Tsyganov V. V., Matvieienko L. S.

Zaporozhye National Technical University. Ukraine, Zaporozhye

INFLUENCE OF POLYMER LUBRICATING-COOL LIQUID ON EFFICIENCY OF TREATMENT METAL CUTTING

The results of researches influence of polymethylmethacrylate are brought around to wearproofness of instrument, roughness of the treated surface of construction steel, temperature and cutting force. Positive influence of polymer is set on efficiency of treatment due to destruction of polymeric constituent lubricating-cool liquids. The shown ways of increase cutting possibility of instrument are by adjusting of molecular mass polymethylmethacrylate that is entered in the zone of cutting. [dx.doi.org/10.29010/085.3]

Keywords: polymer; chisel; lubricating-cool liquids; macroradicals; polymethylmethacrylate.

Introduction

In connection with various requirements that are pulled out to the modern lubricating-cool liquids, it is recommended to enter different functional additives to them. Thus perspective direction of researches and introduction creation and use are pilot-scale considered during cutting of metals of polymers in composition lubricating-cool liquids.

Environments that have in the composition polymers can be created on the basis of solutions and dispersions of high molecular connections. Use of polymers in the different technological processes of treatment solids, including as active components lubricating-cool liquids for cutting, conditioned by ability of polymers to activate the process of superficial deformation and dispergating of solids [1–4]. As known, from the physical point of view, a surface of metals is an atomic plane with the uncompleted crystalline grate that results in high sorption activity of superficial layer. It, in particular, results in the effect of Rebinder (external and internal), that consists in the adsorption lowering of durability materials due to lowering of free energy and splitter action superficially of active substances at their hit in the cavity of superficial cracks, id est the decline of energy of activating surface assists reduction to durability of material and facilitates the processes of his deformation and destruction. P. A. Rebinder marked however, that an adsorption effect can be observed only in concrete, though to the wide enough area of some middle speeds of deformation; position of this area is determined by the temperature of tests [5].

Polymers of that are destroyed activate destruction of parts iron like low – molecular superficially active substances [6]. Than of below energy of activating destruction polymer, the higher degree of destruction metal.

It of is known that such polymers as polystirol, polyvinylchloride, polymethacrylate, fluorine capacious polymers et al positively influence on the processes of friction. Application of polymers as additives in composition lubricating-cool liquids of it is based on that at their thermal destruction difficult organic radicals that have the increased chemical activity in relation to the juvenile surfaces of metals are distinguished in the zone of cutting. At of implementation such operations, as cutting of screw – thread, reaching, development, organic polymers create on the pin surfaces of cutting instrument and shaving elastic tapes that diminish friction and wear. For of formation of unimolecular protective tapes the small amount of polymeric additives is needed [3].

In particular, introduction is determined by perspective in the zone of cutting active macroradicals that appear at destruction of polymer, for adjusting of polishing and receipt of details efficiency with the necessary structural state of superficial layer. On the basis of results previous researches difficult character of dependence operating properties of stainless steel is set from the general action of free macroradicals polymer, structural state of superficial layer of metal, physical and chemical properties of environment and terms of the mechanical loading in the zone of cutting [7].

However in connection with progress in chemistries of high molecular connections and practical application in different industries of various types polymers, that differ not only on physical and chemical properties but also on a cost, there is a necessity for determination of polymer that provides maximal efficiency of cutting in concrete terms.

The research aim is determination of influence lubricating-cool action of solution polymer on efficiency of cutting construction steel.

Research methodology

Determined influence of polymethylmethacrylate in the cut-in state on efficiency of lathe treatment of construction alloy steel of 40X on the machine-tool of

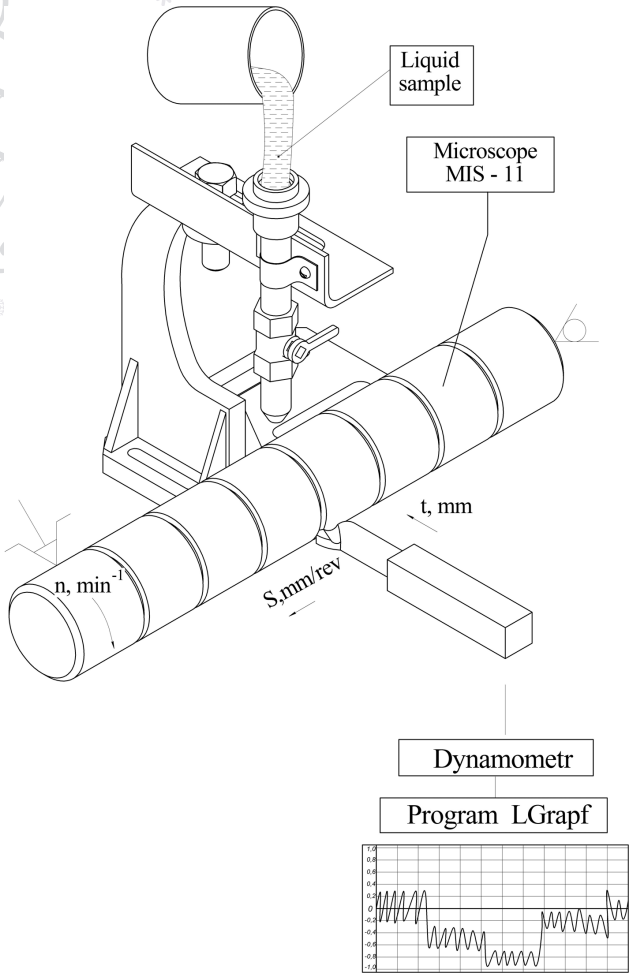


Fig. 1. Scheme of realization researches

1K62. Thus compared the results of researches to the serve zone of cutting acetone and solution of polymethylmethacrylate in an acetone with the concentration of 0,5–1% with speed 0,5 l/min.

The of use of polymethylmethacrylate is related to he is characterized by a relative cheapness and is one of not many widespread polymers, that fully disintegrates to the monomer. At of other polymers the exit of monomer is varied from a zero to considerable part in the general exit of volatile foods. Destruction of polymer is characterized by the breaks in ties of molecule polymer with the origin of pair radicals. Accordingly of the amount of macroradicals at destruction of polymer depends on the number of molecules, id est from their molecular mass. Molecular of mass polymethylmethacrylate of makes 100,12 g/mole, energy of activating destruction – 27 kkal/mole (for a polyethylene 60-70 kkal/mole).

Polymethylmethacrylate well dissolves in carboxylic acids, difficult ethers, including in an own monomer, ketones, chlorinated and aromatic hydrocarbons. In quality of solvent of polymer for researches was select from the row of ketonic substances acetone.

On figure 1 brought scheme over of realization researches. Used of a chisel from high speed steel of P18. Cutting of modes: a serve is longitudinal 0,78 mm/rev, cutting speed a from 40 to 55 m/min, cutting depth a from 1 to 1,5 mm, machine time of work of 1min.

For measuring of temperature in the zone of cutting used multimeter DT – 835 with the thermocouple TP-01A. The wear of cutting edge was measured by an instrumental microscope, roughness of the treated surface – by the microscope MISS-11, cutting force by a dynamometer – УДМ 600 with a record on a computer.

Results of researches and their discussion

Basic results over of researches are brought in a table.

As of follows out the results of researches presented in a table in the considered terms of cutting at the use of solution polymer in comparing to the liquid without a polymer there is reduction to the wear of chisel in three times at the decline of cutting force to 9%, mean linear deviation of cutting force to 29%, and also cutting temperatures to 39%. Thus of the roughness of the treated surface grew on 22...48%. Use of solution polymethylmethacrylate 1% and anymore resulted in formation of tape polymer on contacting surfaces that was accompanied by the speed-up wear of cutting instrument and reduction to the roughness of the treated surface, but here the size of wear remained considerably less than in default of polymer.

Table

Results of researches with the depth of cutting a 1,25 mm

Concentration to the polymer in liquid, %	P_z, N	S^2, N^2	a, N	R_z, mcm	T, °C	S, mm^2
acetone	5893	1205	818	129	173	5,42
0,5% solution	5492	1279	710	191	143	1,72
1% solution	5385	943	581	157	106	3,48

Comment: P_z – cutting force, N; S^2 – dispersion of force cutting of P_z, N^2; a – mean linear deviation of force cutting of P_z, H; R_z – roughness of the treated surface, mcm; T – temperature in the zone of cutting, °C; S – area of wear back surface of chisel, mm^2.

Thus, bringing in of polymethylmethacrylate in the zone of cutting resulted in the increase of cutting possibility of chisel that is confirmed by reduction to his wear, temperatures and cutting forces and entailed the increase of roughness the treated surface. But here is a relatively small decline of cutting force with the unstable change of her dispersion and roughness of the treated surface. It specifies on the unevenness of physical and chemical phenomena in the zone of contact with the presence of polymethylmethacrylate and can be the result of uneven kinetics of mechanical and chemical reactions on the surfaces of metal, the source of that is destruction of polymer.

In this connection, additional studies were undertaken from determination of features of change force of cutting of P_z (figure 2, 3).

So findings of figure 2 specify on that during treatment with different speed of cutting at supply of solution polymer of concentration 0,5% force of cutting diminish from 7 to 30%. But at treatment with speed a 45 m/min with solution of polymethylmethacrylate of concentration 1% arises up cutting force on 23% anymore than treatment without a polymer. It can be the result of decline pyrolysis polymer, by insufficiency of his destruction as a result of reduction of temperature at cutting with subzero speed. Thus surplus of polymer from solution of the increased concentration is distinguished as tape on contacting surfaces and interferes with a cutting process.

From figure of 3, *a* evidently, that at the use of solution of polymethylmethacrylate dispersion of force cutting P_z diminishes and more concentration of polymer, the greater reduction to dispersion. Solution of polymer 0,5% in comparing to the acetone without a polymer diminishes dispersion of force cutting P_z on 30%, and solution with the concentration of 1% – to 45%. It specifies on stability of power expenses of cutting related to destruction of polymer at treatment with solution of polymethylmethacrylate.

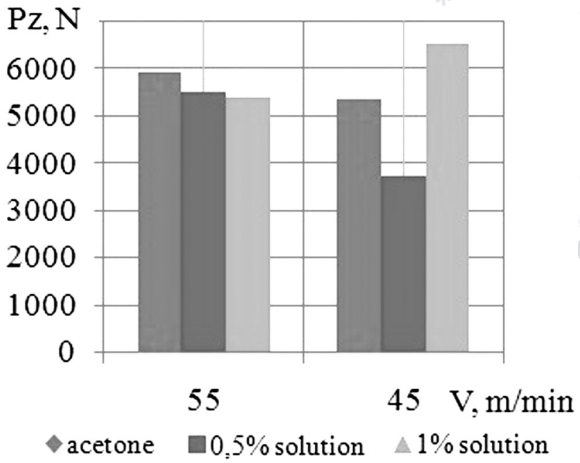
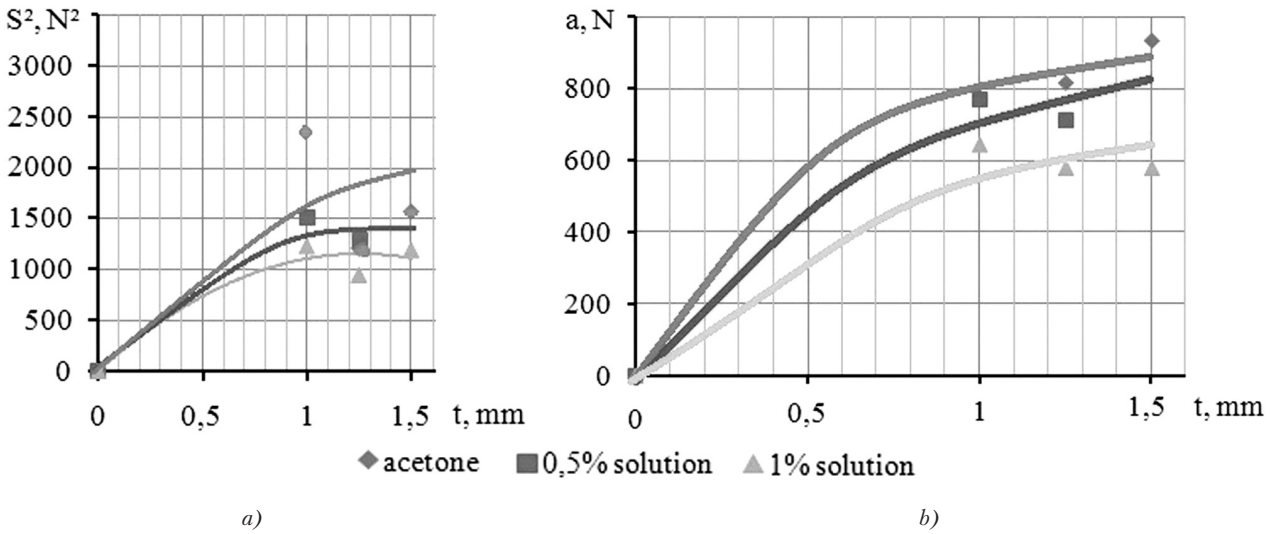


Fig. 2. Histogram of dependence force cutting of P_z from speed of cutting

Increase of cutting evenness during treatment with solution of polymethylmethacrylate more distinctly shows up on the graphic arts of mean linear deviation of force cutting P_z (figure 3, *b*). Mean linear deviation diminishes on 9% at adding to the zone of cutting polymer by the concentration of 0,5% and on 28% – by the concentration of 1%.

It is possible to assume, that a presence in the zone of cutting polymethylmethacrylate assists his adsorption on a metallic surface. Getting in the zone of treatment (cutting or plastic deformation), polymethylmethacrylate tests the process of mechanical and thermal destruction with formation of active products – macroradicals. Macroradicals of chemically sorption are on the metallic surface, creating strong tapes, that divide surfaces that is rub, and substantially reduce the level of superficial energy of the processed metal.



a) *b)*

Fig. 3. Graphic of dependence quantitative indices force of cutting P_z from the depth of cutting *a)* dispersion; *b)* mean linear deviation

In addition, during pyrolytic transformations of polymer there is hydrogen and a carbon is in atomic, or to other active form. Near-by the blade of instrument in the conditions of high temperatures, loading, chemically active surface and presence of exoelectronic emission chemical plasma is created. Going out it there is a hypothesis about permanent carbonization of cutting blade of instrument and to the hydrogen absorption of material workpiece [1, 8].

All of it in an eventual result in the increase of evenness cutting, decline of forces cutting and increase of firmness finishing instrument.

Thus, enhance technological properties of instrument and workpiece during treatment of metal is possible reduction of molecular mass of polymeric constituent and increase here of amount products destruction of molecules polymer. It can be done for an account to the initiator of polymerization that is entered to beginning of polymerization. The increase of concentration initiator polymerization (e.g., peroxides, hydroperoxides, azo compounds) diminishes molecular mass to the polymer, that appears, but accelerates speed of polymerization [9].

But reduction of molecular mass to the polymer is possible and due to introduction to the polymeric constituent of regulator polymerization without the substantial change of speed polymerization. Last years new conception of the controlled processes – pseudoliving radical polymerization develops actively.

By a major feature her there is alternation of periods increase, precipice and reinitiation of polymeric chains due to the negligible quantity of active additions of the special type (stable radicals and their sources, connections of metals variable valency and other), capable of reversible interaction with principal chain by active radicals. Addition of different substances during radical polymerization of methylmethacrylate gives an opportunity to regulate the measure of polymerization and size of the got molecules polymer.

Together with varying of polymerization and terms the modes in the zone of friction of cutting instrument and processed metal, it opens additional possibilities in providing of zone of contact free macroradicals at destruction of polymer [10].

In addition, introduction to the polymeric constituent of regulator polymerization results in the change of physical and mechanical properties of liquid that opens the additional prospects of expansion technological possibilities and increase of cutting possibility of instrument. Optimal chemical composition of regulator polymerization must be determined during the operating tests of liquid taking into account the concrete terms of treatment and material of workpiece.

Conclusions

In the total higher said it is possible to assert that introduction of solution polymethylmethacrylate to the zone of cutting in the considered terms of blade treatment promotes her efficiency. At cutting with a polymeric constituent there is a decline of forces of cutting, dispersion and mean linear deviation of force cutting, temperature, and also to the wear of instrument that can be related to formation in the zone of treatment macroradicals and other products of destruction polymethylmethacrylate.

Thus cutting difficult of physical and chemical processes are the basis of transformation of polymer with a decline to the level of superficial energy of workpiece, that is a process of tooling actually is mechanochemical.

Efficiency of introduction polymeric constituent takes place due to destruction of polymer, that depend on the number of molecules, id est from their molecular mass. Using of polymethylmethacrylate as a polymeric constituent at cutting allows to manage the size of molecules polymer and amount of products their destruction due to varying of realization of the controlled polymerization terms.

References

[1] Soshko A. I. Polymer containing lubricating – cooling liquids /A. I Soshko, Ja.D. Plorkin, V.S. Kuznetsov, Ja.E. Sharapata, L.L. Maksimenko.- Lviv: Kamenjar. – 1986. – 62 p.

[2] Podzolkov A.I. Influence of polymer containing SOTS on efficiency of cutting metals /A. I. Podzolkov, Yu.A. Dubovik, D.A. Babenko //Announcer of the Kharkov national technical university. – 2007 №3(29). –P.184-189.

[3] Latyshev V.N. The increase of efficiency SOZh / V.N. Latyshev. – M.: Engineer. – 1975. – 88p.

[4] Hudobin L.V. Lubricating-cooling technological facilities and their application at treatment cutting: reference /L.V. Hudobin, A.P. Babichev et al. – M.: Engineer. 2006. 544 p.

[5] Rebinder P.A. Select labours. The superficial phenomena are in the dispersible systems. Physical and chemical mechanical /P.A. Rebinder. – M.: Science. – 1979. – 381p.

[6] Gorochovskiy G.A. Polymers in technology of treatment metals /G.A. Gorochovskiy – K.: Naukova dumka.– 1975. – 224p.

[7] Tsyganov V.V. Influence of macroradicals on efficiency of polishing by ribbons from granular abrasive material /V.V. Tsyganov. //Visnik dvigunobuduvannja. – 2012. – №1 – P. 186-191.

[8] Stanchuk E. A. Increase of firmness toolpiece by a diffusive satiation in the process of work /E. A Stanchuk,

A.I. Soshko //Labours of the Mykolaiv shipbuilding institute. – 1981. – № 174. – 56 p.
[9] Vorobev V.A.. Technology of polymers /. V.A. Vorobev, R.A Andrianov. – M. Vyshaya shkola . – 1980. – 303 p.
[10] Tsyganov V.V. Ways by of increase efficiency of granule abrasive material by a tribology methods /V.V. Tsyganov. //Visnuk ChDTU. Seriya «Technical sciences». – 2012. – №4(61). – P. 77-85.

УДК 621.9.01

Циганов В. В., Матвєєнко Л. С.

Запорізький національний технічний університет. Україна, м. Запоріжжя

ВПЛИВ ПОЛІМЕРУ МАСТИЛЬНО-ОХОЛОДЖУВАЛЬНОЇ РІДИНИ НА ЕФЕКТИВНІСТЬ ОБРОБКИ МЕТАЛУ РІЗАННЯМ

Наведено результати досліджень впливу поліметилметакрилату на зносостійкість інструменту, шорсткість обробленої поверхні конструкційної сталі, температуру та силу різання. Встановлено позитивний вплив полімеру на ефективність обробки за рахунок деструкції полімерної складової МОР. Показані шляхи підвищення різальної спроможності інструменту шляхом регулювання молекулярної маси поліметилметакрилату, що вводиться у зону різання. [dx.doi.org/10.29010/085.3]

Ключові слова: полімер; різець; МОР; макрорадикали; поліметилметакрилат; ПММА.

Література

[1] Сошко А.И., Плоткин Я.Д., Кузнецов В.С., Шкарапата Я.Е., Максимонько. Л.Л. Полимерсодержащие смазочно-охлаждающие жидкости. – Львов: Каменяр. – 1986. – 62 с.
[2] Подзолков А.И., Дубовик Ю.А., Бабенко Д.А. Влияние полимерсодержащих СОТС на эффективность резанья металлов. Вестник Харьковского национального технического университета. 2007 №3 (29). 184-189.
[3] Латышев В.Н. Повышение эффективности СОЖ. – М.: Машиностроение. – 1975. – 88с.
[4] Худобин Л.В, Бабичев А.П. и другие. Смазочно-охлаждающие технологические средства и их применение при обработке резаньем: Справочник. – М.: Машиностроение. 2006. 544 с.
[5] Ребиндер П.А. Избранные труды. Поверхностные явления в дисперсионных системах. Физико-химическая механика. – М.: Наука, 1979. – 381с.
[6] Гороховский Г.А. Полимеры в технологии обработки металлов. – К.: Наукова думка, 1975. – 224 с.
[7] Цыганов В.В. Влияние макрорадикалов на эффективность шлифования лентами из гранулированного абразивного материала. Вісник двигунобудування. – 2012. –№1– С.186-191.
[8] Станчук Э. А., Сошко А. И. Повышение стойкости режущего инструмента диффузионным насыщением в процессе работы. Труды Николаевского кораблестроительного института. – 1981. –№ 174. – 56 с.
[9] Воробьев В. А., Андрианов Р. А. Технология полимеров. – 2-е изд., перераб. – М. Высшая школа, 1980. – 303 с.: ил.
[10] Цыганов В.В. Пути повышения эффективности гранульного абразивного материала трибологическими методами. Вісник ЧДТУ. Серія «Технічні науки». – 2012. – №4(61). – С.77–85.