of discharge: light shells (30%-40%) • % of kernel losses in dry shell: 0.3%-0.6%
4	• Fan speed: 2530 rpm • Fan inlet damper: 22 amps (2350 CFM) • % of discharge: light wet shells from the clay bath (5%-6%), dry shells (10%-15%) • % of kernel losses in dry shell: 0.3%-0.7%

The quality of the dry kernels and shells discharged from each winnowing column is shown in *Figure 3*.

Big whole kernels from Column 1

Whole and broken kernels from Column 2

Small shells and small broken kernels from Column 3

Big shells and small broken kernels from Column 4

Figure 3. Quality of dry kernels and shells from the winnowing column.

ADVANTAGES OF THE SYSTEM AND COMMERCIAL BENEFITS

Based on the commercial performance evaluation of the system carried out in a palm oil mill of FPISB for nine months, the commercial benefits and advantages that can be derived from the system are as follows:

1. Reduction in total kernel losses of dry and wet shells.
    - 2.03% compared to 3.0%.
2. Increment in the kernel recovery rate (KER) of the mill.
    - Increment of up to 0.3% in KER with acceptable dirt and shell content and kernel losses.
3. User-friendly system – with adjustable flap controller and digital amps reading.
    - Ease of adjusting the air flow rate – depending on the quality of cracked mixture and throughput variation.
    - Any changes in amps reading or abnormalities in the product specifications can be fixed with an adjustment of the adjustable flap and digital controllers (*Figures 4* and *5*).
4. Low maintenance cost.
    - RM 0.03 t^{-1} fresh fruit bunch (FFB) compared to RM 0.09 t^{-1} FFB in the conventional system.
5. Reduction in clay consumption.
    - 2.18 kg of clay t^{-1} FFB compared to 3.03 kg t^{-1} FFB.
6. Low electricity requirement – power savings.
    - Uses only 185 kW compared to 203 kW in the conventional system.
7. Space saving.
    - Compact design that is suitable for installation in the existing kernel plant (retrofitting).

8. Amount of cracked mixture for wet separation is reduced from 80% to 30%.

    - Most of the separation is carried out by the dry separation system.

9. Generates more dry shells for fuel.

    - Dry shells are used as boiler fuel or sold to the nearby factory as a renewable fuel at RM 110 t^{1}.
    - Dry shells which are free from clay can reduce clinker formation in the boiler.

10. Savings in operational cost.

    - Eliminates or results in less dependent on the clay bath/hydro-cyclone system, thus reducing the use of clay and water as well as the amount of effluent discharge and treatment cost.

11. Flexible and variable throughput capacity.

    - Able to cater for high throughput (cracked mixture), up to 11 t hr^{-1} (90 t hr^{-1} FFB) – suitable for future mill expansion.

Figure 4. Adjustable damper controller.

Figure 5. Digital control panel.

ECONOMIC ANALYSIS

The investment cost for a standard unit of the four-stage winnowing column with a mini clay bath system is estimated at RM 700 000. In order to eliminate the use of the mini clay bath, a single-stage winnower to recover broken kernels from the polishing drum is proposed for installation at a cost of RM 230 000.

The annual increment in kernel recovery and savings from the use of the system is estimated at RM 871 000. This is from the increment in KER, reduction of the amount of clay used and in kernel losses, a saving in power consumption, recovery of broken kernels as well as a reduction in maintenance cost of the kernel recovery plant. From this saving, the payback period of the technology was estimated to be within 1.5 years.

INTELLECTUAL PROPERTY AND COMMERCIAL LICENCES

- A Malaysian patent application (No: PI 20085278) has been made for the four-stage winnowing column system aimed at efficient kernel and shell separation.
- This intellectual property is jointly owned by MPOB, FPISB and HF.
- The technology is licensed to HF.

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