TECHNICAL MANUAL FOR PREPARATON OF THE TOOLS BEFORE PLASMA NITRIDING & NITROCARBURISING *Stainless Steel* Macedonia

In order to achieve the best effects of plasma nitriding or nitrocarburising, a few important rules should be followed:

1. Adequate material choice

The best results are achieved if steels are used, which are consistent of alloy elements, which through the process of plasma nitriding give out nitrides with high hardness and strengths. Best results are achieved if the steel contains the alloy elements: Cr, Mo, W, V, Al, Ti,... and of course, C.
Depending of the part or the tool usage, steels with small or higher content of these alloy elements are chosen. Also, it is possible a usage of steels with not guaranteed chemical content or steels without alloy elements, but in that case the lower hardness is received compared with the steels mentioned before.
Also, very good characteristics can be obtained on parts manufactured of gray, nodular or steel casting.
One of the basic rules in choosing nitridable steels is analysis of their tempering diagrams. The tempering temperature must be high enough to guarantee structural stability at the nitriding temperature: the minimum tempering temperature is usually at least 30-50°C higher than the maximum temperature to be used in nitriding.

The most important property that should be analyzed on the tempering diagram is the hardness after tempering temperatures of 520 – 600°C. If the hardness after the tempering of the mentioned temperatures maintains approximately as the hardness after the hardening, than the steels can be used in parts which in the exploitation are subject not only to abrasion, but to exertion as well (tools for moulding, tools for plastic deformation of metals, tools for cold and hot deformation, knives....)

For tools or parts where the dominant process of the exploitation is abrasion without significant pressures, almost all steels can be used, and in dependence of the present of the mentioned alloy elements, more or less hardness will be obtained and therefore, adequately more or less wear resistance, corrosion resistance and coefficient of friction will be obtained, but ABSOLUTELY after the nitriding will have better characteristics and longer lifetime in compare of before.

For tools or parts which besides abrasion are also subject to high pressures (molding tools, cutting tools, pressing tools....), **must** be used steels which after the tempering and releasing temperatures of 570°C, have hardness of 55 to 60 HRc. From the diagrams of releasing, it can be seen that in that group are steels such as: OCR: Č4850, Č4750, Č4753, Č4650,. . . Steels that carve fast: Č6880, Č6890,... Immersing steels: Č4751, Č4753,...
which maintain their hardness which is obtained by tempering and releasing temperatures of 550°C - 580°C (and in some cases up to 600°C) from 55 to 60 HRc. By plasma nitriding they get

exceptionally high hardness which increases the resistance of wear, shock, fatigue, corrosion; decreases the coefficient of friction and increases their lifetime up to several times.

For gear-wheels and other jagged wares (objects), crankshafts, boxes, spindles etc., which do not have emphatic shocks (strokes) or high pressures, the best recommended materials for nitriding are: Č4739, Č4735, Č4734, Č4732, Č1530, Č1730, or with higher content of alloy elements, where after the coarse machine processing, a thermic processing is exerted and releasing temperatures of approximately 550 - 580°C whereupon a hardness of approximately 28 (30) to 35 HRc is obtained and finely grained structure appropriate for plasma nitriding. In that case, a core is derived with adequate hardness, mechanical characteristics and finely carved structure with hardness of the nitrided layer of 50-60 HRc, which enables very solid performances for normally laden gear-wheels or for other parts mentioned before.

For other applications the recommendations given in almost all manuals for machinery should be applied.

2. Choice of thermic processing before the nitriding

Best results of the plasma nitriding or nitrocarburising are achieved if a proper thermal processing is completed (tempering and releasing).

It is possible plasma nitriding to be accomplished even without the thermal processing, but for cases where there's only abrasion, and not shocks (strokes) and high pressures during the exploitation of the parts or the tools.

Basic rule before nitriding is to accomplish releasing of the temperature of approximately 550 to 580°C, which is higher than the temperature of nitriding or nitrocarburising.

3. Choice of machine or thermal processing before the nitriding for the purpose of barring deformations or distortions of the parts – tools

The plasma nitriding or nitrocarburising is the most contemporary process, where after the nitriding, additional machine processing is not necessary, because the nitrogen ions (from the nitriding) or the nitrogen and the carbon (from the nitrocarburising) are implementing in the basic material with depth of 300, 400 and even more microns, without the dimensions of the parts or the tools being increased.

Therefore, the processes of plasma nitiding or nitrocarburising themselves, don’t lead to change of the dimensions.

In order to prevent deformations during the nitriding, most important is to remove the behindhanded exertions from the thermic or the machine processing, before the parts to be brought in the process of nitriding.

Because the nitriding is occurring on approximate temperatures of 500 - 520°C, and the nitrocarburising on temperatures of 520 - 560°C, it means that if before nitriding the parts or the tools were released on temperature of 550°C - 580°C, during the nitriding or nitrocarburising, there won't be phase changes in the basic material, there won't be dimensional changes or distortions, as a result of the behindhanded exertions from the unbalanced structures from the thermic or the machine processing.

If after the releasing of the mentioned temperatures, there is a significant machine processing, than because of the behindhanded exertions from the machine processing, dimensional change is possible after the nitriding.

In order to avoid this occurrence of behindhanded exertion from the machine or thermic processing, the best order of operation is as follows:

3.1. For parts or tools where there are not complex forms or where high or strict tolerances are not required, the following order of operations is possible:

- Coarse machine processing
- Thermal processing (tempering and releasing of T=550 °C- 580 °C)
- Fine machine processing after the releasing
- Plasma nitriding (nitrocarburising)

3.2. For parts or tools where there are complex forms (complex tools, capsules, cylinders,…) or high or strict tolerances are required, the following order of operations should be accomplished:

- Coarse machine processing
- Thermal processing (tempering and releasing of T=550 °C- 580°C)
- Fine machine processing after the releasing
- Releasing of T=550 °C
- Finishing very fine machine processing for the purpose of removing the small deformations from the releasing
- Plasma nitriding (nitrocarburising)

Stainless Steel is available to give suggestions or advice for the choice of materials or for the choice of thermic or machine processing, depending on the application of the parts or the tools, best results from the nitriding to be obtained and the possible deformations or dimensional changes to be avoided.

4. Application of the parts for nitriding before the delivery-reception

The parts for nitriding should be clean, actually the organic dirt to be removed (grease, oils), oxides…. For removing the before mentioned dirt, *Stainless Steel* **.** is always ready to deliver guidelines or consultations for cleaning or removing the oxides or the other metal dirt.

The parts or the tools that have coils (internal or external) and should be protected from nitriding, should be delivered-received with protection coils (capsules). Further protection from *Plasma*

D.O.O. is additional – unnecessary expenses for the business partner. *Stainless Steel* . is always ready to deliver guidelines or consultations for protection of separate parts of the nitriding.

5. Measurements of the hardness after the nitriding

The measurements of the hardness after the nitriding must be obtained according the Vickers method.

This method is used, because with the Rockwell or the Brinell method bigger measurement strengths are used, that can penetrate in the nitrided layer, which in dependence of the material or the usage is 200 up to 500 microns and therefore instead of measuring the hardness of the nitrided layer, a hardness below the nitrided layer will be acquired.

For disobeying of these rules, for inadequate choice of materials or the delivered material which is different of the declared one, for inadequate thermic or machine treatment, *Stainless Steel* **doesn't have responsibilities for possible deformations or inadequate results from the plasma nitriding.**