

Melentiev R. Yu. Computer modeling of the thermal field in the elementary volume of polymer composites3–8

The paper considers the opportunity for investigation of the thermal field in two-component systems of the type of polymeric composite materials with continuous fibrous filler. In view of the widespread use of polymer composites high relevance of issues relating to their processing. Is a literary analysis of shortcomings of the thermophysical properties of polymer composite materials, arising in the process of machining. The author suggests a method of investigation of thermal processes in complex anisotropic bodies, do not have an analytical solution without primary assumptions that affect the accuracy of these decisions. The method consists in reducing the geometry of the investigated object to this simple structure duplicating that you can get the source object. Created and step-described computer model of the thermal field of structural phases of polymer composite material in an elementary volume. The definition of the process of heat distribution on the surface and on the axis of an individual fiber and unit cell. The researchers calculated that the maximum temperature occurs at the surface of a polymer matrix and considerably differs from the temperature on the surface of the fiber. By isothermal analysis revealed the thermal effect of the polymer matrix on the fiber. In the modeling process, identifies factors affecting the formation of the temperature field in the unit cell material, among them: thermophysical properties of the components, their volume content, geometrical parameters and orientation relative to each other.

Key words: polymer composite materials, thermal field, thermal conductivity, fiber, elementary cell.

Создана и исследована компьютерная модель теплового поля структурных фаз полимерных композиционных материалов в элементарном объеме. Определено различие процесса распределения теплоты на поверхности и по оси отдельного волокна и элементарной ячейки. Установлено тепловое влияние полимерной матрицы на волокно.

Ключевые слова: полимерные композиционные материалы, тепловое поле, теплопроводность, волокно, элементарная ячейка.

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Dynamics and Strength of Machines

Chernobryvko M. V., Avramov K. V., Romanenko V. N., Batutina T. J. and Pirog B. A. Dynamic instability of rockets deflectors in flight.....9–16

The parabolic shells are widely used in rockets production and aircrafts construction. These shells are streamed by gas flow. The interaction of the thin-walled structures with gas stream can lead to the self-sustained vibrations with large amplitudes. As follows from the above-presented survey, the dynamics of parabolic shells in gas stream is not analyzed. Such structures are widely used in rocket production and aeronautics. As follows from the experimental analysis of rockets elements in supersonic gas stream, these structures perform self- sustained vibrations with significant amplitudes.

The equations of the parabolic shell motions are obtained using the assumed- modes method. It is obtained the system of the ordinary differential equations described the parabolic shell vibrations in a supersonic flow. The approach for calculation of the shape of the shell self- sustained vibrations origin is suggested. The dynamic instability of the parabolic shells is analyzed numerically. The properties of the shell vibrations are investigated.

The unstable equilibrium of the parabolic shell in the supersonic gas stream is observed in the following range of the Mach number: $1 < M \leq 1.4142$. The critical Mach number is not changed, if the height of the shell is increased from 2m to 4 m. This is explained by violent vibrations, which are observed in the shell bottom.

The frequencies of the self- sustained vibrations are significantly larger, then the lower eigenfrequencies of the shell. If the height of the shell is increased, the frequency of the self- sustained vibrations is increased too. Note, that the shell eigenfrequencies are decreased, if the shell height is increased.

Keywords: parabolic shell, rockets deflectors, assumed-modes method, Mach number, supersonic gas stream.

Исследуется динамическая неустойчивость обтекателей ракет-носителей в полете. Так как большую часть полета ракета движется со сверхзвуковой скоростью, то для описания давления газа, действующего на обтекатель, применяется поршневая теория. Обтекатель ракеты-носителя описывается параболической оболочкой. Для вывода уравнений колебаний применяется метод заданных форм. Исследуются свойства колебаний обтекателя.

Ключевые слова: параболическая оболочка, обтекатель ракеты-носителя, метод заданных форм, число Маха, сверхзвуковой газовый поток.

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Hasanov F. F. Modelling of crack nucleation in the fibre of composite reinforced with unidirectional fibres under shear 17–25

The model of shear crack nucleation in composite fibre with the periodic structure, based on consideration of fracturing zone is offered. It is assumed, that the fracturing zone represents as finite length layer that containing the material with partially broken bonds between separate structural elements. The analysis of prefracture zone limiting equilibrium under transverse shear is carried out on the basis of criterion of material bonds limiting shear and includes: 1) an establishment of cohesive forces dependence from prefracture zone faces shear; 2) an estimation of the stress state near to prefracture zone in view of external loadings and cohesive forces; 3) definition of critical external loadings dependence from geometrical parameters of the composite environment at which appears the crack.

Key words: nucleation of shear crack, composite, unidirectional fibres, traction in bonds, transverse shear.

Предложена модель зарождения трещины сдвига в волокне композита с периодической структурой, основанная на рассмотрении зоны трещинообразования. Предполагается, что зона процесса трещинообразования представляет собой слой конечной длины, содержащий материал с частично нарушенными связями между отдельными структурными элементами. Наличие связей между берегами зоны предразрушения моделируется приложением к поверхности этой зоны сил сцепления, вызванных отсутствием связей. Анализ предельного равновесия зоны предразрушения при поперечном сдвиге выполняется на основе критерия предельного сдвига связей материала.

Ключевые слова: зарождение трещины сдвига, композит, однонаправленные волокна, усилия в связях, поперечный сдвиг.

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Zulfugarov E. I. Thermoelastic stress state in the brake drum with prefracture zone at braking the wheel machine26–32

The model of cracking in the brake mechanism drum under action of temperature stresses at braking the automobile is work out. Thermal fracture is caused by heat generation in the drum during the friction. The model is based on the analysis of the fracturing zone. During operation of the wheel car friction pair "drum - lining" in the metal brake drum will occur prefracture zones, which model as the area of weakened interparticle bonds of material. It is assumed that under the action of normal and tangential load on the inner surface of the drum interaction between the surfaces in the prefracture zones is characterized by normal and shear constant adhesion stresses. Interaction of prefracture zone faces is modeled by introducing between the faces plastic slip lines (degenerate plastic deformations bands). Relations determining the critical values of heat exposure intensity, under which in the drum brake cracking occurs, are received.

Keywords: brake drum of the wheel machine, prefracture zone, thermoelastic stress condition, fracturing.

Разработана расчетная модель, в рамках которой описывается трещинообразование в барабане тормозного механизма под действием температурных напряжений при торможении автомобиля. Взаимодействие берегов зоны предразрушения моделируется введением между ними линий пластического скольжения. Получены соотношения для определения критического значения интенсивности теплового воздействия, при котором в барабане тормозного механизма произойдет трещинообразование.

Ключевые слова: тормозной барабан колесной машины, зона предразрушения, термоупругое напряженное состояние, трещинообразование.

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Applied Mathematics

Lytvyn O O., Shtepa N. I., Kulyk S. I. and Chornaya O. S. Mathematical simulation of minerals with polynomial interlineation on the system deviated wells.33–39

This paper provides an overview of the new minerals distribution mathematical models construction 3D methods by 3 variables functions interlineation methods on a system of inclined boreholes. The problem of constructing minerals distribution spatial mathematical models for the case when the information about minerals distribution function $f(x, y, z)$ is specified in the M inclined boreholes is considered. Methods of three-dimensional mathematical model construction with the use of functions interlineation on an inclined boreholes system, which are based on the use of limited fractionally rational auxiliary functions, are given. The method of minerals distribution modeling with the help of polynomial interlineants on inclined boreholes system placed both in the same plane and in an arbitrary manner is proposed. Experimental data are mineral resources distribution at every point of the boreholes system. The given mathematical model allows calculating an unknown mineral resources distribution between the boreholes.

Keywords: mathematical model, interlineation, cores, inclined boreholes, polynomial interpolation.

Предложен метод моделирования распределения полезных ископаемых при помощи полиномиальных интерлиантов на системе наклонных скважин, размещенных как в одной плоскости, так и произвольным образом. В качестве экспериментальных данных взяты распределение полезных ископаемых в каждой точке системы скважин. Математическая модель позволяет вычислять неизвестное распределение полезных ископаемых между скважинами.

Ключевые слова: математическая модель, интерлианция, керны, наклонные скважины, полиномиальная интерполяция.

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Chugay A. M. A method of generation of starting arrangements in a problem of structure modelling of systems of densely packed objects40–45

In this paper a mathematical model of a dense packing problem of non-oriented convex polytopes into a cuboid of minimum height is constructed by using the quasi Φ -function.

An application of quasi Φ -functions allows to formulate mutual non-intersections conditions for a pair of objects as a set of inequalities systems left sides of which are infinitely differentiable functions. Owing to this fact a mathematical model of the problem is presented as a classical non-linear programming problem.

For construction of different starting points a special method is proposed. The method includes three stages. On the first and second stages helper problems are solved. The first helper problem allows us to find a covering of polytopes by spheres of minimal radius. The second one allows us to find a dense packing of spheres in an arrangement region. At the third stage parameters of separating planes between the dense packing spheres are calculated.

In order to find local extrema of the helper problems the IPOPT library is used.

Key words: mathematical modelling, quasi Φ -function, non-oriented convex polytopes, objects dense packing

На основе квази Φ -функций построена математическая модель задачи плотной упаковки неориентированных выпуклых многогранников в параллелепипеде минимальной высоты. На основе особенностей построенной модели предложен метод получения различных начальных размещений многогранников. Метод состоит из трех основных этапов. На первых двух решаются вспомогательные задачи нелинейного

программирования, которые позволяют получить начальное размещение многогранников. На последнем этапе определяются параметры разделяющих плоскостей для квази- Φ -функций.

Ключевые слова: математическое моделирование, квази- Φ -функция, неориентированные выпуклые многогранники, плотная упаковка объектов.

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Non-traditional Power Engineering

Koshelnik O. V. and Chorna N. A. Prospects of hydrogen energy conversion systems use for waste recovery of thermal secondary power resources in high-temperature heat technological complexes.....46–53

The scheme of energy conversion complex for the simultaneous thermal and electric power production with the application of hydrogen turbine unit and thermal sorption compressor for waste recovery of low-temperature secondary thermal power resources has been proposed. A structure and basic design stages of the metal hydride systems for energy technological hydrogen processing have been determined. It allows to calculate system operation and completely to define a complex of structural and operation parameters which characterize its general effectiveness. The technique and calculation algorithm of thermo-sorption interaction metal-hydride - hydrogen is developed for case using the kinetic factor. The analysis of unit operation in a range of flue gas temperatures 523–723 K at the inlet to the thermal sorption compressor has been carried out and the main characteristics of the hydrogen circuit of the power plant have been determined. The obtained electric power can be consumed by electrolyzing plants for hydrogen production for the needs of technological processes.

Key words: power technological complex, secondary power resources, hydrogen turbine unit, thermal sorption compressor, power efficiency.

Для утилизации низкотемпературных тепловых вторичных энергоресурсов предложена схема энергопреобразующего комплекса для одновременного производства тепловой и электрической энергии с применением водородной турбоустановки и термосорбционного компрессора. Представлены этапы расчета основных элементов энерготехнологического комплекса. Проведен анализ его работы в диапазоне температур дымовых газов на входе в термосорбционный компрессор 523–723 К и определены основные характеристики водородного контура энергосилового устройства. Полученная электроэнергия может быть использована для производства водорода на технологические нужды.

Ключевые слова: энерготехнологический комплекс, вторичные энергоресурсы, водородная турбоустановка, термосорбционный компрессор, энергоэффективность.

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Ecological Aspects in Mechanical Engineering

Pilipenko S. O. Environmental aspect of competitive use hydrogen as a fuel54–57

This article discusses the prospect of the concept of hydrogen technologies in the context of the approved European Union directives to reduce emissions by vehicles into the atmosphere.

The main purpose of this study is the possibility of using hydrogen technologies based on analysis derived from a variety of sources and activities, research, and adopted guidelines. The use of modern means of communication, the treatment of the scientific literature, allows for the collection and analysis of information received from scientists in different countries. The paper studies the structure of global CO₂ emissions from the transport sector. The influence of the harmful emissions from motor vehicles on public health and the environment in general. The structure of the methods to reduce CO₂ emissions from transport according to the International Energy Agency. The article deals with the European directive on the reduction of CO₂ emissions.

Based on the data and studies, we propose to reduce the amount of harmful toxic emissions of vehicles using hydrogen as a fuel. In this paper, by analyzing scientific articles and studies obtained, we conclude that the search for alternative sources of fuel for motor vehicles will inevitably come to hydrogen as the fuel type is really safe.

Keywords: hydrogen, CO₂ emission vehicles, the environment, the European directive on the reduction of CO₂ emissions, the competitiveness of the use of hydrogen as a fuel.

Представлен анализ результатов исследований выбросов автотранспортными средствами при использовании различных видов топлива в двигателях внутреннего сгорания. Выявлено наиболее экологически безопасное топливо из анализа углеводородного топлива и перспективных альтернатив применения различных видов топлива в автотранспорте. Разработано методика сокращения выбросов вредных веществ двигателями, которая базируется на использовании водорода на борту автомобиля как в качестве автономного вида топлива, так и в смеси с различными видами топлива.

Ключевые слова: водород, выбросы CO₂ транспортными средствами, экология, европейские директивы по сокращению выбросов CO₂, конкурентоспособность использования водорода в качестве топлива.

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High Technology in Mechanical Engineering

Kravchenko O. V., Suvorova I. G. and Baranov I. A. Method of determining the effectiveness of hydrocavitation treatment in technologies for producing and combusting composition fuels58–62

A method is suggested for determining the effectiveness of hydrocavitation activation of hydrocarbon-containing composition fuels in their production and combustion technologies. With this in view, the notion of the indicator of cavitation equipment performance has been introduced. It allows determining the conditions of hydrocavitation treatment of fuel emulsions depending on the required quality of the final product. The dependence of the performance indicator on the operating conditions of the rotor pulsation apparatus has been conducted. The RPA performance indicator graphs are nonlinear and demonstrate that conditions exist when increasing the amount of input energy has no effect on the output of light fractions. Firing trials confirm the effectiveness of hydrocavitation activation in the technologies of producing and combusting composition fuels. It has been shown that application of hydrocavitation techniques for intensification of physico-chemical processes in hydrocarbon treatment technologies should come after research in determining the dependence of the indicator of hydrocavitation activation performance on the operating conditions of cavitation equipment.

Keywords: hydrocavitation activation, cavitation effectiveness factor, composite fuels.

Представлен метод определения эффективности гидрокавитационной активации углеводородсодержащих композиционных топлив в технологиях их производства и сжигания. Для этого введено понятие показателя эффективности работы кавитационного оборудования, который позволяет определять режимы гидрокавитационной обработки топливных эмульсий в зависимости от необходимого качества конечного получаемого продукта.

Ключевые слова: гидрокавитационная активация, коэффициент эффективности кавитационного воздействия, композиционные топлива.

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Savitskyi A. M., Savitskyi M. M. and Shkrabaluk U. N. Fetures of increase of productivity of welding an consumable electrode in gas shielded at the expense of arch activation.....62–67

One of the priorities of arc welding is to improve its performance. The traditional solution to this problem involves increasing the amount of metal per unit of time weld. This is due to the limited capacity of the penetrating arc. However, this increases the attachment of heat in the weld, which adversely affects its quality. To solve this problem requires a fundamentally different approach - an increase in the penetration depth. This can be achieved by increasing the penetrating power of the arc by reducing the diameter of the electrode wire or the use of activating fluxes. Studies indicate that by reducing the diameter of the electrode wire can achieve a substantial increase in the penetration depth. However, the practical implementation of this direction is associated with a number of technical difficulties. The second direction of solving this problem is the development and application of welding consumable electrode activating fluxes by analogy with ATIG-welding.

If the penetrating power of the arc when welding in the traditional way to take 1, the use of activating flux can increase it by 2-2.5 times. Therefore, for single full penetration weld metal thickness of 10 mm with the conventional method requires heat input 24694 J/cm. Increase penetrating power of the arc to 2.5 times accompanied by a reduction of heat input required for the base metal thickness of 10 mm to 8103 J/cm.

Application of activating flux for welding consumable electrode helps to reduce the length of stay of the weld metal at high temperatures, which has a positive effect on its properties. This is to increase the viscosity of weld metal at low temperatures. Activating fluxes for welding consumable electrode provides increased productivity by 3-4 times compared with traditional technologies. Application of activating fluxes for welding consumable electrode gas shielded welding provides increased performance while reducing its energy consumption and improving the properties of welded joints.

Keywords: activation arc, consumable electrode, shielding gas, welding.

Изложены результаты применения активизирующих флюсов при сварке плавящимся электродом в защитных газах. Показано, что активизирующие флюсы обеспечивают увеличение в 2–3 раза глубины проплавления и повышение производительности сварки по сравнению с традиционным способом. Кроме этого, применение активизирующих флюсов обеспечивает уменьшение погонной энергии сварки, что оказывает положительное влияние на свойства сварных соединений, повышая их хладостойкость.

Ключевые слова: активация дуги, плавящийся электрод, защитный газ, сварка.

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