УДК 004.942: 621.97.04

SOME ASPECTS OF BALL BURNISHING PROCESS MODELLING

Bronovskyi I., Storozh Ya., Yurchyshyn V., Yatsyshyn M., Gavryshchuk S.

Ivano-Frankivsk National Technical University of Oil and Gas,
st. Karpatska, 15, Ivano-Frankivsk, 76019

Burnishing is a cold working process in which plastic deformation occurs by applying a pressure through a ball or roller on metallic surfaces. It is a finishing and strengthening process. Improvements in surface finish, surface hardness, wear resistance, fatigue resistance, yield and tensile strength, and corrosion resistance can achieved by applying this process [1]. In addition, burnishing is a highly efficient, technological, and saving-cost process. Therefore, it is widely used in today's manufacturing industry for finishing enhanced machine parts.

Despite the more than 50-year period of the burnishing industrial application, numerous studying, and its seeming simplicity, until now there are not enough reliable engineering methods for predicting the surface layer quality suitable for manufacturing process planning to produce products with predetermined properties. An empirical nature most of conventional studies on experimental determining a relationship between burnishing process parameters and treated part properties directly [2] or by evaluating their surface layer quality [3-6] has a significant drawback: unsuitability of their results for practical applications in other conditions, that is, for designing new manufacturing processes. Approach that is more promising is to develop analytical techniques of technological support in obtaining given service properties of parts worked out by V. Smelyanskyi [2]. It based not on external relations of the burnishing parameters but on internal regularities and mechanisms of the surface layer formation in the center of plastic deformation formed on the theoretical basis of continuum mechanics. However, the simplification underlying the analytical dependence of plastic deformation causing lack of sufficient predictive power of this approach.

A number of foreign publications in recent years (e.g. [4-6]) are devoted to research of some phenomena to improve the surface quality due to local elastic-plastic deformation by numerical methods, including finite-element (FE) analysis. This method of continuum mechanics also has reliable theoretical justification. Although the FE simulation results are not in sufficiently good agreement with the experimental data, this approach is valuable for understanding the material elastic-plastic behavior in the part surface layers. Obviously, we can solve the urgent problem of engineering techniques for the burnishing prediction by using high-quality numerical models and comprehensive approach to their study.

The aim of future research will be to find out regularities of the elastic-plastic behavior of the plane part material during indentation by a rigid sphere through creating and studying the FE model, which is a stage of the burnishing process complex research.

1. Пшибыльский В. Технология поверхностной пластической обработки : пер. с польск. / В. Пшибыльский под. ред. А. Ф. Пименова. – М.: Металлургия, 1991. – 479 с. 2. Смелянский В.М. Механика упрочнения деталей поверхностным пластическим деформированием. - М.: Машиностроение, 2002. - 300 с. 3. Dj. Vukelic1 et al. A burnishing process based on the optimal depth of workpiece penetration. Materials and technology. 47 (2013) 1, pp. 43–51. 4. Deepak Mahajan, Ravindra Tajane. A Review on Ball Burnishing Process. // International Journal of Scientific and Research Publications. 3, (2013) 4, pp. 1-8. 5. M. Sayahi, S. Sghaier, H. Belhadjsalah. Finite element analysis of ball burnishing process: comparisons between numerical results and experiments. // The International Journal of Advanced Manufacturing Technology. 67 (2013), 5-8, pp 1665-1673. 6. Ghodake A. P., Rakhade R.D., Maheshwari A.S. Effect of Burnishing Process on Behavior of Engineering Materials - A Review. Journal of Mechanical and Civil Engineering. 5, Issue (2013) 5, pp. 09-20.

UDC 371.3

AN ONLINE COURSE AND LABORATORY FOR STUDYING AUTOMATIC CONTROL SYSTEMS

Kuchirka Y., Vytvytska L., Pavliv T.

Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, 15 Karpatska Str.

Introduction. Automatic control systems are widely used in industry and everyday life. For example, they are used for automatic control of temperature, pressure, and liquid levels in petroleum and other industries; speed in moving aircraft and spacecraft; and robotics, including operations dangerous to human health or life as well as for automatic control of modern home appliances (smart houses, heating and condition systems, etc.). For designing such systems, the real properties of a control object, including its inertia, imperfection and interaction with the medium, should be taken into account. Although significant differences exist among these processes, the design of automatic control systems (ACS) is based on the same principles and requires the use of special mathematical tools.

This is the subject of a course on the fundamentals of ACS theory. The course is a basic one in automation, measurement, electrical and computer engineering, mechanical, non-destructive control, aerospace and chemical engineering. Such course can be implemented as usual study course in college or university and also e-learning via the Internet.

Problem formulation. An important requirement for such online courses and hands-on labs is to provide access to them with modern mobile devices such as laptops and tablets. This requirement is connected with an increase in the mobility of students, engineers and researchers who are no longer tied to their work places. They need to conduct research using online labs not only at work or at home, but also when they have days off or are travelling. It should also be noted that modern users need to carry out their research in an interactive mode with video broadcasts in real time for operation control of the hands-on lab and to avoid damaging it.