

Szent István University

**THE CUTTING THE MODE OF ACTION OF APPLIED MINIMAL
LUBRICATION (MMS) AND THE INCREASE OF HIS EFFICIENCY**

Thesis of the doctoral (PhD) dissertation

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CONTENTS

CONTENTS.....	3
1. INTRODUCTION AND AIMS OF THE DOCTORAL DISSERTATION	4
1.1. The significance of the research.....	4
1.2. The aims of the research.....	5
2. MATHERIAL AND METHOD	6
3. RESULTS	10
3.1. Energy needs and distribution the chipping temperature the basis of his greatness and his distribution	10
3.2. The role of lubricants in MMS lubrication.....	17
3.3. The mechanism of tool abrasion	21
3.4. Roughness and size keeping	23
3.5. The assessment of Crystallite-modifications.....	25
3.6. New scientific results.....	29
4. SUMMARY	32
4.1. The summary of the research activity.....	32
4.2. Practical adaptability of scientific results, conclusions, recommendations	32
5. PUBLICATIONS IN CONNECTION WITH THE THEME OF DOCTORAL DISSERTATION	34

1. INTRODUCTION AND AIMS OF THE DOCTORAL DISSERTATION

1.1. The significance of the research

We called the lubrication method minimal lubrication for cutting when the hourly lubricant use is not over the 50 milligrams generally, there may be even less in some cases.

The label „Minimal Menge Schmierung” is from an acronym that created of the initials of a german expression, so MMS, in turn in English it called „Minimum Quantity of Lubricant” so it’s MQL in short. In case of the MMS-lubrication defined in the above ones not the cooling-greaser the physical, chemical and thermodynamical characteristics of the substance set of a liquid dominate, but the local **molecular** behaviour of the given substance.

The objective of my doctoral dissertation (PhD) the accurate definition of concepts, the exploration of the mode of action of the MMS-lubrication were useful on the cutting speciality and for the efficiency of the chipping with modifying his increase, the substances for a molecular and effect quantum behaviour.

In the topic onto 1990 so much knowledge accumulated that the draughting of an actual development concept, to which the 1. figure demonstrates his essence, turned into possible one. I dealt with the **transitional (AB) section's** examination in the course of my research work.

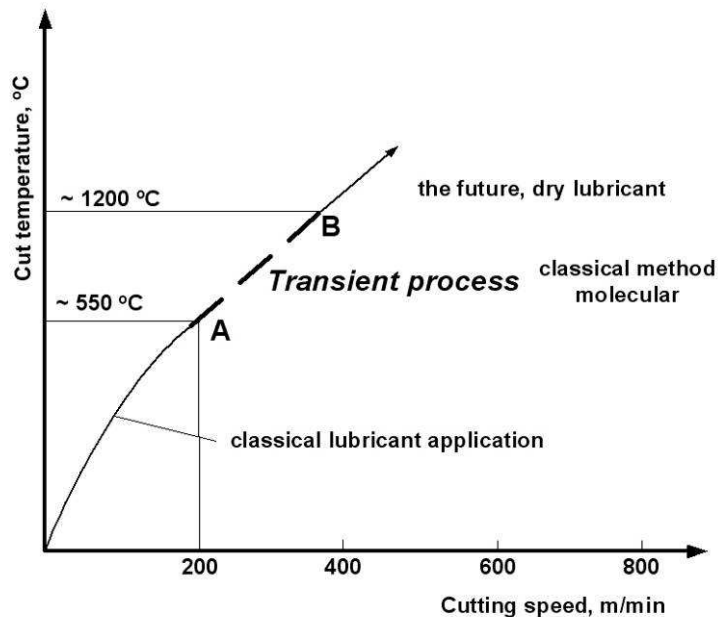


Fig.1. The change of the cutting temperature in the function of the cutting velocity, steel workpiece and hard metal in case of a tool

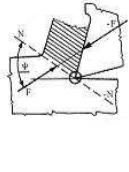
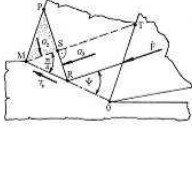
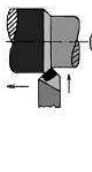
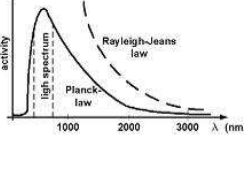
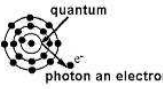
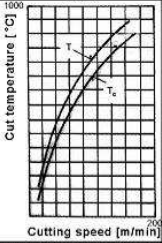
I do not try to observe the reality with a complicated mathematical model in the course of my researches - what is impossible yet today - but I attempt to understand the process with the use of the physical laws, looking for those intervention opportunities, with which the intake reducible, beside the correction of the quality of the cutting.

1.2. The aims of the research

The ENERGY CONVERSION ensuing in the course of the SLIVER DETACHMENT PROCESS with a new view (1. table 4-5-6 pictures) in the transitional section of interpreting him as some THEORETICAL QUESTIONS of his, the wet one and dry shaping the exploration of opportunities, that:

- THE ENERGY NEEDS OF THE SLIVER DETACHMENT ARE REDUCED
- CGL (COOLING-GREASER LIQUID) USE IT IS NEARED TO THE ZERO
- FROM THE MAKING OF THE EMULSIONS – HIS FIRM ALLEY TREATMENT - THE CUTTING FIRMS ARE EXEMPTED FROM HIS STORAGE AND HIS DISMOLITION
- THE SURFACE QUALITY OF THE PRODUCT, HIS SIZE KEEPING ARE INSURED EXCELLENTLY, THE SURFACE NEARLY IN LAYERS THOUGH CRYSTALLITE MODIFICATIONS OPTIMISES.

Table 1. Sliver detachment the physical interpretation of the strength energy process

1. Force, F [N]	2. Specific cutting force, k_c [N/mm ²]	3. Specific cut job, W , [Ws/mm ³]	4. Energy	5. Conversion of energy	6. Heat energy, E [J] Temperature, T [°C]
					
<p>The chip-root is kept in balance by F forces equal in magnitude but opposite in direction from the tool-face and from the shear plane.</p> <p>Cutting force effect on the theoretical chip area unit.</p> <p>Work needed per unit volume to cut material.</p>			<p>Energy marks the capability of change in general meaning, and it marks the working capacity in physics. The energy of a certain physical system can be given with the work-quantity (W) by which it can be brought to this stage from some kind of initial stage.</p>	<p>Coefficients applied at the deduction of the Planck rule describing the absolute black-body by Einstein. They give the probability of the three events whether the atom or molecule:</p> <p>a) absorbs a photon from a ray of light (absorption) b) releases a photon upon the effect of incident light-ray (induced emission) c) regardless whether light falls onto the atom, it emits a photon (spontaneous emission).</p>	<p>The temperature is the amount of an objects heat energy capacity, the heating or cooling can be measured and given by numerical value. The temperature is an intensive state-decider, it characterizes the macroscopic and microscopic condition of material simultaneously. It is a sensible thing on macroscopic level. Microscopically the objects temperature is directly proportional to the average kinetic energy of the particles comprising it.</p>
<p>Macrophysics</p>			<p>Microphysics</p>		

The transitional section's examination on the surface with the analysis of processes taking place it's possible, the tribological thinking offers an exceptionally good basis for this. Namely, that energy conversion happens in the course of the friction process. The work of which use was made for the sliver detachment turns into energy, which is based on a microphysics phenomenon, through the row of the friction.

But if it is strength – work – energy process I analyse it (1. table), the interpretation of a transformation process presented on the 4., 5. and 6. pictures then the knowledge of the single parts of the quantum physics may be necessary. This the physical negotiation of the sliver detachment may not be some other way, but the problem immediately dissoluble, if we analyse the energy conversion with a solid-state and quantum physics knowledge with a microphysics view that presented on the 4. picture.

2. MATHERIAL AND METHOD

Figure 2. Demonstrates research program.

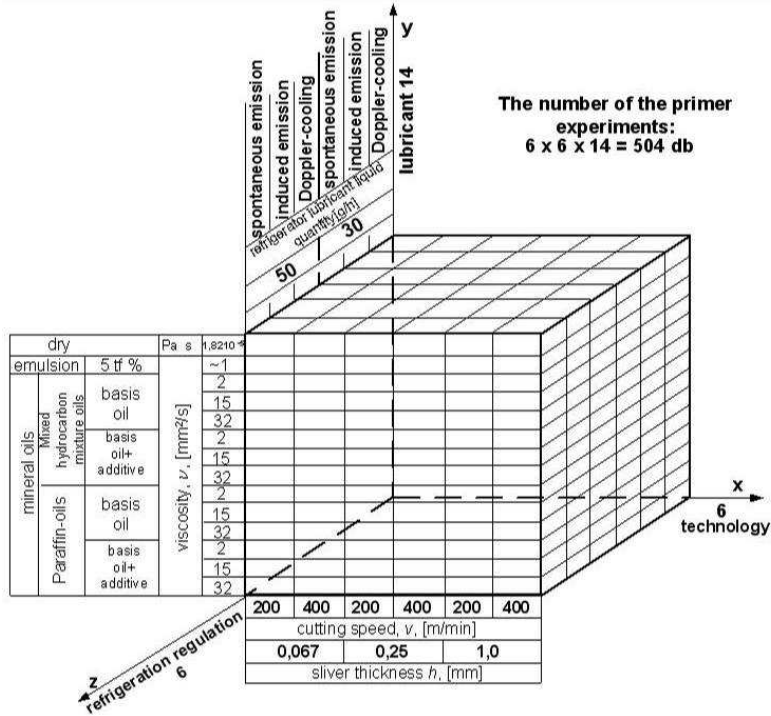


Fig. 2. The experimental program

Pilot data

Normal climate DIN50014 and ISO554-1970
 Tool: HC/TiN, a DIN/ISO 513, CNMG 1204 08 PF 4015
 Workpiece: 42CrMo4 (1.7225)
 The machine-tool: C11A –single- spindle
 System of minimal lubrication: Cobra 2000

Technological data

- step over: $f(h) = 0,25$ mm
- step over: $f(h) = 0,067$ mm
- step over: $f(h) = 1$ mm
- step depth: $a(b) = 1$ mm
- measured spindle speed: $n = 1730$ min⁻¹

The measuring sets and places (Fig.3.)

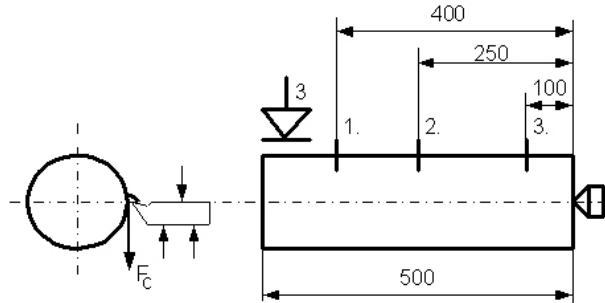


Fig. 3. The measuring places

Measuring instruments

traditional micrometer (measuring range: 50 - 75mm and 75-100mm)
 traditional caliper (1/20 – 150mm)
 metal microscope (Zeits Axi imager 1M, and Axi vision 4.7)
 WA33 (TYP PRLTA13) scale (accuracy: 0,001g) for measuring of the insert mass
 inductive odometer for measuring cutting force (type: TR102)
 revolution counter for measuring revolution (own construction)
 measuring-data collector (spider8 control)
 IGA 300 infra thermometer
 Mitutoyo SJ 201P diamond headed surface profilometer.
 instruments generating photon electrons: photo-emission with visible light, laser cooling (laser: 1 mW, $\lambda= 630-680$ nm): either the Doppler-cooling or side-strip cooling

Measured data

The measuring places signed by '1', '2', and '3':

$$D_1 [\text{mm}], D_2 [\text{mm}], D_3 [\text{mm}],$$

$$R_a [\mu\text{m}], R_z [\mu\text{m}], R_q [\mu\text{m}], R_y [\mu\text{m}],$$

$$n [\text{min}^{-1}], F_c [\text{N}], T [^\circ\text{C}]$$

Calculated data

$$D_d [\text{mm}], v_c [\text{m/min}], s [\text{m}], V_f [\text{mm}^3/\text{s}], VB [\text{mm}], P_c [\text{kW}]$$

I took into consideration the shaping period of the tool from the start to the end of the step and the average value was calculated by the mathematical function of the Excel 2003 program. I fixed the result received so in the table. We prepared the following functions based on these table data then $R_a - V_f$ (the average surface roughness – quantity of detached sliver), $VB - s$ (the measure of back abrasion – length of tool path), $VB - V_f$ (the measure of back abrasion - quantity of detached sliver). We determined the stability of the diameters and the specific cutting force from measured cutting forces which are drawn in diagrams, as well. I examined the different effects in MQL lubrication circumstances of 50 g/h and 30 g/h of oil use. I examined the effect of the viscosity, the molecular structure and the dopes of the oils in manipulated and not manipulated molecular circumstances.

I present the construction of the gauge circle on the 4. figure. I made a rack to the knife holder of the machine tool, to which I fixed the activation elements.

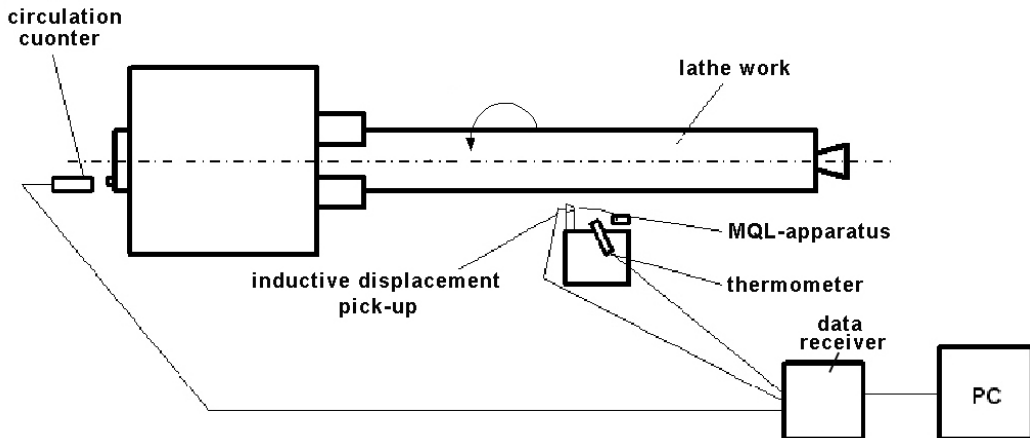


Fig.4. The sketch of the measurements

The next activation and cooling actions were applied

Spontaneous emission: a given atom can get in a lower energy state without exterior reasons. Cooling happening with spontaneous emission: any kind of devices was not needed in this case, since this cooling method is present always yes. Fig.5. shows a measurement like this.



Fig.5. Spontaneous emission

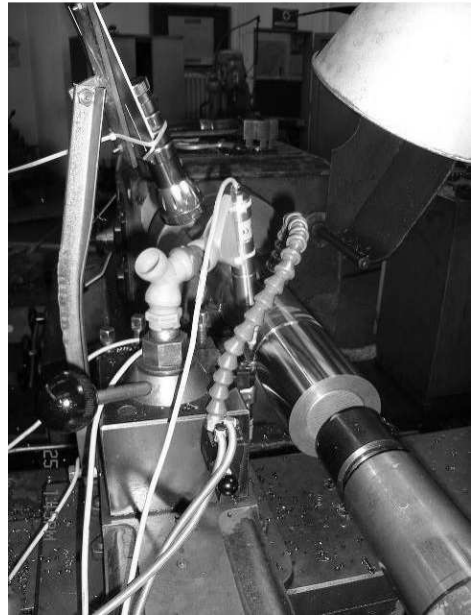


Fig. 6. Induced emission

Refrigeration happening to induced emission¹: in this case a device with a parallel beam (LED lamp) and I used the laser, which one I fixed it on a rack on the knife holder of the lathe. The 6. figure presents this.

Doppler-cooling: energy distraction accomplished on an atomic level with lasers (refrigeration). The temperature rises steadily during the friction, with what the moving atoms amplitude is growing, this effect regulate the laser some that the laser brakes the oncoming moving atoms.

The regulated state until the stability can be increased. The Doppler refrigeration I installed a laser as the 7. figure shows this onto the rack fixed onto the knife holder.

The laser ($P < 1$ mW, $\lambda = 630 - 680$ nms), what I used yet not destroying laser (so onto a cut incongruent), that supplied two functions on the one hand induced activation, on the other hand the so-called Doppler refrigeration.

¹ One ν frequency due to a photon a double with a characteristic just like that a photon is produced, while the atom is the E_2 with taller energy the E_1 with lower energy gets into a state from a state.

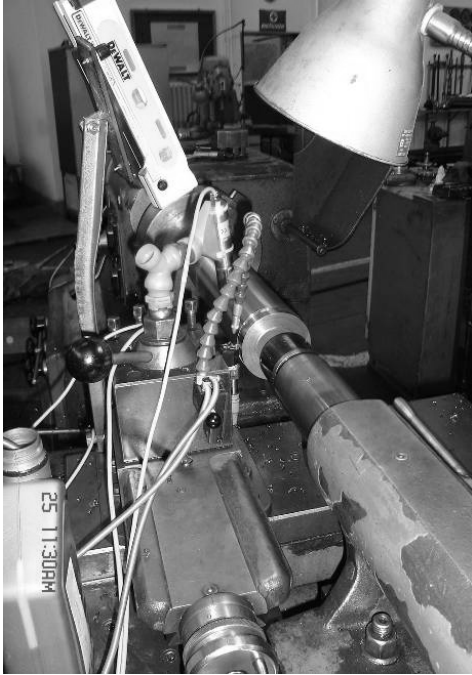


Fig. 7. Doppler-cooling

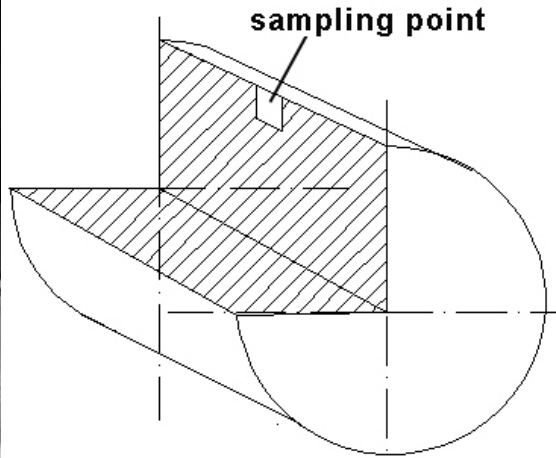


Fig.8. The sampling point

The examination of a crystallit modification on polished

It is necessary to establish the place of the test-piece in such a way that it should be typical of the product to be examined, all combination, all in terms of a fabric. The manner of the test purchase until all of them depends:

- because of the shape of the piece
- because of his greatness, his situation
- because of the aim of the examination.

The description of the examinational method:

Step 1. The cutting of the sample from the workpiece with metallographic rapid chopping under water cooling (Fig.8.)

Step 2. The embedding of the piece (with warm embedding, into a substance having bakelite basis- 3 min, 160 °C -)

Step 3. Preparation

- polishing (wet polishing with SiC basis mixture with water cooling)
- polishing with diamond suspension (9µm, 3µm and 1µm)
- in the end with colloid silica of 0,05µm

Step 4. Etching (with alcoholic nitric acid –NITAL- having concentration of 3-5 %)

Step 5. Microscopic examination (with an objective with own magnification of 20x, 50x and 100x).

3. RESULTS

It is necessary to point out that fact which cannot be gone round before the processing of the experimental results, that the results only in a smaller part can be interpreted the makrofizikai with knowledge, oh -gyobb their part microphysics (quantum physics) knowledge is claimed.

I compiled the experimental program in such a way that the different lubricants, technological one are typical and how the value of the back abrasion changes in the function of the done road in case of a molecule manipulation. I examined how the measure of the back abrasion develops under the average surface roughness and the time unit detached in the function of a sliver quantity.

From the wrought substance I prepared segments in order to be able to value it the surface nearly kristallit taking shape in his layer-being modified and the development of the translation in τ_{\max} plane. All repeated in the case of a measurement in connection with the reproducible the results they are in $\pm 5\%$ intervals.

The shaping technologies of the metals the substance deformation often onto a relatively narrow lane gets localized where the temperature rises adiabatically near due to the deformation work. Into this the shaping one ensuing due to **deformation in the narrow zone** it is necessary to count it with **thermal-soft** beside hardening. It contrary effects on a sign lead to thermoplastic instability simultaneously.

Withdrawing the dry cutting with the big cutting velocity executed under the 1200 °C degrees – our today's knowledge – the cooling greaser we reduce it with the application of liquids or we minimize the instability of the sliver detachment.

The classic shaping the refrigeration took shape and lubrication we may keep clear of it very well beside technologies you are acceptable between borders we may keep it the shaping one hardening, but the system cooling the chipping energy needs may be growing. It the essence of MMS-lubrication on this dot can be taken, namely in the shearing plane the thermo plasticity can be maximized, but the shaping one hardening let him ensue before slipping beginning on the end face after the chipping only, i mean let an elemental sliver be produced.

3.1. Energy needs and distribution the chipping temperature the basis of his greatness and his distribution

I wanted to obtain certainty before the processing of the experimental results, between the cutting features calculated on the theoretical basis and the features received in the course of the experiment.

The experimental results it here relevant they are equal to any theories, I found their correctness necessary at the same time – with the use of the secondary features measured in the course of the examinations – to prove. I summarized the results in the 2. table.

The largest difference it (with experimental code number M1-32) refrigeration happening to induced emission is 50 g/h lubricant use (- 9,09 %). The smallest difference it (with experimental code number M3-2) Doppler refrigeration where 30 g/h the lubricant use (- 0,662 %). The weighted a positive result considering averages in 3 cases while I received negative one in 12 cases.

Table 2. The specific energy-intake (W_{sp1})

Experimental code	Lubrication methods	Lubricant quantity [g/h]	Measured data		Calculated data		Tolerance
			W_{sp1} [Ws/mm ³]	k_c [N/mm ²]	W_{sp1} [Ws/mm ³]	k_c [N/mm ²]	ΔW_{sp1} [%]
dry	spontaneous emission	-	3,196	3196	3,08	3080	- 3,63
dry	induced emission	-	3,376	3376	3,30	3300	- 2,25
dry	Doppler-cooling	-	3,252	3252	3,25	3250	- 0,061
E2-A	spontaneous emission	flooding	2,645	2645	2,56	2560	- 3,21
M1-32	spontaneous emission	50	3,628	3628	3,65	3650	+ 0,606
M1-32	induced emission	50	3,124	3124	2,84	2840	- 9,09
M1-32	induced emission	30	3,292	3292	3,19	3190	- 3,098
M1-32	Doppler-cooling	50	3,668	3668	3,47	3470	- 5,39
M1-32	Doppler-cooling	30	3,240	3240	3,34	3340	+ 3,086
M2-2	induced emission	50	3,260	3260	3,47	3470	+ 6,44
M2-2	induced emission	30	2,508	2508	2,47	2470	- 1,51
M2-2	Doppler-cooling	50	3,160	3160	3,02	3020	- 4,43
M2-2	Doppler-cooling	30	2,540	2540	2,52	2520	- 0,78
M3-2	spontaneous emission	50	2,548	2548	2,40	2400	- 5,808
M3-2	Doppler-cooling	30	2,416	2416	2,40	2400	- 0,662

The done analysis proves that the correlation is exceptionally strong between the measured one and the results calculated theoretically unambiguously, the tribológiai in pilot systems as a limit value granted $r > 0,9$ (DIN 50322). My examinations $r > 0,95$, exceptionally favourable value. The done experiment justified the correctness of the theory series and reversely, so the theory justified the correctness of the experiment.

The smallest one which can be set on the experimental lathe $h = 0,067$ mm with a value each single experiment I made a controlling measurement. Extrapolated scattering belonging to a value was specific cutting strength in ± 5 % percentile intervals, from which can be rendered probable, that in case of more parallel measurements – the researches acceptable – 3% of his percentages the results would be in the scattering interval.

The dry-cooling beside the applied cutting parameters ($a(b)=1$ mm, $f(h)=1$ mm) I made an pre-experiment onto the measurement of cutting strength. There was need for this in order that myself am able to measure the reference straight out. The rev of the machine tool decreased continuously beside parameters like this however, the experiment did not give an appreciable result because of this.

The part assessment of the experimental results

The 9. figure exemplifies the temperature values of the so-called experiments made in case of dry-refrigeration without the lubricant.

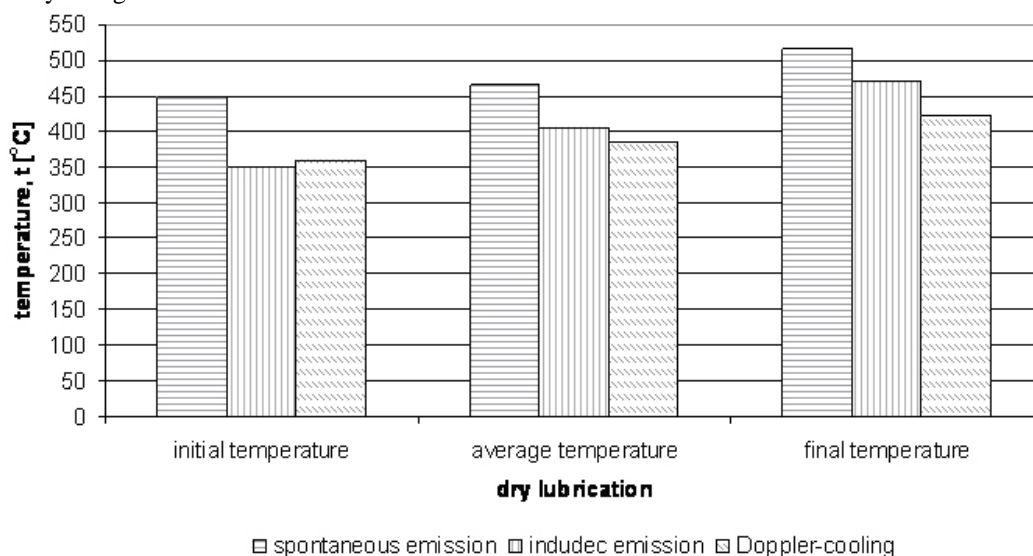


Fig.9. Dry refrigeration the temperature of the chipping zone

Based on the 9. figure can be related, that the initial temperature in case of spontaneous emission is 450 °C degrees the highest one, the average one is 460 °C degrees that mean growing, the final temperature is 515 °C degrees. In the $\lg h - \lg k_c$ coordinate system the specific cutting force is reduced with 10 % percentages that mean significantly reduced.

The temperatures decreased significantly in case of induced emission (initial: 350 °C, average: 400 °C, final: 470 °C). The specific cutting strength decreased by 5 % percentages.

In case of Doppler-cooling the temperature decreased significantly (initial: 360 °C, average: 390 °C, final: 420 °C). The specific cutting strength with 10 % percentages so significantly reduced.

The tool wear:

spontaneous emission:	because of beginning growing	$\Sigma s \approx 740$ m
induced emission:	metal transfer	$a_c=420$ m, $\Sigma s \approx 600$ m
Doppler-cooling:	metal transfer	$a_c=700$ m, $\Sigma s \approx 900$ m

The average surface roughness (R_a) the spontaneous emission and the Doppler refrigeration steadily improving, while in case of induced emission is improving until the a_c , following this declining.

From the tool abrasion can be related, that with induced emission and the Doppler refrigeration the abrasion process can be delayed.

The 10. figure exemplifies the temperature values of the experiments made in the course of the refrigeration with the 5 V% volume percentage emulsions.

On the 10. figure there is visible, that the a initial temperature in case of spontaneous emission is 360 degrees, the average one is 360 degrees so did not change, the final temperature rose onto 418 degrees. In the coordinate system the specific cutting force with 26 % percentages so significantly reduced..

The tool wear:

spontaneous emission:	metal transfer	$a_c=1100$ m, $\Sigma s \approx 1210$ m
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The average surface roughness (R_a) in case of the spontaneous emission until a_c is improving, following this is declining.

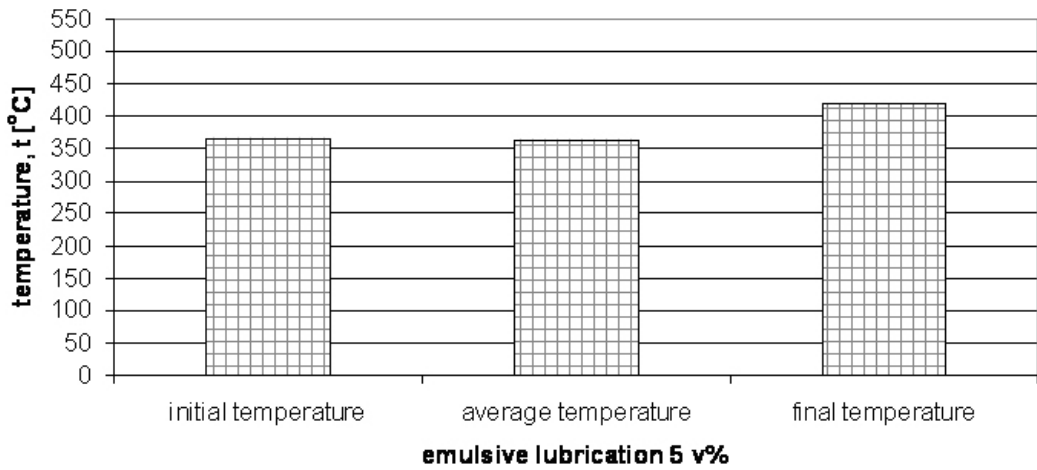


Fig.10. The temperature of the cutting zone by refrigeration with the 5 V% volume percentage emulsions

At the time of the application of the spontaneous emission which can be measured with the dry refrigeration in the cutting zone the temperature approximately 510 °C degrees so with approximately 100 °C degrees more, than in case of emulsive refrigeration.

Analysing the dry refrigeration longer however can be declared, that with the applied refrigeration manners (induced emission, Doppler-cooling) the temperature in the zone decreased compared to the spontaneous emission examination with approximately 100 degrees.

The 9. and it emerges from the comparison of the 10. figure, that the dry refrigeration, when I used the Doppler refrigeration manner, then the cutting zone and his end temperature is equal to the end temperature of the emulsive refrigeration.

The 11. figure exemplifies the temperature values of the experiments made with the lubricant with a complex additive which can be got in the trade flow.

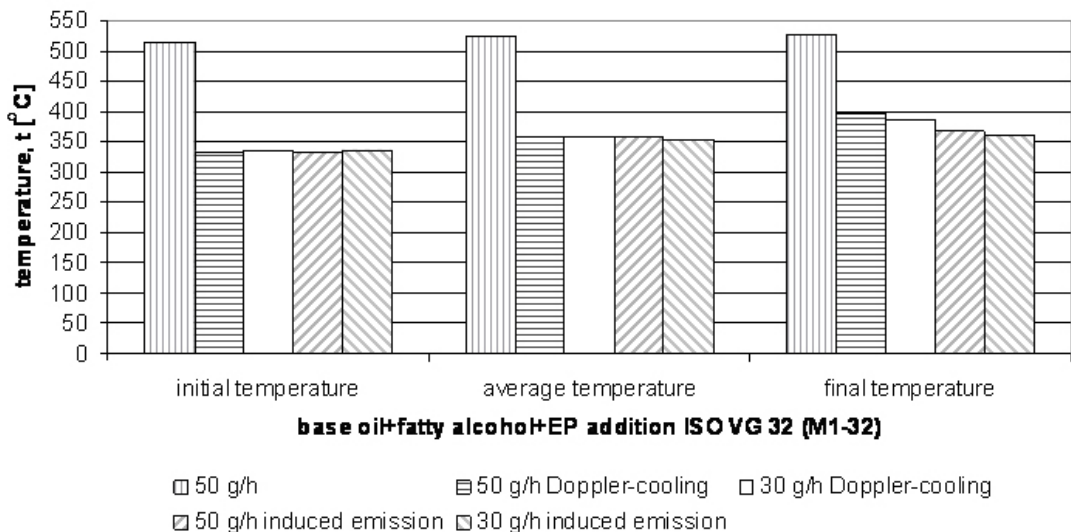


Fig.11. The best product which can be received in the trade at that of MMS lubrication the temperature of the cutting zone

Based on the 11. figure can be declared, that the initial temperature in case of spontaneous emission (50 g/h lubricant quantity) 510 °C degrees the highest one, the average one 522 °C degrees so growing, the final temperature 525 °C degrees. In the $\lg h - \lg k_c$ coordinate system the specific one cutting force with approximately 1 % percentage so not significantly increased.

The temperatures decreased significantly in case of induced emission (30 g/h lubricant quantity), compared to the spontaneous emission refrigeration (initial: 336 °C, average: 353 °C, final: 360 °C). The specific cutting force with 8 % percentages so significantly reduced. (12. figure)

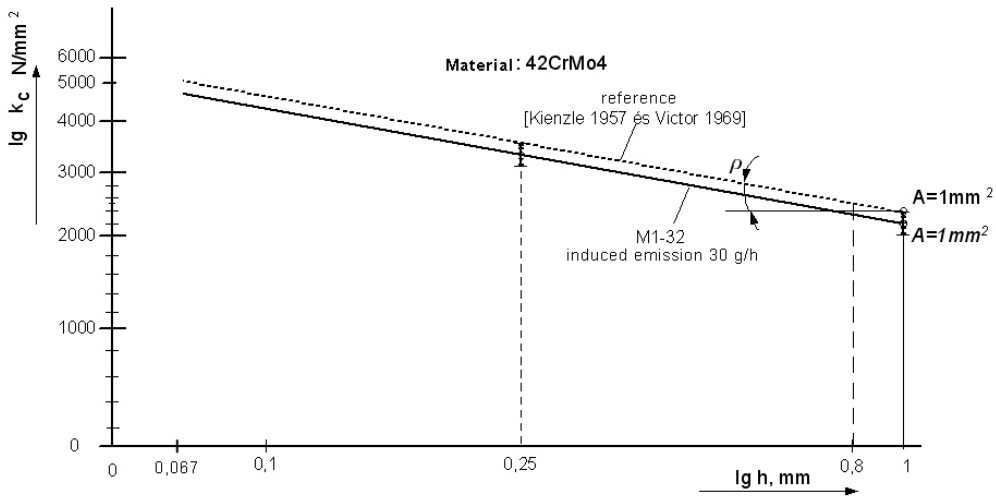


Fig.12. M1-32 induced emission, 30g/h

In case of induced emission (50 g/h of lubricant quantity) the temperatures decreased compared to the spontaneous emission refrigeration significantly (initial: 331 °C, average: 357 °C, final: 367 °C). The specific cutting strength ~12 % with a percentage, so decreased significantly.

In case of Doppler-cooling (30 g/h of lubricant quantity) the temperature decreased significantly, compared to the spontaneous emission refrigeration (initial: 335 °C, average: 357 °C, final: 387 °C). The specific cutting force ~10 % with a percentage, so decreased significantly.

In case of Doppler-cooling (50 g/h of lubricant quantity) the temperature decreased significantly to the spontaneous emission refrigeration (initial: 335 °C, average: 357 °C, final: 396 °C). The specific cutting strength ~2 % increased by a percentage nonsignificantly.

The tool wear:

spontaneous emission (50 g/h):	because of beginning growing	$\Sigma s \approx 510$ m
induced emission (30 g/h):	metal transfer	$a_c=400$ m, $\Sigma s \approx 655$ m
induced emission (50 g/h):	because of beginning growing	$\Sigma s \approx 530$ m
Doppler-cooling (30 g/h):	because of beginning growing	$\Sigma s \approx 480$ m
Doppler-cooling (50 g/h):	metal transfer	$a_c=660$ m, $\Sigma s \approx 680$ m

The average surface roughness (R_a) the spontaneous emission, induced emission (30 g/h and 50 g/h) and Doppler (30 g/h) refrigeration steadily improving, while in case of Doppler refrigeration is improving until a_c , following this declining.

Based on the results can be declared, that the temperature decreased compared to the spontaneous emission examinations significantly in the chipping zone, when you are induced emission one Doppler- refrigeration I applied manners.

Watching the quantity of the lubricant used for the experiments can be related, that the four molecule manipulation experiment series you are the difference between the temperatures hardly altogether cannot be manifested. From the figure it is legible, that when I applied an induced emission refrigeration manner, the temperature only in a little measure elmelkedett (approx 30 °C).

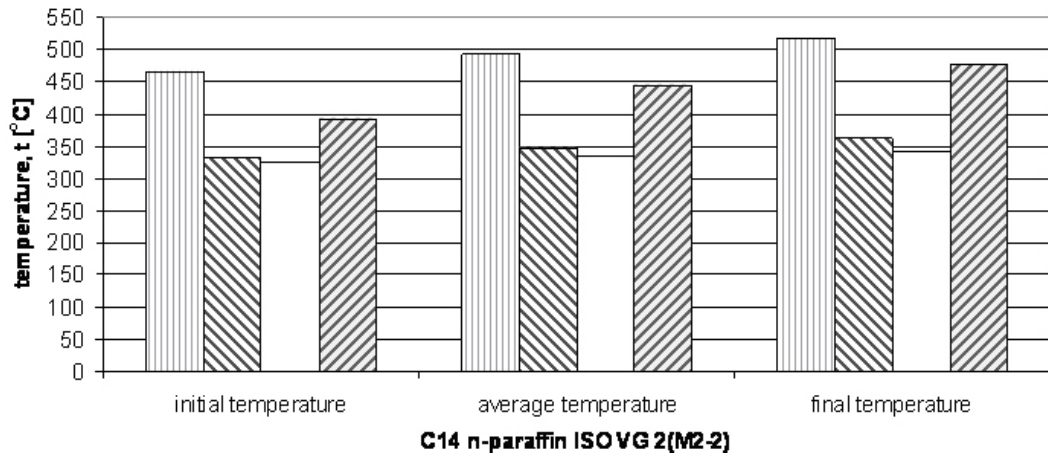
On the 13. figure with a model liquid (experimental code: M2-2) the temperature results of an executed experiment series visible.

In case of induced emission (30 g/h of lubricant quantity) the temperatures were growing in the trade flow with an available complex additive finished lubricant compared to experiments (initial: 392 °C, average: 443 °C, final: 477 °C). The specific cutting force with ~29% percentages, so decreased significantly.

In case of induced emission (50 g/h of lubricant quantity) the temperatures decreased significantly compared to an experiment with a the 30 g/h lubricant use (initial: 325 °C, average: 335 °C, final: 343 °C). The specific cutting strength with ~9% percentages, so decreased significantly.

In case of Doppler-cooling (30 g/h of lubricant quantity) the temperature values grew up significantly (initial: 466 °C highest, average: 493 °C, final: 517 °C). The specific cutting force with ~29 % percentages, so decreased significantly.

In case of Doppler-cooling (50 g/h of lubricant quantity) the temperature decreased significantly compared to an experiment with a the 30 g/h lubricant use (initial: 332 °C, average: 347 °C, final: 361 °C). The specific cutting force with ~12 % percentages, so significantly reduced.



□ 30 g/h Doppler-cooling ▨ 50 g/h Doppler-cooling □ 50 g/h induced emission ▩ 30 g/h induced emission

Fig.13. The temperature of the cutting zone at the time of the application of an experimental MMS lubricant (M2-2)

The tool wear:

induced emission (30 g/h):	metal transfer	$a_c=660 \text{ m}, \Sigma_s \approx 900 \text{ m}$
induced emission (50 g/h):	metal transfer	$a_c=1100 \text{ m}, \Sigma_s \approx 1450 \text{ m}$
Doppler-cooling (30 g/h):	because of beginning growing	$\Sigma_s \approx 760 \text{ m}$
Doppler-cooling (50 g/h):	because of beginning growing	$\Sigma_s \approx 780 \text{ m}$

The average surface roughness (R_a) by the induced emission (30 g/h and 50 g/h) and Doppler refrigeration (30 g/h and 50 g/h) steadily is improving. From the tool abrasion with the induced emission refrigeration can be delayed.

It is visible based on results that I received the better results when I used the 50 g/h lubricant quantity at this lubricant. If we compare it this lubricant quantity the Doppler refrigeration and the induced emission, then can be related, that the refrigeration happening to the induced emission the temperature difference (final temperature – initial temperature) smaller, than the Doppler refrigeration.

The temperature results of the experiment series executed with a model liquid

(experimentel code: M3-2) on the 14. figure are visible.

In case of spontaneous emission the initial temperature is 406 °C degrees, the average one is 450 °C degrees so growing, the final temperature is 476 °C degrees. In the $lgh - l g k_c$ coordinate system the specific cutting force with ~28% percentages, so decreased significantly.

In case of Doppler-cooling (30 g/h lubricant quantity) the temperatures were growing (initial: 415 °C, average: 454 °C, final: 526 °C) in a little measure. The specific cutting force with ~32% percentages, so decreased significantly. (15. figure)

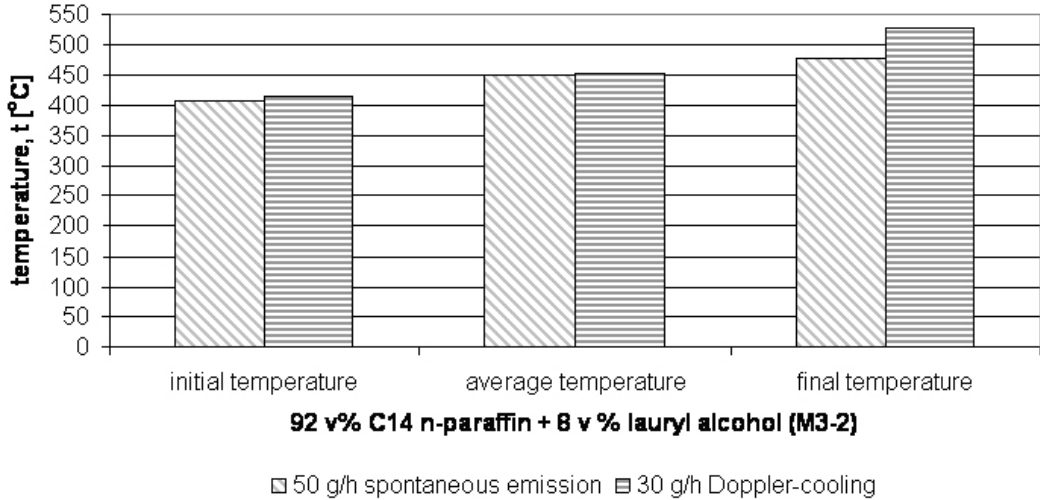


Fig.14. The temperature of the cutting zone at the time of the application of an experimental MMS (M3-2) lubricant

The tool wear:

spontaneous emission (50 g/h):	metal transfer	$a_c=660$ m, $\Sigma s \approx 880$ m
Doppler-cooling (30 g/h):	metal transfer	$a_c=650$ m, $\Sigma s \approx 870$ m

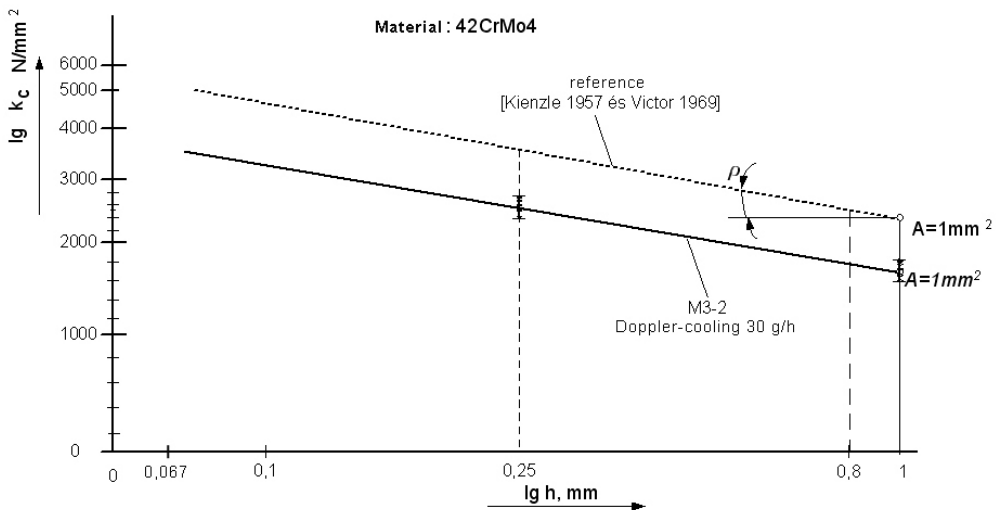


Fig.15. M3-2 Doppler cooling, 30g/h

The average surface roughness (R_a) in case of the spontaneous emission and Doppler refrigeration is improving to a_c , following this declining.

It can be related about the tool abrasion, that the experiments with an applied model liquid and refrigeration manners the abrasion process can be delayed.

There is visible at the time of the usage of the 30 g/h lubricant quantity, that onto the end of the shaping the temperature grew better, compared with experimental codes M1-32 and M2 lubricants.

On the 16. figure there is visible, that the slipping began on the end face during the cutting already, so the exterior friction appeared in this case beside the inner friction.

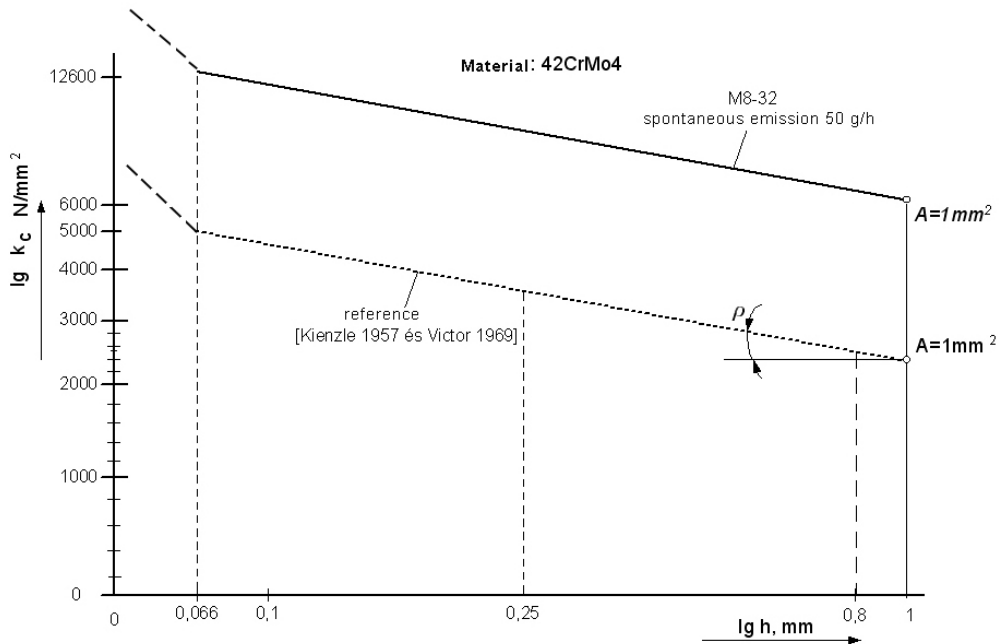


Fig.16. M8-32 spontaneous emission, 50 g/h

This case is manifested in the fact that a river sliver was produced instead of the elemental sliver. The specific cutting force increased with approximately 100% percentages, which a sliver slipping on the surface of the tool with a zero facial angle ($\gamma = 0$) overwhelmingly brings about. The figure justifies the theory. With the smaller than $f = 0,001$ mm of feeding values shaping did not belong to the topic of my dissertation tightly, that's why I did not deal with this interval more richly.

3.2. The role of lubricants in MMS lubrication

The lubricants complex disperse systems, that his characteristics, among other things the viscosity, defines by the diameter of the big molecules and his difference for the medium open road length of their motion, so the viscosity is the function of the space, the temperature and the strength between the molecules.

The collisional energy grows with the activity of the molecules, for which the molecule construction stores his predominant part. The collisional energy can infiltrate into the molecule construction on the two undermentioned manners:

- the mobile (little) molecules turn into Super structures, they form into an aggregate
- The molecules adapt to the extorted systems and relations with optimal symmetry (phase transitions), limiting the molecular mobility. In case of the full hindrance of the motion, the

energy arouses a vibration, which leads to the rip of bandages between the molecules exceeding the activity doorstep.

To deduce the construction of the fatty acids like systems consisting of different particles, may be from their inner filling distribution, which is electromagnetic radiation, may orient himself onto his effect or may shift:

- The direction is the consequence (oriental polarisation) of the spatial vectorial summation of the single dipoles, that is possible to express in a low frequency alternate space with the dielectric constant (δ)
- if the dipoles can't already change their direction because of the increased frequency of the changing space, then comes to dipol changes along the bandages, which yields shift polarisation.

The fatty acids are asymmetric molecules, with permanent dipolcircumstance. The dipol molecules create an adsorption layer oriented on a metal surface with positive filling. If the fatty acid is attached into a saturated straight chain hydrocarbon, then the so-called amphipathic² molecule arises.

It the extraordinary benefit of amphipathic molecules, that the metal surface is attached to them with adsorption, on the other side they are inert so there is no electromagnetic filling. Onto the first layer covering the surface already the inert hydrocarbon orientates - on the manner which can be seen on the 17. figure - and creates loose bandage with secondary valency. The fatty acids create van der Waals bandage on the metal's surface.

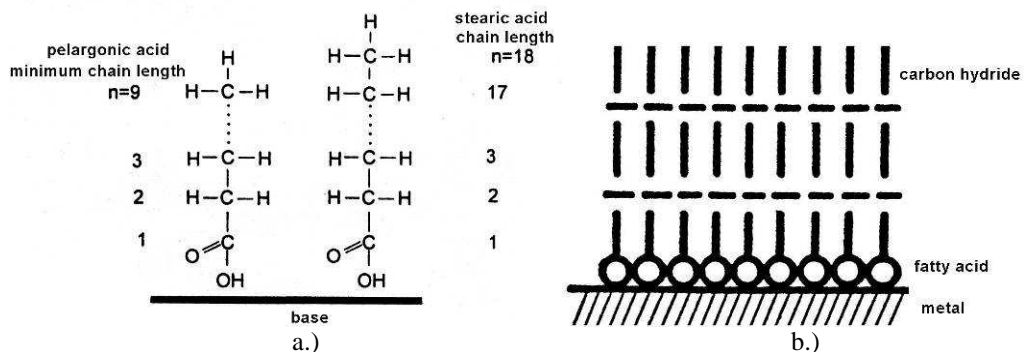


Fig.17. The adsorption of liquids on the surface of metals
a.) the adsorption of fatty acids b.) oriented polimolecular construction

The sort of Lorentz-Lorenz equation defines the polarizability. We may calculate the molecular refraction (R), the refraction like the structural unit of light optics watch from the refractive index, the molecular weight and the density.

The refractive index³ shows a direct context between the character of the structural substance and the lubrication to be realized. It is definable with the ASTM D 1218, D 1747 standard examination methods.

Generally the hydrocarbon basis the refractive index of lubricants measured on an atmospheric pressure is 1,51. If we feed the hydrocarbon oil with fatty acid then his volume decreases slightly so devorces to thicker. We may make the most of this in the lubrication process, cuase by the minimal-lubrication the well surface-moistening liquids give the best lubrication technique results. It is the very important feature of the feasibility of MMS lubrication because of this since the refractive index is exceptionally sensitive to the combination of the lubricant. The lubricant's moistening ability defines by the proportion of adhesion and the cohesive forces.

² Colloid-chemical term

³ the refractive index is the quotient of the velocity of a light with a given wavelength measured in air and his velocity measured in the examined oil

Lying of liquids on the surface of the firm surfaces

We characterize the lying of liquids with the greatness of the affecting angle (α) of the drop on the firm surface (3. table).

Little affecting angle \rightarrow **better moistening**, big affecting angle \rightarrow **worse moistening**. If the alpha is bigger than 90° degrees, the liquid drop starts to „ooze” on the surface, see it 3. table 2. pictures. The oozed oil is rolling on the surface, so does not supply a lubrication function (in macro sizes there is very well can be seen this process by hotrolling the aluminium wide band).

The sort of Young formula establishes a context between the greatness of the tangent angle, the surface tension of the firm body and the surface and border surface tenseness of the

The dopped lubricant with the fatty acids makes it sit up lying better, than that of the mineral oils, succession his affecting angle is smaller. The size of the oil drop, which we may define with the decrease of the affecting angle, increases because of the changes ensuing due to the heat. The surfaces becoming wet depends on the proportion of the oils polar and dispersive parts.

Table 3. Lying of liquids on firm surfaces

Wetting ability	Wetting	Non-wetting
Cause	adhesion force \gg cohesion force	adhesion force \ll cohesion force
Effect	spreading the liquid on the firm of the surface	the liquid blobby of contraction
Block-scheme	<p>Picture 1.</p>	<p>Picture 2.</p>
Equation	Young's formula: $\sigma_{12} \cos \alpha = \sigma_{13} - \sigma_{23}$	
Bounding	$0 \leq \alpha \leq \frac{\pi}{2}$	$\frac{\pi}{2} \leq \alpha \leq \pi$

Since the the bond tendency is strong between the the proportion of firm bodies' and the liquids' energy, opposite this the synthetic esters are predominant apolars, so in them the dispersive energy proportion is the bigger. The experience shows it, that if the disperie part of the firm body is the bigger, the firm body's wetting improves then, $\alpha \rightarrow$ decrease.

Amint az ismeretes a szénhidrogén olajok krakkolódása (hőbomlása) 260°C -on megindul és már 300°C -on gazdaságos technológiák alakultak ki. The coatings carried up with the physical carburation (PVD) have especially big significance since the adhesion stability of the oils improves. The spontaneous epilamization modifies the polarity of the firm body, may worsen and may repair it. As soon as known the hydrocarbon oils cracking (heat decomposition) begins on 260°C degrees and economical technologies took shape on 300°C degrees already.

In the shearing zone the temperatures $400 - 500^\circ\text{C}$ degrees it is attained, on which the heat decomposition accelerates up in a measure like that, that the substance in the everyday sense stops existing formally and quantitatively.

There are characteristic corrective and functionrepairing additives, that his function definitely temperature pendant. If the particles of these substances depart soon, than that the semi-ash burning of residues would ensue, harmful sediments ensue then (epilamization). It the thickness of a newly formed substance $3 - 5$ nanometers is enough to let the polar energy proportion of the tool decrease.

By MMS lubrication where there is not a continuous lubricant supply - but only 5-6 seconds the lubricant drips on the surface of the tool - there is instrumental in the decrease decrease of a polar energy proportion of the tool (the lubricant lying and his adhesion are declining).

I changed the quantity of the lubricant beside constant technological parameters in the course of the experiments. It can be related by comparing the dry refrigeration, the MMS lubrication (in case of a best product which can be received on the market – M1-32 -) and the 5 v% volume percentages emulsive lubrication, that it is possible to present better measurement results with the dry refrigeration (in context of the average one roughness, the back abrasion and the specific cutting force)

By MMS lubrication, when I applied a best product which can be received on the market in 50 g/h and in 30 g/h of quantity then the changing of specific cutting force compared to the basis diagram which can be found in the literature considerable there was not difference.

By the other MMS lubrication, the lubricant was the C14 n-paraffin and i used likewise in 50 g/h and in 30 g/h of quantity. By 30 g/h of quantity the specific cutting force decreased with e.g. 30 % percentages.

By the next MMS lubrication by using 92 v% volume percentages C14 n-paraffin + 8 v% volume percentages laurilalcohol using first 50 g/h, then 30 g/h quantity of lubricant compared to a reference which can be found in the literature the specific cutting force's greatness reduces by 33 % percentages.

This is verifiable, that beside the reduction of the quantity of the applied lubricants the specific cutting force's greatness is reducible by given CGL, dosage greatness and electing additional refrigeration manner (manipulation of molecule). This is reasonable , that setting out from the wet shaping and reaching the stage of the dry shaping in a considerable measure the sliver detachment's energy need is reducible. So the sliver detachment simultaneously the mass of the used lubricant is reducible gradually 50 g/h → 30 g/h → 20 g/h, etc.

This is proved done by the results of experiments with M2-2 model liquid, where the M2-2 induced emission in case of using 50 g/h of lubricant effected 8,93 % percentile decreasing specific cutting force, if leaving all other parameters invariably the M2-2 induced emissions in case of use the 30 g/h of lubricant effected already 29,94 % percentile decreasing of specific cutting force.

Beside the considerable result (decreasing of specific cutting forcet) is very important to establish that this tendency is a finder in the development of the future. (Since we may get so to the dry lubrication.)

The assessment of the applied refrigerating effect

I kept the technological parameters (feeding, depth of cut, rev) on a constant value inside the single measurement in the course of the experiments, while I changed the type and the quantity of the coolant-greaser liquid concerning the the manner of the refrigeration. The standart types of coolant-greaser liquids' are the followings:

- dry lubrication
- emulsive lubrication
- MQL lubrication

The manners of refrigeration are the followings:

- o spontaneous emission
- o induced emission
- o Doppler-cooling.

I present the used up lubricants in the followings. The first four products are the best products which can be received on the market (their experimental codes: E1-A, E2-A, E3-S, M1-32), while the other lubricants are stock solutions only (model-liquid), that were made on on Almás-füzitő in the MOL-LUB Ltd.'s laboratory. The examination minutes of these lubricants originate from here, in which I granted their technical and safety features,.

Based on the received results molecule manipulation uses by me has a considerable effect on the applied coolant-greaser liquids by the sliver detachment. But I did not manage to manifest the positive effect of this molecule manipulation on the available on market (traditionally functional additive coolant-greaser liquids) and the examined coolant-greaser liquids by me.

3.3. The mechanism of tool abrasion

The lubricant creates an elastic contact between the frictional machine parts, which there is with influence onto the friction resistance and the development of the abrasion⁴. The classic abrasion curve consists of three sections as the 18. figure shows it.

From this the tool abrasion is generally different. The tool and the contact between the workpiece are exceptionally strong. The last stage what means that the abrasion became more intensive may be different from time to time.

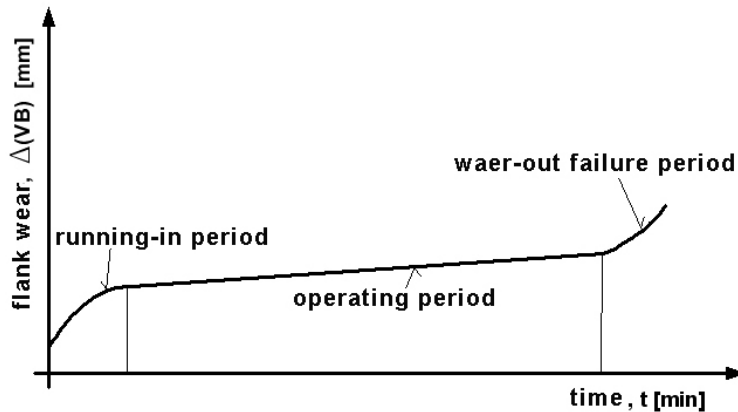


Fig.18. Classical abrasion curve

It is possible to characterize the measure of the tool abrasion- in case of modern tools - with the back abrasion the best. I measured the mass of the blanks in the course of the experiments, then I calculated the measure of the back abrasion from these data.

I depicted the values of the back abrasion in the function of the detached sliver quantity and the done road by cutting based on the domestic and international literature. The back abrasion of the tools may be with three characteristic processions in case of the legatee and the newer modern tools.

First type of abrasion procession, on the 19. figure this is visible, that very soon or promptly after the starting of the shaping the progressive tool abrasion.

I received a result like this:

- dry lubrication, spontaneous emission
- M2-2 Doppler-cooling 30 g/h.

Second type of abrasion procession, that is visible on the 20. figure. The tool abrasion begins promptly after the starting of the shaping, some that the initial section with a lineal character, then becomes progressive after a point.

I received a result like this:

- M1-32 induced emission 50 g/h
- M1-32 spontaneous emission 50 g/h
- M1-32 Doppler-cooling 30 g/h
- M2-2 Doppler-cooling 50 g/h.

⁴ The DIN 50321 standard defines the abrasion. We may grant the measure of the abrasion with the **abrasion-characterizing number** according to the definition

- because of the complete strain and
 - because of the construction of the tribological system
- consists
- onto forms of appearance of abrasion and
 - onto the greatness of abrasion.

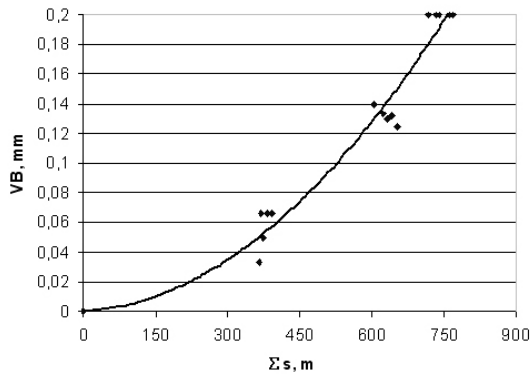


Fig.19. Dry lubrication

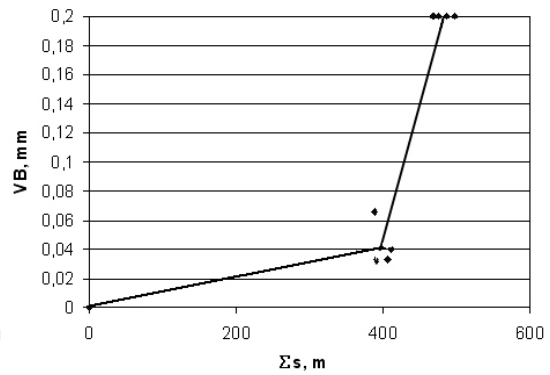


Fig.20. M1-32, Doppler-cooling, 30 g/h

Third type of abrasion procession.

By coated hardsteel tools, where an edge helmet may not form, the adhesion abrasion has it started because of the beginning of the strain there because the coating constitutes a heat gate his section only than a change, which we call **metal transfer**, comes into existence.

So the molecule goes over from the tool onto the workpiece and reversely (that's why not possible to characterize the greatness of the only initial abrasion with a surface abrasion trace, it occurs often that fading is an abrasing trace, but the departure mass of the abrasing element is growing).

The metal transfer in Europe figures in the mostly accepted the sort of Csikós abrasion taxonomy, but only some like changing. This means that the size standing for taking action on the technical level or mass's definition are not possible. But energy accumulates in the tool causes of the strain, which causes of the 3. body on a given level, randomly getting between the surfaces so-called sort of Fridrik break ensues, the break picture of which exceptionally characteristic.

After that the cold broken abrasion turns into intensive, which is abrasion with fast procession with a big direction tangent. The 21. and 22. figure shows the typical example of this.

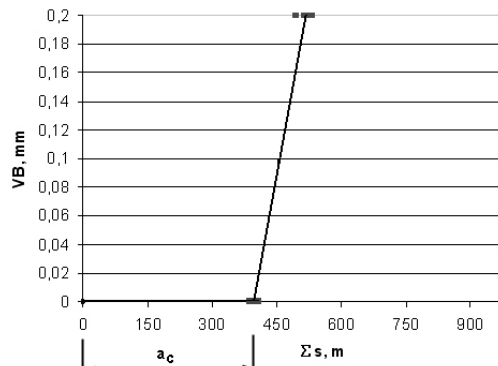


Fig.21. Dry lubrication, induced emission

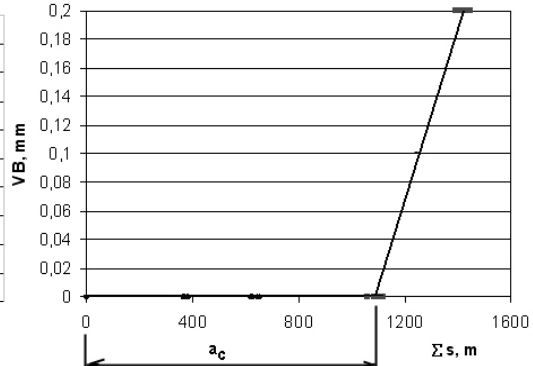


Fig.22. M2-2 induced emission 50 g/h

A break point (a_c) ensuing randomly appears on the manner which can be seen on the 21. figure, this kind of diagram I was able to plot it to more experiments. The values of a_c defined by Roßmann (1999), like contant factor we can not grant it to the tool by cutting shaping.

The character which can be seen on the 20. figure the assessment of the experimental results I observed it by the followings: (in a parenthesis is the appearance of a a_c break point:

- dry lubrication, induced emission (390 m)
- Dry lubrication, Doppler-cooling (657 m)
- E2-A 5 tf %-os emulzió (1102 m)
- M1-32 Doppler-cooling 50 g/h (655 m)

- M1-32 induced emission 30 g/h (400 m)
- M2-2 induced emission 50 g/h (1129 m)
- M2-2 induced emission 30 g/h (650 m)
- M3-2 spontaneous emission 50g/h (658 m)
- M3-2 Doppler-cooling 30 g/h (650 m).

The quantity of the used up lubricant does not influence in big size the randomly ensuing break point, on the other hand those experiments I recorded the diagram which can be seen on the 20. figure, where I applied Doppler refrigeration and induced emission.

Is apparent from the listed results well, that can be reached the best result with a model-liquid and a suitable refrigeration manner. ($s = a_c = 1129$ m). (Fig.22.)

So it is necessary to aim for it, that it $a_c = s$ at what let him be bigger, but abrasion which can be defined on a technical level till then no, let changing only ensue. A theory that would grant it until the start of the intensive abrasion uniformly does not exist according to our today's knowledge passed time out. Certain signs pointed out what kind of factors affect the start of the intensive abrasion in the experiments.

Based on the results can be declared, that the molecule manipulation has a strongest effect on the tool abrasion (delays the formation of the back abrasion).

3.4. Roughness and size keeping

I depicted the average surface roughness based on the measured data under the time unit detached in the function of a sliver quantity. I present the cases qualified by me as extreme in this chapter.

It is possible to characterize the change of the average surface roughness with a tendency of two kinds in the course of the experiments. The 23. figure shows that the average surface roughness improves by the applied refrigeration continuously. Onto the applied lubricant (that a model liquid) the molecule manipulation is with a good effect.

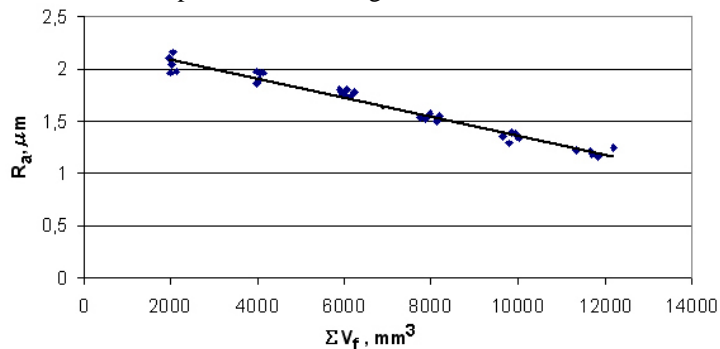


Fig.23. M2-2, Doppler-cooling 50 g/h

With a product which can be received on a market - on the same quantity and refrigeration manner - the surface roughness improves likewise, after a point this is spoiling rapidly as the 24. figure shows it.

But here a much bigger dispersion can be observed. So can be related, that the roughness is repairable with the molecule manipulation, and an average suitable lubricant ($R_a = 1,24 \mu$) that compared with the emanated refrigeration ($R_a = 1,64 \mu\text{m}$). with 5 v% volume percentages emulsion.

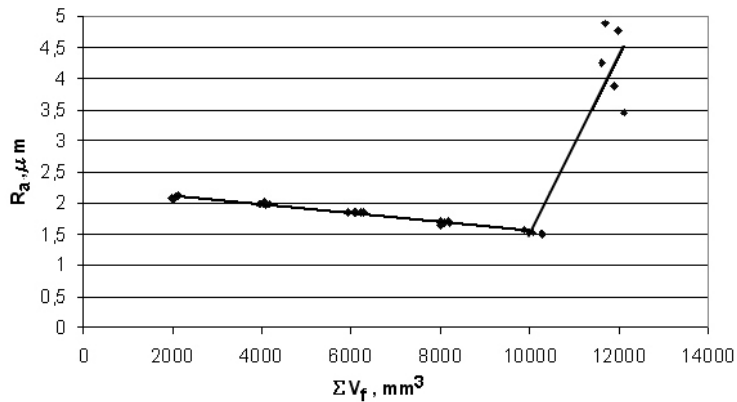


Fig.24. M1-32, Doppler-cooling 50 g/h

It gives the difference between the two diagrams, that by the measurement the knife reached the maximum value of the back abrasion before the 3. measurement place. The mathematical context of the change of the surface roughness in all cases the successor:

$$f(x) = \begin{cases} a_1x + b_1 & \text{if } A \leq 100 \\ a_2x + b_2 & \text{if } A \geq 100 \end{cases}$$

where: „A” is the distance of the 3. measurement place (Fig.3.).

Based on the context this is visible from the diagram that presented on the 24. figure, that the detached average one makes it fall for roughness in the function of sliver volume, an improving one and a declining section of his exist.

This is emerges from a 25. figure, that can be reached in terms of the sliver detachment the best result by my done experiments with the C14 n-paraffin (M2-2) and with a molecule manipulation (induced emission).

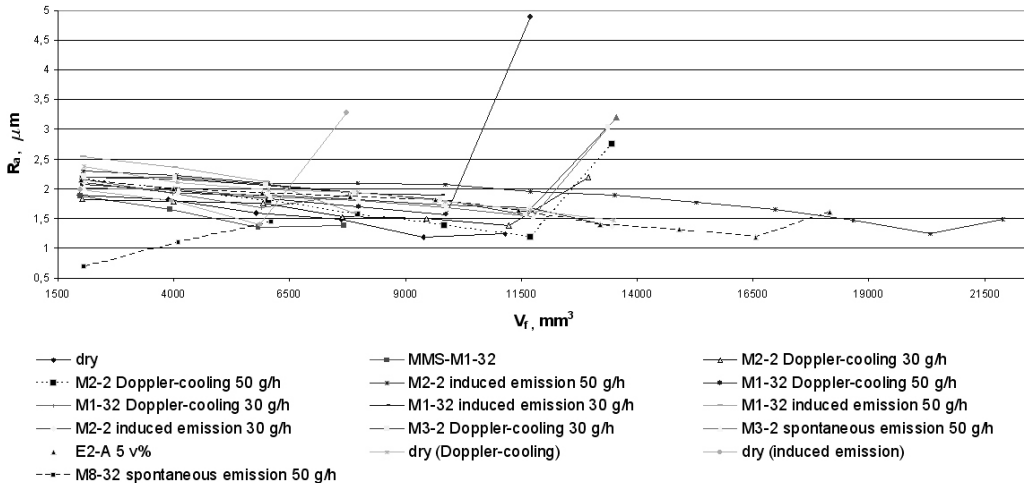


Fig.25. Aggregated diagram between the average surface roughness and the detached sliver volume

The development of the efficient cutting technology, by contacting to the continually intensifying requirements of size keeping and of the surface quality, progresses into the direction of the cutting velocity growing steadily and feeding.

The next assessment point concerned the size keeping of the products (workpieces). From

measured diameters on the examination places I counted an average, I established the upper and lower differences compared to the average then. After that I defined it this from the standard, a what kind of tolerance grade the received values belong to how. For the definition of diameter stability (size keeping) I present an *example* in the followings.

1. $92,22^{+0,13}_{-0,14}$	2. $90,23^{+0,13}_{-0,14}$	3. $88,33^{+0,1}_{-0,19}$	4. $86,30^{+0,14}_{-0,13}$
5. $84,44^{+0,13}_{-0,14}$	6. $82,59^{+0,06}_{-0,09}$	The accuracy of the diameters suits for the IT7 accuracy.	

Of course beyond the example mentioned already better, the IT4 accuracy class size keeping appeared too. This result the next experiments I received it:

- dry lubrication, Doppler-cooling
- M1-32 Doppler-cooling 50 g/h
- M1-32 induced emission 50 g/h
- M2-2 induced emission 50 g/h.

I received result in one case which can be assigned into an IT2 accuracy class:

- M1-32 Doppler-cooling 30 g/h.

Based on the analysis of the results can be declared, that the refrigeration manners applied by me are with influence onto the size keeping of the workpieces, the size keeping of the ready workpiece comes true so.

3.5. The assessment of Crystallite-modifications

The largest part of the chipping energy is needed for the balancing of the exceptionally complicated deformation and the tensile state, the smaller part 3% is needed for the crystal modification. From the prepared polished samples I present the modifications in the grain structure with the application of the following method.

The patterns of the samples having measure of 50 μm are presented in the following figures. A darker domains show the ground layers, the clearer domains show the layer where the effect of the shaping is observable.

Figure 26. shows the case when we applied emulsion of 5 % as lubrication and spontaneous emission to cool the workpiece. The size of the grains is big, the grains at the transition are deformed, the translational plane is visible in small rate.

In Figure 27. the workpiece was cooled with dry lubrication and spontaneous emission. The size of the grains is big, the grains at the transition are deformed, the translational plane is visible good.

In Figure 28. the sample of the experiment made with dry lubrication and with induced emission can be seen. The size of the grains is big, however high deformation at the transition cannot be seen, the translational plane is not visible.

In Figure 29 the sample of the experiment made with dry lubrication and Doppler cooling can be seen. The size of the grains is smaller than it was in the case of the induced emission, however the size of the grains at the transition is smaller and deformations are smaller, the translational plane cannot be seen.

I used MQL lubrication with spontaneous emission in the case of a market product which is shown in Figure 30. The size of the grains is big, deformation at the transition can not be seen, but the translational plane can be seen well.

Figure 31. shows the sample of the experiment where we used MQL lubrication with the

solution prepared by us, with induced emission. The use of the lubricant was 50 g/h. The size of the grains is smaller, high deformation can be observed at the transition. The translational plane is visible mildly. In terms of a friction and abrasion the structure is favourable.

Figure 26, 27 and 30 the translation plane is visible and the deformation of the grains is considerable at the transition. But when we carried out the molecule manipulation with induced emission or Doppler-cooling (Figure 28, 29 and 31), the grain structure is smoother, the translational plane is not or only narrowly visible and the deformation of the grains at the transition is small.

In cases like that, when the crytallite modification is rough granular and is in the layer under the surface – in τ_{\max} plane – dislocation comes into existence, ageing time setting out from the surface then – which form of appearance is the shell shaped pitting – decreases.

In case of surface training, in as much it agrees the trained a layer's depth with the maximum τ plane of tenseness, then the surface ageing accelerates up, in certain cases even full surface decay may ensue after some 10 clocks. The deleterious effects of the substance modifications are avoidable in full whole one's beside optimal technological parameters with MMS lubrication.

The crystal modifications ensuing during the cutting not unconditional harmful, with what known, that it directed in case of a strain with a very good friction characteristic and fading reducing a dendritic fabric at which an effect is may take shape.

My experiments justified that dislocation which can be manifested if the layer under the surface passes through a fine-grained modification does not come into existence.

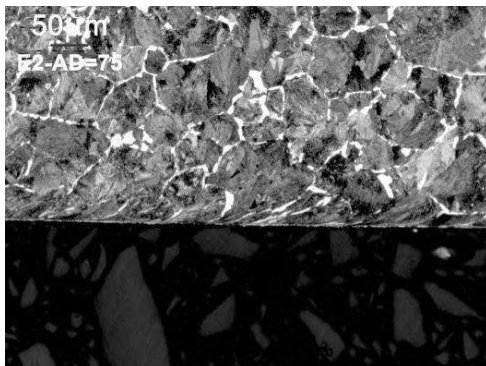


Fig.26. 5tf% emulsion

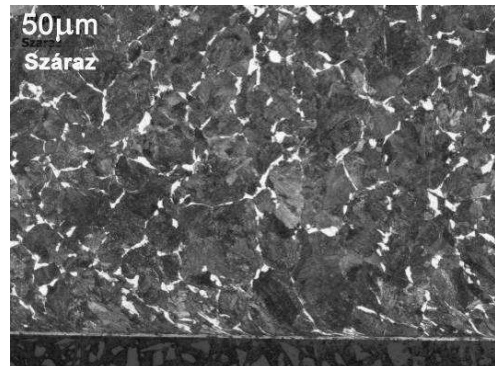


Fig.27. Dry-lubrication

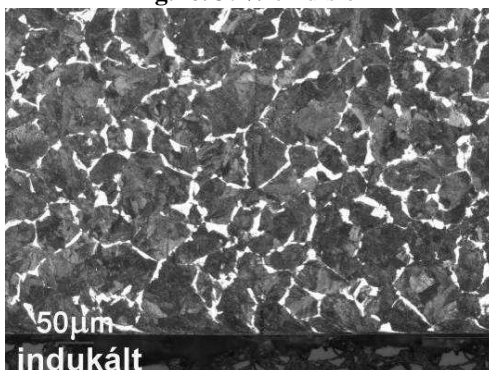


Fig.28. Dry-lubrication (induced emission)

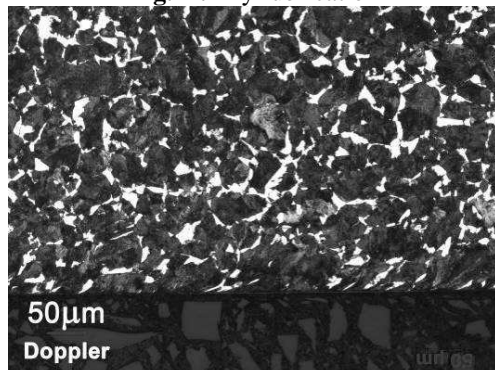


Fig.29. Dry-lubrication (Doppler-cooling)

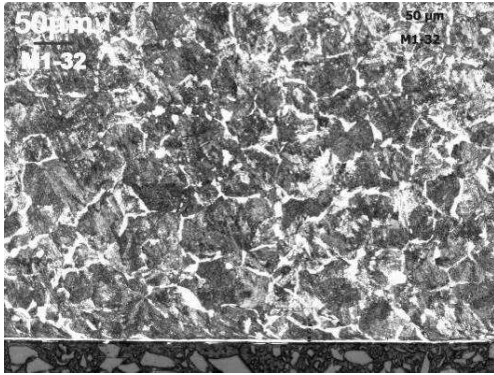


Fig.30. MQL-lubrication (50 g/h)

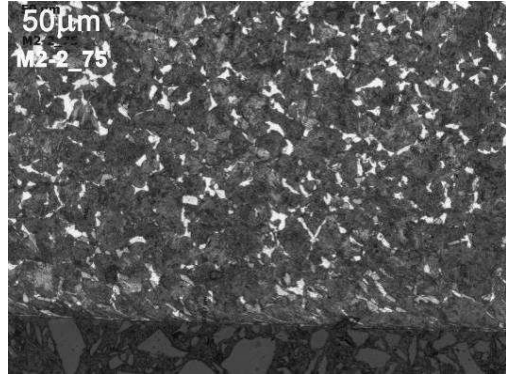


Fig.31. MQL-lubrication (M2-2 induced emission, 50 g/h)

Conclusion (Sequitur)

I formulated the concept of the enlarged cutting shaping with a new view on the 1. figure. After the processing of the experimental results like comprehensive results I present it on the 32. figure. The 32. figure is divisible into three well-separable parts.

The first part presents the cutting happening to the traditional refrigeration procedure. We use emulsion for the cutting at this section. The principal feature of the emulsions developing continuously, that let him be with an environmentally friendly, high-performance, distinguished long lifetime with colloid stability. In this interval the max cutting velocity is 200 m/min.

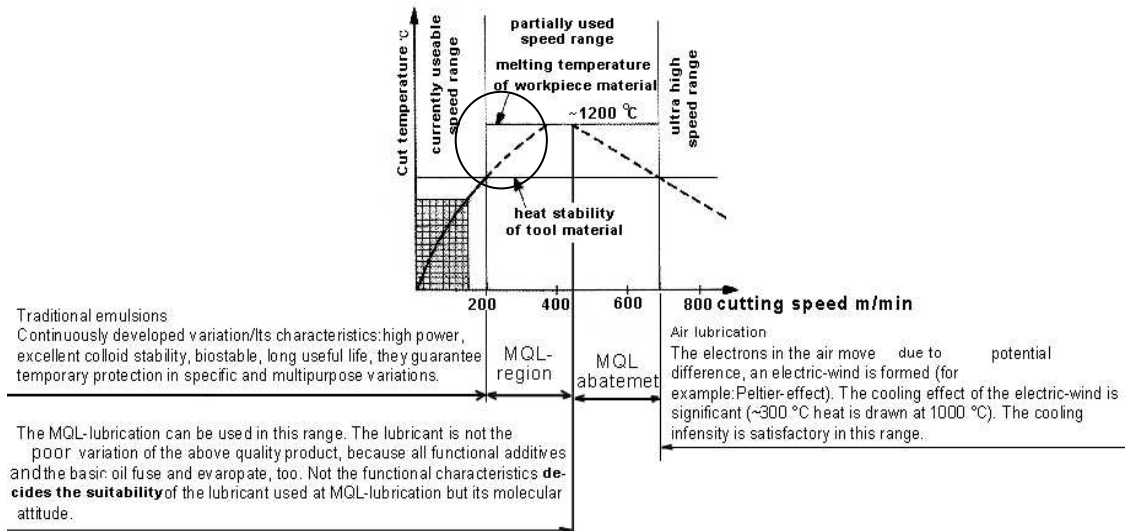


Fig.32. The concept of the cutting shaping with a new view

The next interval is the so-called transitional section, where we may apply MMS lubrication already beside the emanated refrigeration. On the other hand the MMS lubricant is not the diminished quantity of the traditional products, since some are a functional additive in this interval, but even the basis oil melts and vapours. So the functional characteristic does not define the suitability of the used lubricant by MMS lubrication, but his molecular behaviour. The interval of the cutting speed is between $200 < v_c < 400$ m/min.

On the 33. figure this is visible, that how we may get on a what kind of road according to the objective of the future to the dry shaping with the two refrigeration procedures applied beside

each other. On the figure can be observed, that it in case of MMS lubrication that we get into the C point crossover the A point by regulated refrigeration, applying emulsive lubrication strongly cooling from B point we manage to get on a straight line into the C point.

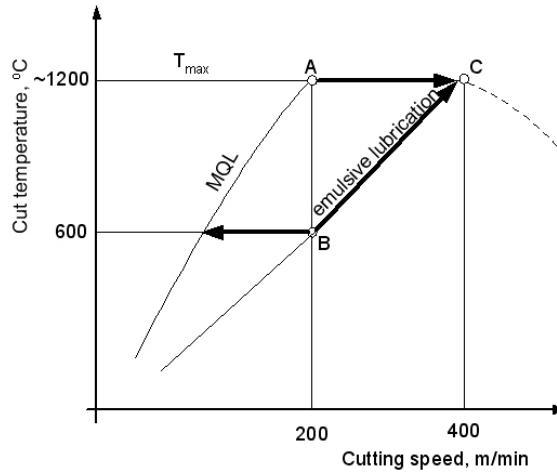


Fig.33. The effect of the refrigeration manner onto the cutting temperature

As soon as it is well-known the relative metamorphoses (ϵ) – of the values occurring at the material testings – is multiple.

$$(0,035 < \epsilon < 1,0) \text{ material testings } \boxed{1 < \epsilon > 6} \text{ cutting interval } (1 < \epsilon \leq 6)$$

By the $\epsilon = 1$ value we grant the $k_{c1,1}$ specific cutting force, as this gets to a review in the 1.1.2. chapter in detail. The contexts' based formula which used for calculations:

$$\tau_0 = \tau_1 \cdot \epsilon^m,$$

where:

- τ_1 - typical slide tenseness for each substances [MPa]
- ϵ – relative deformation [-]
- m – substance pendant exponent [-], his value changes between 0,16 – 0,25, his avarage value is 0,2.

So the theoretical specific cutting force indirectly depends on the tensile strength of the substance ($\tau_1 = 0,8 \cdot R_m$), on the „ m ” exponent and on the sliver thickness which influencing the „ ϵ ” value fundamentally, and depends on the cutting velocity furthermore.

The processing of my research results – it got to a review in previous already – I depicted it in the $\lg h - \lg k_c$ coordinate system the k_c values (that is a straight) and I consider this a root position. I granted it compared to this due to the changing parameters resulting specific cutting force. My done series examinations prove that it is resulting in an energy use changes unambiguously into a context can be brought for with the surface energy level. But according to Einstein's statement the energy depends linearly on the electromagnetic frequency (ν), the changes are parallel though the functuin of „ h ” I and onto some metal surfaces are identical.

The visible light being restricted to the narrow frequency interval, and the used not yet damaging laser's frequency is constant. It follows from this that the new viewed cutting shaping's energy level is the same by given conditions, so the different metals' value of change compared to the k_c basis straight % percentile value is the same

Can be declared, that **the theory of the cutting shaping with an enlarged new view is collective.**

I did the majority of my experiments in this interval and the lubricant (that not the one with traditional dosage, but so-called model liquid) the reduction of his quantity (from 50 g/h to 30 g/h)

continually I reached the third province better. In the third interval, it decreases already the role of MMS lubrication, so his lubricant quantity of which use was made through minimal one onto zero reducible, so the dry shaping we may get into a province. I may say that these experiments may contribute to the **paradigm shift of the cutting**.

3.6. New scientific results

1. Thesis. I laid the foundations for a new modified sliver detachment theory with my experiments and I complemented it with the analysis of the energy conversion process.

1.a.) I proved myself with the experiments, that with electromagnetic waves can be forged the process of the energy conversion, this proves it the measured one and the exceptionally strong correlation between the results calculated theoretically ($r > 0,95$). The thermo plasticity and the shaping one hardening is modifiable with the molecule manipulation locally and from each other independently.

1.b.) I proved on an experimental way that the energy conversion in the cutting zone is adjustable in case of using given, special coolant-greaser, if we create the induced emission with visible light ($\lambda = 10^{-6} m$, $10^{14} < f < 10^{15} Hz$), or rather with a laser ($P < 1mW$, $\lambda = 630-680 nms$) we realise an energy distraction (refrigeration). On a theoretical way it is provable, that with a smaller wavelength ($\lambda = 10^{-8} m$) and with a bigger frequency ($f = 10^{17} Hz$) with the application of X-ray radiation (γ -photon) the results yet can be increased. The enlarged sliver detachment theory with a new view is collective.

2. Thesis. I justified it unambiguously with experiments, that in case of the 42CrMo4 material (the new procedures are extendible onto some materials which can be cutting) it is possible to reduce significantly the specific cutting force (k_c) with MMS lubrication, if in the $k_c (k_c = \frac{k_{c1,1}}{h^m} = \frac{F_c}{h \cdot b})$ context the single features changed between the granted borders ($230 < F_c < 920 N$; $0,067 < h < 1 mm$; $b \leq 1 mm$).

I established on the basis of my cutting experiments executed with the different technological features, that it is possible to delimit the following typical intervals in the decrease of the specific cutting strength in the course of the cutting (34. figure):

2.	k_c abatement [%]	lubrication methods	lubricant	viscosity [mm^2/s]	lubricant quantity [g/h]
2.a.)	5 - 15	induced emission	mixed based, dopped <i>mineral oil</i>	2 - 32	50
2.b.)	16 - 30	spontaneous emission	5 v% <i>emulsion</i> (the emulsol is the best product which can be received in the trade flow)	the viscosity of emulsol >28	flooding
2.c.)	31 - 50	Doppler- cooling	92 v% C14 n- paraffin + 8 v% laurilalcohol	2 - 7	30

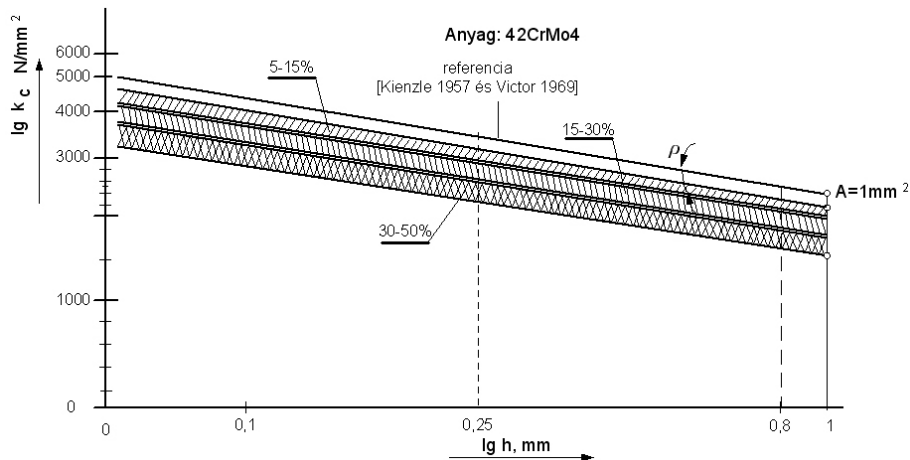


Fig.34. The decrease of the specific cutting force

3. Thesis. I analysed the energy level of the modern tool coatings and I established that their polar energy proportion is identical near, their change mainly the lubricant soiling – chemical modified - being left over from an additive may modify it (it is spoiled generally). The profile completeness factor of the surface is $K_h \sim 96\%$ percentages, which means it, that the surface's ABBOTT-sorted oil contain ability is nearly zero. These adverse circumstances lubricant with a quality, the setting of technological parameters etc. it is necessary to compensate for it. The compensation is necessary in order that the effects which can be brought about by the molecule manipulation assert themselves.

4. Thesis. Manifold experiments and analyses prove that it is a MMS lubricant ornately basis and his additional requirements the traditional emulsions differ significantly and cutting oils his requirements. It is not necessary to count it the (4 – 6) s lifetime oils with the time-bound characteristics.

4.a.) I established that for a MMS lubricant it must be a very good lying, i mean very good wetting capable ($\alpha < 30^\circ$) has to be at his disposal and it must be with strong bandage to the surface of the tool ($\sigma = 32 \text{ mN/m}$).

4.b.) I proved that those lubricants give better results in case of MMS lubrication, that from a polar head (-OH, -COOH, -NH₂ etc.) and saturated, identical one with a coal number being attached to him, lineal, apolar they consist of hydrocarbon, so these are amphipathic molecules. The application of a lubricant like this is built up on his case on the surface the most quickly and getting injuredmentesen the necessary one oriented polomolecular lubricant layer.

4.c.) I established that the MMS lubrication is the most efficient, if in 4 -5 s by evaporation and ionization way this departs from the surface without residual.

4.d.) It was provable unambiguously in the course of my experiments that the largest significance of the character of the curve of distillation is concerned for the starting boiling point of the lubricants. We distinguish two standard makes:

- mineral standard oils és
- ester oils.

MMS oils need it with a stable refractive index to provide, his greatness is $n = 1,51$.

5. Thesis. My researches proved it, that the classic abrasion process which three sections can be assigned on shaping tools – onto the machine parts feature - does not take shape. The shaping

procession of arising tool abrasion is parallel to the horizontal axis and onto this so-called **basis abrasion** superpose „in the function of the cutting velocity” the abrasions with a different mode of action (like e.g.: adhesion, skinning and big cutting velocities diffusion, etc.). On coated hardsteel tools the basis abrasion on a molecular level, like a metal transfer appears and on 400 m/min cutting velocities – if the tool and there is metallurgical affinity between the workpiece – is diffusion. Other additional abrasions do not take shape. Becoming shiny is the form of appearance of the abrasion. In the tool - in case of a continuous usage – energy accumulates, which is after a time, effected by the „third body’s” initiating suddenly, brings broken abrasion. It we may regard it as the edge duration of the tool for shaping till now and based on the nomination of the typical ceramics’ lifetime we nominate it with a_c (Fig. 35.).

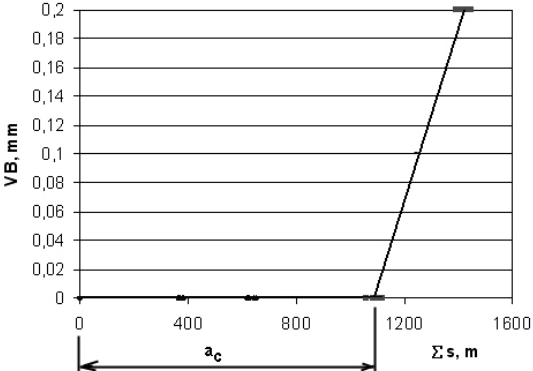


Fig.35. The a_c section's interpretation

The broken abrasion turns into exceptionally intensive, which leads to the decay of a surface quality and the elevation of an energy level already, after the first break point. The first break point is not parameter pendant, but with the energy level of a system feature, which there is in an inverse proportion for the fruition of the sliver detachment,.

6. Thesis. I proved experientially, that adequately for the Hamiltoni-precept, the sliver detachment happens on the minimal-energy-level. At this time the surface nearly in layers fine-grained crystallite-modifying comes into existence, takes shape with the distinguished friction characteristic and fading reducing so-called dendritic fabric at which an effect is, τ_{max} under the surface does not come into existence in plane furthermore dislocation.

4. SUMMARY

4.1. The summary of the research activity

There is a strong ambition in the lubrication technologies to minimize the lubrication used. These are widely used with well defined circumstance. However the development of the lubrication sets is very significant. In these days the concepts are not clear, neither in the practice nor in the sciences. Some researchers make experiments with colloid systems, although the MQL would be used better. In base of the references I draw the definitions of the widely used machining technologies. First I showed the demand of energy of the machining processes.

During my research work I draw the base of the machining in new point of view. In the next I had to decrease the number of the experiments in the theoretical research program because of the conditions. Beside this I tried to keep the maximum measurements, which was possible.

I presented the technological and safety behaviours of the measured lubricant, the circumstances of the experiments, the tools and equipments, the measures (main cutting force, revolution and temperature), the calibration and the reproduction.

The third chapter contains the process of the measures and the evaluation of results. At first the demand and distribution of the energy in connection with the value and distribution of the cut temperature was established. I investigated the rule of the lubricant in the MQL-system. In the next chapter I studied the mechanism at the tool wear. I estimated the results in base of the surface roughness and the size keeping. Finally I estimated the modifications of the crystallites on their photos.

In the last chapter I draw the new thesis, the results and the conclusions. These are summed up in the thesis booklet.

At finally I made some proposals for the utilizations of the results in the practice.

4.2. Practical adaptability of scientific results, conclusions, recommendations

The dissertation shows the results of the three possible directions of the cutting shaping

New „recycling” technology

The substance of the presented essence of the new technology is that the, we insure the emulsions stability by the forming of emulsion provider system without separate intervention.

By this the vulnerability of the emulsions decreases, by the keeping of the even efficiency. It is necessary to reinterpret the lifetime of the emulsions that is not going on from the filling into the machine to the taking out from the machine, it's continuous.

So the production technology does not define the lifetime, the substance time of use which can be calculated from balance. It makes possible to leave the chemical dissolution till now separately mainly applied - in many cases far from the place of application – and the recovery of water like a valuable component that is 92-98% of the emulsion, with the locally continuous, economic realisation of water taking away.

The new technology makes it possible to the substances compared to the opportunities in the firm circulate and let them not get out after a use from the firm's area. Let's not organize its trip

the water many times, but let us accomplish its full circulation with including the energy-saving water-recovering environmentalist distilling equipment in a technological process.

Environment protection

It is necessary to ensure the placement of the components. For example: the water. The firms buy qualitative water to the emulsion making, it is delivered, they make use of it, then the emulsions are transported into the demolishing one where it is disturbed with polluting acid technology, and the got water is set free from the gently dispersed oil and fat particles with an additional coagulation technology to suit for the 28/2004.(XII.25.) KvVm statute about the emission requirements of sewages and then it is let into a channel. The arising hydroxide mud's in the last operation are exceptionally harmful and his disposal expense is whacking. In the country there is about 400000 tons/year of used up emulsion produced, that repeatedly travel on the country's public roads, meanwhile the qualitative change is checked continuously and with increasingly more expensive appliances, it is disturbed with costly and strongly polluting technology, there is introduced a spare technology to the water can be allowed to get into the channel. Setting out from this we drew it up an energy saving distilling equipment which can be executed on the place of the emulsion of application, with which the used up emulsion locally can be distilled the water, like a treated component is reusable to the emulsion production. With the new procedure in the price of the components the present one with 17% emulsion + service charges would decrease to the tierce, about 6%.

Chipping with a new view

The worked out collective theory for the sliver detachment process can be enlarged onto other substances, other frictional systems for example onto the coated ceramic disk braking systems, engine valves, those elements of hydraulics, for which caulking they have a function and the poles of the control elements may not fade.

Some new knowledge or the new sense of old knowledge, as soon as possible let him get into the speciality higher education before and let them be put into the practice, for example: machine planning, lubricant development, etc.

The scientific results are attached to the practice in a higher measure, that immediately actual technologies can be worked. Like the following:

- the definition of the quantity of the applied MQL lubrication
- the definition of optimal technological parameters
- the application of the molecular behaviour of a lubricant
- transition from the wet lubrication into the air lubrication
- the paradigm shift ensuing in the chipping technology circumscribes his firing direction and adds actual knowledge to the technical solutions.

5. PUBLICATIONS IN CONNECTION WITH THE THEME OF DOCTORAL DISSERTATION

Periodical articles:

Opposed article in World language:

[1.] A. KÁRI-HORVÁTH, I. Valasek (2009a): Machining: some new aspects, R&D Mechanical Engineering Letters, 75-87.p., HU ISSN 2060-3789, CD-ROM ISSN 2060-3797

[2.] A. KÁRI-HORVÁTH, I. Valasek (2009b): Developing directions and utilization technology of cooling-oiling liquids from environmental effects, R&D Mechanical Engineering Letters, 324-331.p., HU ISSN 2060-3789, CD-ROM ISSN 2060-3797

[3.] A. KÁRI-HORVÁTH, I. Valasek, I. Zsoldos (2009): The effect of the molecule manipulation on the lifetime of the product, R&D Mechanical Engineering Letters, 34-42.p., HU ISSN 2060-3789, CD-ROM ISSN 2060-3797

Opposed article in Hungarian language:

[4.] Valasek I., Pálffy A., KÁRI-HORVÁTH A. (2007): Minimálkenesű (MMS) forgácsolási jellemzők meghatározása, Gépgyártás XLVII. Évfolyam, 2-3. szám, 47-56. p., HU ISSN 0016-8580

[5.] Valasek I., KÁRI-HORVÁTH A. (2007a): Az üzemi emulziókezelési technológia felülvizsgálata és fejlesztési irányának meghatározása, Gépgyártás XLVII. Évfolyam, 5.szám (I. rész) 18-25. p., HU ISSN 0016-8580

[6.] Valasek I., KÁRI-HORVÁTH A. (2007b): Az üzemi emulziókezelési technológia felülvizsgálata és fejlesztési irányának meghatározása, Gépgyártás XLVII. Évfolyam, 6.szám (II. rész) 26-33. p., HU ISSN 0016-8580

[7.] Valasek I., KÁRI-HORVÁTH A. (2008): Az üzemi emulziókezelési technológia felülvizsgálata és fejlesztési irányának meghatározása, Gépgyártás XLVII. Évfolyam, 1-2. szám (III. rész) 53-59. p., HU ISSN 0016-8580

[8.] KÁRI-HORVÁTH A., Valasek I. (2009a): Az üzemi emulziókezelési technológia felülvizsgálata és a gyorsvizsgálati módszerek alkalmazása, Gép, LX. évfolyam 4-5. szám, 105-111. p., ISSN 0016-8572

[9.] KÁRI-HORVÁTH A., Valasek I. (2009b): Energiatakarékos forgácsolás molekulamanipuláció alkalmazásával – Mezőgazdasági Technika, L. évfolyam, március 2-5. p., HU ISSN 0026 1890

[10.] KÁRI-HORVÁTH A., Valasek I.: Energiatakarékos, környezetbarát forgácsolás, Gépgyártás HU ISSN 0016-8580 megjelenés alatt

[11.] KÁRI-HORVÁTH A., Valasek I.: Energiaigény- és energiaszóródás a forgácsleválasztásnál, Gép ISSN 0016-8572 megjelenés alatt

Conference proceedings:

Hungarian conference proceedings:

[12.] KÁRI-HORVÁTH A., Valasek I. (2008b): Forgácsolási segédanyagok, mint alattomos és rendkívül veszélyes környezetkárosító ágensek, VI. Alföldi Tudományos Tárgyalkodási Napok, Mezőtúr, 2008. október 16-17. ISBN 978-963-87874-2-2 , ISBN 978-963-87874-1-5

[13.] KÁRI-HORVÁTH A., Valasek I. (2008a): A minimál (MMS)-kenés elméleti alapjainak bizonyítása, MTA-AMB 2008. évi XXXII. Kutatási és Fejlesztési Tanácskozása, Gödöllő, 2008. január 22. Kiadvány p.189-194. ISBN 978-963-611-449-7

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[14.] Valasek I., KÁRI-HORVÁTH A. (2007): „Szerszámgépek, Szerszámok, Szerszámanyagok” konferencia a MACH- TECH 2007 kiállításon: Forgácsoláshoz használt hűtő-kenő folyadékok szerepének felülvizsgálata, Budapest 2007. május 10.

[15.] KÁRI-HORVÁTH A., Valasek I. (2006):Fotonenergia alapon megvalósított minimálkenésű (MMS) forgácsolási jellemzők meghatározása (Abstrac) – SZIE TDK Előadásainak összefoglalói, Gödöllő ISBN-10: 963-9483-70-2, ISBN-13: 978-963-9483-70-5

Book, book detail, editing:

Book with a Hungarian language:

[16.] Zsidai L., Kakuk Gy., KÁRI-HORVÁTH A., Szakál Z. (2008): Gyártástervezés, NSZFI, Budapest NS 108 0276 06 005-1