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OIL SEED PROCESSING TECHNOLOGY IN PAKISTAN
Part –VI. Design Improvements in Oil Expeller

DIN MOHAMMAD AND SHAFIQ AHMAD KHAN

PCSIR Laboratories Complex, Lahore - 54600, Pakistan

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Further modifications have been effected in the design of the previously modified expeller 4" (Model-1) by enlarging the screw length (from 11" to 16"), feed worm pitch and optimizing the slots of the drainage barrel (Model-2). Consequently a smooth operation of the expeller has been achieved with enhanced performance and free from the screw jamming problem. The case hardening of most wearing parts of expeller was carried out by simple pack hardening carburizing process to increase their life three times as compared to the existing practice.

Key words: Modified expeller, Drainage barrel, Case hardening, Screw assembly.

Introduction

An oil expeller essentially has a horizontal main worm shaft, which carries the worm assembly consisting of a series of hardened worm sections with spaced rings and decreasing pitch towards the discharge end of the assembly. The screw or worm is rotated inside a cylindrical cage with a minimum clearance.

A barrel normally consists of an axially placed lining or barrel bars contained within a horizontally split frame. The bars are locked in the cage frame and spaced apart by shims or spacers of different sizes provided at the feed and discharge ends of the cage. The slots are more open at the feed and less so at the discharge end of the cage for efficient oil flow during expression. Optimization of slots is necessary as on being narrow they cause the expressed oil to rotate inside the cage affecting the forward push of the cake and when too open heavy foots are produced alongwith the expelled oil. The expeller is always provided with a choke mechanism at the screw assembly end to regulate the cake thickness.

The worm sections are so arranged that volume displaced at the feed end is considerably greater than at the discharge end. The first feed worm has the largest pitch and it gradually decreases in the discharge end of the cage facilitating the conveyance of the material from the feed to the discharge end with successive pressure increase for better oil flow through the slots.

Rapid wearing of the cage lining bars after a short operational period resulted in heavy foots' production, decreased processing capacity, oil extraction rate, increase energy consumption and repair time and costs were some of the draw backs in the previously modified small oil expeller-4" size [1]. This demanded improvements in the basic design and material of construction have been effected to develop an efficient expeller (Model-2). The main design features of the expeller Model-2 described in this report, in continuation of the earlier studies on improvements in the village level oil seed processing technology in Pakistan [2-6] are: (i) Increased chamber length from 11" (Model-1) to 16" (Model-2). (ii) Increased feed worm pitch. (iii) Optimization of the drainage barrel slots. (iv) Case hardening of the most wearing parts of expeller by an improved method.

Experimental

An expeller, chamber length 16" (Model-2) compared with previously modified expeller chamber length 11" (Model-1) was designed, fabricated and tested on rapeseeds. Six screw configurations were also designed and tested as listed in Table 1 to determine the best performing configuration. All screw configurations were tested at 57 rpm for comparison purposes. The optimum spacing openings for better oil expression were also determined and the results are given in Table 2. The expeller (Model-2) was operated by an electric motor (10 H.P., three phase, 440 volts, 950 rpm) and is illustrated in previous Part-V (Fig. 2) and the drawings of the enlarged configuration are provided in Fig.1. The oil seed processing results of the expeller Model-2 (16") are shown in Table 3 and comapred in Table 4 with expeller Model-1 (11") illustrated in previous Part-V (Fig. 1). The most wearing parts of the expeller, the worm sections, rings, cone and iron bars were case hardened both by the traditional [7] and the improved carburization procedure [8]. The latter (layer thickness 0.5 mm) was preferred over the former (layer thickness 0.015 m) for use in expeller Model-2.

Results and Discussion

The traditional (4" size) expeller was earlier constructed in 11" cage length with a screw assembly of 4 separate

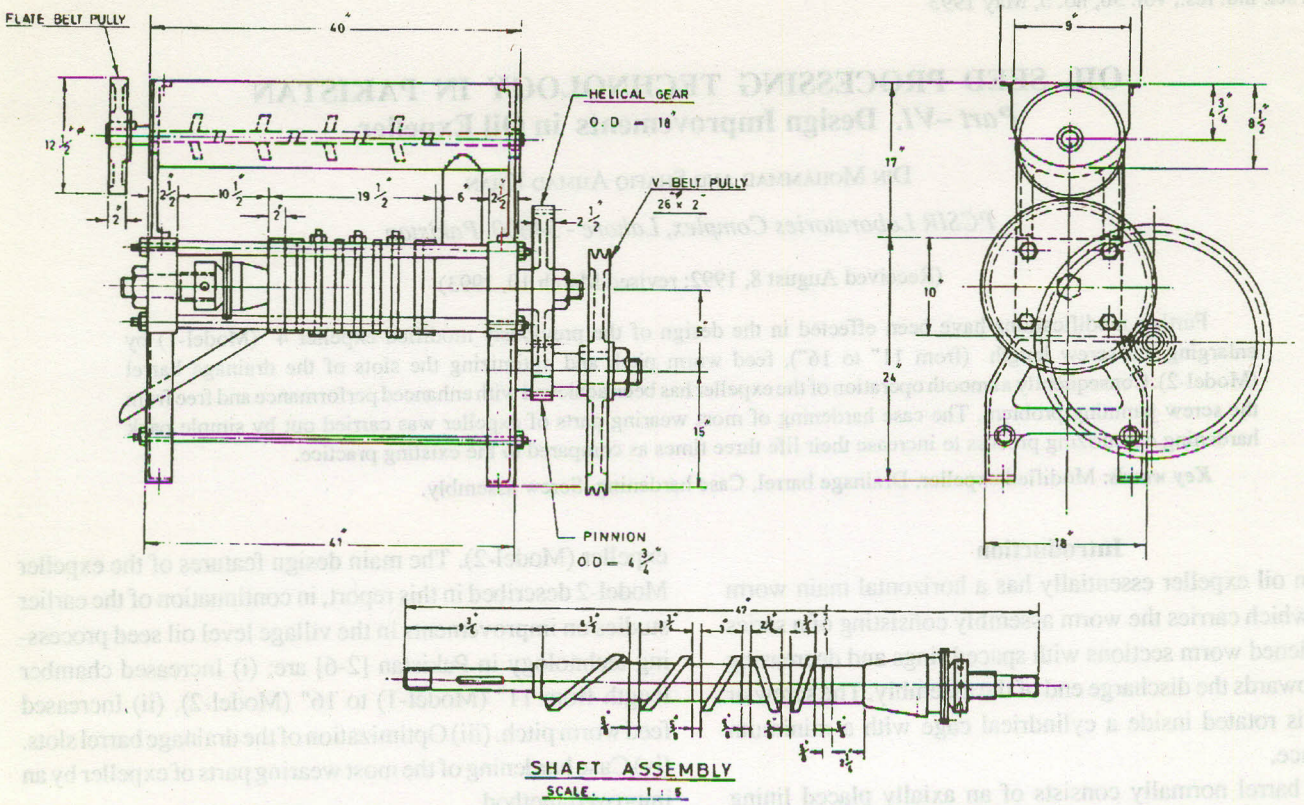

Fig. 1. Modified oil expeller 4" x 16".

sections. The section lengths were in order of 6.5, 3.0, 2.75 and 1.75 inches while the respective pitches were 4.0, 3.0, 2.75 and 1.75 inches. This expeller was previously modified (Model-1) by the addition of a reverse worm (length 1.75" pitch 1.75") preferably at the 2nd last or last position of the screw assembly (Fig. 1). It was successfully field operated with an electric motor (10 H.P. three phase, 440 volts, 950 rmp) and showed performance improvements compared to the traditional expeller [1].

The increase in chamber length to 16" in present expeller (Model-2) is the major modification. However, screw modification was also affected by increasing the pitch of the first or feed worm 4" – 5" in order to improve the feeding of material. In the process six screw configurations were designed and studied to optimize the performance and obtain a smooth operation. The first two configurations, without spaces, were unable to produce high pressure, yielded high residual oil in cake (11-13%), increased rotational movement of the material being crushed and reduced axial push. Under ideal conditions the flow of material is required to be purely axial for efficient working of the expeller [9].

When the last worm was reversed (configuration No. 3, Table 1) the jamming problem was encountered due to generation of abrupt heavy back pressure before the reverse worm. The last two configurations (Nos. 5 and 6) also failed to provide satisfactory results due to the same problem. The best performance was, however, shown by the configuration No. 4 (Table 1). The selected screw configuration was constituted by 5 worms 6.5, 3.75, 3.0, 2.25 (reversed) and 1.7 inches in length, having pitches in the respective order of 5.0, 3.0, 2.25, 1.25 (reversed pitch) and 1.5 inches with spacers (0.625") in between each worm section.

For a smooth operation, optimum spacings at the feed and the discharge ends, are highly important. Observations were, therefore, made with various spacings created by the help of iron shims and the results are produced in Table 2. Optimum results with smooth operation were obtained by using 22 or 21 guage clips at the feed end and 24 gauge at the discharge end. These modifications considerably increased the performance of the expeller Model-2 as given in Table 3.

The use of proper size spacers between the worm sections played an important role in grinding the seeds to a better fineness and rupturing the cell sacs to liberate oil rapidly.

The free space between the last worm of screw configuration and the discharge cone was of crucial importance and it was optimized to 2" in the present case. It was observed that increasing the distance beyond 2" produced heavy pressure in the drainage barrel and the machine stopped due to jamming of the material. Decreasing the distance below 2" produced low pressure and reduced oil extraction rate (Table 1).

TABLE 1. SCREW CONFIGURATION.

Screw confg.	Feed or Ist worm		2nd worm		3rd worm		4th worm		5th worm		6th worm		Remarks
	L	P	L	P	L	P	L	P	L	P	L	P	
1.	6.5	5.0	3.75	3.0	3.0	2.5	2.25	2.0	1.75	1.5	1.75	1.5	Poor oil extraction
2.	6.5	5.0	3.75	3.0	3.0	2.5	2.25	2.0	2.25 (Rev.)	2.0	1.75	1.5	Poor oil extraction
3.	6.5	5.0	3.75	3.0	3.0	2.5	2.25	2.0	1.75	1.5	2.25	2.0	Screw jamming problem
4.	6.5	5.0	3.75	3.0	3.0	2.5	2.25 (Rev.)	2.0	1.75	1.5	(Rev.)	–	Smooth operation
5.	6.5	5.0	3.75	3.0	2.25	2.0	3.0	2.5	1.75	1.5	–	–	Not worked
6.	6.5	5.0	3.75	3.0	3.0	2.5	1.75	1.5	2.25 (Rev.)	2.0	–	–	Heavy back pressure and machine jamming

Note: First three configurations constituted without spacers. The last three configurations constituted with spacers in between each worm sections (0.625)"; L = Length; P = Pitch.

TABLE 2. COMBINATION OF STRIPS TO PROCURE SLOTS IN DRAINAGE BARREL.

Strip combination	Feed end (clip guage)	Discharge end clip (guage)	Remarkss
Ist	26	26	Working stopped
2nd	24	24	Heavy foots
3rd	24	28	Frequent clogging
4th	24	30	Unsmooth operation
5th	22	24	Very smooth operation
6th	20	30	Frequent clogging
7th	18	30	Heavy foots

TABLE 3. PERFORMANCE OF EXPELLER MODEL-2 USING RAPESEED.

Characteristics	Range	Average
Capacity (kg/hr)	65-75	70
Oil extraction rate (%)	34-39	36
Residual oil in cake (%)	7-8.3	7.4

A 10 H.P. unit was used, with an energy consumption of 96 watts/kg seed, and an average repair and maintenance of 1.6 Paisa/kg seed.

TABLE 4. COMPARISON OF EXPELLER MODEL-1 AND MODEL-2 ON RAPESEED.

Characteristics	Expeller Model-1	Expeller Model-2
Capacity (kg/hr)		
(i). Range	37-60	65-75
(ii). Average	50	70
Oil extraction range (%)		
(i). Range	30-60	34-39
(ii). Average	35.3	36.0
Residual oil in cake (%)		
(i). Range	7.0-8.5	7.0-8.3
(ii). Average	7.5	7.0
Cycles	3-4	3-4
H. P	10	10
Energy consumption	112 wh/kg seed	96.0 wh/kg seed
Repair & maintenance	2 Paisa/kg seed	1.6 Paisa/kg seed

With these modifications/improvements expeller Model-2 provided optimal performance as compared to expeller Model-1, when both were operated under identical conditions (Table 4). Comparison of the two worm assemblies indicated that Model-2 had 40% increased processing capacity compared to Model-1 with a concomitant energy saving of 14.3% and increased oil yield (Table 4). Even repair and maintenance charges were lower for Model-2 compared to Model-1.

The life expectancy of the more wearing parts of expeller was increased three folds by treating these parts with a simple pack-hardening/carburizing process. These results were obtained during field testing on the two machines.

It is, therefore, concluded that the introduction of modified expeller Model-2 units at the village/town level, permitted larger quantities of oil seeds to be processed with energy and time savings and more trouble free expeller. This expeller is presently being field tested for processing of soft as well as hard oil seeds. The operational parameters for these processings of the modified expeller (Model-2) will be communicated latter.

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