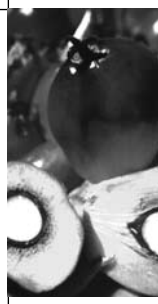
Feature Article



Rolek Nut Cracker - FELDA's Experience

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ABSTRACT

Palm kernel is a secondary product of the palm oil milling process contributing to about 5%–7% of the total fresh fruit bunch processed. Its recovery process involves cracking of nuts and separating it from shells and other particles. Good and efficient recovery process will result in optimum kernel extraction rate (KER) as well as consistent quality of the palm kernel.

This requires good and reliable nut crackers that are able to achieve consistent high cracking efficiency and quality cracked mixtures for efficient separation of kernel and shell. Realizing these needs, FELDA Palm Industries Sdn Bhd (FPISB), has adopted Rolek Palm Nut Cracker (Rolek) as a main cracking unit in its kernel recovery station. Commercial trials of Rolek in FPISB mills were started back in year 2004 in collaboration with Malaysian Palm Oil Board (MPOB).

To date, more than 140 units of Rolek have been installed in more than 60 mills of FPISB. From the performance evaluation of Rolek, it shows that Rolek has consistently achieved high cracking efficiency of palm nuts (>98%) including tenera *and* dura *for a comparatively long duration of time. The cracked mixtures produced from Rolek are small and uniform in sizes with low percentage of broken kernel. This superior quality of cracked mixture facilitates an efficient dry separation of shell and kernel via winnowing column which later improve KER of mills. The use of Rolek also contributes to the significant reduction in maintenance cost and down time. This article describes the technical performance and economic benefits of Rolek operated in FPISB mills.*

INTRODUCTION

Over the years, the palm nut cracker has departed from its original principle of centrifugal throwing machines to a concept of squeezing and rubbing effect, *i.e.* ripple mill. Due to the highly abrasive nature associated with cracking materials such as stones, foreign metals and variation in shell thickness, many crackers are not able to sustain and perform as expected for a long duration. The cracking becomes more difficult due to variation in nut sizes especially when the palm estate practices progressive replanting.

The experience with Rolek started when MPOB approached FELDA to conduct commercial trial for the newly developed nut cracker. For FELDA, the most suitable place to try out this new product is at Tenggaroh Palm Oil Mill. This mill has the toughest nut cracking job due to the presence of thick

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shell *dura* nuts, which constitute up to 25% of the total nuts produced.

DESIGN AND WORKING PRINCIPLE OF ROLEK CRACKER

The first version of Rolek cracker is shown in *Figure 1*, where each of rotor and stator assembly has three and two concentric rods fitted. The stator is lined with wear plate made of high wear resistance material. The small and medium size nuts are cracked between the rods while the bigger ones may hit the body liner before cracking. However, the rotor is too heavy while components are subject to very fast wear and tear.

The final version of Rolek is shown in *Figure 2*. Its rotor is now fitted with sleeved rods while the body is also fitted with wear liner plates. When nuts enter the cracker, it will line up between the sleeved rods and cracking will take place when the rotor and stator interact.

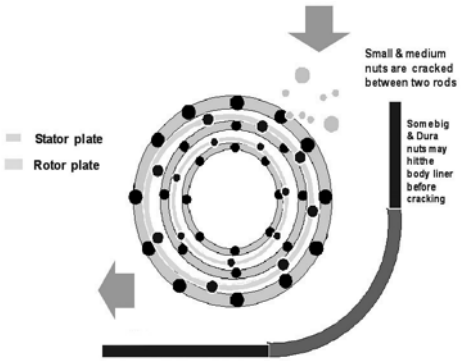

Figure 1. First version of Rolek.

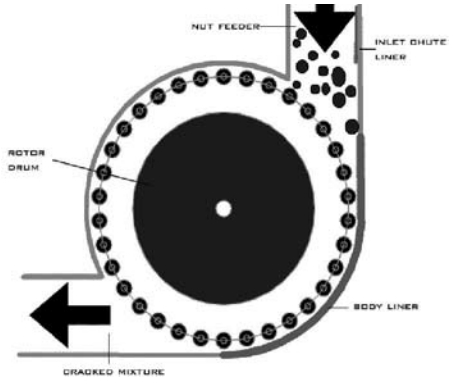

Figure 2. Final version of Rolek.

Expectation and Performance Benchmarking

The commercial trials conducted on Rolek were made with the following expectations:

- the cracker must be able to perform consistently at above 98% cracking efficiency for long durations;
- must be able to facilitate good separation process, capable of producing kernel with acceptable dirt content and minimum losses;
- ease of maintenance and able to reduce the labour as well as its cost;
- improvement in kernel extraction rate;
- consistent throughput with acceptable reliability and durability; and
- kernel breakage below 10%.

For comparison and evaluation purposes, the following performance parameters have been set for monitoring and benchmarking (*Table 1*).

Trial Run and Monitoring Activities

The implementation and monitoring activities carried out during the trial run programme are summarized in *Table 2*.

Test Result and Analysis

Summary of the performance data collected from January to June 2005 from Tenggaroh Palm Oil Mill is shown in *Table 3* while the performance of other cracker for the period of July to December 2004 is shown in *Table 4*.

The results of both nut cracker performances can be summerized as follows:

- the cracking efficiencies for both crackers are good being consistently above 98%. However, performance by the Rolek is slightly higher at an average

TABLE 1. PERFORMANCE BENCH-MARKING

Parameter	Existing cracker	Rolek cracker
Cracking efficiency	>98%	>98%
Broken kernel	15% - 22%	<10%
Uncracked nut	0.5% - 1.5%	<1.2%
Half cracked nut	1% - 2.5%	<2%
Throughput	2.3 tph	4 - 5 tph
Component life span (min)	200 hr	400 hr

Note: tph – tonnes per hour.

TABLE 2. TRIAL RUN OF ROLEK CRACKER AT TENGGAROH PALM OIL MILL

Date	Activities	Supervision
Early December 2004	MPOB introduced Rolex Nut Cracker to FELDA	MPOB, Technical Services Dept., mill and contractor
December 2004	First machine installed in Line A, Tenggaroh Palm Oil Mill	MPOB, Technical Services Dept., mill and contractor
January 2005	Second Machine installed in Line B, Tenggaroh Palm Oil Mill	MPOB, Technical Services Dept., mill and contractor
February 2005	Data collected for 3 months	MPOB, Technical Services Dept., mill and contractor

TABLE 3. PERFORMANCE OF ROLEK CRACKER

Parameter	Year 2005							
	Limit	Jan	Feb	Mar	Apr	May	June	Ave
Losses LPTS (by line)	< 2.5	0.31	1.31	0.95	0.36	1.05	0.94	0.82
Broken	< 10	8.42	8.26	8.7	11.17	9.12	8.15	8.97
Half crack nut (%)	< 2%	1.00	1.20	1.07	0.94	1.05	1.80	1.18
Whole kernel (%)	30-48	32.04	32.82	32.87	34.12	32.67	33.16	32.95
Cracking efficiency (%)	> 98	98.52	98.61	98.61	98.65	98.95	98.20	98.59

TABLE 4. PERFORMANCE OF EXISTING CRACKER (2004)

Parameter	Year 2004							
	Limit	July	Aug	Sept	Oct	Nov	Dec	Ave
Losses LPTS	<2.5	1.36	1.21	1.31	0.99	0.86	0.95	1.11
Broken	<10	10.01	9.21	9.75	8.05	9.36	9.11	9.25
Half crack nut (%)	<2%	2.45	1.49	1.94	1.84	1.42	0.92	1.68
Whole kernel (%)	30-48	30.06	29.2	31.74	30.53	29.88	32.01	30.57
Cracking efficiency (%)	>98	98.08	98.51	98.06	98.16	98.09	98.23	98.19

of 98.59% compared to the existing cracker at an average of 98.19%;

- the good cracking efficiency achieved by Rolek is also reflected in the low partially cracked nut at 1.18%;
- in terms of whole kernel percentage, the average figure achieved by Rolek at 32.95% is within the target limit and this is also slightly better than that achieved by the existing cracker at 30.57%; and
- the kernel loss in the winnower is well below the limit of 0.82%.

Latest survey on the performances of Rolek cracker installed in other four mills namely Maokil Palm Oil Mill (Segamat), Lepar Hilir Palm Oil Mill (Kuantan), Umas Palm Oil Mill (Tawau), and Keratong 9 Palm Oil Mill (Muazam Shah) on the cracking efficiencies and percentage of kernel breakage which use final version of Rolek are shown in *Figures 3* and *4*.

Results show that the cracking efficiency and percentage of broken kernel are all within the targeted limits and are very consistent. The quality of cracked mixtures produced by the Rolek crackers also met the performance bench-marks set earlier.

PALM KERNEL EXTRACTION RATE AND QUALITY OF PRODUCTION

The achievement of kernel extraction rates by various mills using Rolek cracker are considered good, which are in the range of 5% to 6% as shown in *Figure 5*. The cracker has helped to improve kernel quality in our mills especially the dirt content. *Figure 6* shows that the dirt content has been maintained at an average of 4.31% for the year 2007 with more introduction of Rolek.

Maintenance of Rolek Cracker

Another aspect of monitoring conducted during the trial period is on the wear rate of the Rolek components to determine the economical life span, maintenance workload and its costs.

The results show that the carbon steel rotor rod sleeves of the Rolek cracker had a life span of more than 700 hr as compared to the similar part of the other cracker of 200 hr. The body liners lasted up to 400 hr equal to that of the jaw plate achieved in other cracker. With the lower wearing rate of its components, Rolek has able to achieve a lower maintenance cost at RM 0.10 t^{-1} FFB which is RM 0.04 cheaper than the existing cracker.

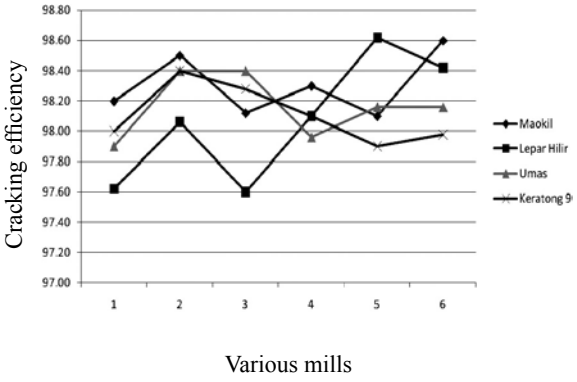

Figure 3. Cracking efficiency of Rolek crackers for various mills (2008).

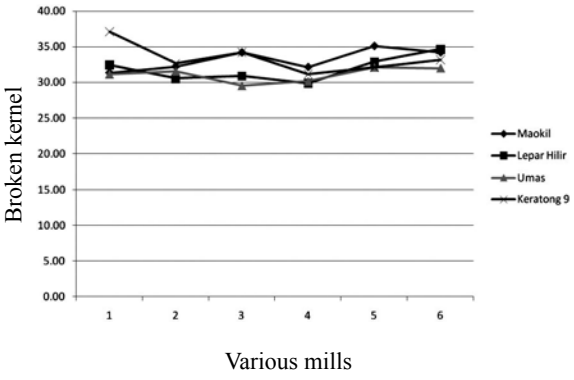

Figure 4. Whole kernel percentage of Rolek crackers for various mills (2008).

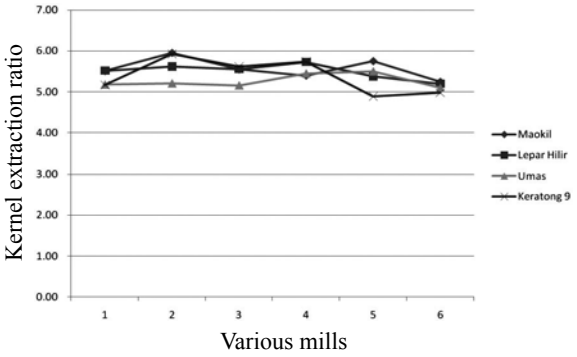

Figure 5. Kernel extraction rates for various mills 2008.

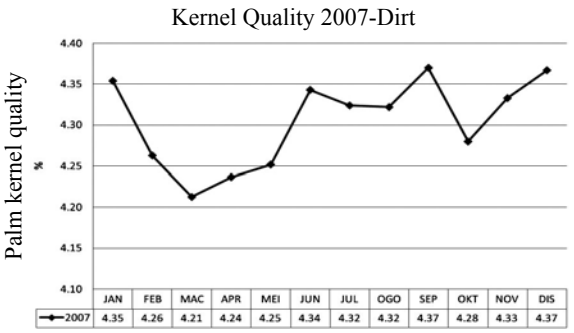

Figure 6. Palm kernel quality (2007).

The longer life span of the components has reduced the work-load of the maintenance staff up to certain extent. This reflected by the lesser need to open up the cracker not like before which was on every three days or whenever the performance deteriorated. When Rolek was installed this has been reduced and only arises after two weeks or more of operation.

The annual maintenance cost for various mills shown in *Table 6* indicate that the cost achieved by Rolek at RM 0.13 t^{-1} FFB is comparatively lower than the other cracker at RM 0.19 t^{-1} FFB.

COMMERCIAL BENEFITS OF ROLEK CRACKER

- The prominent benefits of this cracker are the consistency in the cracking efficiency, reduction in the percentage of kernel breakage, increase in the whole kernel percentage and uniformity in the cracked mixture produced. These have led to easier and better control of the separation process resulting in losses being kept to minimum, contributing to a better kernel extraction rate. The reduction in kernel loss of up to 0.29% at the winnower system obtained during this commercial trial is definitely giving some positive effects on mill kernel extraction rate.

- Longer life span of the rotor part which last up to 400 hr has helped lessen the burden of the maintenance crew as the maintenance interval now could be extended by double. Maintenance works are much easier, as for example, there is no need to carry out rebuilding of stator surface since the body liner life span is quite lasting and much faster to replace.

TABLE 5. MAINTENANCE ACTIVITIES FOR THE ROLEK CRACKER AT TENGGAROH PALM OIL MILL

Maintenance activity	Rolek nut cracker	Other nut crackers
Change inlet chute liner	200 hr	Not applicable
1st body liner	400 hr	Not applicable
2nd body liner	600 hr	Not applicable
Carbon steel sleeves	700-1 000 hr	200 hr
Remove fibre (magnetic trap)	Every 2 hr	Every 2 hr
Jaw plate	Not applicable	400 hr
Housing	Every month	Every month
Bar rod	Not applicable	200 hr
Maintenance cost	RM 0.10 t^{-1} FFB	RM 0.14 t^{-1} FFB

TABLE 6. THE ANNUAL MAINTENANCE COST OF NUT CRACKERS FOR VARIOUS MILLS

Palm oil mills	Rolek (RM t^{-1})	Other cracker (RM t^{-1})
Penggeli	0.19	0.52
Tenggaroh	0.23	-
Belitung	0.04	0.06
Wa Ha	-	0.15
Maokil	0.05	0.03
Average	0.13	0.19

- The reduction in wear and tear of the machine parts not only reduces the maintenance cost up to RM 0.05 t^{-1} FFB but also help the cracker to sustain its performance for a longer period.

OPERATIONAL ASPECT OF ROLEK CRACKER

Rolek cracker has shown its reliability and good performance during the trial or after being fully commercialized as shown by the marked increase of units installed in FELDA mills. However, certain aspects of the Rolek cracker need to be understood so that when any mill wants to install and use, it will get maximum result.

- The rotor stator clearance is fixed in this cracker, which may create a problem when dealing with highly variable sizes of nuts especially with size below 8 mm. Optimization can be made by selecting a correct pulley size to vary the cracker speed. For

mills having big size nuts of above 15 mm or having *dura* of 25% to 50% the best pulley size to use is either 160 mm or 180 mm (6.5 or 7 inches). Rolek also has models suitable for variable nut sizes provided there is nut grading screen available.

- The machine needs initial running of 100 hr to smoothen the internal surfaces before final adjustment for throughput and cracking efficiency can be properly carried out.

- For milling operation up to 30 t FFB hr^{-1}, one unit Rolek is able to cope with the quantity of nut produced. Basing on nut to FFB of 15%, this translates into 4 - 5 t hr^{-1}. However, this might be reduced if operated for efficiency above 98% and the breakage below 10%.

- Proper sterilization and digestion is needed to ensure clean and well polished nut. This is to prevent fibre from going into the cracker which gives the cushioning effect leading reduced throughput and may cause chokage.

- The cracker is supplied with rotary airlock and magnetic trap at the feeding chute. Cleaning of this chute and trap should be done regularly at 1 hr to 2 hr interval.

- Regular maintenance of the air-lock, inlet chute and other components to be carried out according to the supplier's recommendation. Rebuilding and resurfacing of the wearing parts are not recommended as this will affect its performance badly.

CONCLUSION

The results obtained during the trial period as well as for the units currently in operation show that Rolek machines are found to be the most reliable machines so far for the nut cracking job in FELDA mills. The machines are not only reliable in term of performances but also highly durable. It does not require rigorous maintenance, which means lesser work-load and cheaper maintenance. There is no doubt that the cracker has contributed to improvement of our kernel quality and helps to optimize the kernel recovery in our mills. However, to ensure uninterrupted operation and longer life span of the machine components, proper destoner system and magnetic trapping are needed.

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