ABSTRACT AND REFERENCES

APPLIED PHYSICS. MATERIALS SCIENCE

DEPENDENCE OF THE COEFFICIENTS OF RESIDUAL GASES ON THE TYPE OF MIXTURE FORMATION AND THE SHAPE OF A COMBUSTION CHAMBER (p. 4-12)

Vladimir Korohodskyi, Andrii Khandrymailov, Oksana Stetsenko

Experimental research and 3D-modeling of gas exchange in a two-stroke engine with spark ignition at the modes of a load characteristic (n=3000 min^{-1}) have shown how external mixture formation (carburetor power supply system), internal mixture formation (direct fuel injection), and the shape of the combustion chamber affect the coefficient values of residual gases.

The calculated mass values of the fresh charge in an engine cylinder differ from the experimental data up to 3 % at external mixture formation and up to 9 % at internal mixture formation. Coefficients of the residual gases change in engines: (1) with a symmetric hemispherical combustion chamber and external mixture formation – from 0.17 to 0.24, (2) with a hemispherical combustion chamber shifted to the outlet port and internal mixture formation – from 0.13 to 0.15, and (3) with a symmetric hemispherical combustion chamber and internal mixture formation – from 0.13 to 0.4.

It is found that transition from external to internal mixture formation and using a hemispherical combustion chamber would reduce the coefficient values of residual gases up to 41 %.

Keywords: two-stroke engine, combustion chamber, exhaust gases, mixture formation, modeling, gas exchange processes.

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SIMULATION OF CABLE AND WIRE WASTE SEPARATION PROCESS (p. 12-18)

Lena Nazimko, Sergey Malko, Anna Semenova

Growth in the amount of waste containing non-ferrous metals leads to environmental pollution. Waste recycling is economically advantageous not only from an environmental standpoint. The problem is to separate the scrap components for further processing. The cheapest method is gravity separation in the air stream. The study found that the process efficiency and performance depend on the material looseness in the working space of the separator. The effect of this parameter is examined through numerical simulation using the discrete element method and GranularLux software package.

This method allows exploring various process parameters in very small, discrete time periods, the impact of which is difficult to reveal in the field experiment. The theoretical basis of the method and the results of simulation of cable and wire waste separation process are presented. It is shown that simulation allows determining the rational looseness of scrap particles in the working space of the separator, which provides the required quality of separation products. The results can be used in the development of technology and equipment for waste separation into components. Waste recycling will reduce human impacts on the environment.

Keywords: waste, cables and wires, components, separation, air separation, numerical simulation, looseness.

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THE WATER JET GUIDED LASER METHOD IN PUNCHING HONEYCOMB CORES FOR AEROSPACE SANDWICH PANELS (p. 19-30)

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The study shows the options and proves feasibility of applying the water jet guided laser method in perforating 55 micron-thick aluminum foil AMg-2N that is used in corrugated sets of honeycomb panels for aircraft and spacecraft interiors. It is proved that the modes of treatment have a significant effect on the durability characteristics of the material since they predetermine the thickness of the defective layer at the obtained holes. An optimal choice of the pulse rate and the flow rate can reduce the width of the defective layer by 20–50 % and bring it down to 0.035 mm. Intensive cooling of the perforated zone can also eliminate cracking at the edges, thereby increasing the tensile strength up to 229 MPa, which is close to the strength value of the supplied material; meanwhile relative elongation remains virtually unchanged.

The experimental research used LBC-400-5. The laser-jet stream was formed due to the original head design that minimizes the loss of the output power.

The research has proved that deviation of the flashed hole from the circumference is minimized by an adjustment of the laser-jet head, i. e. combining the axes of the laser beam and the jet of fluid. The use of nozzles with profile cut (in the form of a rectangle with rounded corners, oval, or triangle) produces an appropriate shape of the holes, which is very important for manufacturing honeycomb panels with an aperiodically curvilinear corrugated-core structure.

Keywords: water jet guided laser method, perforation, aluminum-magnesium foil, defective layer, a hole, high-energy stream, honeycomb panels.

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POLYAMIDE RESIN FOR PAPER WET STRENGTH IMPROVEMENT (p. 31-38)

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In order to enhance consumer properties of the tissue paper, effective chemicals, namely the epichlorohydrin-modified polyamide resin of different manufacturers, are selected for paper strength improvement in dry and wet conditions. The environmentally friendly Kymene 25X-Cel resin made in the USA is characterized by the highest efficiency. Also, the given resin appeared the most economic in production. Expenditure amounted to 2 kg per ton of paper.

Fiber composition for paper production based on bleached sulphate softwood pulp – 40 %, bisulphate softwood pulp – 20 %, bleached sulphate hardwood pulp – 40 %, ground to 27–32°SR is developed. Such ratio of fiber semi-products provides the highest consumer properties of paper.

It is found that the Kymene 25X-Cel resin should be added to the paper pulp after grinding of cellulose fibers and diluted with water prior to introduction. Under these conditions, the highest efficiency of the resin is achieved.

Paper samples with different contents of the epichlorohydrin-modified polyamide Kymene 25X-Cel resin (0.2–0.8 % of absolutely dry fiber), which were compared with the paper sample made without the resin are made.

It is determined that 0.6–0.8 % of absolutely dry fiber is an effective resin content in the paper composition. It allows achieving the necessary paper strength of 9.3–9.6 % for the developed fiber composition, which provides basic operational properties of finished products.

Keywords: tissue paper, paper strength, consumer properties, epichlorohydrin-modified polyamide resins.

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THE DEPENDENCE OF INTERGRAIN DAMAGEABILITY OF CASTING ON THE TECHNOLOGICAL TREATMENT ROUTE (p. 39-47)

Yaroslav Kusyi, Oleg Kuzin, Nikolai Kuzin

The study determines the role of heredity varieties in machining and assembling the products. The paper presents an analysis of interdependence between technological heredity, the stages of a product life cycle, and structural features of the surface layer. It emphasizes the importance of taking into account procurement operations in analyzing the impact of technological heredity on the parameters of a product. We have analyzed modern concepts for assessing damageability of materials and products and suggested the method of LM-firmness to analyze and assess the transformation of inhomogeneous surface layers of the cast samples into technological damage during machining. We have experimentally studied the role of technological surface treatment in damage formation and processed the findings. We used the model of functionally-graded structure of grain boundaries to determine the role of the cutting modes in the formation of structural stress concentrators.

The devised method for determining the Weibull homogeneity coefficient (m) on the surface of the cast billets allows prognoses of the damage development in the surface layers after machining. The most rational technological treatment route for the casting of AD-type alloys comprises two successive finishing millings, and the Weibull homogeneity coefficient increases by 26–84 % compared to the starting workpiece due to a lower damage of the material at the stage of finishing milling.

Keywords: workflow, reliability, cast billet, technological damage, stress concentrator.

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DEVELOPMENT OF PENETRATION ZONE SIZE PREDICTION TECHNIQUE FOR HOLLOW-CATHODE WELDING TECHNOLOGY OF SPHERICAL TITANIUM TANKS (p. 47-52)

Viktor Pererva, Elena Karpovich, Alexey Fedosov

Implementing the process of hollow-cathode vacuum welding at the plant requires correct mathematical processing of experimental data in order to obtain dependencies of geometrical parameters of the weld on welding conditions.

A technique for predicting the geometry of the welded joints obtained by hollow-cathode vacuum welding depending on the welding variables is proposed. The analysis was conducted on samples made of high-strength titanium alloys VT6S. The technique showed that the combined method based on a joint analysis of the results of theoretical and experimental studies allows predicting the geometrical parameters of the penetration zone with a sufficient degree of accuracy.

This technique provides a high accuracy of the calculation of the weld sizes in a predetermined range of welding conditions and can be applied in a production environment.

Keywords: high-strength titanium alloys, mathematical physics, hollow-cathode welding, mathematical modeling.

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INFLUENCE OF TECHNOLOGICAL PARAMETERS OF CENTRIFUGAL REINFORCEMENT UPON QUALITY INDICATORS OF PARTS (p. 53-62)

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Analysis of surface and three-dimensional reinforcement methods to enhance the wear-resistance of parts is performed. The advantages of centrifugal reinforcement of the part blanks with two mutually perpendicular axes of rotation of the ceramic mold to produce the reinforced zone with desired properties are substantiated. The influence of technological parameters of centrifugal reinforcement of steel parts with tungsten carbide particles in the casting process on the concentration and the wear of the working area using the mathematical experimental design is investigated. Second-order regression models for dependencies of concentration and wear on the technological process parameters: the number of rotations around the horizontal and vertical axes of the ceramic mold, heating temperature of the ceramic mold and heating temperature of reinforcing tungsten carbide particles are built.

The optimum values of frequencies of rotation around the horizontal and vertical axes, heating temperatures of the mold and reinforcing particles, which provide the maximum concentration of tungsten carbide particles in the working area and minimum wear are determined. It is found that the concentration of tungsten carbide particles in the working area and wear are affected by the kinematic components of technological parameters more than temperature ones. For centrifugal reinforcement of inserted drilling bit teeth with 1.0 mm tungsten carbide particles with two mutually

perpendicular axes of rotation of the ceramic mold, the following technological parameters are optimal: n_x=217 rpm; n_z=702 rpm; $T_ф$=270 °C; T_a=208 °C providing a maximum tungsten carbide concentration in the working area and minimum wear.

The research results are useful in the development of technological processes of manufacturing turned parts with the reinforced working area, namely disc and tooth rolling cutters, milling cutters, blade drilling bits, inserted drilling bit teeth.

Keywords: technological parameters, centrifugal reinforcement, tungsten carbide particles, concentration, wear-resistance.

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