

Surface quality assurance of ring gear during precision stamping of gearwheels

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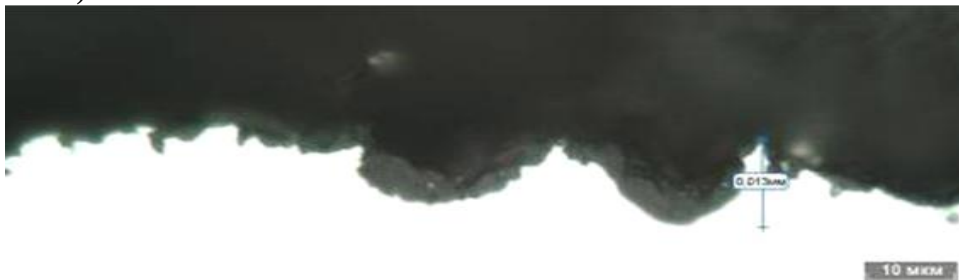
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Abstract. The article highlights the main factors, defining the surface quality of ring gear during hot bulk precision stamping. It offers enhanced techniques of surface quality of stamped ring gear.

During precision stamping of gearwheels strict requirements are imposed on the surface quality of a stamped ring gear.

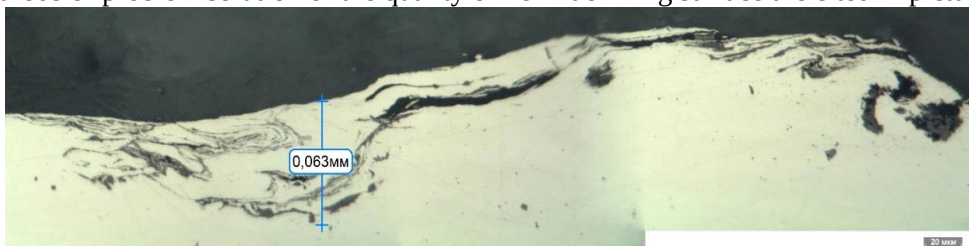
In manufactured units of foreign producers the size of overused iron scale amounts to 0,013 mm (picture 1)

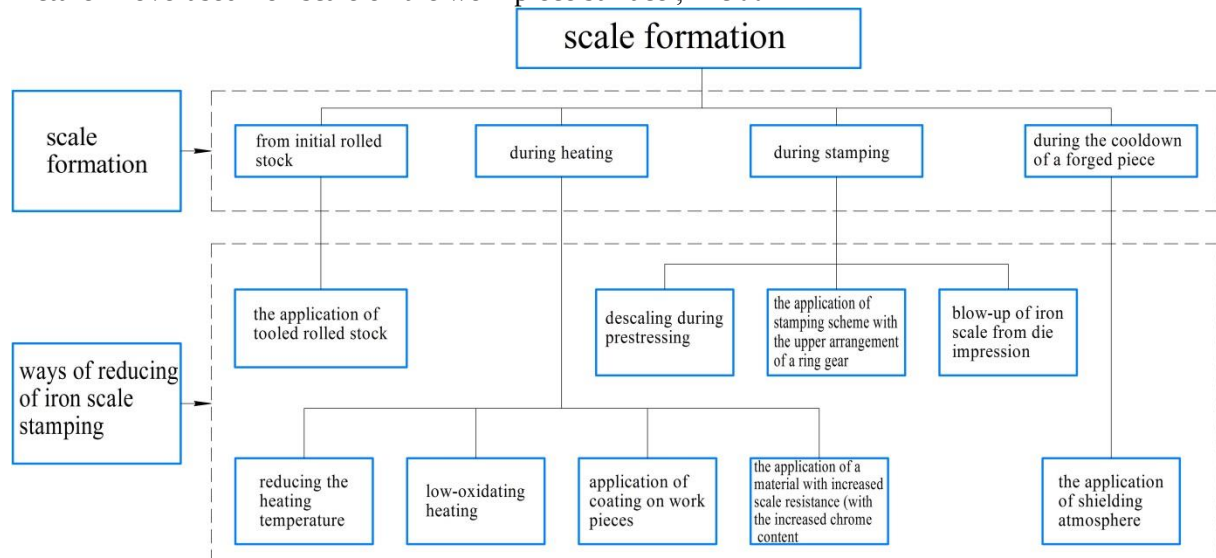


Picture 1- overused iron scale on the work piece surface $\times 1000$

While examining the microstructure on the work piece surface, stamped in standard conditions, overused iron scale has been exposed to a depth of up to 0,063mm according to picture 2.

The surface defects of mentioned character will lead to premature wearing-out and cog chipping and drop-out of gear transmission. To provide the performance reliability of a gear pair, it's necessary to find out the reasons of stamping the iron scale and determine its solution strategies. The reasons and methods of problem solution of the quality of nonmachining surface are cited in picture 3.



Picture 2- overused iron scale on the work piece surface , $\times 300$ 

Picture 3 – ways of improving of surface quality of nonmachining cutting of ring gear

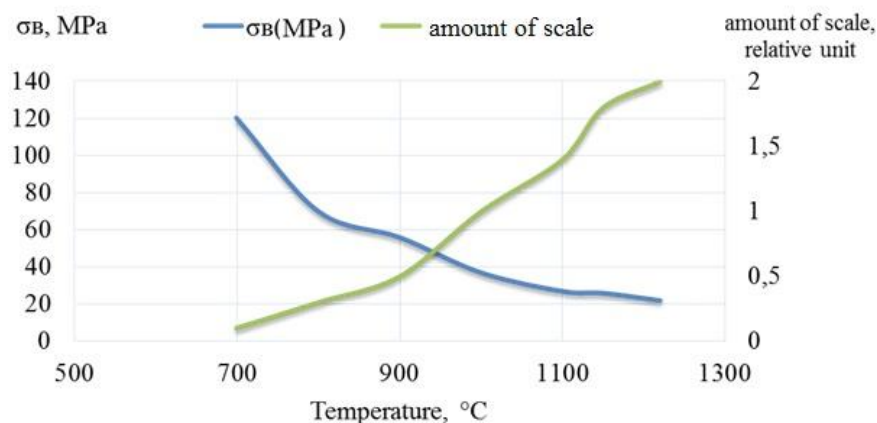
According to [1] on the surface of hot-rolled rolled stock into encrusting matter of rolled-in scale to a depth of up to 0,2 mm. Rolled-in scale is difficult to remove by pickling and dressing. Consequently, to exclude the stamping of surface defects in the area of nonmachining part of finished articles the necessary requirement to the surface quality of initial work piece is quality group 1 in surface quality of rolled stock in tooled condition.

The reduction of stamping temperature leads to the reduction in scale formation [2] and the increase of stamping power (pic.4). The increase of stamping power is limited by the capacity of pressure equipment, reduction in resistance of stamping tool and formability of material of initial work piece

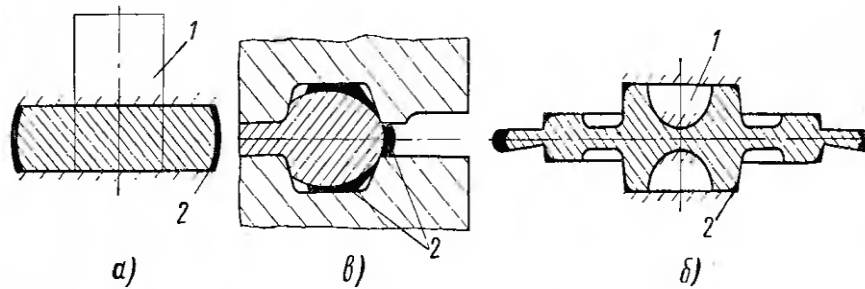
Ways of low-oxidating and nonoxidating heating of work pieces before stamping are described in [3].

The application of envelope has a negative impact on the precision of an item as there occurs envelope sticking in the area of a finished surface (pic.5) [4].

The scale resistance of chrome steel is conditioned by chrome content in them (pic.6). If the alloy contains it more than 20% Cr the scale resistance increases most abruptly. The more the chrome content in the alloy is, the higher the steel process temperature. Steel that contains 4—6% Cr and 0,5% Mo has a lot more resistance to creep at 400—600° C, than plain carbon steel, moreover this resistance increases with the increase in alloy 7% Cr and up to 1—1,5% Mo[5].

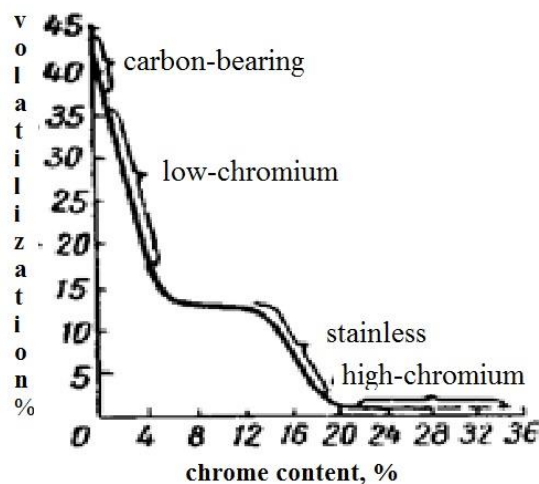


Picture 4 – the example of response of scale formation σ_B to metal heating temperature.



Picture 5 – the scheme of glass distribution in forged pieces: *a*- at the work piece after upsetting ; *b* – in forging of gear wheels; *c* – at the rim during stamping; 1 – the glass film; 2 – glass pileup

Thus, from the line-up of constructional steel applied in standard machinery one should recommend steel resistant to high-temperature oxidation, such as 20H2N4A, X12CrMo5, 20CrNi4 and others.



Picture 6 – Scale resistance of steel at 1000° C, 48 h., in Mac-Kwig

Scale formation immediately during hot die forging can be minimized by means of selecting the most effective in terms of scale knocking the upsetting scheme at the first juncture. To prevent the stamping of scale on the ring gear impression it's necessary to foresee the cog formation in the upper forged insert element and forced scale blow-off by compressed air after each forging.

Results:

- The major factors, defining the surface quality of the ring gear during precision hot bulk stamping are: the surface quality of initial rolled stock, scale formation during the work piece heating, during stamping and during forging cooldown.

- The following enhanced techniques of surface quality of stamped ring gear have been offered:

- the application of tooled rolled stock,
- reducing the stamping temperature,
- the application of low-oxidating heating,
- the selection of material with maximum allowable chrome content,
- the selection of rational upsetting technique to knock scale from the work piece surface,
- scale removal from the surface of die impression.

When required, one can evaluate the significance of solutions in terms of resulting precision [6].

References

- [1] State standard (GOST) 4543-2016 Steel products of structural alloy steel.
- [2] Gubinsky V I, Minaev A N, Goncharov U V 1981 *Reduction of scale formation during rolled stock production* (K.: Technika) p 135
- [3] Petrov P A, Krutina E V, Kalpin U G 2010 *Heating and heaters in forgings: University textbook* (M.: MGTU «MAMI») p 110
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- [5] Manjurov S B 2014 *The planning of reduction of surface oxidation and decarburization of steel work pieces during heating with the application of nondurable technological protective layers* dissertation of PhD in Engineering Science
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