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TO IMPLEMENT INDUCTION HARDENING INSTEAD OF CASE CARBURIZING IN BULL GEAR OF A TRACTOR

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ABSTRACT
Development of Induction Hardening of a bull gear was taken up multiple of times in the past also but was not successful due to different reasons it was taken as a challenging again to start a fresh trial and develop induction hardened bull gear without compromising performance targets. Changing from a well- established and proven carburized design to induction hardening design involves some major challenges. To maintain core strength of simplicity and robust design it was decided to not tochange the existing module and reduction ratio which was a major challenge to introduce induction hardening in a bull gear with module of 5.5. In contrast to carburizing and nitriding, induction hardening does not require heating the whole gear. With induction, heating can be localized to only those areas in which metallurgical changes are required. For example, the flanks, root and tip of gear teeth which is beneficiary in productivity, energy saving & process improvement.
Keywords: Induction,hardening, carburizing

I. INTRODUCTION
Now a days, gear manufacturers have adopted their technological knowledge of the production of quality gears. This knowledge has led to many advantages, including lower noise, lighter weight and lower cost, as well as increased load-carrying capacity to handle higher speeds and torque with a minimum amount of heat dissipation. This paper tell us on the role of induction hardening of bull gears in obtaining these advantages.

Not all gears are well suited for induction hardening. Helical and spur gears, worm gears, and internal& external gears, racks and pinions are among the parts that are mainly induction hardened. Conversely, non circulargears, hypoid gears, and bevel gears are some time heat treated by induction.

In comparison to carburising and nitriding, induction hardening does not require heating of the whole gear. With induction, heating can be easily identified to the located area where metallurgical changes are needed (e.g., flank, root and gear tip can be selectively hardened) and the heating effect on adjacent areas is minimum. Depending upon the uses, tooth hardness ranges mainly from 40 to 70HRC.

One of the aimof induction gear hardening is to present a fine-grained fully-martensitic layer on specific areas of the gear to increase hardness and wear resistance, while allowing the remainder of the part to be unaffected by the method of induction hardening. The increase in hardness also improves contact fatigue strength. A combine form of improved hardness, resistance to wear, and the capability to provide a fine martensite structure, often allows the substitution of cheap medium- or high-carbon steel or low-alloyed steel for more costly highly-alloyed steels.

It is not always possible to obtain a fully-martensitic case. Depending on the type of steel, the presence of some retained austenite within the hardened case is unavoidable (unless cryogenic treatment is used). This is particularly true for steels with high carbon content and cast irons

Up to the certain point, few retained austenite does not accurately decrease the surface hardness. However, it introduces few ductility and gives better absorption of impact energy, which is beneficial for heavily-loaded gears. In addition, having an unstable nature, retained austenite has a nature, with time, to change into

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martensite, adding to compressive residual stresses and increasing the surface hardness. From this research, a little amount of retained austenite is not only less harmfull but may even be taken as beneficial in some cases.

II. RISE PILLAR : ACCEPTING NO LIMITS- CHALLENGES LIMITS

Swaraj Transmission is known for most reliable &rugged transmission in all the competitor models. To retain this image all new deelopments were done keeping in view to have no compromise with the existing performance level.

Development of Induction Hardened bull gears was taken up multiple times in the past also but was not successful due to different reasons.

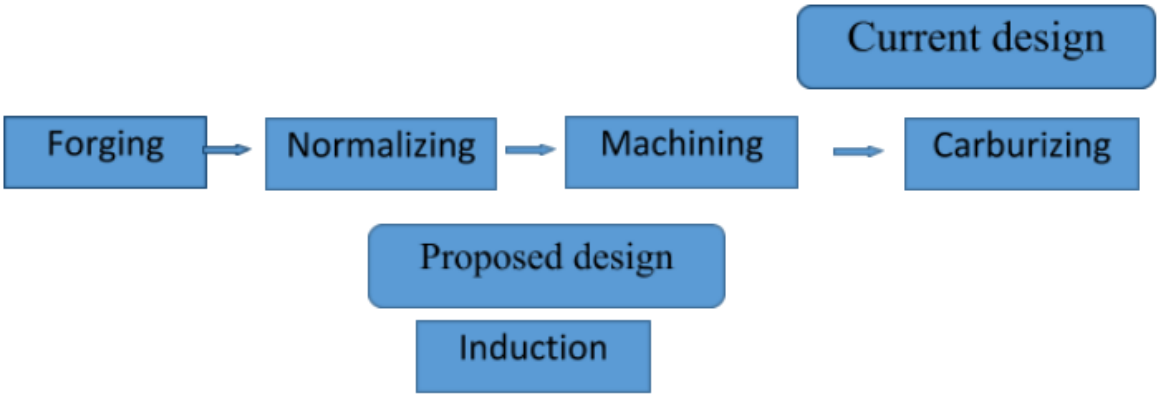
It was taken as a challenge again to start a fresh trial and develop induction hardened bull gear without compromising performance targets.

III. WHAT WAS THE PROBLEM/ OPPURTUNITY:

Changing form a well established and proven carburized design to Induction hardening design involves some major challenges .To maintain core strength of simplicity and robust design it was decided to not to change the existing Module and reduction ratios,which was a major challenge to Introduce Induction Hardening in a bull gear with a Module of 5.5 (most of the competitor had achieved induction hardening with higher module bull gear). Further a dedicated activity of trials and testing was required to get shifted to the new process.

IV. WHAT WAS THE SOLUTION:

Process flow-



Introduction of induction hardening was done by validating a number of trials to achieve required hardened profile more or less same as carburized, as not to compromise with performance.

Following variable parameters were set after a number of trials to get the desired hardened profile as above

SET VARIABLE PARAMETERS

COIL	POWER	HEAT TIME	QUENCHING DELAY	QUENCHING TIME	COOLANT FLOW	COOLANT TEMP.	LOADING METHOD	PART RPM	RPM AT QUECH.
CIRCULAR	170 KW	36 SEC	2 SEC	90 SEC	800/850 LPM	29	HORIZONTAL	18/19	22/23

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V. HOW WAS IT IMPLEMENTED:

After development of proto samples with required induction hardened specifications ,Bull Gear was tested with higher loading condition on skid to ensure satisfactory performance before regularising it. 3 sets of bull gear from 2 different suppliers were tested for 500+hrs.

BULL GEARS	TESTING CONDITION	TARGET HRS.	ACHIEVED W/O FAILURE	REMARKS
P350512	834	500	700	No pitting/ Uprooting observed
P750512	744	500	650	No pitting/ Uprooting observed

After getting sufficient confidence in in-house testing, pilot lot was tested to check performance under actual field conditions.

Based on satisfactory feedback from field it was released for regular production.

VI. HOW DID IT ADDRESS THE ISSUE/GAP:-

1.Cost saving through material change and heat treatment process change
Cost saving in bull gear by material change from 20MnCr5/SAE 8620 to En43D and process change

S.NO	BULL GEAR	MATERIAL SAVING	SAVING IN PROCESS	NET SAVING
1	350512	Rs 44	Rs 300	Rs 344
2	750512	Rs 330	Rs 300	Rs 630

VII. SAVING SO FAR:

		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
P350512	Qty	50	100	234	642	680	552	424	120	553
	Saving	16290	32580	77760	214791	224591	184476	152174	43068	198472
P750512	Qty	38	100					2232	1210	2006
	Saving	23951	63030	226908	235732	288677	252120	1412854	772461	1286228

1) Increase in productivity by reduction in total cycle time
Improvements in Bull Gear productivity increase from 40pcs/shift to 350pcs/ shiftapprox 10 times.

By cycle time reduction for heat treatment from 1800 sec /pc to 140 sec/pc. , Carburizing process 20 hrs per piece charge induction hardening single piece induction hardening i.e. 2.33 units.

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VIII. CONCLUSIONS

Financial • Avg. saving of Rs 500/tractor • Productivity Increase	Customer • Better quality of product • Lesser breakdown • Improved productivity
• Internal processes • Process improvement • Energy saving	• Learning and growth • Adaptation of new technologies to achieve cost reduction without compromising performance

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