CONTENTS

Vol. 29, No. 4, 2016

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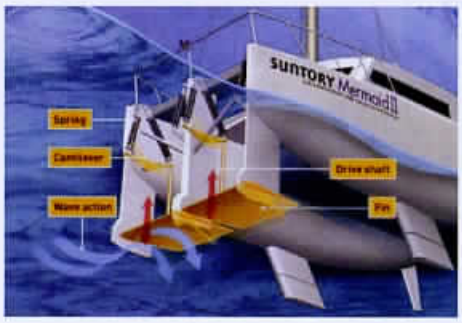
Mechanism and Robotics

CONTENTS

Vol. 29, No. 4, 2016

DOI: 10.3901/CJME.2016.0317.032

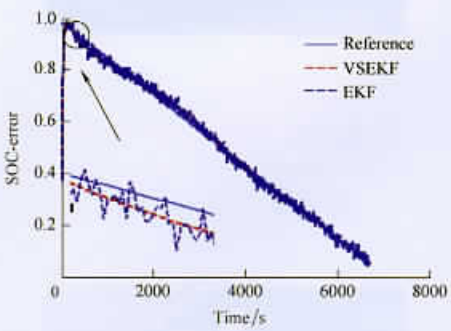
Abstract: Marine mobile buoy(MMB) have many potential applications in the maritime industry and ocean science. Great progress has been made, however the technology in this area is far from maturity in theory and faced with many difficulties in application. A dynamic model of the propulsion mechanism is very necessary for optimizing the parameters of the MMB, especially with consideration of hydrodynamic force. The principle of wave-driven propulsion mechanism is briefly introduced. To set a theory foundation for study on the MMB, a dynamic model of the propulsion mechanism of the MMB is obtained. The responses of the motion of the platform and the hydrofoil are obtained by using a numerical integration method to solve the ordinary differential equations. A simplified form of the motion equations is reached by omitting terms with high order small values. The relationship among the heave motion of the buoy, stiffness of the elastic components, and the forward speed can be obtained by using these simplified equations. The dynamic analysis show the following: The angle of displacement of foil is fairly small with the biggest value around 0.3 rad; The speed of mobile buoy and the angle of hydrofoil increased gradually with the increase of heave motion of buoy; The relationship among heaven motion, stiffness and attack angle is that heave motion leads to the angle change of foil whereas the item of speed or push function is determined by vertical velocity and angle, therefore, the heave motion and stiffness can affect the motion of buoy significantly if the size of hydrofoil is kept constant. The proposed model is provided to optimize the parameters of the MMB and a foundation is laid for improving the performance of the MMB.



Vehicle Engineering

DOI: 10.3901/CJME.2016.0111.005

Abstract: Since the main power source of hybrid electric vehicle(HEV) is supplied by the power battery, the predicted performance of power battery, especially the state-of-charge(SOC) estimation has attracted great attention in the area of HEV. However, the value of SOC estimation could not be greatly precise so that the running performance of HEV is greatly affected. A variable structure extended kalman filter(VSEKF)-based estimation method, which could be used to analyze the SOC of lithium-ion battery in the fixed driving condition, is presented. First, the general lower-order battery equivalent circuit model(GLM), which includes column accumulation model, open circuit voltage model and the SOC output model, is established, and the off-line and online model parameters are calculated with hybrid pulse power characteristics(HPPC) test data. Next, a VSEKF estimation method of SOC, which integrates the ampere-hour(Ah) integration method and the extended Kalman filter(EKF) method, is executed with different adaptive weighting coefficients, which are determined according to the different values of open-circuit voltage obtained in the corresponding charging or discharging processes. According to the experimental analysis, the faster convergence speed and more accurate simulating results could be obtained using the VSEKF method in the running performance of HEV. The error rate of SOC estimation with the VSEKF method is focused in the range of 5% to 10% comparing with the range of 20% to 30% using the EKF method and the Ah integration method. In Summary, the accuracy of the SOC estimation in the lithium-ion battery cell and the pack of lithium-ion battery system, which is obtained utilizing the VSEKF method has been significantly improved comparing with the Ah integration method and the EKF method. The VSEKF method utilizing in the SOC estimation in the lithium-ion pack of HEV can be widely used in practical driving conditions.



CONTENTS

Vol. 29, No. 4, 2016

CONTENTS

Vol. 29, No. 4, 2016

CONTENTS

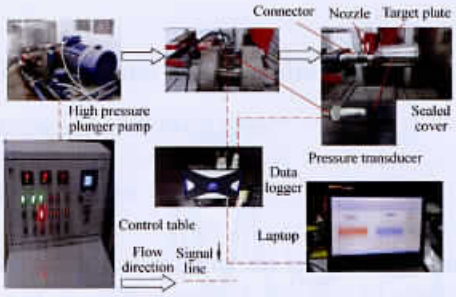
Vol. 29, No. 4, 2016

CONTENTS

Vol. 29, No. 4, 2016

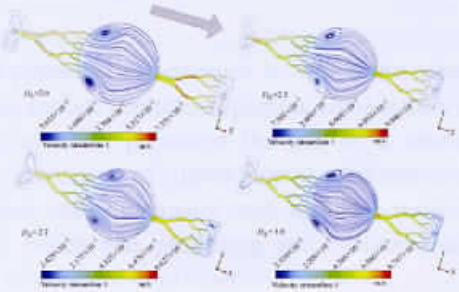
DOI: 10.3901/CJME.2016.0426.060

Abstract: The current research on self-resonating cavitating waterjet(SRCW) mainly focuses on the generation mechanism and structure optimization. Researches relating to the influences of disturbances at nozzle inlet on the characteristics of the jet are rarely available. In order to further improve the performance of SRCW, effects of area discontinuity(enlargement and contraction) are experimentally investigated using three organ-pipe nozzles. Axial pressure oscillation peak and amplitude as well as aggressive erosion intensity of the jet are used to evaluate the effects. The results reveal that area enlargement and contraction affect the peak differently, depending on the inlet pressure, nozzle geometry, and standoff distance; while area contraction always improves the amplitude regardless of these factors. At inlet pressures of 10 MPa and 20 MPa, area discontinuity improves the peak at almost all the testing standoff distances, while this only happens at smaller standoff distances with the inlet pressure increased to 30 MPa. The capability of area discontinuity for improving the amplitude is enhancing with increasing inlet pressure. Moreover, the cavitation erosion ability of the jet can be largely enhanced around the optimum standoff distance, depending on the type of area discontinuity and nozzle geometry. A preliminary analysis of the influence of area discontinuity on the disturbance waves in the flow is also performed. The proposed research provides a new method for effectively enhancing the performance of SRCW.



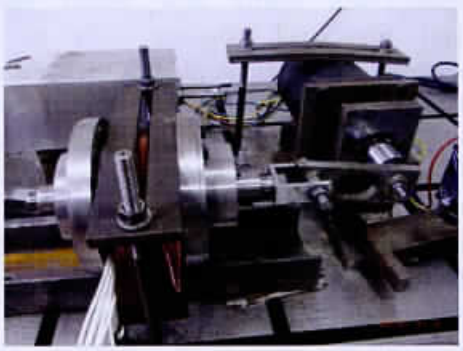
DOI: 10.3901/CJME.2016.0427.061

Abstract: Due to the special transportation and heat transfer characteristics, the fractal-like Y-shape branching tube is used in valveless piezoelectric pumps as a no-moving-part valve. However, there have been little analyses on the flow resistance of the valveless piezoelectric pump, which is critical to the performance of the valveless piezoelectric pump with fractal-like Y-shape branching tubes. Flow field of the piezoelectric pump is analyzed by the finite element method, and the pattern of the velocity streamlines is revealed, which can well explain the difference of total flow resistances of the piezoelectric pump. Besides, simplified numerical method is employed to calculate the export flow rate of piezoelectric pump, and the flow field of the piezoelectric pump is presented. The FEM computation shows that the maximum flow rate is 16.4 mL/min. Compared with experimental result, the difference between them is just 55.5%, which verifies the FEM method. The reasons of the difference between dividing and merging flow resistance of the valveless piezoelectric pump with fractal-like Y-shape branching tubes are also investigated in this method. The proposed research provides the instruction to design of novel piezoelectric pump and a rapid method to analyse the pump flow rate.



DOI: 10.3901/CJME.2016.0429.063

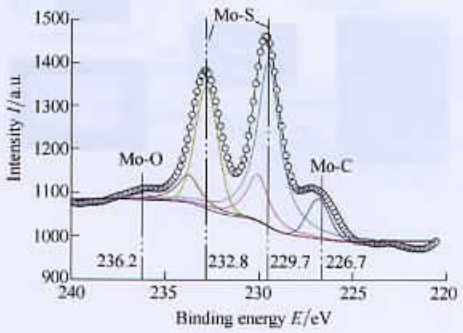
Abstract: Transverse-flux with high efficiency has been applied in Stirling engine and permanent magnet synchronous linear generator system, however it is restricted for large application because of low and complex process. A novel type of cylindrical, non-overlapping, transverse-flux, and permanent-magnet linear motor(TFPLM) is investigated, furthermore, a high power factor and less process complexity structure research is developed. The impact of magnetic leakage factor on power factor is discussed, by using the Finite Element Analysis(FEA) model of stirling engine and TFPLM, an optimization method for electro-magnetic design of TFPLM is proposed based on magnetic leakage factor. The relation between power factor and structure parameter is investigated, and a structure parameter optimization method is proposed taking power factor maximum as a goal. At last, the test bench is founded, starting experimental and generating experimental are performed, and a good agreement of simulation and experimental is achieved. The power factor is improved and the process complexity is decreased. This research provides the instruction to design high-power factor permanent-magnet linear generator.



CONTENTS

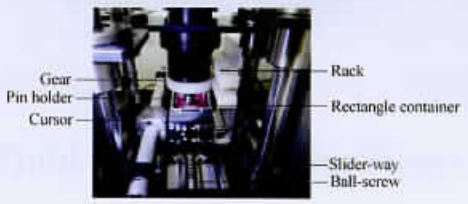
Vol. 29, No. 4, 2016

Friction and Wear



DOI: 10.3901/CJME.2016.0331.043

Abstract: With constant enlargement of the application areas of the spherical plain bearings, higher quality lubrication of the bearings is required. To solve the lubricating problems of spherical plain bearings under high temperature, high vacuum, high speed, heavy loads and strong oxidation conditions, it is urgent for us to develop more excellent self-lubricating technologies. In this paper, the bonded solid lubricant coatings, which use inorganic phosphate as the binder, the mixture of MoS_2 and graphite with two different weight proportions as the solid lubricant, are prepared by spraying under three different spray gun pressures. The bonding strength tests on the coatings show that the best spraying pressure is 0.2 MPa and the better mixing proportion of MoS_2 to Graphite is 3:1. Then for the radial spherical plain bearings with steel/steel friction pair, after the coatings are made on the inner ring outer surfaces, the friction coefficient, the wear loss and the friction temperature of the bearings under four oscillating frequencies are investigated by a self-made tribo-tester. The test results, SEM of the worn morphologies and EDS of worn areas show that tribological properties of the bearing are obviously improved by the bonded solid lubricant coatings. When sprayed under the spray gun pressure of 0.2 MPa, the bearings have better anti-friction and anti-wear properties than those sprayed under 0.1 MPa and 0.3 MPa. Further as proved from the XPS analysis, between the coating with 3:1 mixing ratio of MoS_2 to Graphite and the coating with 1:1 ratio, the former has less oxidation occurred on the surface and therefore has better tribological characteristics than the latter. This paper provides a reference to developing a new product of the radial spherical plain bearings with high bonding strength, oxidation resistance and abrasion resistance.



DOI: 10.3901/CJME.2016.0418.054

Abstract: Tribological tests play an important role on the evaluation of long-term bio-tribological performances of prosthetic materials for commercial fabrication. Those tests focus on the motion simulation of a real joint in vitro with only normal loads and constant velocities, which are far from the real friction behavior of human joints characterized with variable loads and multiple directions. In order to accurately obtain the bio-tribological performances of artificial joint materials, a tribological tester with a miniature four-station tribological system is proposed with four distinctive features. Firstly, comparability and repeatability of a test are ensured by four equal stations of the tester. Secondly, cross-linked scratch between tribo-pairs of human joints can be simulated by using a gear-rack meshing mechanism to produce composite motions. With this mechanism, the friction tracks can be designed by varying reciprocating and rotating speeds. Thirdly, variable loading system is realized by using a ball-screw mechanism driven by a stepper motor, by which loads under different gaits during walking are simulated. Fourthly, dynamic friction force and normal load can be measured simultaneously. The verifications of the performances of the developed tester show that the variable frictional tracks can produce different wear debris compared with one-directional tracks, and the accuracy of loading and friction force is within 5%. Thus the high consistency among different stations can be obtained. Practically, the proposed tester system could provide more comprehensive and accurate bio-tribological evaluations for prosthetic materials.