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APPENDIX TO THE STUDY OF THERMAL CONDITION BY PROCESS OF GRINDING

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ABSTRACT
*A generated thermal energy from subject of processing is becoming coolant, means of rinsing and lubrication (**SHIP**) by the process of grinding. Grindstone consumption and its pore blockage are reducing grindstone stability and its processing quality is making worse. A grindstone pore blockage causes shavings' and mechanical particles of SHIP. Explorations of a tensional condition in the layer surface are very important to dynamic load parts in a presence of higher temperature.*
This work gives results of exploration of SHP's means influence on mechanical and physical conditions, and indexes of condition's efficacy.
Key words: cooling, lubrication, friction, and consumption.

1. INTRODUCTION
The process of grinding develops in a combination of cutting and friction, and that is the reason of the warmth quantity development. Undesirable developments appear on the grinding area as a consequence of that, such as burning up, tempering, micro crack, tension of layer surface, and consumption of the sawn surface of grindstone, as well. This warmth, which is developed mainly by friction, can be affected by:

- ✓ Forming a stable lubricated wedge, that reduce a level of friction
- ✓ Cleaning and rinsing of the sawn surface of grindstone
- ✓ Cooling of sawn grindstone and processing surface, than taking warmth away.

SHIP is taking the warmth away, that is developing itself intensively during a grinding, but it (*SHIP*) is making this temperature lower by the effect of lubrication of *SHIP*. Practice shows that great percentage of the problems connected with the quality of the ground surface emerge because of bad *SHIP* choice, its insufficient quantity or bad wire solution.
This work gives results of exploration of *SHIP* quality by grinding in a more efficacious manner.

2. THE INFLUENCE OF TERMAL PROCESSES ON ELEMENTS OF THE PROCESS-SYSTEM
Thermal processes effects on subject of processing and tools in the sawn area during the grinding. Experiments are necessary for the exploration of the process of grinding, and mathematical data processing. Usage of the modern equipment for precise measuring of output parameters of the processes of grinding and usage numerical methods (MPK for example) give us a chance for a

discovering the indicators that are able to make the process of grinding optimal in a more efficacious manner.
The goal of process is the enlargement of the grindstone steadiness, extension of *SHIP* duration for its usage with achievement of gratifying quality process.
The influence of thermal processes on the grindstone can be controlled by grindstone steadiness. The grindstone failures by grinding in a more efficacious manner are the result of:

- ✓ Abrasion of grindstone grain;
- ✓ Pore blockage of grindstone;
- ✓ Non-achievement of precise construction.

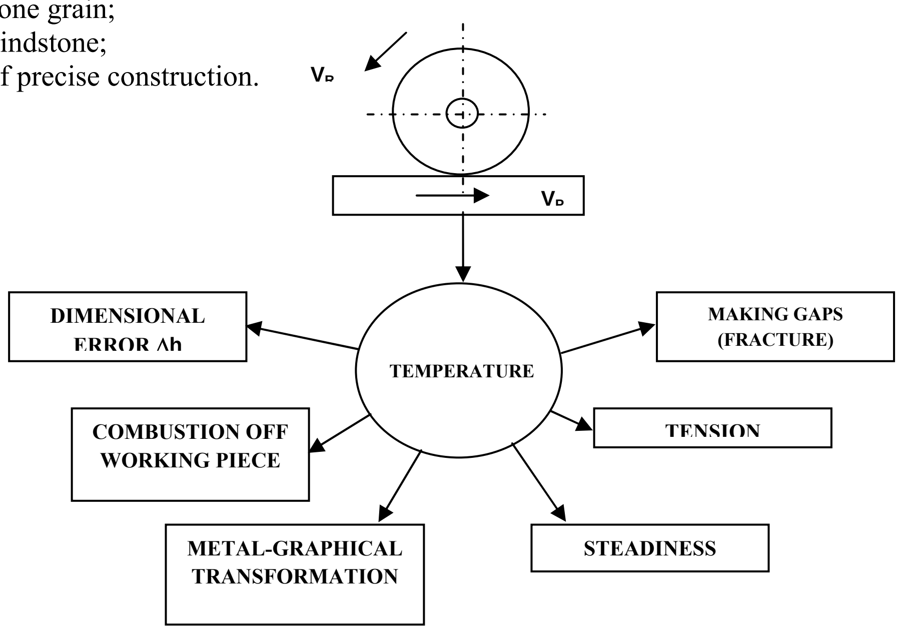


Figure 1. The heat-thermal influence on the ground surface

A proportion of the middle temperatures can be used as a criterion for a technical/technological score of *SHIP* characteristics:

$$I_\theta = \frac{\theta_{m0}}{\theta_{mk}} \tag{1}$$

Where is:

θ_{m0} - The mean temperature by the basic *SHIP* cooling;

θ_{mk} - the mean temperature by the new *SHIP* cooling.

Index of SHIP efficacy in a way of characteristic of lubricant compute in accordance with the pattern:

$$I_F = \frac{F_{20}}{F_{2x}} \tag{2}$$

Where is:

F_{20} - The total resistance to the grinding in a more efficacious manner by the basic *SHIP* cooling;

F_{2x} - the total resistance to the grinding in a more efficacious manner by the new *SHIP* cooling.

3. ANALYSIS OF THE BACKWARD INTERNAL TENSIONS

The backward tensions by the grinding processing grow from thermal and mechanical load. This process is described by the system of the harnessed equations of thermal-plasticity [7].

$$\begin{aligned} &C\left[tr \cdot \ddot{T}(M,t) + \dot{T}(M,t)\right] + 3K_\alpha\left[tr \cdot \dot{T}(M,t)\dot{U}_{i,i}(M,t) + tr \cdot T(M,t)\ddot{U}_{i,i}(M,t) + T(M,t)U_{i,i}(M,t)\right] = \\ &= \lambda \cdot \nabla^2 \cdot T(M,t) + tr \cdot q_v(M,t) + q_v(M,t) \end{aligned} \tag{3}$$

$$G \cdot \nabla^2 \cdot U_i(M,t) + \left(K + \frac{G}{3}\right) \cdot U_{j,ji}(M,t) + f_i^{\circ}(M,t) = \rho \cdot \ddot{U}_i(M,t) + 3K_{\alpha}T, i(M,t) \quad (4)$$

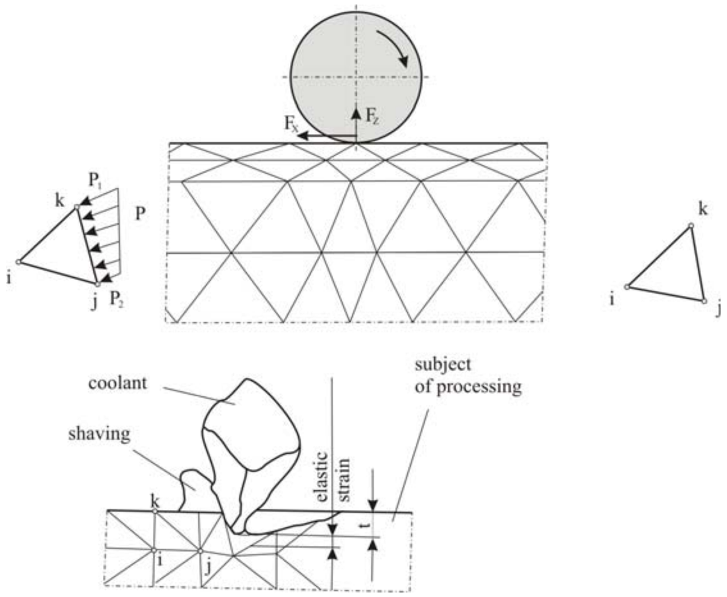


Figure 2. Illustration of the grinding processing and division of the sawn area on the final elements

Where is: $M = x, y, z$, t – Time [s], ∇^2 - operator, tr – time of making inroads of thermal energy waves, α - coefficient of expansion, U – moving.

With the initial and border conditions in [7]. Treating material characteristics depend on the temperature, in the presence of the grindstone grains dynamic activity. (Picture No. 2.).

Considering that is $\frac{\chi}{\left[\frac{1+\chi+4G}{3K}\right]} << 1$ possible situation in which (1) and (2) variation methods can be used for the purpose of getting the shape of functionale:

$$I(U_i) = \int_F \left\{ \begin{matrix} K(M)\left[U_{k,k}(M) - 3\varepsilon^{(T)}(M)\right]^2/2 + G(M)\left[U_{k,k}^2(M) - U_{k,k}(M)U_{l,l}(M)\right] + \\ G(M)\left[U_{1,2}(M) + U_{2,1}(M)\right]^2/2 - f_i^{\circ}(M)U_i(M) \end{matrix} \right\} dF - $$
$$\int_{r'} P_i^{\circ}(N)U_i(N)d\Gamma_i \qquad i, k, l = 1, 2, 3 \quad (5)$$

Which is appropriate for the usage of the final elements' method. The term for the linear equations system is being given by organizing functionale.

$$[K]\{U\} = \{P\} \quad (6)$$

Where is:

$[K]$- Hard matrix, $\{U\}$- moving vector, $\{P\}$- vector of power.

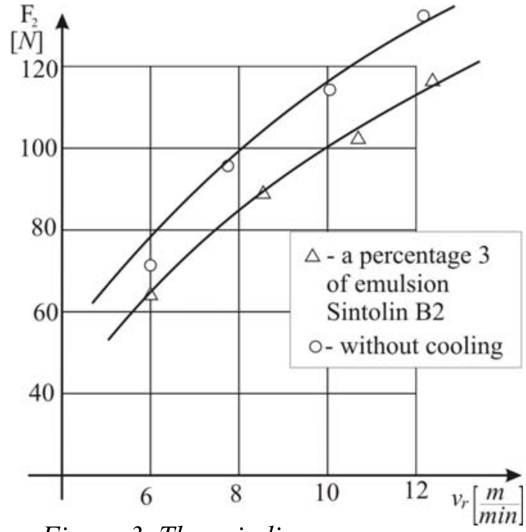


Figure 3. The grinding power depending on a way of cooling – without cooling and 3% emulsion

Temperature field is defined iteratively [4] in a time interval $\Delta t = 0{,}001\ s$.

$$\left([K] + \frac{2}{\Delta t}[e]\right)\{T\} = \frac{2}{\Delta t}[C]\{T\}_0 - \{F\} \quad (7)$$

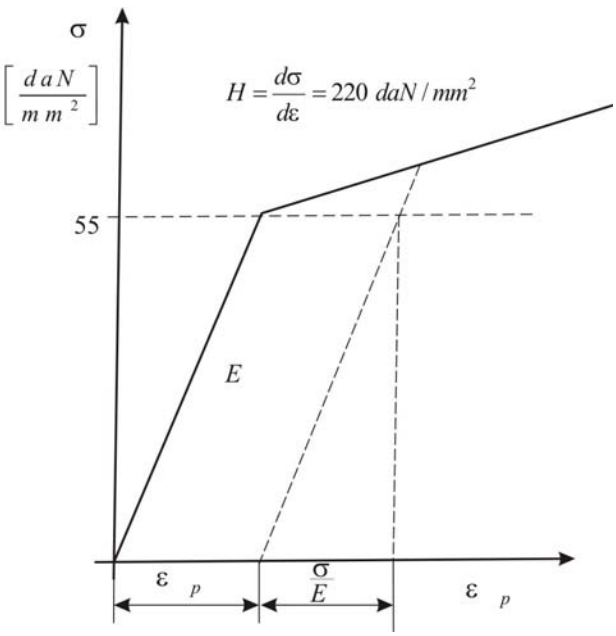
Where is: $[K]$ - Matrix of conductivity, Δt – iterative move.

Estimate results are concerning to backward inner tensions made by grinding of the tempered steel Č. 4751 by the grindstone 2B 54 10V SWATY. Dependence of the sawn resistance, in relation to processing factors, is defined and reads as follows:

$$F_x = 89 \cdot Vr^{0,235} \cdot t^{0,735} \cdot b^{0,662} \ [N]$$
$$F_z = 113 \cdot Vr^{0,470} \cdot t^{0,74} \cdot b^{0,492} \ [N] \quad (8)$$

These magnitudes of the sawn resistance were being needed for the estimate of the temperature fields (for defining the thermal fluks power $q = \frac{F_x \cdot v}{M \cdot A}$ and mechanical loads that are obtained on the basis of the equation $P = \frac{F_z}{A}$).

Here it is A – intersection of the grindstone contact and the working subject.



Picture No 4. Characteristic curve for the plastic flowing estimate

Special tools do hardness measuring in the layer surface, and tensional magnitudes are estimated by magnitude of hardness.

4. CONCLUSION

Following claims are given from the foregoing text:

- ✓ Measured results of the backward tensions are placed in the same zone in relation to estimated temperature backward tensions, and they are with the same omen, too
- ✓ Magnitudes of resistance are reduced by the usage of coolant that has positive effect on the sawn temperature falling off and the backward temperature tensions, as well. The temperature falling off and tensional decrease can be achieved by the intervention made on a grindstone and by making an additional development.
- ✓ This shows that backward inner tensions can be specified by the process of grinding in a relative simple way if its the sawn resistance and thermal condition of the subject areas in crops are known.

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