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Status of Metallurgical Techniques Practiced by Agricultural Machinery Manufacturers for Fast Wearing Components in India

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ABSTRACT

The fast wearing components of agricultural machinery requires frequent replacement, which affects the work output as well as the quality of the equipment. Metallurgical techniques such as material selection, bulk hardening and surface modification are quite preventing for enhancing service life of these components. The study reveals that only 41% manufacturers were using steel conforming to BIS recommendations, based on the carbon percentage. The tested samples could be categorized in to mild steel (10%), medium carbon steel (56%), high carbon steel (28%) and high carbon tool steel (6%). The heat-treatment was observed in rotavator blades, disc, chaff cutter blades and sickle blades. But due to improper heat-treatment the grains of tempered martensite were found coarse. Except in case of export, the manufacturers do not undertake chemical, mechanical and micro structural testing. Heat-treatment has not been a part of their facilities.

Key words : *Steel, Heat-treatment, Agricultural Implements, Manufacturers*

Introduction

The critical components of farm equipment are subjected to abrasive, corrosive and adhesive wear under dynamic and static condition. The worn out components reduce work out put as well as the quality of work of the equipment. Therefore, after a period of use, these components need replacement, which contributes hundreds of crores rupees annually beside machine down time. It has been reported that over half of all wear situations are abrasive in nature. This is quite common to agricultural machinery where friction exist between a stressed metal and harder body. It has been further stressed that manipulation in metallurgical variables (hardness, toughness, and micro-structure and chemical composition) reduces abrasive wear of fast wearing components of agricultural machinery. This study focuses on assessing the material classification, composition and hardness of critical components manufactured by agricultural machinery manufacturers. The study further reviewed the percent manufacturers following the metallurgical specifications framed by the Bureau of Indian Standard.

Material and Methods

The fast wearing components of agricultural machineries were divided in two classes such as soil working components and crop working components. The components were selected from these two categories for the study purpose.

Duck foot sweep, rotavator blades, shovel, harrow disk, tine, bar point, and shear point, suggar cane harvesting knife, chaff cutter blade, sickle blades, lawn mover blades and cutter bar blade were selected as the fast wearing components of agricultural machinery. The manufacturers of these items were identified in different parts of the country and survey was done in these selected areas covering whole country i.e. Ludhiana, Amritsar in Punjab; Karnal, Bahadur Garh, Faridabad and Ambala in Hayrana; Agra, Matura, Meerut and Khatauli in Uttar Pradesh; Coimbatore in Tamil Nadu;

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Bhopal, Khurai and Gwalior in Madhya Pradesh and Ahmadabad and Rajkot in Gujrat. The production process of these components was also recorded and samples of these components were also collected. Test samples of size 25x25x(5-8) mm size were prepared at the institute from all collected fast-wearing components for chemical composition, hardness and for microstructure observations.

Survey of twenty-four selected industries making fast wearing components was conducted, based on the information given by the manufacturers of agricultural implements. During survey it was found that only a few manufacturers of fast wearing components of agricultural implements were purchasing raw material from branded companies and using proper production sequence and machinery but in most cases manufacturers were not caring for health problem of their labours. It was also observed that none of the manufacturer used to claim for BIS specified implements. A total of fifty-one components of twelve fast wearing components were collected from all over the country. The list of these components is given in Table 1. The purpose of assessment of production process is to know the actual manufacturing process of fast wearing components of agricultural machinery and facilities required for the manufacturing. The collected samples of fast wearing components were tested for chemical composition, hardness and microstructure by using spectroscope, Rockwell hardness tester and metallurgical microscope respectively.

Table 1. Name of fast wearing component and their number collected for testing

S. No.	Name of component	Number of industries (Samples collected)
1	Duck foot sweep	05
2	Rotavator blades	05
3	Shovel	05
4	Harrow disc	05
5	Tyne	05
6	Bar point	03
7	Shear point	02
8	Sugar cane harvesting knife	05
9	Chaff cutter blade	05
10	Sickle blades	05
11	Lawn mover blades	01
12	Cutter bar blades	05

Result and Discussion

Classification on fast wearing components of agricultural machinery on the basis of BIS recommendations is given in Tables 2. It is evident from Table 2 that fifty nine percent manufacturers were not using BIS specified materials for manufacturing fast wearing components. This phenomenon is widely visible in case of duck foot cultivator sweep, harrow disc, sugar cane harvesting knife, chaff cutter blade and cutter bar blade. However, manufacturers producing components like lawn mover blade (100%), sickle blade and shovel (80%), bar point (66.67%) and rotavator blade (50%) were using BIS specified materials. Table 2 further states that the hardness of 58% of the fast wearing components of agricultural implements is not as per BIS recommendations. In case of harrow disc and sickle blades all tested samples (100%), were found in BIS specified range followed by rotavator blades (66.67%) and tynes (60%). This leads to inferior wear resistance of the components which results into low service life. The classification of the fast wearing components of agricultural implements on the basis of carbon percentage is given in Table 3. It is clearly depicted from this table that majority of manufacturers of these components are using medium carbon steel (56%) followed by high carbon steel (28%), low carbon steel (10%) and high carbon tool steel (6%) for fast wearing components. The reason of using medium carbon steel by most of the manufacturers (56%) is its availability at cheaper rate in form of used spring leaves (EN-45) of medium and heavy duty automobiles. The bulk properties of this steel could be altered with appropriate heat-treatment process. The low value of surface hardness tested in samples could be attributed to improper or no heat-treatment or surface modification treatments and inadequate selection of material. There is a need to create awareness among the manufacturers of these components to select appropriate materials and their heat-treatment / surface modification techniques. Manufacturers should associate themselves with research and

Table 2. Classification of fast wearing components on the basis of BIS recommendation

S. No.	Name of Component	Composition		Hardness	
		Not as perBIS	As per BIS	Not As Per BIS	As per BIS
1.	Duck Foot Sweep	1(20%)	4(80%)	0(0%)	5(100%)
2.	Rotavator Blades	3(50%)	3(50%)	4(66.67%)	2(33.33%)
3.	Shovel	4(80%)	1(20%)	0(0%)	5(100%)
4.	Harrow Disk	1(20%)	4(80%)	5(100%)	0(0%)
5.	Tyne	2(40%)	3(60%)	3(60%)	2(40%)
6.	Bar Point	2(66.67%)	1(33.33%)	-	-
7.	Share Point	0(0%)	1(100%)	0(0%)	1(100%)
8.	Sugarcane Harvesting Knife	1(20%)	4(80%)	2(40%)	3(60%)
9.	Chaff Cutter Blade	1(20%)	4(80%)	0(0%)	5(100%)
10.	Sickle Blade	4(80%)	1(20%)	5(100%)	0(0%)
11.	Lawn Mower Blade	1(100%)	0(0%)	0(0%)	1(100%)
12.	Cutter Bar Blade	1(20%)	4(80%)	1(20%)	4(80%)
	Total	41%	59%	42%	58%

Table 3. Classification of fast wearing components on the basis of carbon percentage

S. No.	Name of component	Low Carbon 0.05-0.3% C	Medium Carbon 0.3-0.6% C	High Carbon Steel 0.6-0.9% C	High Carbon Tool Steel 0.9-1.5% C
1.	Duck Foot Sweep	0	5(100%)	0	0
2.	Rotavator Blades	0	2(40%)	3(60%)	0
3.	Shovel	0	5(100%)	0	0
4.	Harrow Disk	0	2(40%)	3(60%)	0
5.	Tine	2(40%)	2(40%)	1(20%)	0
6.	Bar Point	1(20%)	2(40%)	0	0
7.	Shear Point	0	1(100%)	0	0
8.	Sugarcane harvesting knife	1(20%)	2(40%)	2(40%)	0
9.	Chaff cutter blade	0	2(40%)	0	3(60%)
10.	Sickle blades	1(20%)	3(60%)	1(20%)	0
11.	Lawn mover blades	0	1(100%)	0	0
12.	Cutter bar blade	0	1(20%)	4(80%)	0
	Total	10 %	56%	28%	6%

development institutes for appropriate manufacturing of these components.

Conclusion

Following conclusions have been drawn from the study:

1. A wide variation was observed in component dimension within the manufacturer and manufacturer to manufacturer.
2. The manufacturing of agricultural components/spares is still tedious, labour intensive and time consuming.
3. Most of the manufacturers procure raw material from small rolling mills, so does not confirm to BIS or any certified agency.
4. Only 41% manufacturers are using steel confirming to BIS recommendations.
5. Based on the Carbon percentage, the tested samples could be categorized into mild steel (10%), medium carbon steel (56%), high carbon steel (28%) and high carbon tool steel (6%).
6. Heat- treatment was observed in rotavator blades, disc, chaff cutter blade and sickle blade. But due to improper heat treatment the grains of tempered marten site were found course.