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CONTROLLING THE PRESSURE FORCE TO OBTAIN A BETTER QUALITY OF ALUMINUM 6061 FRICTION STIR WELDED JOINT (p. 6–10)**Djarot B. Darmadi**

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Friction stir welding (FSW) is one of the mechanical joint methods that need no filler metal. The heat is obtained from the friction force between the base metal and friction tool. The FSW is proposed by The Welding Institute – TWI in 1991 which is hoped to overcome problems to weld metals with low weldability. Parameters of FSW determine the quality of the joint and in this paper the normal force as an independent parameter varied at 13,000, 14,000 and 15,000 N. The rotation and feeding speeds are controlled at 1,092 RPM and 200 mm/min respectively. From the experimental results, it is found that 15,000 N provided the strongest joint (specimen 1). The highest heat input was claimed to cause a better joint. This high heat input provides enough weld nugget and time for the aluminum to grow its grains, which in turn increase the tensile strength of the FSW joint.

However, from the average values and the trend line it cannot be assumed that the greater pressure force always produces higher tensile strength. The tensile strengths were almost at the same level (115.44 ± 1.56 MPa) meanwhile the calculated heat input is linearly dependent on the pressure force: 73.59, 79.25 and 84.91 J/mm for pressure forces equal to 13,000, 14,000 and 15,000 respectively. The recorded temperature, which indicates heat input showed the same trend with tensile strength, it was on the same level, those are: 491.55 ± 2.22 °C. There must be some aspects which were not taken into account in the heat input mathematical model. Or maybe, the assumption of higher heat input is not always accomplished by the higher pressure force. Based on the literature, it is found that the yield strength is mitigated at a higher temperature. This lower yield strength decreases the friction force for a constant normal force which in turn causes declining heat input which contradicts the previous assumption.

Another literature that inspected the coefficient of friction as a function of temperature showed that the coefficient is altered due to temperature.

And finally, the higher normal force does not mean a stronger joint can be produced by means of Friction Stir Welding.

Keywords: Friction stir welding, normal force, friction force, coefficient of friction, tensile strength.

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DEVELOPMENT OF A TECHNOLOGY FOR THE SURFACE STRENGTHENING OF BARREL CHANNELS IN THE LARGE-CALIBER ARTILLERY GUNS (p. 11–18)**Ivan Aftanaziv**

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High temperatures and exposure to the chemical effect of powder gases that accompany artillery salvos actively destroy the surface layer of a barrel channel material. This disrupts the geometry of a barrel channel, thereby reducing the accuracy of an artillery gun aimed firing. We have proposed a technology of surface

plastic deformation of the channel inner surface for strengthening the barrels of large caliber artillery and tank guns. The strengthening implies the cold-work hardening of a barrel channel metal with spherical deforming bodies that are mounted onto a massive cylindrical reinforcer. During machining, the reinforcer is driven into a rolling motion over the treated inner surface of a barrel channel and moves along the geometrical center of the machined gun's barrel. As a result of such a hardening treatment, the residual compression stresses form in the thickness of a barrel channel material, thereby improving its surface microhardness. That contributes to an increase in the resistance of a barrel channel material against its burn-out and wear during artillery salvos.

The reinforcing equipment for the implementation of such a treatment includes a reinforcer in the form of a cylinder with deforming bodies, an electric motor of the drive, and a mechanism to transfer the torque from the motor shaft to the reinforcer. During strengthening treatment, the set-up moves along a gun barrel channel, cold-working its material. The ensured hardening thickness is 0.15–0.20 mm.

The hardened surface layer of a gun barrel material, due to the heightened microhardness, firmly opposes the formation of operational microcracks within it. The compression stresses, formed in the thickness of a barrel channel metal, resist the temperature propagation of microcracks. Owing to this, the resistance of the hardened barrel metal against operational destruction increases, thereby improving the reliability and durability of costly artillery armament.

Keywords: artillery gun, gun barrel channel, high-temperature burnout, wear, surface hardening, microhardness improvement.

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APPLICATION OF INDEX ESTIMATES FOR IMPROVING ACCURACY DURING SELECTION OF MACHINE OPERATORS (p. 18–26)**Alexander Laktionov**Poltava Polytechnic College of the National Technical University
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The methods proposed in this paper for calculating index ratings when selecting machine operators provide greater accuracy than the selection based on expert estimates and integrated indicators for groups of expert estimates.

Index estimates are calculated based on the algorithm that combines self-assessments and expert estimates into the Quality index of professional competence of a machine operator (I_{PC}) while expert estimates and standardized assessments are combined into the Quality index of a machine operator training (I_{QT}). The proposed methods for computing the index estimates comprehensively characterize an element in the functioning of the social subsystem in the system «Machine operator – Machine with numerical control – Part manufacturing program», OMMP.

Index estimates characterize the degree of coherence/imbalance among self-assessments and expert estimates, as well as expert estimates and standardized assessments, as well as systemic interrelations between a machine operator and elements of the social, technical, and information subsystems within an open system.

Advantages of index-based selection of machine operators over that based on expert estimates were assessed by comparing the two series of rankings in a list of names. The series of rankings were obtained using such methods as linear convolution and multiplicative convolution. It has been proven that the selection of machine operators using linear convolution is considerably more accurate if carried out based on the index estimates, when compared with expert estimates. It is appropriate to use a binary search method to select machine operators in accordance with a customer's requirements.

Keywords: self-assessments, expert estimates, standardized estimates, objective assessments, index estimates.

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RESEARCHING THE INTERACTION OF DIFFERENT PRINTED MATERIALS TYPES WITH LIQUIDS (p. 26–34)**Kateryna Zolotukhina**National Technical University of Ukraine
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The interaction of papers and films with the testing liquid was researched. Measurements of the contact angle were taken depending on the substrate and its morphology. Linear dimensions of the paper were determined while wetting the samples with distilled water, also the dynamics of water penetration into the paper's structure was researched. The quality control of liquid absorption by the paper was conducted. The research of mentioned parameters is required while creating absolutely new materials to be a printing surface. These measurements allow determining the possibility of current existing materials use in a particular technological process of printing.

The relationship between printed surface wetting and its technical-printing parameters is determined. The interaction of the «printed surface – liquid» system is predicted. The component pairs mutual influence onto the printing process is determined. The ability of materials to be used as the printing surface in the inkjet printing and their ability of being used in the offset printing with the printing plate's dampening are researched. The possibility to ensure the normalized color difference of imprints was taken into account.

The stated hypothesis was checked for correspondence to the mathematical-statistical certainty statements. The correlation values and correlation ties were calculated. It was mathematically confirmed that the greatest water repellency depends on the porosity and surface liquid volume values. Also, it more significantly depends on the paper's wetting if comparing to surface liquid volume value. So, while selecting the printed surface, it is necessary to take into account the substrate's porosity, and its liquid wetting degree. The data obtained while measuring the set parameters allows making a decision about printing on the material via several printing types. The research results allow setting the stability of the technological process and getting the reproductions with the normalized values of optical density and with the color difference no more than 5 units.

Keywords: printed surface, printed product, inkjet printing, contact angle, surface wetting.

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