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Techno Economically Viable Production Package of Rotavator Blade for Entrepreneurs

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ABSTRACT

In appropriate material, production technology & bulk hardening of rotavator blades results into inferior quality and short service life. Central Institute of Agricultural Engineering, Bhopal has developed the production technology of these blades which results into enhanced service life. The production package includes material, production aids for cold and hot forging technology and bulk hardening cycles. The economic viability of the unit adopting this package at different level of production has also been worked out for aspiring entrepreneurs.

INTRODUCTION

Seed bed preparation is the first and the prime operation in a crop production schedule. In other words, the tillage operation is performed to acquire a seed bed with improved soil health free from weeds. The operation includes ploughing, harrowing and mechanical destruction of weeds and soil crust. In advanced farming system, the land preparation is done in two ways: by use of a plough (mould board or disc) or by means of rotating mechanisms such as rotary tillers. The first process produces big clods and requires higher energy bill and is quite prevalent in America and Europe. The second system suits to Asian countries where rice-wheat cultivation dominates the agricultural scenario. This system produces fine seed bed at par to the level required for rice and wheat cultivation. It can incorporate every kind of crop residues into soil mainly to improve soil organic health. It retains soil moisture, increases soil porosity and aeration - a condition for enhanced germination and crop growth. It can be used for dry land and wetland cultivation. These features lead to popularity of rotavator amongst Indian farmers.

Description of Machine

consists of top yoke, tube / MS flat support, PTO gear box, chain - sprocket/spur - gear assembly, rotor assembly, skid, blades, rack (for skid

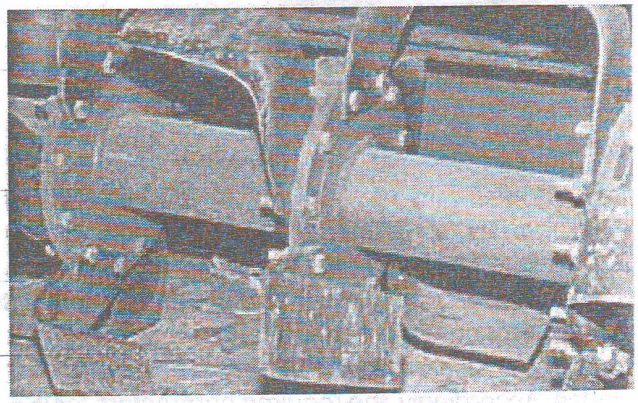

Fig. 1: Blade mounted on a tractor driven rotavator

adjustment) and trailing board (Fig. 1). Under dynamic loading, rotavator blades are subjected to fatigue and abrasive wear. The continuous fluctuating impact of soil crust/clods/stone develops high stress areas on blade tip or blade critical edges. The nature of material removal on critical edges/ surface is shown in Fig. 2.

The local and imported blades costing Rs. 135/- and Rs. 250/-, respectively are available in Indian market. A rotavator has a useful life of 2400 h (8 year) with annual use of 300 h. The local blades need replacement after 80-200 h of their use; however, imported blades need replacement after 300-350 h in normal soil. The local and imported blade sets are changed 23 times and 7 times respectively

Table 1: Composition of Materials

Sl. No	Material Grade	Chemical composition. %					
		Carbon	Silicon	Manganese	Chromium	Vanadium	Boron
1.	SAE 6150	0.48-0.52	0.15- 0.30	0.70-0.90	0.80-1.00	0.15 min	-
2.	AISI 50B50	0.48-0.53	0.15-0.30	0.75-1.00	0.40-0.60	-	5 ppm
3.	AISI 30MnCrB4	0.28-0.32	0.10	0.60-0.90	0.90-1.20	-	15-50 ppm

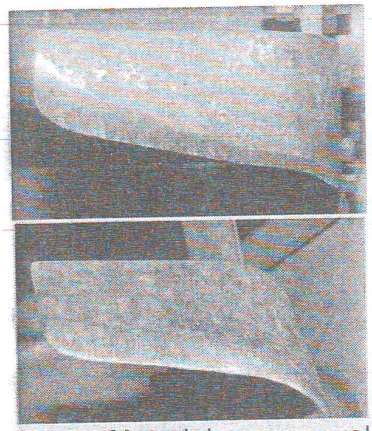

Fig. 2: Material removal process on blade critical edge / surface.

during their entire service life. It is estimated that around 5 lakhs blades are required annually towards replacement and for new machines.

Development of Technology

Central Institute of Agricultural Engineering, Bhopal has undertaken a study on ***Metallurgical Upgradation of Rotavator blade for service life extension.*** The study aimed to identify materials, develop manufacturing aids and production schedule for quality production and appropriate heat treatment for service life extension of rotavator blades. Accordingly, the required parameters for ISF (Indian Standard Flat section) 85x7 mm size rotavator blades were identified. Spring steel grades SAE 6150, AISI 50B50 and AISI 30MnCrB4 with the composition given in Table 1 are recommended for long duration use.

Production Technology

Cold working and hot forging processes are widely used. Eight step manufacturing process was developed to fabricate the blade of ISF 80x7 mm size. If the manufacturers have the facilities of forging press, then many of the process can be eliminated which results into cost saving. The hot forging is recommended for higher volume of production.

- Cutting to size (290x80 mm)
- Clamping end short edge cutting (29 mm)
- Clamping end long edge cutting (75 mm)
- Taper cutting of cutting edge (117.5 mm)
- Taper cut beveling of cutting edge (18 mm wide for 260 mm)

Table 2: Details of Dies and Punches.

Name of die & punches	Specifications
Length Cutting Die - Punch set	AISI M2 steel ; punch hardness 48 HRc
Clamping end edge cutting die punch set	AISI M2 steel ; punch hardness 48 HRc
Cutting Edge Beveling Fixture for Horizontal Milling (Select as per existing facilities)	Cutter - high speed tool steel ; hardness 64 HRc
Cutting Edge Beveling Fixture for vertical Milling (Select as per existing facilities)	Cutter - high speed tool steel ; hardness 64 HRc
Blade Bending (L Shape) Die Punch Set	AISI M2 steel ; punch hardness 48 HRc
Blade End Scooping Die Punch Set	EN 24 steel; punch hardness 45 HRc
Blade Clamping Hole Drilling Jig - Single Hole (Select as per existing facilities)	EN 24 steel; punch hardness 45 HRc
Blade Clamping Hole die punch set- Twin hole (Select as per existing facilities)	AISI M2 steel ; punch hardness 48 HRc

Table: 3 Rotavator blades costing for different level of production

Head, Name	Annual Production in thousands			
	12	24	36	48
Fixed Investment, Rs	10,07,000	10,07,000	10,07,000	10,07,000
Working Capital for three months, Rs	4,75,650	8,28,900	11,13,525	14,84,700
Fixed capital investment , Rs.	15,45,650	18,98,900	21,83,525	25,54,700
Loan Amount, Rs	12,36,520	15,19,120	17,46,820	20,43,760
Personnel, Rs	4,89,600	4,89,600	4,89,600	4,89,600
Raw Material, Rs	11,64,000	23,28,000	34,92,000	46,56,000
Utilities, Rs	45,000	90,000	1,35,000	1,80,000
Other contingencies, Rs	2,04,000	4,08,000	6,12,000	8,16,000
Annual Fixed cost, (D+I)* Rs	2,92,478	3,34,868	3,69,023	4,13,564
Cost of Production, Rs.	21,95,078	36,50,468	53,42,423	70,44,764
Annual Turnover, Rs	21,96,000	43,92,000	65,88,000	87,84,000
Net Profit , Rs	922	7,41,532	12,45,577	17,39,236
Gross Profit , Rs	1,07,922	8,48,532	13,52,577	18,46,236
BEP in units	-	12002	11678	12442
BEP in days	-	150	98	78
Return on investment , %	0.060	39.99	58.87	70.77
Payback period , Years	-	1.44	0.86	0.62
Unit cost, Rs	182.90	152.10	148.40	146.76

• D= Depreciation; I= Interest

• Assumptions Material cost= Rs 70/- per kg; Heat Treatment cost = Rs20/- per kg; Power cost= Rs. 5/- per kWh

- Clamping end top hole (10 mm)
- Clamping end bottom hole (10 mm)
- Blade bending (36R) and cutting edge bending (220 R)

A set of dies and punches are required to fabricate the blade using hot or cold forging processes. The details of these dies and punches are given in Table 2.

Forging die (For hot working process only.100 T hot forging press) HCR forging grade steel. The raw strip of 250 x 60 x 10 mm size at 800 °C is placed in the slot and forged to size.

Economic Viability of the Rotavator blade Manufacturing Unit

The economic viability of the rotavator blade production unit at different level of annual production is presented in Table 3. It is evident from the table that the per unit production cost of rotavator blades reduces with increase in annual production.

CONCLUSIONS

- An eight step production process to fabricate rotavator blade using cold working has been developed with suitable dies and punches. Alternatively, a forging die has also been developed for manufacturers fabricating rotavator blades using hot working process.
- The study recommends SAE 6150 and AISI 50B50 grade steels with appropriate bulk hardening cycles with enhanced service life for rotavator blades.
- The increase in annual production results into higher return on investment and lower pay back period and per unit cost of the rotavator blades.