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No. 172

February. 1995

NOTICE

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Analysis of Factors Leading to Failure in JIS Standard Qualifying Examination for Welding Technique by Hokkaido Candidates

Takayoshi UKAI, Sigeru TADANO, Toshiaki TAKADA and Tetsuo ASANO

(Received October 26, 1994)

Abstract

The results of the welding qualifying examinations under Japanese Industrial Standards (JIS) show low ratios of successful applicants in Hokkaido in comparison with the nationwide.

This seems likely to disturb the development of the mining and manufacturing industries in Hokkaido.

In this study, the authors classified and evaluated factors leading to the failures of candidates during the past 5 years in 7 local zones of Hokkaido. The factors examined were the season in which the test was held, the district of origin of the candidate, the scale of the workshop, and others.

Candidates were more likely to qualify when from large scale workshops or when from industrial or metropolitan regions. Candidates from smaller workshops or rural regions tend to lack fundamental knowledge concerned with the welding technique, resulting in more welding defects.

It is recommended to upgrade the technical education system.

An application of a stochastic genetic algorithm to strategy acquisition in games

Yuki TOMIKAWA, Masaharu MUNETOMO, Yoshiaki TAKAI, and Yoshiharu SATO

(Received October 28, 1994)

Abstract

A stochastic genetic algorithm (StGA) realizes adaptive learning in stochastic environments. A stochastic learning automaton (SLA) is used for fitness evaluation of the genetic algorithm. The learning process of the StGA converges faster than that of the SLA because the genetic operators are applied to a sampled, relatively small sized population.

We apply the StGA to strategy acquisition of games defined by payoff matrices. Through simulation studies which compare a learning scheme by StGA and that by SLA, we show the effectiveness of our scheme.

Static Characteristics of a Magnetic Fluid Actuator with a non-Magnetic Plunger

Kazuhiro MATSUMURA, Shizuo YOSHIDA and Yo MIZUTA

(Received November 11, 1994)

Abstract

Current configurations of actuators used for processing agricultural and fisheries products are ineffective for handling products of varying size and shape. Magnetic fluids seem to offer some possibilities for more flexible actuator designs. This study proposes a design for a magnetic fluid-based actuator for carrying non-magnetic articles and describes the theoretically predicted and the experimentally observed static characteristics of the design.

The experimental apparatus consisted of a solenoid, several sizes of disks of non-magnetic material, and a magnetic fluid in which each disk was suspended above the solenoid. The magnetic force exerted by the solenoid was measured simultaneously with the lifting force exerted by the disk. In one series, the vertical position of the solenoid was varied while holding the position and size of the disk constant, and in the other series, different sizes of disks were used to vary the ratio between solenoid-disk gap and disk diameter. A theory was developed to predict the lifting force exerted by the disk and the results of the theory were compared with experimental findings.

This study found optimal sizes and configurations of solenoids and optimal sizes of disks for maximum lifting force.

The effect of Orientation on Grain Boundary Migration and Radiation-Induced Segregation under Irradiation

Naoyuki HASHIMOTO and Heishichiro TAKAHASHI

(Received August 31, 1994)

Abstract

To study the effect of orientation on grain boundary migration, a Fe-Cr-Ni alloy was electron irradiated using a high voltage electron microscopy (1000 kV), and in-situ observations on structural evolution and microchemical analyses were carried out. When the Fe-Cr-Ni alloy was irradiated, the nucleations of dislocation loops followed by voids were observed and at the same time when a grain boundary migration occurred. The compositional analyses after irradiation of an area including a grain boundary indicated nickel enrichment and chromium depletion near the grain boundary. It is suggested that when the radiation-induced point defects flow into the grain boundary, boundary migration and solutes redistribution are induced and the magnitudes depend on net point defects flow.

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May 1995

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Necessary Grid Size Conditions for Accurate Diffusion and Convection Calculations with KIVA-II

Kazushige KIKUTA* Takemi CHIKAHISA* Tadashi MURAYAMA*
and J. K. MARTIN**

(Received December 26, 1994)

Abstract

This paper investigates the effect of grid size on the accuracy of simulations of fuel spray penetration in KIVA-II, a three-dimensional simulation program for flow and combustion in engines. The analysis was made semi-theoretically for the momentum diffusion in a two dimensional gas jet. Predictions were compared with numerical simulations. The results of the comparison partially validated the semi-theoretical predictions, identifying the necessary grid size condition for diffusion and convection calculations. However, because of unexpected flow pattern changes with different grid geometries, the evaluation of the semi-theoretical prediction could not be fully completed. The reason for these flow pattern changes is not clear, but they may be partially due to insufficient simulation of the top of the spray.

Vibration Characteristics of Angle-Ply Laminated Plates

Gen YAMADA, Yukinori KOBAYASHI and Shogo KIMURA

(Received December 27, 1994)

Abstract

Vibration characteristics of angle-ply laminated plates are studied using the Ritz method. The effect of shear deformation is considered by applying the first order shear deformation theory, and shear correction factors are introduced accordingly. Strain and kinetic energies for the laminated plate are obtained and power series which satisfy the geometric boundary conditions are employed as admissible functions for the Ritz method. The frequency equation is derived from the stationary condition of the Lagrangian. Natural frequencies and mode shapes of vibration for simply-supported, symmetrically or antisymmetrically laminated square plates are calculated numerically. Convergence studies of eigenvalues are discussed and comparison of those with other authors' results show good agreement. Effects of fiber angles and thickness ratios of the layers on the vibration characteristics are investigated.

Analysis of Completeness of Laboratory Assignment Algorithm by Abstract Reduction Systems Theory

Masato NOTO, Masahito KURIHARA and Azuma OHUCHI

(Received December 26, 1994)

Abstract

A laboratory assignment algorithm is a procedure that assigns each of the m students to one of the n laboratories. In this paper, we prove the *completeness* (i.e., *termination* and *confluence*) of the algorithm by using *abstract reduction systems* theory. Termination guarantees that the computation will not proceed indefinitely, and confluence guarantees that the computational result is unique even in the presence of indeterminacy.

Investigation on Critical Energy of Superheated-liquid-drop Detector

Teruko SAWAMURA and Hatsuo YAMAZAKI

(Received December 28, 1994)

Abstract

A superheated-liquid-drop detector utilizes bubble formation induced by ionizing radiation in a superheated liquid. Several values characteristic to properties of the liquid are calculated by semi-empirical equations in order to estimate the critical energy of bubble formation for freon and butene. The theoretical expressions and the experiments determining the critical energy, which have been reported, are discussed and compared with each other. To investigate the detailed process of the bubble formation, butene is proposed as a sensitive liquid. The expected characteristics of the butene detector are described.

A General Analysis of Beam Monitor for High Energy Electrons

Teruko SAWAMURA, Akira HOMMA and Hatsuo YAMAZAKI

(Received December 28, 1994)

Abstract

The beam monitor response for high energy electrons is studied generally on the basis of electromagnetic wave interaction of a beam induced field with a monitor conductor. The response of a wireline-type monitor dependent on electron energy, monitor load impedance and monitor-beam configuration is derived. The limiting case of an extremely short wireline is analyzed and the response of a capacitive monitor or inductive monitor is obtained for an open-ended and a short-ended wireline. The time dependent output of a wireline-type monitor for a gaussian beam is calculated by taking the transfer function of the observing system into consideration.

Design of a Low Emittance Electron Gun for a Linear Accelerator

A. HOMMA, T. SAWAMURA, H. YAMAZAKI, K. NAKATA

H. TANIDA*, S. SAWAMURA* and K. TSUMORI**

(Received December 28, 1994)

Abstract

A test design of a low emittance electron gun for a linear accelerator with a thermionic cathode was made. The configuration of the anode and focusing electrode was determined using the computer simulation program code EGN2. POLYGON, a boundary setting routine, was also utilized. The expected characteristics and beam trajectory of this gun were obtained under a condition of 100 kV accelerating voltage.

The beam current, using a calculated perveance of 1.88×10^{-8} [A/V^{3/2}], is 0.59 [A] with 4.66[mm] beam diameter at the distance of 75[mm] from the cathode surface.

A Study of the Influence of a Wake-Field Generated by an Electron Beam Passing Through a Linac Beam Exit Window on Measurement of the Beam

A. HOMMA, T. SAWAMURA, H. YAMAZAKI, H. TANAKA, T. AOKI*
J. OHKUMA**, S. OKUDA**, T. YAMAMOTO**, S. SUEMINE**, and K. TSUMORI***

(Received December 28, 1994)

Abstract

In order to study the response of a wire-line type beam monitor to an electron beam from a linear accelerator, detailed knowledge about the electromagnetic field produced by a beam is necessary. The wake-field of a beam caused by a beam exit window of an accelerator was studied by numerical analysis.

It was found that the radial electric field at a fixed position showed a complicated time variation lasting after the passage of the beam pulse. The wake-field was reduced by placing a flared conducting wall immediately after the window. Setting a metal disk with a beam entrance hole upstream from the measuring point was also found to suppress the effect of the wake-field.

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July. 1995

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Influence of Initial Gas Conditions on NO Formation in Combustion Gas

Gao ZHI HONG and Noboru MIYAMOTO

(Received March 6, 1995)

Abstract

It was attempted to calculate process for formation of NO under varying initial gas conditions in combustion with the extended Zeldovich mechanism. Initial gas conditions included temperatures, pressures, and concentrations of O₂, N₂, CO₂, CO, H₂O, and NO. The results clarified the influences of individual initial gas conditions on NO formation characteristics.

Hydrogen desorption behavior from Al-alloy used as a vacuum chamber

Yuko HIROHATA, Taro TANAKA, Tomoaki HINO, Toshiro YAMASHINA

(Received March 31, 1995)

Abstract

Aluminum alloy has been widely used as an ultra and extreme high vacuum chamber material. In the use of Al-alloy as a vacuum chamber, it is important to investigate on the gas desorption behavior. We have so far studied the gas desorption rate and the amount of gases desorbed from Al-alloy (6063T6) based on the thermal desorption spectroscopy (TDS) technique which the ramp rate was varied from 5K/min to 30K/min. H₂, H₂O, CO, CO₂ and CH₄ were mainly desorbed from Al-alloy. The quantity of hydrogen was about 60 percents of all desorbed gases. At least, two desorption peaks were observed in the TDS spectra for hydrogen. The activation energies with respect to two desorption peaks were obtained as 0.22eV and 0.83eV, respectively. Based on the measured activation energies, we examined to determine the desorption spectrum either due to the surface reaction limit of second order reaction, or due to the diffusion limit. These desorption peaks correspond with due to the diffusion of the surface oxide layer and due to the diffusion from bulk, respectively. The total amount of hydrogen desorbed during heating up to 773K was evaluated as 5.3×10^{17} molecules/cm³ (0.8 cc/100 g Al-alloy) which was five times and two orders of magnitude larger than those of Al(1050H24) and pure Al(1001), respectively. It is necessary to reduce the desorption rate of hydrogen in order to use Al alloy as a vacuum chamber material.

Electron beam irradiation experiments of LHD divertor mock-up

Ichiro FUJITA, Yuko HIROHATA, Tomoaki HINO, Toshiro YAMASHINA,
Yusuke KUBOTA, Nobuaki NODA, Akio SAGARA, Osamu MOTOJIMA,
Dennis L. YOUCHISON and Robert D. WATSON

(Received March 31, 1995)

Abstract

It is necessary for the divertor plates of fusion reactor to be equipped with actively cooled structures since it's subjected to an extremely high heat load from the fusion plasma. Thermal response tests were performed on a flat-type of divertor mock-up consisting of bonded CFC tiles on an OFHC-Cu block. The CFC tile of this mock-up was exposed to one-side heat loads by using the electron beam up to 10 MW/m^2 . The temperatures at the surface and the inside of this mock-up were measured under various coolant water conditions. The temperature of this mock-up was found to be independent of the pressure of the coolant water by ranging from 0.2 to 4 MPa. The mock-up temperature decreased with increase in coolant velocity and with decrease in inlet temperature. The critical heat load at 1200°C was about 6 MW/m^2 at the coolant temperature of 20°C . This critical heat load was decreased by 1.5 MW/m^2 at a coolant temperature of 50°C compared to that of 20°C . In the case of the inlet coolant temperature at RT, the surface temperature was kept below 1200°C at 6 MW/m^2 . This mock-up can be applied for LHD divertor plates in the operational condition of 5 MW/m^2 for 10s.

Hydrogen and helium desorptions from B_4C overlaid graphite and isotropic graphite

Yuji YAMAUCHI¹, Tomoaki HINO^{1,2} and Toshiro YAMASHINA¹

(Received March 31, 1995)

Abstract

The desorption behavior for hydrogens and heliums trapped in B_4C overlaid graphite and isotropic graphite were examined by using a technique of thermal desorption spectroscopy. For the B_4C overlaid graphite, the trapped helium desorbed at relatively low temperature, $\sim 300^\circ\text{C}$, which was much lower than that of the hydrogen ($\sim 800^\circ\text{C}$). For the graphite, the similar behavior was observed. The present data are useful to understand the uptake of the helium or the fuel hydrogen in a burning plasma.

An Adaptive Algorithm for Motion-Compensated Video Coding

Yuqiang GU, Toshifumi KANAMARU, Yoshihiko OGAWA
Tomoaki SHIRAKAWA, Hideo KITAJIMA, and Nobuhiro MIKI

(Received March 27, 1995)

Abstract

This paper presents an adaptive algorithm for motion-compensated video coding. The algorithm can be used for video-conferencing and broadcast television. It saves computation by conducting a variable-stage motion search according to the motion. The new algorithm is compared with a conventional algorithm (Method 2) and it is shown to attain approximately 50 percent saving in computing the motion vector. It is also shown that the algorithm can control the computation for searching motion vectors and can control the MSE for motion compensation. The performance of this algorithm is similar to the conventional algorithm (Method 2) with DCT coding when the motion is big.

Study of Focused Ion Beams for Probe Tip Milling .

Yasushi SASAKI*, Kazuhisa SUEOKA, Tatsuo IWATA*, Masahiro MIYAO**
Hiroshi ADACHI**, Kazunobu HAYAKAWA***, Koichi MUKASA

(Received March 31, 1995)

Abstract

Several kinds of ultra-sharpened metallic tips were made by means of focused ion beams (FIB). In contrast to chemically sharpened tips, the FIB milled tips are well defined at the nano-meter scale. In this study, we tried to make polycrystalline W, Ni, Mo wires and a Si-tip on a micro cantilever into ultra-sharpened tips. The shapes of these tips were observed by SIM (Scanning Ion Microscope) images and also the FIB milled W, Mo and Ni tip were observed by FIM to identify their apex radius. We found that the cone angle of $12 \pm 3^\circ$ and the apex radius of 10nm can be achieved. This technique is not limited to these materials, and has many potential applications. The FIB milled ultra-sharpened tip is one of the candidate for a probe tip for Scanning Probe Microscopy (SPM).

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October, 1995

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Mutual Correlations among Various Properties for Worldwide Diesel Fuels.

Noboru MIYAMOTO and Kenji YAMAZAKI

(Received June 17, 1995)

Abstract

Various properties for worldwide diesel fuels were combined into a data base for use on a personal computer. Some relationships among fuel properties were analyzed and experimental equations were established to describe the relationships quantitatively. Fuel properties included density, viscosity, distillation temperature, cetane index, cetane number, aniline point, cloud point, aromatics content and sulphur content.

Origin and Characteristics of Smilarity in the Structure of Turbulent Jet Diffusion Flames

Takemi CHIKAHISA and Tadashi MURAYAMA

(Received June 30, 1995)

Abstract

This paper describes similarities in temperature distribution and boundary layer characteristics in turbulent jet diffusion flames. Temperature distributions vary with the fuel, nozzle diameter, and jet velocity ; however, when temperature distributions are re-plotted in a non-dimensional manner using flame length, all data coalesces to a single curve, except for fuels with low volatility. Boundary layers of jets measured by Schlieren photographs were all straight and the angles were constant regardless of whether combustion was taking place or not.

The paper discusses the mechanism of the similarity, and shows a semi-theoretical flame length applicable for different fuels. Conservation of angular momentum in the vortex rings in the flame jet is the cause of the straight boundary. This mechanism leads to apparent reductions in air entrainment at the flame region, showing that the density change is the major cause of the phenomena ordinarily termed "laminarization".

As above, the phenomena are closely related to the turbulence structure, and laser tomography was applied to observe the eddy structure in the flames. The results showed apparent differences in the small scale eddies of non-flame and flame jets. It was also observed that air is entrained into the fuel by turbulent mixing, but combustion takes place by molecular diffusion in thin layers of fuel and air.

Performance of Electric Heaters with Hydroxides as Heat Storage Medium

Takemi CHIKAHISA, Naohiro NANRI, Nobuyuki SAWADA, and Norio HONMA

(Received June 30, 1995)

Abstract

The overall efficiency of energy utilization would be improved if it was possible to balance the consumption of daytime and late-night electricity. Electric heaters with storage for heat generated using electricity tapped late at night is one promising method for flattening electricity demand. However, the heaters generally consist of brick as a heat storing substance, and its heavy weight is a major problem in practical applications. The present paper investigates and evaluates performance of heaters equipped with hydroxides as the heat storage medium. The estimate is made in a thermodynamic one-dimensional calculation of the system. The results show that the weight can be reduced to one fourth that of the conventional brick system by the use of calcium oxide, one of the most promising hydroxides for this system. The paper also indicates factors necessary to be considered in development of a hydroxide heater system.

Lafferty Gauge for Pressure Measurement of Extremely High Vacuum

Tomoaki HINO¹, Yuko HIROHATA¹, Toshiro YAMASHINA¹,
Toshio KIKUCHI² and Nobuharu OHSAKO²

(Received May 24, 1995)

Abstract

The electron motion, the upper limit of the electron density, the electron density balance and the ion collection current of the Lafferty gauge with negative wall potential were analyzed for the pressure measurement of extremely high vacuum, XHV. The electron emitted from the cathode takes $\vec{E} \times \vec{B}$ drift along the azimuthal direction within a time scale determined by the Bohm diffusion. The upper density of the electron may be determined by the condition that the negative self potential be smaller than the negative wall potential. For the ion to be collected without collision with the residual gas or the wall, the negative potential of the ion collector has to be larger than some critical value. The ion output of the gauge with a reasonable size becomes $\sim 0.1\text{A/Torr}$, so that the ratio of secondary emission due to photons produced in the wall has to be below 10^{-9} for the measurement pressures less than 10^{-14} Torr.

Conditionings for Hydrogen Retention of Plasma Facing Material

Yuji YAMAUCHI, Kazunori KOYAMA, Koh KANAYA, Yuko HIROHATA,
Tomoaki HINO and Toshiro YAMASHINA

(Received June 5, 1995)

Abstract

For isotropic graphite, SiC converted graphite and B₄C converted graphite, the conditions of baking and He ion impact for the reduction of retained hydrogens are discussed based on a hydrogen desorption model. For this purpose, the existing data concerning the hydrogen retention and the helium ion irradiation are employed. It is seen that the hydrogen trapped in form of C-H or Si-H bonding can not be desorbed by baking alone. Thus, the He discharge cleaning has to be applied for C-H and Si-H bondings. The hydrogen trapped in form of B-H bonding is very easily desorbed by baking alone with temperature of only 300 °C.

Schemes for Reduction of Helium Ash in a Fusion Reactor

Tomoaki HINO^{1,2}

(Received May 24, 1995)

Abstract

For the reduction of helium ash in a fusion reactor, several methods have been proposed. These methods are systematically discussed based upon the density balance of heliums, e.g. the term of the helium flow from the divertor to the core plasma. In addition, it is shown that the emission of heliums retained in the wall may largely enhance the helium ash level. Then, the helium retention in the wall during the plasma discharge shot has to be sufficiently reduced.

Comparison of pumping efficiency of He selective pumping metal between divertor and limiter configurations

Hideto YANAGIHARA, Kazuya KUBO, Tomohiro NAKAMURA,
Yuko HIROHATA, Tomoaki HINO, and Toshiro YAMASHINA

(Received June 5, 1995)

Abstract

We compared the helium pumping efficiency due to the selective pumping metal between divertor and limiter configurations. If the helium trapping efficiency of selective pumping metal is the same in both the configurations, the divertor configuration is superior to the limiter configuration for the reduction of helium ash. Thus, the helium selective pumping metal has to be used in the divertor region.

Process of Low Energy Ion Implantation

Tomoaki HINO

(Received June 6, 1995)

Abstract

The process of low energy ion implantation into metal surface was analyzed by the two point model. The implanted amount was observed to increase rapidly with the range and substrate temperature. The temporal evolution of the implanted amount was also examined. The present analytical results qualitatively can explain the experimental data.

Extraordinary Traces Produced during Pulsed Discharges in Water

Takaaki MATSUMOTO

(Received June 14, 1995)

Abstract

This paper describes experiments of electrical discharges in water, in which AC shots of up to 100 V were applied to wire electrodes of palladium and platinum. Various kinds of anomalous traces were observed on the nuclear emulsions. Some of them were similar to that which were observed in previous experiments of electrolysis cold fusion. Extraordinary combined rings were newly observed, suggesting that tiny ball-lightning was hopping up and down between the nuclear emulsions. The mechanisms of forming the traces are also discussed by The Nattoh Model.

Migration Behavior of Sodium Ions in Compacted Sodium-Montmorillonite

Tamotsu KOZAKI, Atsushi FUJISHIMA, Seichi SATO and Hiroshi OHASHI

(Received June 22, 1995)

Abstract

Apparent self-diffusion coefficients of sodium ions in compacted sodium montmorillonite were determined so as to obtain basic data for safety assessments of geological disposal of high level radioactive wastes. The self-diffusion coefficients of sodium ions obtained were in the range from 1.2×10^{-11} to $1.2 \times 10^{-10} \text{ m}^2 \text{ s}^{-1}$ under various conditions at temperatures from 278K to 323K for compacted montmorillonite of dry density from 1.0 to $1.8 \times 10^3 \text{ kg m}^{-3}$.

Retardation factors and partition coefficients (S/L ratio) were calculated from the diffusion coefficients obtained at 303K. The retardation factors and the partition coefficients were in the range from 1.5 to 2.8 and from 1.1×10^{-3} to $1.0 \times 10^{-4} \text{ m}^3 \text{ kg}^{-1}$, respectively. The partition coefficients decreased with increasing dry density of montmorillonite. The dry density dependence of sodium ions was almost the same as strontium ions, but different from cesium ions.

An activation energy of from 14.1 to 24.7 kJ mol⁻¹ was obtained from the temperature dependence of the diffusion coefficients of sodium ions. It was found that the activation energy increases with increasing dry density of montmorillonite. This can be attributed to an alteration in the kind of diffusion path for sodium ions in the compacted montmorillonite caused by the change in the dry density.

Effects of Sample Conditions on the Reliability of Thermal Conductivity Data taken by the Laser-flash Method

Kenji OHKUBO, Yoshihiro TERADA, Tetsuo MOHRI and Tomoo SUZUKI

(Received June 21, 1995)

Abstract

The laser-flash method is very convenient way to measure thermal conductivity. It requires a coin-shaped specimen $10\text{ mm}\phi \times 2\text{ mm}$ in size. In some intermetallic compounds, however, brittleness can interfere with preparation of a sample with good geometry. The effects of the parameters of specimen thickness, surface shape and surface condition were investigated using the well-established materials; copper, brass and alumina, which have representative levels of high, medium, and low thermal conductivities, respectively. Thermal conductivity was found to be sensitive not to thickness or shape, but to surface condition in every material.

A Study on the Relations between the Stochastic Learning and Information Divergences

Hiroyuki SHIOYA, Takayuki KOMATSU, Tsutomu DA-TE and Yoshiharu SATO

(Received June 23, 1995)

Abstract

In computational learning theory, PAC learning (Probably Approximately Correct Learning) was suggested by Valiant in 1984. An improved PAC learning with stochastic rules is called stochastic PAC learning. The evaluation of this learning (the convergency and sample complexity) depends on the choice of the information divergences which are the measure of distance between the target rule and the hypothesis outputted by the learning algorithm.

In this paper, we study the evaluation of learning for each case of several information divergences, and discuss the mathematical relations between the evaluation of the learning and the choice of information divergences.

Project Overview and Prospect of Solar Power Satellite, SPS2000

Kiyohiko ITOH, Yasutaka OGAWA, Manabu OMIYA

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Abstract

The most famous solar power satellite system (SPS) is the SPS Reference System, a quite large-scale power system for the United States of America proposed for construction in the 21st century. This would produce as much electricity as five current atomic power stations. SPS2000 is much smaller than the Reference System with only 0.2 % or two-thousandths of the power generation capacity. Because of its smallness, the SPS2000 project can avoid many difficult problems facing the Reference System; it would be easier and take less time to build. In several respects, SPS2000 is completely different from the SPS Reference System. This paper introduces a conceptual study on SPS2000.