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## Appendix

Abstracts &amp; Titles, No. 87~93

BULLETIN  
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NOTICE

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## A Measurement Method of Air Movement and Radiant Temperature with Dry and Wet Kata Thermometers

Tohru MOCHIDA

(Received June 26, 1977)

### Abstract

The purpose of the present study is to discuss the formula attached to a Kata thermometer for calculating air movement, especially the convective and the radiative heat transfer coefficients in the formula and a calculating formula for radiant temperature by a Globe thermometer.

As a result of the present investigations, it is clarified that the calculating formula of air movement of the Kata thermometer can be applied only in a uniform thermal environment where the air temperature is equal to the radiant temperature and that although the value of Kata radiative heat transfer coefficient appears to be almost appropriate in a temperature range of our current living conditions, its convection coefficient seems to be suspect.

On the other hand, with regard to the Globe thermometer, it is pointed out that the formula for calculating radiant temperature should be applied with due consideration of the value of air movement to be substituted.

Further, an approach for rational measurements of air movement and radiant temperature is proposed by using dry and wet Kata thermometers at the same time, in order to correct errors arising in the case of using the existing formulas attached to the Kata thermometer and Globe thermometer.

## Characteristics of Flow around a Yawed Circular Cylinder Subjected to an Interference of Plane Wall

Mikio ARIE            Masaru KIYA  
Yasuhiro SUZUKI    Hideyu YOSHIMURA

(Received September 30, 1977)

### Abstract

Experiments were performed to clarify the effect of a neighbouring plane wall on the hydrodynamic characteristics of a yawed circular cylinder with the yaw angle  $\beta$  between  $0^\circ$  and  $60^\circ$ . Measurements were made on the pressure distributions along the surface of the cylinder together with the frequency of the vortex shedding from the cylinder, the Reynolds number based on the cross-flow component of the approaching

velocity being 7250–14500. The behaviour of the properties of the yawed cylinder is usually based upon the cross-flow component of freestream velocity, which is referred to as the independence principle. It was found that the independence principle was also applicable even when the interference of the plane wall was included. The pressure drag coefficient was correlated with the relative clearance  $c/d$ ,  $c$  being the clearance between the plane wall and  $d$  the diameter of the cylinder and the base-pressure coefficient in the forms

$$C_{Dp} = \begin{cases} 0.75(1+c/d)\cos^2\beta & (c/d < 0.6) \\ 1.2\cos^2\beta & (c/d > 0.6) \end{cases}$$

$$C_{Dp} = 0.4\cos^2\beta - 0.68C_{pb}$$

The correlation of  $C_{Dp}St/\cos\beta$  with  $(1-C_{pb})^{1/2}$  for the yawed cylinder showed a fairly good agreement with the well-known relation between  $C_{Dp}St$  and  $(1-C_{pb})^{1/2}$  which was originally proposed by Bearman for normal cylindrical bluff bodies in a uniform stream.

### Thick Turbulent Boundary Layer along the Model Hub of Axial-Flow Turbomachines

Mikio ARIE            Masaru KIYA            Hisataka TAMURA  
Hiroyuki MIYABE    Takashi KIKUCHI    Yoshito OHTAKA

(Received September 30, 1977)

#### Abstract

Measurements of pressure distributions, mean velocity profiles and turbulence intensity were made in thick turbulent boundary layers near the conical tails of two model hubs of axial-flow turbomachines. Mean streamline patterns and pressure-recovery effectiveness in a diffuser which is formed between the conical tail of the hub and the circular duct wall are clarified on the basis of the measured velocity and static pressure distributions. The thick boundary layer is characterized by significant variation in the direction of velocity vector across the boundary layer and an abnormally low level of turbulence near the surface of the hub. The flow-angle variation is associated with a strong interaction between the boundary layer and the surrounding potential flow, whereas the changes in the turbulent structure appear to be the consequence of the transverse surface curvature.

A potential-flow analysis based on the technique of distributing vortex rings along the surface of the hub yielded a pressure distribution in good agreement with the measured distributions up to about a half of the conical tail of the hub. The theoretical pressure distribution was used to calculate the boundary-layer characteristics by a semi-empirical procedure to obtain a fairly good agreement between theory and experiment in the region described above.

## Characteristics of an Artificially-Generated Thick Turbulent Boundary Layer

Mikio ARIE Masaru KIYA Yasuhiro SUZUKI  
Ichiro SAKATA Susumu MATSUSHIMA

(Received September 30, 1977)

### Abstract

The present paper describes an experimental investigation on a thick two-dimensional turbulent boundary layer artificially generated on a rough plane wall by means of a modified version of turbulence generators originally proposed by Counihan *et al.*,<sup>2)</sup> for the purpose of simulating the turbulent planetary boundary layer in wind tunnels. Detailed measurements were made on the mean velocity profiles, turbulence intensities in three directions, Reynolds shear stress, auto-correlation functions, longitudinal integral scale of turbulence, turbulence-energy spectrum and intermittency factor. The experimental results showed that the artificially-generated turbulent boundary layer reached a state of equilibrium in the region downstream of about 6 times the height of the turbulence generators, where the values of displacement and momentum thicknesses, the shape factor and the power-law constant became almost unchanged in the direction downstream. The thick turbulent boundary layer artificially-generated in the present experiment was found to satisfactorily simulate the turbulent planetary boundary layer on earth in neutrally stable conditions.

## Optimum Thickness and Maximum Allowable Pulling Force of a Band Saw-Blade in Wood-Working Band Saw Mill

Osamu DOI

(Received September 16, 1977)

### Abstract

For the purpose of improving the operation efficiency of wood-working band saw mill, the most effective method is to increase the pulling force of band saw blade to reinforce the twisting rigidity thereof.

The author proves theoretically in this paper the existence of maximum allowable pulling force of saw blade considering the fatigue strength against stress repetition due to pulling and bending by two pullies, and gives the optimum thickness of saw blade to make allowable pulling force maximum.

These results offer a standard for makers to design woodworking band saw mill and also produce a guide for users to select a type of band saw mill and to decide an operation standard.

## On the Thermal Conductivity of Cast Iron with Various Graphite Configurations

Tōru NOGUCHI   Yasuo MATSUMOTO   Kingo NAGAOKA

(Received September 30, 1977)

### Abstract

In order to investigate the role of graphite flakes on the thermal conductivity of cast iron, ferritic irons with various chemical compositions and graphite configurations were examined by the step-heating method. The effect of graphite flakes was expressed by the ratio  $\lambda_e/\lambda_c$ , where  $\lambda_e$  was the measured conductivity of the iron and  $\lambda_c$  was the conductivity of the matrix estimated from its chemical compositions.

The value of  $\lambda_e/\lambda_c$  was 1.7~2.4 in flake graphite iron. The values increased with increase in carbon content, the increase in coarseness and the length of graphite flakes. In spheroidal graphite iron,  $\lambda_e/\lambda_c$  was 1.03~1.15, and only slight increase was seen with the increase in carbon content. The role of eutectic D-type graphite was almost the same as in the case of flake graphite. The iron with less spheroidized wormtype graphite showed higher  $\lambda_e/\lambda_c$  values than fully spheroidal iron.

Form factor  $\psi$  was introduced according to Hamilton's method for the evaluation of the effect of graphite shape. A correlation was observed between  $\lambda_e/\lambda_c$  and the value of  $\psi$  calculated in some specimens. It is suggested that, in addition to the graphite shape, the remarkable difference in conductivity may be caused by the anisotropic structure of the graphites, and graphite-matrix coherency.

## Effect of Natural Convective Heat Transfer on Effective Heat Conductivity of a Horizontal Fibrous Glass Layer Heated from below

Nobuhiro SEKI   Shoichiro FUKUSAKO

Hideo INABA

(Received June 30, 1977)

### Abstract

The placement of a heating surface of a confined glass wool layer, including horizontal or vertical, is an important factor affecting the behavior of heat transfer.

In this report the heat transfer in a horizontal glass wool layer heated from below is studied. The effects of the distance  $W$  between the hot and the cold walls, the specific weight of the glass wool  $\gamma$  ( $\text{kg}/\text{m}^3$ ) and surface temperature of the cold wall  $T_c$  on the apparent or effective heat conductivity  $\lambda_{eff}$  are investigated.

The results of the experiments show a strong influence of natural convection on  $\lambda_{eff}$  of a horizontal glass wool layer having  $\gamma=0\sim 12$  ( $\text{kg}/\text{m}^3$ ). (However, in the case of vertical glass wool layer, the effect of natural convection on  $\lambda_{eff}$  is strong in the range of  $\gamma=0\sim 20$  ( $\text{kg}/\text{m}^3$ )).

## Heat Transfer in an Enclosed Rectangular Cavity with a Relatively Small Aspect-Ratio

Nobuhiro SEKI   Shoichiro FUKUSAKO  
Hideo INABA

(Received September 27, 1977)

### Abstract

This paper presents a numerical study on natural convective heat transfer in an enclosed rectangular cavity with a relatively small aspect-ratio  $H/W$  with opposing vertical walls having each different temperature.

The present numerical calculations are carried out for an enclosed rectangular cavity having  $H/W=0.03\sim 1$ ,  $1\sim 10^3$  of Prandtl number  $Pr$  and  $10^2\sim 10^6$  of Rayleigh number  $Ra$ . The numerical results obtained indicate that the geometrical aspect-ratio significantly affects the heat transfer through the vertical fluid layer. Moreover, useful correlations of the natural convective heat transfer are derived from the computed results.

## Stability Limits of Regenerative Chatter in Turning

Satoru IGARASHI   Akira FUKUDA

(Received September 30, 1977)

### Abstract

Stability limits of self-excited regenerative chatter in turning are investigated. A method by which stability limits of regenerative chatter can be predicted theoretically while taking into account the variations of the cutting parameters during cutting is presented. It is assumed in analysis that static (steady state) cutting force equations can be used for dynamic cases when instantaneous values are adopted as the cutting parameters in the equations.

In order to show the validity of this approach, a tool-holder flexible in only one direction is manufactured, and stability charts calculated by applying the method to this

simplified tool system are compared with those obtained from experiments in which the end of a tubular steel workpiece is cut using this tool-holder. The data necessary for numerical calculation of stability limits are prepared from steady state quasi-orthogonal cutting tests of steel.

Agreement between theoretical and experimental results is good, and thus the validity of the method presented is confirmed.

## **ICOSS-1 : An Interactive Digital Continuous System Simulator**

**Shoichi KOYAMA    Takashi SANO  
Ryoichi MIURA**

(Received September 30, 1977)

### **Abstract**

This paper describes ICOSS-1 designed as a pilot-system of the ICOSS (Interactive COntinuous System Simulator) project, which tries to establish a software system for a new-type digital simulator using the multiprocessor system being proposed by the authors [7], [8]. An "easy to operate simulator" is the basic design concept of the ICOSS project. Main feature of ICOSS-1 is the thorough interactiveness from program editing to its execution. The set of statements and commands while being simple are sufficient to carry out simulation so that even a novice can easily learn and operate it. The system can be used like an analog computer.

## **Dynamic State Estimation for a Synchronous Generator**

— The Formulation to Apply the Kalman Filter —

**Ken-ichi NISHIYA    Ryoichiro AWANO  
Jun HASEGAWA      Toichiro KOIKE**

(Received September 30, 1977)

### **Abstract**

It is important for the control and stability prediction in an electrical power system to determine how to estimate the states of synchronous generators. In designing an estimator, inner magnetic flux linkages are basic state variables because the dynamic behavior of a synchronous machine is defined by them, and these cannot be measured directly. Miller and Lewis proposed a method which applied the Kalman filter to the

state equations obtained by Park's two-reaction theory. But they neglected nonlinear terms in the differential equations and only flux linkages are incorporated into the state vector.

In this paper a more detailed model is used, in which the nonlinear terms are included and the automatic voltage regulator, the speed governor and the swing equation are considered. Consequently the field voltage, the mechanical torque input to the rotor and the angular velocity of the rotor shaft are incorporated into the state vector as well as the flux linkages. The nonlinear state and observation equations are linearized by the Taylor's expansion in order to make the application of the Kalman filter possible.

### **A Continuous-Discrete Hybrid System Description by the E-net Modeling Method**

Keiji MAKINO Koji TOCHINAI Kuniichi NAGATA

(Received September 30, 1977)

#### **Abstract**

The E-net modeling method, which has been developed for describing a computer system and evaluating its performance, is a general modeling method for a discrete system. The method can represent an asynchronous parallel process, specify a spending time with an action, describe a data flow, a control flow, and their interaction and the change of an attribute value with an action, and so on.

In remarking on the above features and the resemblance between an E-net structure and a block diagram for analog computer programs, we show that the E-net modeling method can describe a continuous system, and more generally, a continuous-discrete hybrid system. The method by which it is shown, is by means of the corresponding relation of the block diagram element to its E-net representation, and then by means of an E-net description for the interface between a continuous subsystem and a discrete subsystem. And an example is exhibited concerning a mass-spring damper system.

As a result, it was clearly shown that the E-net modeling method is an excellent unified description for a continuous-discrete hybrid system.

## Microwave Shadowgraphy

Yoshinao AOKI

(Received September 30, 1977)

### Abstract

An imaging technique in radio wave region is discussed, where shadows of objects by a microwave, namely microwave shadowgrams, are recorded as microwave images. The so-called microwave shadowgraphy, is discussed theoretically referring to the analysis of the coherent imaging systems such as holography by the method of ray optics. An experiment by an object-scanned shadowgraphy is conducted with a 10 GHz microwave, where objects are scanned in a plane of 45 cm×50 cm size perpendicular to the axis connecting the fixed receiver and projector of microwave. An open end of an X-band waveguide is used as a receiver and an iris mounted on the end of the waveguide is used as a projector. Shadowgrams are displayed on the CRT scope by applying the amplified signals from the receiver to Z axis of the CRT and the position signals of the scanned object from the scanner to X and Y axes. The difference between the optical and radio wave images is discussed by comparing the shadowgram of an object made of metallic and dielectric materials with the photograph of the object. In the microwave shadowgram the metallic objects are visualized through the optically opaque dielectric materials. The relation between the shadowgram and hologram is discussed referring to the obtained experimental results. Further the advantages and disadvantages of this technique are discussed.

## Formation of N,N'-Diacyl Hydrazines by the Reaction of Carboxylic Acid Hydrazides with Aqueous Solution of Inorganic Acids

Yoshiyuki TAKATA    Yuichi KITAGAWA  
Toshiro CHIBA        Kazuaki YOKOTA

(Received September 27, 1977)

### Abstract

N,N'-Diacyl hydrazines [I] were formed when carboxylic acid hydrazides treated with aqueous solution of inorganic acids. The author investigated the relation between the structure of carboxylic acid hydrazides and the yields of [I]. The yields of [I] increased with the increase of the carbon numbers of fatty acid hydrazides and reached quantitatively with higher fatty acid hydrazides. With aromatic carboxylic acid hydrazides, the yields of [I] decreased to 50~70% and particularly remarkably with benzhydrazides having a methyl, nitro group or chlorine at o-position. With acid hydrazides having an

alkylene group or an ethereal oxygen between phenyl and carboxylic group, the yields of [I] were a median value between those with fatty acid hydrazides and with benzhydrazide.

### Synthesis of Acid Chlorides by Reaction of Carboxylic Acids with Sulfur Monochloride III

Toshio MATSUDA Kazuaki YOKOTA Yoshiyuki TAKATA

(Received September 27, 1977)

#### Abstract

Sulfur, produced in the reaction of carboxylic acids with sulfur monochloride in the presence of iron-salt-catalyst, causes often causes trouble in the purification of the acid chlorides.

Regeneration of sulfur monochloride from sulfur by chlorine introduced into the reaction mixtures, and simultaneous reaction of regenerated sulfur monochloride with carboxylic acids was attempted.

Acid chlorides, such as benzoyl, p-nitrobenzoyl, terephthaloyl, isophthaloyl, acetyl, propionyl, butyryl and adipoyl chloride were obtained with better yields in pure states.

### Effect of $\gamma$ -ray Irradiation on $\alpha$ -particle Registration in Cellulose Nitrate Track Detectors

Teruko SAWAMURA Hatsuo YAMAZAKI Yasutomo OZAWA

(Received September 28, 1977)

#### Abstract

Cellulose nitrate track detectors were exposed to  $\alpha$ -particles after  $\gamma$ -ray irradiation. These detectors were then etched with 25% solution of NaOH. The effect of  $\gamma$ -ray irradiation on  $\alpha$ -particle registration on these detectors were investigated.

It has been observed that  $\gamma$ -ray irradiation induces changes in bulk properties of detector material, that is, the increase of bulk etching rate and, with respect to track formation, the decrease of developing velocity of track diameter and the increase of sensitivity of track registration. From these results it is concluded that the effect of low LET radiation on track registration can not be ignored when the irradiation dose is higher than  $10^7$  rads.

## Backscattering of 122 keV Gamma-Ray

Takashi MOROZUMI Hiroshi OHASHI Eiji OKABAYASHI

(Received September 30, 1977)

### Abstract

The 122 keV photon backscattering, which occurred on the surfaces of various kinds of metallic and non-metallic materials, was investigated by irradiating these materials with Co-57 gamma-ray and measuring the energy spectrum of backscattered photon. Among the materials tested, lead behaved very differently, namely the backscattering occurred predominantly by the evolution of K-X ray on its surface. As a consequence, the backscattering from lead was almost comparable to that from low atomic number materials, such as aluminium, titanium, concrete block and organic plastics. Coating with thin copper or cadmium plate was effective to cut the backscattering from lead. For practical purposes, it is of interest to cover a concrete wall with very thin layer of lead or lead compound in which the thickness of layer is less than that which corresponds to saturated scattering.

## On a Hypothesis in Luneburg's Theory of Binocular Visual Space

Masaru SHIMBO Takahiro YAMANOI

(Received September 30, 1977)

### Abstract

A non-Riemannian geometrical treatment of visual space is shown with reference to Luneburg's theory of Riemannian binocular visual space. Microscopic transformation between physical and visual space elements is assumed, so that non-Euclidean concept of torsion tensor due to the rotational characteristics of space elements is introduced together with another non-Euclidean concept of Riemann-Christoffel curvature tensor. The twisted cord illusion is an experimental evidence of the torsion tensor. The parallel and distance alley curves are explained as geodesics in the non-Riemannian visual space under the restriction of teleparallelism and Riemannian configurations, respectively.

**Extension of Fletcher's One-Parameter Family of  
Variable-Metric Method to Minimization  
under Linear Constraints**

**Toshihisa HONMA    Ikuo KAJI**

(Received September 30, 1977)

**Abstract**

A property of Fletcher's one-parameter family of the variable-metric method in the linear constraint manifold is examined. We can find that if linear constraints remain unchanged for successive iterations then the method has an important property represented by the concept of exactness and is stable for the convergence in the range of the parameter  $\phi > -a/b$ , where  $a = g_i^T H_q^i g_i$ ,  $b = g_{i+1}^T H_q^i g_{i+1}$ ,  $g_i$  is the gradient vector of the objective function at  $x_i$  and  $H_q^i$  is the updating matrix. Since a proper choice of the parameter  $\phi$  is derived as  $\phi = 1$ , we can obtain the Broyden-Fletcher-Goldfarb-Shanno algorithm in the constraint manifold.

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## Interaction between a Pair of Circular Cylinders in a Varied Free-Stream Direction

M. ARIE, M. KIYA, H. TAMURA and T. MORI

(Received December 28, 1977)

### Abstract

An experimental investigation of the interaction between a pair of circular cylinders in a varied free-stream direction was performed for several fixed distances between the cylinders; the Reynolds number based on the cylinder diameter is 7,100. The principal aim is to enhance the understanding of the flow around buildings in close proximity or the flow around tube banks in heat exchangers. The experimental results predict that the cylinder pair will undergo highly unsteady drag and lift forces, both in magnitude and frequency, when the free-stream direction is in a particular range which depends on the distance between the two cylinders. The time-averaged and turbulence characteristics of the wake behind the cylinders are also presented.

## Generalized Optimal Control Problem with a Vector-valued Performance Criterion under a Strongly Conflicting Situation

Susumu YAMAMOTO, Syoichi KOYAMA, Ryoichi MIURA

(Received December 28, 1977)

### Abstracts

Under a strongly conflicting situation generalized optimal control problem with a vector-valued performance criterion is considered.

Two types of solutions for the problem in which one control strategist dominates the other, that is to say,  $\phi$  [ $\psi$ ]-preferential solution, is defined appropriately by the different setting of the problem.

Seeking the solution theoretically is impossible to be performed directly from its definition, but is possible through the equivalent transformation of optimization under proper assumptions.

It is shown that an open-loop type preferential solution is obtained analytically on a linear system with a vector-valued performance criterion, which considers the difference of energy consumption between a couple of control strategists.

In the course of deriving this solution, the appropriate selection of the third hypothetical control-strategist's strategy necessarily arises, therefore, finally the determination of triple control strategies are to be performed and a corresponding optimal performance criterion may also be derived analytically.

## **A Program Code and Tables of Analytical Solutions of the Helmholtz Equation for Toroidal Coordinates**

Masaharu SEKI , Ikuo KAJI and Toshihisa HONMA

(Received December 26, 1977)

### **Abstract**

The Helmholtz equation is solved in toroidal coordinates. The solutions are useful for the analyses of a toroidal plasma or other problems to be solved in the toroidal coordinates. The authors programmed a numerical calculating FORTRAN code for the solutions, using the representation by series in the Legendre functions. The solutions of the Helmholtz equation for the toroidal coordinates were computed by the FORTRAN code and tabulated.

## **Adaptive Antenna Array Systems**

Hideonobu HONDA, Kiyohiko ITOH and Tadashi MATSUMOTO

(Received December 28, 1977)

### **Abstract**

In an adaptive antenna array system, a set of constraints was derived which settles a chosen frequency characteristic in the direction of interest. Dealing with wide-band signals, however, a frequency response for the array can hardly be determined, since a set of linear constraints depends on a number of parameters.

In this paper, a new set of linear constraints is presented and the number of parameters are reduced to only one. Analysis of GCLMS algorithm and computer simulations are done in a differential form, since the device is complicated in a sampling process and the "learning curve" shows an improvement on the model in so far as the applications were made.

## **Application of Kalman Filter Theory to Adaptive Array Antenna Systems**

Kazuhiro KIMURA, Kiyohiko ITOH and Tadashi MATSUMOTO

(Received December 28, 1977)

### **Abstract**

Godard's algorithm, which is derived from an application of Kalman filter theory, is the expanded form of the classical LMS algorithm. Several important advantages are obtained by the algorithm: 1) the weight vector is adapted in the near direction of the optimal one; 2) the misadjustment of the weight vector does not occur because of the arithmetic decrease of the step size. Especially the first property is attractive, when the conditional number of  $R$  (input correlation matrix) is greater than unity.

This paper shows the relation between Godard's algorithm and LMS algorithm, and the results of computer simulation.

## **A Chemical Reaction in a Spouted Bed**

Osamu UEMAKI, Masahisa FUJIKAWA and Masao KUGO

(Received December 28, 1977)

### **Abstract**

A theoretical model of vapour phase chemical reaction in a spouted bed reactor is proposed to estimate the conversion of water gas reaction in a thermal cracking equipment of residual oil, and experiments of water gas reaction alone were carried out for testing the validity of the proposed model.

The experimental results indicated that the data obtained were consistent with the predicted values from the model, and that reasonable conversion of water gas reaction can be calculated readily from the present model derived from the hydrodynamic features of spouted beds and will be applicable to estimate the heat and mass balance in thermal cracking equipments.

## Neutron Quasi-elastic Scattering for Liquid Crystals

Yoshiaki KIYANAGI and Kazuhiko INOUE

(Received December 27, 1977)

### Abstract

Neutron quasi-elastic scattering measurements using a pulsed cold neutron source were performed on nematic liquid crystals, para-azoxyanisole (PAA) and p-(p-ethoxyphenylazo) phenyl undecylenate (PPEPU). The neutron spectrometer used is of the inverted geometry type and the performance is revealed to be comparable to the usual geometry type through the measurements. The full widths at half maxima in the nematic phase show a linear dependence on the square of momentum transfer for both samples. The effective diffusion constants in a temperature range of nematic phase would be constant for PAA but slightly dependent on temperature for PPEPU.

## A Germanium Crystal with a Mosaic Structure as a Neutron Monochromator (II)

Norio OHTOMO and Hirokatsu IWASA

(Received December 26, 1977)

### Abstract

The mosaic structure of a great number of hot-pressed Germanium crystals was studied by a detailed X-ray diffraction technique and discussed based on the theory of dislocation in crystals. The characteristics of the mosaic crystals as the neutron monochromator have been obtained by means of the neutron diffraction method, and such characteristics connected with the mosaic structure clarify the optimal conditions of the hot-pressed method.

## Surface Segregation of Ag and/or Au on clean Ag-Au Alloys with Ion-bombardment and/or Annealing

Masao YABUMOTO, Kuniaki WATANABE and Toshiro YAMASHINA

(Received December 28, 1977)

### Abstract

Surface segregation of Au and/or Ag on clean surfaces of Ag-Au alloys with ion-bombardment and/or annealing was studied by Auger electron spectroscopy (AES). The surface composition of each alloy was determined quantitatively by AES after annealing at 550°C *in vacuo* and following argon ion-bombardment (700 eV) by using polycrystalline foils as specimens. It was found that silver segregated slightly on each alloy surface after the annealing, on the other hand gold segregated following ion-bombardment. In addition, by comparing the Auger electron spectra of different escape depths for each of the alloys, it was found that silver was more enriched in the first layer than in the lower surface layers (i. e., the second and/or the third layers) for each alloy surface either after ion-bombardment or following annealing. The results agreed qualitatively well with the broken-bond model for the equilibrium surface segregation and the kinetic model for the selective sputtering, but not quantitatively. The discrepancy between the experimental results and the theoretical predictions for the surface segregation was discussed.

## A Rapid-Scan Infrared Spectrometer and Infrared Emission Spectra in CO-O<sub>2</sub> Explosion

Masako TANAKA, Yoshikazu KONDO, Kaichi TAKAHASHI, Sadashi SAWAMURA,

Saburo SAKAMOTO, and Meiseki KATAYAMA

(Received December 23, 1977)

### Abstract

A rapid-scan infrared spectrometer with a low resolving power was developed by modifying a commercial prism spectrometer. The new instrument was equipped with a rotating mirror and a PbSe detector. The repetition time lapse of scanning was 220 msec and it required 2-4 msec to scan for a spectral range from 1 to 4.5  $\mu$ . The resolving power was about 70  $\text{cm}^{-1}$ . In order to test the scanning performance, the instrument was used in the case of explosion of CO-O<sub>2</sub> mixture by spark discharge. The infrared emission bands due to the vibrationally excited CO<sub>2</sub> were observed. The decay process of the spectra was recorded by multi-trace technique for the periods of 660 msec following the explosion.

## Information Structure of Scientific Documents I

—On an Automatic Extraction of Significant Phrases—

Takashi MAEDA, Yoshio MOMOUCHI and Hajime SAWAMURA

(Received December 28, 1977)

### Abstract

In this paper, we have presented an automatic method for extracting significant phrases in the Titles and Abstracts of scientific documents. The method is based on the connection with a manner of representing document information from a view point of hierarchical semantic structure analysis and a method of text structural analysis of the Abstract.

Experiments were made on 5 sets of scientific documents in the A.I. research area, using a relatively small dictionary consisting of eliminable words and some selected concepts following the knowledges about the research area and its description language. The results show that significant phrases are effectively extracted in all cases and their numbers for each document and the processing time are fairly satisfactory.

## The Effect of Precipitation Conditions on the Dissolution Characteristics of Fe(III) Hydroxide in a Tartaric Acid Solution

Hiroki TAMURA, Masaru OHSHIMA, and Masaichi NAGAYAMA

(Received December 28, 1977)

### Abstract

Fe(III) hydroxide was formed by precipitation from an  $\text{Fe}(\text{NO}_3)_3$  solution and its dissolution behavior was examined in a 0.16 M tartaric acid solution ( $\text{pH}=1.90$ ) at  $25^\circ\text{C}$ . The dissolution reaction invariably obeys the equation,

$$1 - (1 - x)^{1/3} = kt$$

where  $x$  is the fraction of the dissolved Fe(III) to the total Fe(III),  $t$  is the dissolution time and  $k$  is a constant.

The value of  $k$  is affected by the conditions under which Fe(III) hydroxide is prepared, i.e., (1) kinds of alkalis used for precipitation, (2) pH after precipitation, (3) solution temperature and (4) aging time. It was found that  $k$  value decreases with weaker alkalis, higher pHs and temperatures, and longer aging times. This is explained by considering Fe(III) hydroxide to form through (A) and (B), (A) nucleation and particle growth and (B) aggregation and dehydration of particles. When  $\text{Fe}^{3+}$  ions are brought in contact with weaker alkalis at higher temperatures, a smaller number of nuclei will be generated in (A) resulting in larger

particles. These are more resistant to dissolution because of the smaller total surface area. In (B), the particles aggregate and dehydrate, and  $k$  decreases with time. The aggregation is facilitated with the increasing pH because the positive surface charge of the particles decreases. Dehydration changes the nature of Fe(III) hydroxide to increase its resistivity to dissolution.

## Configurational Partition Function of Quaternary Systems

Masaji ONODERA

(Received December 12, 1977)

### Abstract

The asymptotic method applied to ternary solutions is extended to quaternary system. The configurational partition function is obtained for the system of particles having spin value  $3/2$ . The method of calculation thereof is based on the assumption of treating pairs of neighbors as independent entities.

## Two-Camera Measurement of Smoke Plumes and Puffs

Kenji ISHIZAKI

(Received December 28, 1977)

### Abstract

A simple relation between smoke plume properties and wind fluctuations is often assumed for determining diffusion characteristics of the atmosphere. As photographic techniques for recording instantaneous plume and puff shapes, a two-camera system is proposed. This technique requires two cameras operated simultaneously and arranged on the ground stereoscopically off to one side of the plume.

Although the partial uncertainty in the lateral plume dimension introduces an error to estimate lateral plume displacement from the mean, it is suggested from the measurements that, for a sampling time of 3 minutes, the vertical dimension of the averaged plume is greater than the lateral one. The error analysis presented in this paper shows that the success of the two-camera technique will depend on the synchronization of the two cameras.

## On the Development of a Method for Latent Class Analysis

Kazuaki SUGAWA, Yoshiharu SATO, Michiaki KAWAGUCHI  
and Takashi KANETA

(Received December 28, 1977)

### Abstract

In latent class analysis, the main problem is to estimate the latent parameters. Its difficulties are due to the fact that the number of estimated parameters is extremely large as compared with the observations, in addition the structure equations are nonlinear. The traditional methods are reduced to the eigenvalue problems. But, in some of these methods, the estimates depend on the selection of items. In this paper, the solution is obtained by directly solving the structure equations using M. J. D. Powell's algorithm for the nonlinear algebraic equations. Because of the direct solution, this has an advantage over other solutions reported hitherto

## An Axiomatization of Computer-oriented Modal Logics

Hajime SAWAMURA and Takashi MAEDA

(Received December 28, 1977)

### Abstract

The need of modal concepts has been recognized in artificial intelligence and mathematical theory of computation.

In this paper, an axiomatization of computer-oriented modal logics with the modalities, necessity and possibility, has been given in such a way that an effective decision procedure will be readily constructed.

Also, the characteristic theorems of the axiom system, i. e. soundness, consistency, decidability were proved.

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## Recovery of Iron and alumina from Red Mud

Chikao YOSHII Koutaro ISHIMURA

(Received March 31, 1978)

### Abstract

Red mud is a leached residue in Bayer's process, which is discarded as a waste product by alumina producing industries. In terms of alumina and aluminium, one ton of red mud is produced for every ton of alumina and 0.5 tons of aluminium metal respectively.

The major constituents of red mud are iron oxide, alumina, titania, sodium oxide and silica along with minor amounts of calcium oxide.

Except for limited use in cement and aggregate, red mud is hardly being utilized as an industrial material.

Iron is produced by heat treatment under reducing conditions, with a suitable addition of calcium oxide, which controls the basicity and viscosity of the slag. More than 90% of iron is recovered from red mud.

The slag contains about 40% alumina. Powders of this slag are sintered with CaO and CaSO<sub>4</sub>. 4CaO·3Al<sub>2</sub>O<sub>3</sub>·SO<sub>3</sub> is formed in this sinter. When this sinter is leached with 3% Na<sub>2</sub>CO<sub>3</sub> aq. solution at 50°C, more than 92% of alumina is recovered.

## Surface Topography and the Corrosion Prevention of Copper by Benzotriazole

Takenori NOTOYA

(Received March 31, 1978)

### Abstract

An electron scanning microscopic study was made on the surface topographies subsequent to immersion in 3% NaCl solution in specimens of both fine polycrystalline copper and coarse grained copper with a thin copper-benzotriazolite (CuBTA) film on the surfaces. The results indicate that corrosion initiates at active sites in the protective multilayer films of copper oxide and CuBTA. Protectiveness of the CuBTA films appeared to be related to the crystallographic orientation of the metal substrate and underlying oxide.

## A Model Experiment on the Discharge Rate through Balancing Holes in a Centrifugal-Pump Impeller

Mikio ARIE                      Masaru KIYA  
Masayuki MITANI          Shinichi ONO

(Received March 28, 1978)

### Abstract

The present paper describes an experimental investigation of the discharge from balancing holes which are sometimes installed in single-stage centrifugal pump impellers for the purpose of reducing the axial thrust based on the pressure difference between front and back shrouds of the impellers. Although the balancing holes are highly effective in reducing the axial thrust, reduction of the volumetric efficiency of the pump is unavoidable because of the leakage through the holes. Accordingly an accurate demerination of the discharge from the balancing holes is required to determine their appropriate dimension and location. In the present experimental study the balancing holes are replaced by a few circular holes drilled in a rotating disc installed at the bottom of a stationary circular cylindrical head tank. The discharge rate from the holes is correlated with the diameter and radial location of the holes and the revolution of the disc. The experimental results can be summarized by an empirical formula in a form

$$C_d/C_{d0} = Re_d^{-A} Re_r \exp(BRe_r)$$

where  $C_d$  is the discharge coefficient from the rotating disc,  $C_{d0}$  is that from the stationary disc,  $Re_d$  is the discharge Reynolds number,  $Re_r$  is the revolution Reynolds number, and  $A$  and  $B$  are numerical constants of approximately  $2.4 \times 10^{-6}$  and  $2.1 \times 10^{-5}$  respectively, the exact values of  $A$  and  $B$  depending on the diameter of discharge holes.

## Effects of the Recirculation Zone on the Stabilization of Double Concentric Burning Jets

Kenichi ITO      Hiroshi TANAKA

(Received March 28, 1978)

### Abstract

The characteristics of the recirculation zone forming behind a burner rim was investigated experimentally in several tube burners with different rim sizes fitted in parallel with air flow. Propane-air mixture was supplied to the burners with 14 and 20 mm inner diameter. Temperature and length of the zone were measured for various mixing ratios, mixture and parallel air velocities.

The results show that temperature of the recirculation zone is affected by the mixing ratio and the flow velocities, but the length of the zone is not affected by the mixing ratio. The representative temperature of the zone depends on the mean mixing ratio within the zone as a result of mass exchange between the zone and the two streams.

Measurements for cold flow indicate that the length shows different behaviors in comparison with combustion flow. Empirical equations for the characterized length of the recirculation zone were obtained for each flow state as a function of blockage ratio and mass velocity ratio. It was found that the characterized length is independent of the inner diameter of burner tube.

### **Transition of Residual Stress in Steel Plate due to Plane Bending**

Osamu DOI Takayoshi UKAI Tomohiro KAMEHATA

(Received March 31, 1978)

#### **Abstract**

The authors measured by X-ray method the change of surface residual stress and half-value breadth of the X-ray diffraction curve of worked layer in steel plate arising from plane bending, and classified the process of change into the following two types.

In the first type, the surface residual stress in bending direction decreases after the first single cycle of bending and the transverse residual stress does not change, when the sum of the initial residual stress and stress amplitude exceed its yield point. In the second type where the stress amplitude is over the fatigue limit, the surface residual stress and half-value breadth in both directions decrease gradually due to fatigue.

### **Lateral Vibration of Rotational Shaft with Coupling**

Osamu DOI Mitsuharu OHMOMO

(Received March 31, 1978)

#### **Abstract**

The authors have analyzed the lateral vibration of a shaft-disk system with a flexible coupling. First the critical speeds and modes of vibration were obtained in consideration to the distributed mass of shaft, gyromoment and supporting condition. Then the amplitude of the forced vibration arising from an unbalanced mass was introduced. The results of the analysis are as follows.

(1) In a symmetric set of coupling, two modes of vibration are present. One is affected by the shear rigidity of the coupling and the other is affected by the flexural rigidity.

(2) In an unsymmetric set, the first critical speed is higher than that of symmetric set.

(3) In forced vibration with an unbalanced mass of coupling, the critical speed without resonance may exist for a certain phase angle of unbalanced mass and for a small or no damping of coupling.

## SEM Fractography of Gray Iron Fractured at Low Temperatures

Tōru NOGUCHI Yukio SUGAWARA

(Received March 31, 1978)

### Abstract

SEM observation was carried out on pearlitic and ferritic gray irons fractured in low temperature range of  $+20^{\circ}\text{C}$  to  $-196^{\circ}\text{C}$ , and the correlation of fracture morphology with the strength and stress-strain properties were considered. The feature of a fracture surface was expressed by the fractional area of ductile facet to the whole fractured matrix.

The ductile fracture ratio was almost 1.0 near room temperature, and with the lowering of the test temperature, the ratio decreased by increasing the cleavage area.

The transition temperature of ductile to cleavage in ferritic iron was about  $50^{\circ}\text{C}$  lower than in pearlitic iron. Although the ratio was almost zero at  $-196^{\circ}\text{C}$ , ductile fracture was observed to a certain extent in ferritic iron.

The change of fracture appearance, however, was not necessarily correlated to the stress-strain properties. For example, while the fracture was mostly cleavage at  $-150^{\circ}\text{C}$ , the fracture strain was the same as that at room temperature. And the fracture, in which cleavage and trans-granular facets were predominant, was followed by the ductile stress strain properties.

## Optimal Control by Combinatorial Input Functions

Azuma O-UCHI Akio MIYAKOSHI Ikuo KAJI

(Received March 31, 1978)

Let  $\mathcal{S}$  be an arbitrary dynamical system,  $T$  a set of control times,  $\tau = \{t_0, t_1, \dots, t_N\}$  a finite set of control switching time,  $U_i$  a finite set of admissible control function

available in a control time period of  $T_i = (t_{i-1}, t_i]$ .

The problem here is to obtain the sequences of control functions for the system  $\Sigma$  which minimizes the objective function subject in the presence of certain constraints. This problem is a sequential decision process with a finite decision set.

We give a general model for the system and algorithm.

### **Primal-Dual Programming Code for Capacitated Transportation Problems**

Hideaki ARISAKA   Azuma O-UCHI   Ikuo KAJI

(Received March 31, 1978)

#### **Abstract**

In this report, the primal-dual programming code for the capacitated transportation problem (algorithm, specification and programme) is represented. The programme code is written by FACOM FORTRAN Language for a FACOM-230-75 computer of the Hokkaido university computing center. Some numerical examples and results are described.

### **Formulation for Mode Coupling in Optical Fibers and its Application to Random Bends**

Kohichi TATEKURA   Kiyohiko ITOH   Tadashi MATSUMOTO

(Received March 27, 1978)

#### **Abstract**

In optical fibers, mode coupling is caused by random irregularities of the fiber wall or random bends of the fiber axis. The effects of mode coupling in multimode optical fibers have been reported using coupled power equations or power flow equations. Although mode coupling mechanism is very complicated, these equations have been applied only to simple theoretical models up to the present. Based on the above, it would be useful to develop general methods to analyze power flow equations for a random mode coupling mechanism.

This paper deals with a general solution of the above mentioned equation, and application of the obtained results were applied to Jeunhomme and Pocholle's experimental results. A good agreement between the theoretical and experimental results shows that our method is a useful description of mode coupling in multimode optical fibers.

## The Effects of the Reference Carrier Phase Error on a High-Speed Data Communication System Employing a Viterbi Detector

Yasutaka OGAWA Masakazu SENGOKU Tadashi MATSUMOTO

(Received March 31, 1978)

### Abstract

A Viterbi detector for high-speed data transmission over a voice-band telephone channel is receiving an increasing amount of attention recently. On the other hand amplitude modulation and coherent detection are employed in a high-speed data communication system for the purpose of using a frequency band efficiently. This paper describes the effects of the reference carrier phase error on the high-speed data communication system employing the Viterbi detector. First the relation between the phase error and the effective signal-to-noise ratio (an evaluation function of the system) is derived. Secondly further analysis is performed regarding a SSB-AM (single-sideband amplitude modulation) system. Numerical results indicate that the performance of the data communication system is degraded substantially due to the reference carrier phase error. And it was also shown that the allowable phase error in a SSB-AM system with data rates of 12,000 bits/s is about 2 degrees.

## Analog Hadamard Transform Circuit

Ryoichi SANO Hideo KITAJIMA Teiichi KUROBE

(Received March 31, 1978)

### Abstract

Orthogonal transforms, such as Fourier transform, Karhunen-Loève transform, Harr transform, and Hadamard transform, have recently been applied in communication and in pattern recognition for image processing and feature extraction. Since the Hadamard matrix is a matrix of elements plus and minus one, only real number additions and subtractions will be sufficient to calculate the coefficients of the Hadamard transform. That makes an order of magnitude speed advantage compared with the complex number Fourier transform.

In this paper a new type of Hadamard transform circuit is presented. With analog circuitry and serial input and output signals, only two summing amplifiers and one differential amplifier are required. Serial data are converted to parallel data and are distributed to the appropriate adder through analog switches controlled by Walsh-Function-like clocks. One of the sums is subtracted from the other to yield the Hadamard transform coefficients.

## Evaporation Rates in a Falling Film Evaporator Heated with Waste Gas of Dryers

Osamu UEMAKI      Masahisa FUJIKAWA  
Noboru WATANABE    Masao KUGO

(Received March 1, 1978)

### Abstract

An application of waste gas from dryers was experimentally investigated as a possible heating media of the evaporator in place of steam. In the experiments, highly humidified airs with steam, such as 0.5–0.8 (kg-H<sub>2</sub>O/kg-dry air), were tested to survey the evaporation rates in a falling film evaporator. The temperature of the inlet gas was 110–120°C which had been estimated as the outlet gas temperature of a dryer for drying of a filtrated stock of 65% moisture. The temperature of the outlet gas was 55–60°C corresponding to the boiling point of 50–55°C controlled at 100–120 mm Hg abs. pressure

The results indicated that the evaporation rates were so 2–10 (kg/m<sup>2</sup>·hr) as increased with the humidity of air. It would be expected that the evaporation rate could be promoted by more efficient calandrias from the result that the feed rate of solution also increased the evaporation rate.

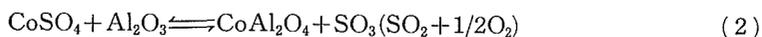
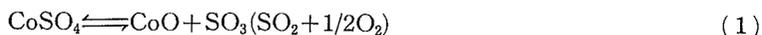
## Formation of CoAl<sub>2</sub>O<sub>4</sub> by the Solid State Reaction in CoSO<sub>4</sub>-Al<sub>2</sub>O<sub>3</sub> Systems and its Reactivity for SO<sub>2</sub>

Tadao ISHII      Ryusaburo FURUICHI  
Hiroaki MATSUSATO    Takeshi OKUTANI

(Received March 1, 1978)

### Abstract

The reaction behaviour of CoSO<sub>4</sub> alone (1) and CoSO<sub>4</sub>-Al<sub>2</sub>O<sub>3</sub> systems (2) was studied in a temperature range of 25–1200°C by means of DTA apparatus, in which nitrogen gas flows through the sample bed during the tests, and isothermal kinetic technique. In the CoSO<sub>4</sub>-Al<sub>2</sub>O<sub>3</sub> systems, especially in the initial reaction step, decomposition of CoSO<sub>4</sub> was promoted by the oxide, presumably because of the formation of binary metal oxide through some intermediate which is CoSO<sub>4</sub> incorporated with the oxide, (3) and (4).



The reactivity of CoO and CoAl<sub>2</sub>O<sub>4</sub> formed was studied in a flowing atmosphere (100 ml/min) of SO<sub>2</sub>-air mixture (1:1).

## Synthese von 2-Phenylbenzimidazolderivaten I. Mitteil

— Kondensation von o-Phenylendiamin mit  
aromatischen Carbonsäurephenylestern —

Takaaki EBANA Kazuaki YOKOTA Yoshiyuki TAKADA

(Received March 31, 1978)

### Zusammenfassung

Wir fanden, daß 2-Phenylbenzimidazolderivate durch Kondensation von o-Phenylendiamin mit aromatischen Carbonsäurephenylestern bei 220° während 1.5 Stunden mit gutem Ausbeute von 80–94% der Theorie dargestellt werden kann.

Nach diesem Phenylesterverfahren kann man die in o-Stellung substituierten 2-Phenylbenzimidazolderivate, die nach anderer Methoden sehr schwer zugänglich sind, leicht mit hohem Ausbeute darstellen.

Dieses Phenylesterverfahren ist zur Darstellung von 2-Phenylbenzimidazolderivaten, besonders in o-Stellung substituierten 2-Phenylbenzimidazolderivate geeignet.

Das Gemisch von 0.01 Mol o-Phenylendiamin und 0.01 Mol Benzoesäurephenylester erhitzt man auf 220° und erhält während 1.5 Stunden bei dieser Temperatur. Nach dem Erkalten rührt man mit Wasser und dekantiert das Waschwasser. Das in kristalliner Form ausgeschiedenen Produkt kristallisiert man aus Äthanol um.

## Synthese von 2-Phenylbenzimidazolderivaten II. Mitteil

— Kondensation von o-Phenylendiamin mit aromatischen  
Carbonsäuren in Gegenwart von Phosphoroxychlorid —

Takaaki EBANA Kazuaki YOKOTA Yoshiyuki TAKADA

(Received March 31, 1978)

### Zusammenfassung

Wir fanden, daß 2-Phenylbenzimidazolderivate durch Kondensation von o-Phenylendiamin mit aromatischen Carbonsäuren in Gegenwart von Phosphoroxychlorid als Kondensationsmittel mit gutem Ausbeute dargestellt werden kann.

Nach diesem Phosphoroxychloridverfahren stellten wir 2-Phenyl-2-o-, 2-p-Oxyphenyl-, 2-o-, 2-m-, 2-p-Toluy-, 2-o-, und 2-p-Chlorphenylbenzimidazol mit Ausbeute von 80–88% der Theorie dar.

Das Gemisch von 0.01 Mol o-Phenylendiamin und 0.01 Mol aromatischer Carbonsäure erwärmt man 1/4 Stunde auf 120° und tropft 0.01 Mol Phosphoroxychlorid zu. Die Temperatur von Reaktionsgemisch steigert man auf 200° und erhitzt bei dieser Temperatur während 1½ Stunden. Man gießt das Reaktionsgemisch in Wasser und macht alkalisch mit ammoniak.

Man wäscht das ausgeschiedene Produkt mit heißem Wasser und kristallisiert aus heißem Äthanol um.

## Cracking of Aliphatic Thiols over Solid Phosphoric Acid and Metal Phosphates

Masatoshi SUGIOKA Kazuo AOMURA  
(Received March 31, 1978)

### Abstract

The activities of solid phosphoric acid (SPA) and metal phosphates (Me-P) for the cracking of aliphatic thiols were examined by the use of pulse reactor.

SPA showed a high catalytic activity for the cracking of ethanethiol and it was shown that the cracking reaction proceeded following a first order irreversible rate equation. The catalytic activity of SPA was poisoned by injection of pyridine and it decreased with an increase of the calcination temperature of SPA. Thus, it was concluded that the active site of SPA for the cracking of aliphatic thiols is the Brönsted acid site of SPA and the cracking reaction proceeds via alkyl carbonium ion as the reaction intermediate.

On the other hand, Me-P such as  $\text{Fe}^{3+}\text{-P}$ ,  $\text{Fe}^{2+}\text{-P}$ ,  $\text{Cu}^{2+}\text{-P}$  and  $\text{Ni}^{2+}\text{-P}$ , etc, also showed a high activity for the cracking of 2-propanethiol. However, the cracking product was only propylene and hydrogen sulfide was not detected by gaschromatography. The activities of Me-P decreased as the pulse number increased and finally disappeared and were independent of the acidity of Me-P. X-ray analysis of Me-P before and after cracking reaction indicated that the metal ions in Me-P were changed to metal sulfide after the cracking reaction. From these results, it was concluded that Me-P acts as a desulfurization reagent rather than a catalyst for the cracking of aliphatic thiols.

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## **Thermal Characteristics of Kata Thermometer and its Application to Measuring Air Movement and Radiant Temperature**

Tohru MOCHIDA  
(Received June 15, 1978)

### **Abstract**

The Kata thermometer invented as a man-thermal model by L. Hill in 1916 is nowadays applied in order to measure air movement. It is said to be useful for low air movement such as those found in an ordinary room.

In the present study, the air movement formula of Kata thermometer is examined and an approach for measuring air movement and radiant temperature rationally is proposed.

As a result of investigations and experiments, it was proved that the existing Kata calculating formula of air movement can not be applied in an ordinary thermal environment where air temperature is not equal to the radiant temperature and that the value of Kata convective heat transfer coefficient is considerably larger than that obtained from the laboratory work by the author in a controlled test-chamber.

On the other hand, in the case of the Globe thermometer, it has been pointed out that it is advisable to use the formula for calculating radiant temperature with due consideration to the air movement to be substituted.

Further, a principle for measuring air movement and radiant temperature by using dry and wet Kata thermometers at the same time is proposed, and satisfactory results are obtained when air movement and radiant temperature are measured in an office-room by the measurement method proposed.

## **Results of the Strength Tests of Rocks in Coal Bearing Formations in Ishikari Coal Fields (Part I)**

—The Strength Characteristics of Horonai, Ikushunbetsu  
and Horokabetsu Formations—

Shigenori KINOSHITA, Yoji ISHIJIMA, Tatsuhiko GOTOH and Akira NAKAMURA  
(Received June 30, 1978)

### **Abstract**

In order to investigate the strength characteristics of rocks in main coal bearing formations at Ishikari coal fields in Hokkaido, a series of strength tests of the rock samples taken from coal mines at those coal fields were carried out in our laboratory for last two years. The results will be reported dividing into two parts.

The present paper of Part I gives the experimental data concerning Horonai formation composed mostly of shale, Ikushunbetsu formation consisting of coal seams and various coal bearing rocks and Horokabetsu formation locating intermediately between Yubari and Noborikawa formation. The items of strength tests are uniaxial compression, tension and triaxial compression test.

All the specimens were prepared from the boring cores obtained in coal mines by cutting and grinding in state of dry condition.

### **Results of the Strength Tests of Rocks in Coal Bearing Formations in Ishikari Coal Fields (Part II)**

—The Strength Characteristics of Noborikawa, Yubari and Bibai Formations—

Shigenori KINOSHITA, Yoji ISHIJIMA, Tatsuhiko GOTOH and Akira NAKAMURA

(Received June 30, 1978)

#### **Abstract**

As a continuation of the previous paper, the results of strength tests which were performed on rocks overlying and underlying main working coal seams in New Yubari and Sunagawa collieries are described in this paper.

New Yubari colliery in Yubari district is working only the coal seams of Yubari coal bearing formation. While Sunagawa colliery in Sorachi district is mining the coal seams of Noborikawa, Yubari and Bibai formations.

Uniaxial compression, tension and triaxial compression tests were performed on the rock specimens which were prepared from the boring cores.

In addition to rocks, a test of coal at the Akabira coal mines was made and its results are shown in this paper as a reference.

Lastly a comparison of whole data including Part I and some discussions regarding them were made,

### **A Study on the Behaviour of Solute-rich Liquid in the Crystal Growth of Steel Ingots**

Tadayoshi TAKAHASHI, Masayuki KUDOU and Keiichi YODOSHI

(Received June 30, 1978)

#### **Abstract**

It is necessary to know the behaviour of the liquid in the solid-liquid coexisting zone on the solidification in steel ingot, in order to understand the macrosegregation such as the

inverse *V*-segregation, the healing of the hot-tearing during solidification etc.

In this study, an artificial spacing is made in the solid-liquid coexisting zone and the liquid is allowed to flow into it. This was done in such a way that the fluidity of the solute-rich liquid flowing into the spacing and the morphologies of crystals and non-metallic inclusions formed in the liquid which filled the spacing may be examined at various temperatures. The mechanism of crystal refinement in the liquid of the spacing is also considered.

### **Design of a Concise Torque Magnetometer and Its Application to Texture Analysis**

Hitoshi NAKAE, Koichi HAMADA and Mitsuru NARITA

(Received June 30, 1978)

#### **Abstract**

A recording torque-magnetometer to meet the requirement of handiness and low cost in construction was designed by simplifying the constituent elements using a permanent magnet.

It was then applied to the analysis of the phenomena involved in the recrystallization and texture formation in cold rolled ferromagnetic materials by utilizing its quantitiveness and of which some significant results were obtained.

### **Quantitative Analysis of Recrystallization and Texture Development in 3.25% Si-Fe Alloys**

—Mainly on the Effect of AlN, MnS—

Hitoshi NAKAE, Mitsuru NARITA and Koichi HAMADA

(Received June 30, 1978)

#### **Abstract**

Magnetic torque measurement revealing a texture formed in ferromagnetic materials in a quantitative fashion were applied to the study of the recrystallization and texture development by grain growth in some Si-Fe alloys.

From the results, the very starting temperature of recrystallization was identified for each alloy and the modes of nucleation, normal and abnormal growth were characterized for the sorts of small additions in the alloys. Further, some suggestions for a method of obtaining highly textured alloys were proposed.

# Numerical Studies for the Nonlinear Behavior of the One-Dimensional Vlasov Plasma by the Power Transform Method

Masaharu SEKI and Ikuo KAJI

(Received June 29, 1978)

## Abstract

The nonlinear electrostatic wave behavior of a Vlasov plasma is studied numerically for perturbation applied to a Maxwellian plasma with two beams. The solutions for large perturbations are carried out beyond the time points of minimum electrostatic amplitudes. After reaching their minimum values, some modes which are linearly stable grow, due to the interaction with particles and the mode coupling effect. The effect of a weak beam of electrons with shifted Maxwellian distribution on a Maxwellian plasma is studied. After the initial conditions die out, mode behavior as would be expected according to quasilinear theory was seen. The nonlinear response of Vlasov plasma is calculated for the perturbations applied to a spatially inhomogeneous equilibrium. The period of a fundamental spatial mode closely agrees with the second and third modes. Each mode approaches a new equilibrium after  $t \approx 18$ .

## Neutron Quasielastic Scattering Study of Random Motions in Solids

—A New Pulsed Cold Neutron Source Hybrid Spectrometer and  
Results of Preliminary Experiments—

Kazuhiko INOUE

(Received June 30, 1978)

## Abstract

Quasielastic scattering of neutrons is useful as a technique for the study of random motions in solids for the characteristic time of  $10^{-12}$  to  $10^{-9}$  sec. A new cold neutron spectrometer has been installed at the 45 MeV electron LINAC at Hokkaido University for the main purpose of measurements of quasielastic scattering. The facility consists of a LINAC cold neutron source, four high sensitivity crystal monochromator assemblies, and a four-detector time-of-flight system. This paper gives a brief discussion of the quasielastic scattering and a description of the spectrometer. Results of preliminary measurements are also reported.

## Analysis of Time Behavior of Fast and Intermediate Neutrons in LINAC-TOF Experiments

Masafumi ITAGAKI, Tadashi AKIMOTO and Yuichi OGAWA

(Received June 30, 1978)

### Abstract

Time behavior of fast and intermediate neutrons in a graphite assembly is analyzed. Mean emission time of neutrons is calculated by the diffusion theory assuming the separability of space and time. And also space and angular dependent mean emission time of neutrons is analyzed by one-dimensional SN code "ORISN". Interesting results are obtained for the dependence of mean emission time on energy, space, pulse width of neutron source etc. on comparing the two results. There is a special feature in SN code "ORISN" in which the first trial input data of neutron flux for iterations is not required. Time dependent neutron spectrum is obtained with time dependent SN code "T-ORISN" developed by authors. Employed nuclear data is JAERI-FAST set and ABBN set.

## Hydrodesulfurization of Benzothiophene over NiO-MoO<sub>3</sub>-Al<sub>2</sub>O<sub>3</sub> Catalyst

By Masatoshi SUGIOKA, Kazuo AOMURA and I. G. DALLA LANA

(Received June 29, 1978)

### Abstract

A kinetic study of hydrodesulfurization (HDS) of benzothiophene (BT) over NiO-MoO<sub>3</sub>-Al<sub>2</sub>O<sub>3</sub> catalyst was carried out using a differential fixed-bed reactor operated at atmospheric pressure and in a temperature range of 275 to 325°C.

The rate equations of power-law expression and Langmuir-Hinshelwood type expression were obtained as follows;

Power-law expression,

$$r = kP_H P_{BT}^{0.67}$$

Langmuir-Hinshelwood type expression,

$$r = \frac{kP_H P_{BT}}{1 + K_{BT} P_{BT}}$$

The mechanism of HDS of BT over NiO-MoO<sub>3</sub>-Al<sub>2</sub>O<sub>3</sub> catalyst were discussed on the basis of the latter rate equation.

## Measurements of Refractive-Index in Thin Films by Optical Waveguiding

Keiji TANAKA

(Received June 15, 1978)

### Abstract

A prism coupler, developed for exciting guided optical waves in integrated optical circuits, can be used to determine the refractive index and the thickness of a light-guiding thin film. Both quantities are obtained simultaneously by measuring the coupling angles of a light beam at the prism and plotting the results on a dispersion chart. The fundamentals, mathematical procedures and the experimental details are reported. It is revealed that satisfactory accuracies of 0.001 and  $0.001 \mu\text{m}$  for refractive index and film thickness, respectively, can be obtained.

## Brownian Motion Theory and Neutron Scattering Models I

Hidetoshi KONNO, Keiichi SAITO and Masanao KITAMURA

(Received June 30, 1978)

### Abstract

The relation of neutron scattering models with "Coarse-graining" procedure is investigated on the basis of the generalized Brownian motion theory proposed by Mori. The Markoffian and the non-Markoffian quantal Langevin equations are derived by the coarse-graining using two types of the quantum mechanical fluctuation-dissipation theorem. In this case, the difference between the canonical correlation formalism and the usual correlation formalism is clarified. Then the simple model Hamiltonians corresponding to the two types of quantal fluctuation-dissipation theorem are exemplified. The relation theorem are exemplified. The relation of several scattering models derived from the quantum mechanical Brownian oscillator model with coarse-graining procedure is shown in a flow chart.

## **Stability Analysis of Surface-Preserving Modes by an Energy Principle**

Toshihisa HONMA Masafumi KITO and Ikuo KAJI

(Received June 30, 1978)

### **Abstract**

A stability criterion for surface-preserving modes in closed-line systems in an axisymmetrical toroidal plasma is derived from an energy principle. The criterion is compared with a criterion for localized modes of plasma with closed-line field. There exists a discontinuity between those criteria. The stability criterion for the surface-preserving modes is represented by elliptic quadratic curves for toroidal plasmas.

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## **Application of fluidized bed and spouted bed techniques to thermal cracking of heavy residual oils.**

Osamu UEMAKI    Masahisa FUJIKAWA    Masao KUGO

(Received July 8, 1978)

### **Abstract**

Fluidized bed and spouted bed techniques were applied to the thermal cracking of heavy residual oils in order to convert them into more valuable matter. Three types of the reactors have been developed; a dual and a single fluidized bed reactor to produce coke, a dual spouted bed reactor to produce ethylene and propylene, and a dual spouted bed reactor with three chambers to produce low sulfur fuel oil.

Basic research studies suggested that applications of these reactors to commercial operations could be successful and the fundamental results obtained in this experiment would be useful to a better understanding of the behavior of the fluidized bed as well as the spouted bed in case of applications of the thermal cracking reactors of heavy residual oils.

## **Relations between induced convections and transfer rates for a gas-liquid contact**

Toshiharu SHIBATA and Masao KUGO

(Received July 8, 1978)

### **Abstract**

The convections induced in liquid with gas-liquid mass transfer are affected by various conditions, such as concentration levels of liquid and gas phases, changes of density, surface tension and viscosity of liquid, shape of interface and depth of liquid phase. Some of these were experimentally discussed for absorptions of hydrogen sulfide or carbon dioxide into aqueous monoethanol amine or potassium hydroxide solutions.

Approximate rate analyses for convection mass transfer, here, were carried out with special regards to contact times in such a way as to obtain explanations of experimental results with fairly good correspondences.

One of these included the desorption of ammonia gas from its aqueous solutions to the agitated gas (air) phase which had a restricted volume.

## Mechanism of Hydrogenolysis of Coal Derived Asphaltene

Nobuyasu KANDA    Hironori ITOH

Susumu YOKOYAMA    Koji OUCHI

(Received July 8, 1978)

### Abstract

Asphaltene derived from Akabira coal was hydrogenated at 370°C and 400°C, with the pressure of 22~23MPa for 0~240 minutes, using red mud and sulfur as the catalysts. The product was separated into non-reacted asphaltene and product oil with *n*-hexane. The structural analysis showed that this reaction did not proceed with the splitting of bridge parts linking each unit structure, but with the saturation of aromatic nuclei in unit structure, the splitting of naphthene or hetero rings and the dehydroxyl reaction.

## A Study on the Elution Behavior of Aliphatic and Aromatic Compounds in Gel Permeation Chromatography

Hironori ITOH    Susumu YOKOYAMA    Tomonori HATORI

Gen TAKAYA    Koji OUCHI

(Received July 8, 1978)

### Abstract

The elution behavior of about 70 aliphatic and aromatic compounds in gel permeation chromatography (GPC) was discussed to accumulate basic data for the analyses of asphaltenes such as petroleum asphalt, pitches and coal derived products by using a GPC method. The Shimadzu GPC-IA (Shimadzu Seisakusho Ltd.) was used. Four 4-ft columns (3/8 in. in diameter) in series were used as the sample column. Each column was packed with SG-gel with a different pore size. A 4-ft reference column was used on the reference side. In this work, three kinds of sample column systems were used and the elution behavior of those system were compared with one another. Tetrahydrofuran (THF) was used as the eluent. All measurements were carried out at room temperature. The principal results obtained by the column system consisted of one 12.5A (SG-1 gel), two 340A (SG-2 gel) and one 2,500A (SG-3 gel) pore size designation were as follows.

The elution volumes of *n*-paraffin decreased with increasing carbon numbers and this elution behavior resembled that of synthetic polymers such as polystyrene. The elution behavior of pericondensed aromatic compounds was markedly different from

other compounds. The larger the molecules were, the slower they were eluted. In other compounds except for pericondensed aromatics, elution volume decreased with the increasing molecular weight, namely, the larger the molecules were, the more rapidly they were eluted.

Elution volume decreased to about 1.5 counts (7.5ml) for *p*-phenylene, and to 0.5~0.6 counts (2.5~3.0ml) for catacondensed aromatics with an increasing number of benzene rings. However, the elution volume of the pentacene decreased to about 2.5 counts (12.5ml) as compared to that of naphthalene.

The elution volume decreased to about 0.5~0.7 counts (2.5~3.5ml) with the increasing number of methylene groups for the series of alkylbenzene and to about 0.3~0.5 counts (1.5~2.5ml) for the methyl groups substituted on naphthalene and anthracene.

Functional groups such as hydroxyl, carbonyl and amino groups substituted on benzene also decreased the elution volume in almost the same proportions.

## New Organic Synthesis Using Organoboranes

—Carbon-Carbon Bond Formation Reactions, Mainly  
Using Tetracoordinate Organoboranes—

Akira SUZUKI  
(Received July 8, 1978)

### Abstract

Recent progress of new carbon-carbon bond formation reactions using tetracoordinate organoboranes including  $R_3\bar{B}-C\equiv CR^1$ ,  $R_3\bar{B}-CH=CHR^1$ ,  $R_3\bar{B}-CHXR^1$ , and  $[R_3\bar{B}Me]Cu^+$  are discussed.

## Studies in Organic Reactions Using Super Acids

Norihiro YONEDA    Yukio TAKAHASHI    Tsuyoshi FUKUHARA  
Nobu TOMITA and Akira SUZUKI  
(Received July 8, 1978)

### Abstract

Organic reactions in the presence of super acids such as  $HF-SbF_5$  and  $FSO_3H-SbF_5$  were studied in order to elucidate their characteristic behaviors, compared

against those using the usual strong acids. Reactions presented in this report are as follows.

1. Carboxylation of aliphatic alcohols and diols having short C-C chains with carbon monoxide.
2. Carboxylation of alkanes with carbon monoxide.
3. Ionic oxidation of alkanes with ozone and hydrogen peroxide.
4. Electrophilic reactions toward  $\sigma$ -bonds in the aliphatic alcohols, aliphatic ketones, aliphatic carboxylic acids and phenyl alkylketones.

Judging from the experimental results, the following conclusions may be given.

1. Alcohols and diols having a small number of carbon atoms which are hardly carboxylated with carbon monoxide in the presence of the usual strong acid such as sulfuric acid, give the corresponding carboxylated products in high yields with the use of HF-SbF<sub>5</sub> super acid systems under mild conditions, which is considered to be due to the highly stabilized carbenium ions derived from alcohols under the conditions.

2. Alkanes which are hardly subjected to an ionic reaction react with carbon monoxide giving corresponding carboxylic acids in the presence of HF-SbF<sub>5</sub> and FSO<sub>3</sub>H-SbF<sub>5</sub> under mild conditions. The reaction is well explained to proceed initially via the protolysis of alkanes giving rise the corresponding alkyl cations. The behaviors of alkyl cations, together with alkyl cations formed by the carboxylation of alkyl cations, are also discussed from the experimental results of the product distribution.

3. Protonated ozone and hydrogen peroxide in the FSO<sub>3</sub>H-SbF<sub>5</sub> act as an electrophile toward the  $\sigma$ -bond in alkanes to produce oxyfunctionalized products. The reactivity order of  $\sigma$ -bonds for these electrophiles is: tert-C-H > sec-C-H  $\gg$  C-C > primary-C-H.

4. The electrophiles such as H<sup>+</sup>, O<sub>3</sub><sup>+</sup>H and H<sub>3</sub><sup>+</sup>O<sub>2</sub> in super acid systems attack effectively toward the single  $\sigma$ -bonds in functionalized organic compounds such as alcohols, ketones and carboxylic acids giving rise to characteristic bifunctional products.

## The Formation of Spherulites of Bacterial Cellulose from *Acetobacter xylinum*

M. Takai , J. Hayashi , J. R. Colvin and L. C. Sowden

(Received July 8, 1978)

### Abstract

Two dimensional spherulites are formed in the pellicle of bacterial cellulose by static cultures of *Acetobacter xylinum*. These spherulites are much larger (sometimes more than 2 cm in diameter) than those usually observed in other natural or synthetic

polymers. Evidence from polarizing and phase microscopy as well as scanning electron microscopy indicates that the cellulose microfibrils in the spherulites of bacterial cellulose are oriented tangentially and not radially. Also, the orientation may be limited to only a fraction of the thickness of the pellicle. It is suggested that the tangential deposition may be caused by a gradient of concentration of a weakly soluble inhibitor of cellulose formation around the center.

## Nascent Stage of Cellulose Microfibril in Bacterial Cellulose Biosynthesis

M. Takai , G. G. Leppard and J. R. Colvin

(Received July 8, 1978)

### Abstract

The morphological aspects of biosynthesis of cellulose by *Acetobacter xylinum* were studied by transmission electron microscopy on both freeze-etched replicas and sections of cellulose-free cells in suspension culture before and subsequent to the induction of cellulose synthesis. Also examined were freshly synthesized, thoroughly washed, cellulose pellicles. Thin sections of rapidly dividing, glucose-metabolizing cells showed irregular features on the cell surface including small polar invagination which sometimes was contained or was associated with fibrils as fine as 30 Å in diameter of a substance which stains with electronmicroscopic negative-stains. Cellulose microfibrils in thin sections of freshly synthesized pellicles were coated with a surface material which also stained with the same negative-stains. The effect of air-drying on freshly synthesized cellulose was striking. When examined by freeze-etching, and thoroughly washed, never air-dried pellicles showed a nascent form of cellulose fibril which consisted of a central, dense core surrounded by a sheath of amorphous gel. This sheath may be up to 1000 Å in width. When the pellicle was air-dried and rehydrated before freeze-etching, the amorphous sheath was scarce and shrunken but ordinary microfibrils of usual dimensions were visible. The sheath and core are sometimes closely associated with the envelope of the cells. These observations can be interpreted in the context of recent advances in cellulose biosynthesis by assuming that chains of an initial, highly hydrated, intermediate polyglucosan are released from the cell and that such chains associate to form a nascent fibril external to the cell that are associated with the cell envelope. Air-drying of nascent fibrils converts them to familiar microfibrils and this conversion is considered here in molecular terms.

## Complexes of Benzonitrile and Montmorillonites Saturated with Various Interlayer Cations

Atsumu TSUNASHIMA    Masaru TACHIKI

Kohei KODAIRA    Toru MATSUSHITA

(Received July 8, 1978)

### Abstract

The benzonitrile complexes with montmorillonites containing various interlayer cations have been investigated to clarify the role of interlayer cations in the formation of clay-organic complexes.

The perturbation of CN stretching frequency of benzonitrile in complexes increases proportionately with polarizing power (charge/ionic radius<sup>2</sup>) of the interlayer cations. This indicates that montmorillonites saturated with more strongly polarizing cations form more stable complexes.

## A Study on the Formation and Sintering of LiNbO<sub>3</sub>

S. SHIMADA,    K. KODAIRA    and    T. MATSUSHITA

(Received July 8, 1978)

### Abstract

The formation and sintering of LiNbO<sub>3</sub> were studied from the results of TG experiments, X-ray analysis, shrinkage measurements and/or SEM observation. The formation process of LiNbO<sub>3</sub> was followed by heating the equimolecular mixture of Li<sub>2</sub>CO<sub>3</sub> and Nb<sub>2</sub>O<sub>5</sub> at 20–900°C. The reaction between Li<sub>2</sub>CO<sub>3</sub> and Nb<sub>2</sub>O<sub>5</sub> proceeds with CO<sub>2</sub> evolution to form LiNbO<sub>3</sub> at ca. 300–700°C. The diffusion of Li<sub>2</sub>O through the layer of LiNbO<sub>3</sub> is rate-controlling. At 600–800°C, a slight formation of LiNb<sub>3</sub>O<sub>8</sub> or Li<sub>3</sub>NbO<sub>4</sub> occurs by the reaction between LiNbO<sub>3</sub> and Nb<sub>2</sub>O<sub>5</sub> or Li<sub>2</sub>O, respectively. The single phase of LiNbO<sub>3</sub> is formed above 850°C. Thus, powder of LiNbO<sub>3</sub> with a homogeneous composition was obtained by heating the equimolecular mixture of Li<sub>2</sub>CO<sub>3</sub> and Nb<sub>2</sub>O<sub>5</sub> at 900°C for 2 hr, and was used for the sintering study.

The effects of oxides of CdO, ZnO, CoO, Fe<sub>2</sub>O<sub>3</sub> and GeO<sub>2</sub> on the sintering of LiNbO<sub>3</sub> were discussed on the basis of Kingery's model of initial sintering. Among these oxides, CdO was found to be most effective. Exaggerated grain growth in pure LiNbO<sub>3</sub> occurs at 1050–1100°C and hinders the attainment of sintered densities higher than 83–87%. Addition of CdO causes rapid densification to a density of 98% at

1000°C for 2 hr. DTA curves indicated a reaction between CdO and LiNbO<sub>3</sub> at 750–895°C: the second phase thus formed probably hinders exaggerated grain growth.

### Thermoanalytical Studies on Reactivity of Solids (I)

— Single Solid and Solid–Gas Reactions —

Tadao ISHII

(Received July 8, 1978)

#### Abstract

In order to study the effect of various factors such as preparation history, structure, impurity, additive, atmosphere, etc. on the reactivity of solids, thermoanalytical techniques were applied to the following reactions including solids.

(1) Single solid reactions: (a) thermal decomposition of CuSO<sub>4</sub> · 5H<sub>2</sub>O, MgCl<sub>2</sub> · 6H<sub>2</sub>O, oxalates—KClO<sub>3</sub> and NH<sub>4</sub>VO<sub>3</sub>, (b) transformation of Fe<sub>3</sub>O<sub>4</sub> and  $\eta$ -Al<sub>2</sub>O<sub>3</sub>.

(2) Solid–gas reactions: (a) oxidation of UO<sub>2</sub>, (b) chlorination of Mg–containing ores, MgO, bauxite and aluminas, (c) aluminates—SO<sub>2</sub>, (d) H<sub>2</sub>–reduction of  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub>.

### Thermoanalytical Studies on Reactivity of Solids (II)

— Solid–Solid and Catalytic Reactions —

Tadao ISHII

(Received July 8, 1978)

#### Abstract

In order to study the effect of various factors such as preparation history, structure, impurity, additive, atmosphere, etc. on the reactivity of solids, thermoanalytical techniques were applied to the following reactions including solids.

(1) Solid–solid reactions: (a) MgO–Al<sub>2</sub>O<sub>3</sub> and MgO–Fe<sub>2</sub>O<sub>3</sub>, (b) Cr<sub>2</sub>O<sub>3</sub>–MgO and Cr<sub>2</sub>O<sub>3</sub>–ZnO, (c) aluminas–ZnO, (d) V<sub>2</sub>O<sub>5</sub>–Fe<sub>2</sub>O<sub>3</sub>, V<sub>2</sub>O<sub>5</sub>–V<sub>2</sub>O<sub>3</sub>, V<sub>6</sub>O<sub>13</sub>–V<sub>2</sub>O<sub>3</sub> and V<sub>2</sub>O<sub>3</sub>–MgO, (e) Fe<sub>2</sub>O<sub>3</sub>–ZnO, Fe<sub>2</sub>O<sub>3</sub>–MCO<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub>–Al<sub>2</sub>O<sub>3</sub>, (f) sulfates–oxides and carbonates–oxides, (g) TiO<sub>2</sub>–CaSO<sub>4</sub>.

(2) Catalytic reactions: (a) oxidation of SO<sub>2</sub> by V<sub>2</sub>O<sub>5</sub>–M<sub>2</sub>SO<sub>4</sub> catalysts, (b) thermal decomposition of KClO<sub>4</sub> by Fe<sub>2</sub>O<sub>3</sub> catalysts.

## The Composition and Layer-Structure of Passive Films on Iron in Neutral Solution

Rokuro NISHIMURA    Norio SATO

(Received July 8, 1978)

### Abstract

The passive films formed on iron in neutral borate and phosphate solutions of pH 8.42 were investigated by using electrochemical and ellipsometric techniques. From analyses of iron dissolution and  $\delta P$ - $\delta A$  curve during galvanostatic cathodic reduction of the film, it was found that the passive films formed in these solutions consisted of a deposit layer next to the solution and a barrier layer in contact with the metal. In borate solution, the deposit layer was hydrated iron(III) oxide at relatively noble potentials and hydrated iron (II-III) oxide at less noble potentials. Furthermore, the barrier layer composition changed from iron (II-III) oxide at potentials below the Flade potential to iron (III) oxide at more noble potentials. The thickness of the barrier layer increased nearly linearly with the potential. In phosphate solution, the deposit layer was of the same nature as that in borate solution, but the barrier layer always contained iron (II) ions with the mean oxidation valency  $Z_{Fe} = 2.33$ .

It was also found for the passive film in borate solution that there was an iron enrichment or depletion at the deposit/barrier interface and that an adsorption layer of OH radical was probably formed at the deposit/solution interface. However, no such adsorption layer and iron depletion (or enrichment) were found in the passive film formed in phosphate solution.

The results were explained by assuming an anion selective property for the film formed in borate solution and a cation selective property for the film formed in phosphate solution.

## Adsorption of $Zn^{2+}$ Ions on Fe(III)-hydroxide

Hiroki TAMURA    Masaru OHSHIMA

Kazuhisa GO    Masaichi NAGAYAMA

(Received July 8, 1978)

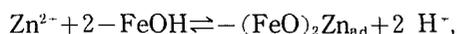
### Abstract

The extent of  $Zn^{2+}$  ion adsorption on Fe(III)-hydroxide prepared by hydrolyzing Fe  $(NO_3)_3$  was measured as a function of the solution pH(5-7) and the amount of the

hydroxide. Acid–base titrations of the hydroxide were also carried out, and its surface area was measured by the BET method. It was found that the concentration of the adsorbed  $Zn^{2+}$  ions is proportional to the concentrations of  $Zn^{2+}$  ions in solution and Fe(III)-hydroxide, but is inversely proportional to the second power of the hydrogen ion concentration:

$$[Zn^{2+}_{ad}] = K [Zn^{2+}] [Fe(III)]/[H^+]^2$$

This behavior is explained by considering the adsorption reaction to be



where  $-FeOH$  is the site at which the  $Zn^{2+}$  ion can adsorb. The  $-FeOH$  type site was found to prevail over the  $-FeOH_2^-$  and  $-FeO^-$  type sites in the pH region investigated, and the concentration of  $-FeOH$  sites was much higher than that of the adsorbed  $Zn^{2+}$  ions.

## Study on the Site Selectivity of Exchangeable Cation in Synthetic Zeolite A

Masahiro NITTA and Kazuo AOMURA

(Received July 8, 1978)

### Abstract

Synthetic Zeolite A is a crystalline aluminosilicate well known for its industrial applications as an adsorbent and molecular sieve. Zeolite A has exchangeable cations which are distributed among the three kinds of sites and the cations have their own intrinsic site selectivities. The site selectivity was investigated by the two methods. One of them is an experimental method that is based on the molecular sieve action of zeolite A, and another is a theoretical method that is based on the estimation of cation–zeolite lattice interaction energy. There was a good agreement between the results obtained by the two methods. As a result, the site selectivities determined for cations were as follows:  $Li^+$ ,  $Na^+$ ,  $Ag^+$ ,  $Ca^{2+}$  and  $Sr^{2+}$  ions prefer the six–membered oxygen ring site, whereas  $K^+$ ,  $Cs^+$ ,  $Tl^+$  and  $Ba^{2+}$  ions prefer the eight–membered oxygen ring site. It was also concluded that the theoretical method would have considerable use in the determination of the cation sites of other zeolite types, such as X and Y.

## The Spin-trapping Technique using Nitroso-compounds as Spin-trapping Agents

Hiroshi YOSHIDA    Takahisa DOBA

(Received July 8, 1978)

### Abstract

In order to determine the basis of exploiting the spin-trapping technique for quantitative studies of short-lived free radicals, nitroso-compounds (most commonly used spin-trapping agents) such as nitrosobenzene, nitrosodurene, pentamethylnitrosobenzene, 2,4,6-tri-*t*-butylnitrosobenzene, and 2-methyl-2-nitrosopropane were studied in several aspects. The optical absorption spectrum, the monomer-dimer equilibrium constant, and the ESR hyperfine coupling constants of spin-adduct radicals are collected for these spin-trapping agents, and for phenyl-*N-t*-butylnitrene for comparison. The secondary reaction between a spin-adduct radical and a short-lived free radical generally occurs and deteriorates the kinetical analysis of spin-trapping data. A model calculation of this effect gives the results which enables us to understand the kinetical features involved in this technique.

## Study of Gilsonite Pitch in the Early Stage of Carbonization

—Structural Parameters obtained from Reflectance and X-ray Diffraction Methods—

K. NEMOTO    Y. SANADA

(Received July 8, 1978)

### ABSTRACT

The layer stacking and the optically anisotropic texture of a mesophase were clarified by using X-ray diffractometric, reflectance and microscopic methods. For the mesophase obtained from Gilsonite pitch, a kind of natural pitches, by heat-treatment for various residence times at 430°C, refractive and absorptive indices were obtained from reflectance. Stacking index (SI) and average number of stacked layer ( $\bar{N}$ ) were calculated by Patterson function derived from X-ray diffractometric method. In optically anisotropic mesophase, the maximum reflectivities occur when the line of polarization of light is in parallel with the lamellae, and is at a minimum when perpendicular to the lamellae. The anisotropy index was defined from maximum and minimum absorptive indices. The anisotropy index was related to SI, and  $\bar{N}$ . By combining the results from reflectance with those from X-ray diffractometric method, the degree of stacking layers was obtained.

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## **An Overall Modelling of Fully Nonlinear R/C Buildings under Extreme Earthquakes**

HARUO TAKIZAWA

(Received July 10, 1978)

### **Abstract**

For describing the overall structural behaviour of planar R/C buildings, a self-contained set of fully nonlinear and dynamic formulations is presented in a mathematically consistent way. Limited degrees of freedom in system deformation, associated with a bare-minimum reduction of constituent restoring force elements, feature the model developed; without going into specific structural details, this modelling of a gross nature is primarily intended to cover a certain class of buildings by incorporating the relevant common properties of a particular interest. In addition to permitting to adequately reflect the inelastic and hysteretic characteristics, the current formulation accounts for the effects of nonlinear geometry in the deformed configuration, and can be used, with a practical sufficiency, for the purposes of clarifying significant features in the serious damage and ultimate failure sustained under the combined action of intense ground motion and gravity. The discussions also include the quantitative identification of the role of basic system parameters in this regard, and the related characterization of the destructive capabilities of excitation. In particular, the influence of failure concentration at a comparatively soft and vulnerable portion of structure is emphasized by comparison with other typical instances of overall failure.

## **Ultimate Strength Equations of Reinforced Concrete Members at Brittle Failure**

Takuji SHIBATA    Yasuyuki ARAI

(Received July 10, 1978)

### **Abstract**

It is widely recognized that the designer must ensure the ductility for reinforced concrete members by avoiding brittle failure such as shear and bond-splitting, particularly in the earthquake resistant design of structures. This would be realized on the premise that the manners to assess the ultimate strength at the respective modes of failure were properly established.

The strength equations proposed to date are examined quantitatively by using the available experimental data set forth by several investigators, and the most effective equations to bunch

the scatterings of the data to the values calculated with themselves are evaluated with distinction of the loading processes, monotonic and cyclic, in the respective modes of failure. New strength equations are also proposed for the initial shear-cracking of columns with monotonic and cyclic loading, respectively, and for the bond-splitting of columns with cyclically repeated loading.

## **Dynamic Behaviour of Buildings with the In-plane Deformation of Floor Slabs**

Osamu Joh

(Received July 10, 1978)

### **Abstract**

The dynamic behaviour of buildings with long and narrow floor plans should be dependent on the in-plane deformation of the floor slabs. In this paper, soil-structure interaction is analyzed by using two-dimensionally distributed multi-mass models in order to obtain the effective factors which lead to the in-plane deformation of slabs. The eigenvalues and the response values of soil-structure system are computed and discussed in the following cases : (1)where a partial basement is laid at different positions in the whole floor plan of a building, (2) where the soil formation under the site has a dislocation or consists of duplicated bias layers,(3)where a partial basement and multi-storied walls are disposed simultaneously,(4)where a building is divided into some blocks with expansion joints.

Two approximate methods on vibration analysis of buildings with consideration for the in-plane deformation of floor slabs are proposed. The relations between the maximum response value and the direction of ground motion are also investigated.

## **Effect of Entrained Air on the Prevention of Frost Damage of Concrete at Early Ages**

Yoshiro KOH

(Received July 10, 1978)

### **Abstract**

This paper presents an outline of experimental studies on winter concreting to prevent frost damage of concrete at early ages.

The drop of the measured data of concrete damaged by frost action at early ages from a curve

showing the relationship between the tensile strength and the dynamic modulus of elasticity of sound concrete is remarkably large. However, the data after 28 days of curing are plotted on the curve by healing of the concrete, although the values of tensile strength are not so high compared with that of sound concrete. Therefore, it is desirable to measure the dynamic modulus of elasticity combined with the tensile strength for the evaluation of properties of concrete against frost action. In the case of using ordinary coarse aggregate with a maximum size of 20 mm, it is necessary to secure 4 % of the entrained air and more than  $40^{\circ}\text{D}\cdot\text{D}$  of maturity for the prevention of frost damage at early ages.

### **A Study on Frost Damage of Concrete, Especially on the Role of Cracks**

Eiji Kamada, Yoshiro Koh Masayuki Tabata

(Received July 10, 1978)

#### **Abstract**

The Amount and extent of the cracks observed on the surface of concrete were measured by using test specimens exposed to the outdoors in Sapporo, and the process of the crack formation caused by frost action was discussed based on the measurements.

Two series of freezing-and-thawing test were carried out in order to confirm the results obtained in the exposure test. In the first test series, specimens reinforced by crimped wire mesh were loaded with shear load until visible hair crack was observed. And specimens without reinforcement were exposed to several kinds of drying conditions in another test series. After these treatments, both specimens were subjected to freezing-and-thawing, and influences of cracks on the frost damage of concrete were investigated.

The following conclusions regarding the role of these cracks on frost damage of concrete seem to be reasonable.

- (1) Visible cracks observed on the surface of concrete are caused by the expansion of the interior and not by the direct action of the freezing-and-thawing.
- (2) The acceleration of frost damage derived from the cracks mainly arises from the penetration of water into the concrete from the surface.
- (3) The action, which enlarges cracks during the freezing process, does not play a too significant role in frost damage of concrete.

## **Influence of the External Weathering Factors on the Frost Damage of Concrete as a Reference for the Degree of Frost Damage of Concrete in Japan**

Toshio HASEGAWA, Yoshiro KOH

(Received July 10, 1978)

### **Abstract**

External factors due to weathering action are one of the main factors which cause the frost damage of concrete, and gives rise to and accelerates the frost damage of concrete. Several experiments were performed regarding the temperature conditions, such as freezing temperature, thawing temperature, freezing speed, frozen period and temperature change of freezing time, and the degree of saturation of concrete related to the weathering action.

On the basis of the experimental results related to the external factors, the value of risk of frost damage ( $V_F$ ) was calculated and defined by using weather data during a typical winter of Japan. The degree of risk of frost damage ( $D_F$ ) was determined by classifying the value of  $V_F$  into 6 grades considering the actual frost damage of concrete found in various districts in Japan.

## **Research on Urban Spatial Structure Contemplated from a Viewpoint of Spatial Patternings of Building Floor Use Activities within Cities**

Minoru OHTA, Hidetsugu KOBAYASHI and Hiroshi NAKAHARA

(Received July 10, 1978)

### **Abstract**

In order to formulate a theoretical planning model of urban spatial structure, we have analyzed the spatial patternings of the floor spaces classified into 33 use activities within developed areas of 9 cities in Hokkaido.

As a result, some clear correlations constituting the exponential formulae between the building volumes in each central business district were disclosed and the total size of each city calculated with the amount of urban activities in these uni-center type cities.

The spatial differentiation of an urban complex was clarified according to some typical spatial patterns through distribution analysis of the building floor use activities.

Also, by means of the correlation analysis and group pair analysis, we defined some inter-connection models among the 33 use activities.

Moreover, through the principal component analysis of the spatial distribution of these 33 use activities we detected 6 dominant use activities which make it possible to express the

urban skeleton system, and with focus of attention on the utilization of these 6 dominant use activities, we also developed multiple regression models of the cities surveyed.

To confirm these serial findings, we have proposed a significant and useful theoretical pattern of urban spatial structure as a basic concept for urban land use planning.

### **On some Characters and Problems of Rural Districts in Hokkaido and the Planning of Infant Facilities**

Yozo Ueda      Rinko Hattori

(Received July 10, 1978)

#### **Abstract**

Two themes based on a series of studies in the last few years are reported in this paper.

One is based on rural planning in Hokkaido. We have special issues on the rural planning in Hokkaido because of the low density population and cold climate. First, we analyzed the characters of agriculture and rural living environments in Hokkaido and sought for a theory of classification of the rural municipalities using the social indicators. Next are the results of our survey. The life style, the social behaviour, the allocation patterns of the facilities, the existing problems of reorganization of rural settlements in a typical rural district in Hokkaido are reported.

The other is a study of modules for infants based on the observation of their behaviours according to the physical and psychological development and we propose a flexible system of nursery schools with due consideration to both infants and nursery school teachers.

### **A Few Phases of Modern Architecture in Hokkaido**

Takeshi Koshino, Yukihiro Kado

(Received July 10, 1978)

#### **Abstract**

#### 1. Development of Early Westernized Architecture

Hokkaido, that has been colonized since the late nineteenth century, serves as an important example to survey the trends of the early westernization of architecture at the time in Japan. The earliest momenta were the introduction of the western architecture into Hakodate, one of the ports newly opened in 1859, and the buildings executed by the Colonial Department chiefly

around Sapporo since 1872. The latter achieved a particularly plain type of architecture, that defined in turn the characters of later buildings in Sapporo. While, in Hakodate they kept the stylistic coherence until 1910s. In Otaru, there are observed characteristic buildings of the timber-masonry construction, that stemmed from the substitution for the traditional plastered warehouses, and developed under the influence of the western building types. Among the fishermen's houses near Iwanai, a rudimentary westernization appeared as early as in 1870s.

## 2. Modern Architecture in the Taisho and the Early Showa Periods

This phase of architecture remains least studied, although it was particularly important, for, at the time, early professional architects began to work in Sapporo. Among them was Max Hinder(1887-1963), an architect born in Zurich, who executed several fascinating modes of architecture including two missionary schools and more than five abodes.

# **Thermal Characteristics of the House and Living style**

Noboru Aratani

(Received July 10, 1978)

## **Abstract**

The custom of the intermittent and partial heating in Japan may well have arisen from the traditional open living circumstances.

This paper was prepared for a review of studies in the environmental engineering section over the past ten years for the improvement of the thermal environment of the house in the cold area.

The main problems are as follows;

- ( 1 ) the characteristics of the open living circumstances
- ( 2 ) the differences between the intermittent and continuous heating
- ( 3 ) the relations between the thermal characteristics of the house and the living style
- ( 4 ) the relations between the living conditions and energy conservation

Then the author discussed the features and evaluations of the houses and living conditions in this age of energy conservation.

## **A Questionnaire Survey for Estimating Seismic Intensities**

Yutaka Ohta, Noritoshi Goto, and Hitomi Ōhashi

(Received July 10, 1978)

### **Abstract**

A questionnaire survey was developed for evaluating seismic intensities as well as seismic microzoning characteristics. Immediately after a moderate-to-large earthquake occurs thousands of questionnaire sheets are delivered to the shocked area. Detailed analyses by means of electronic computer disclosed that the intensities thus obtained are responsible for imperceptible differences of the earthquake ground motions and are superior to those reported by the Japan Meteorological Agency.

A seismic microzoning map in the surveyed area, proposed by drawing intensity difference contours, was sufficiently stable regardless of earthquakes.

## **A Study on the Effects of Ground Conditions on Seismic Strong Motions at the ground Surface**

Hiroshi Kagami

(Received July 10, 1978)

### **Abstract**

The effects of ground conditions on the seismic surface motions are discussed through an analysis of layered models for various ground conditions. The following two relations are pointed out. First, in case of softer ground, the surface motions have more influence to the amplification of waves in soil layers. Second, in contrast, in case of firm ground, subsoil effects are very small on the surface motions.

As an example of soft ground, amplification characteristics at several points in Sapporo City which is situated on a soft alluvium plain, are calculated. And it is shown that these amplification characteristics change widely from point to point.

These two relations are also ascertained by an analysis of strong motion records obtained at soft and firm grounds.

## Study on Apartment House Planning in Snowy and Cold Region

Fujio ADACHI, Takahiro NOGUCHI and Mitsuru MORISHITA

(Received July 10, 1978)

### Abstract

The natural features of a region have an important effect on the lifestyle of the region. Therefore it is inevitable that the lifestyle of snowy and cold regions would be different from that of warm and mild regions.

The aim of this paper is to study the lifestyle and the spacial organization of collective housings in a snowy and cold region.

As a result of an investigation into the actual conditions of living in housing, we have clarified many features of its lifestyle. The main features are :

( i ) In winter, the people are obliged to live indoors for a long time. Therefore a living room is necessary, as a space where the inhabitants spend their lives with the exception of their lives.

( ii ) There are many household installations and facilities they must have, and they must be kept indoors. Therefore it is necessary to enlarge the storage space, arrange them indoors and at the same time their function must be classified.

( iii ) It is necessary to increase the utility space.

( iv ) There is a life they enjoy outdoors in summer, for example, playing, social life in neighborhood, etc. In winter they are obliged to have these indoors. Therefore it is necessary to arrange facilities and put them to practical use as a common space for daily living.

## NOTICE

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## **Transmission Effects due to Random Distortions of Fiber Walls**

Kohichi TATEKURA, Kiyohiko ITOH and Tadashi MATSUMOTO

(Received September 29, 1978)

### **Abstract**

Recently, multimode fibers as an optical communication medium have been investigated and developed because of less stringent requirements of optical carriers and lower loss splices between fiber segments than single mode fibers. However, some problems remain not well understood. Mode coupling phenomenon is one of them, and is an important subject to be elucidated.

Mode coupling is caused by imperfections of the fiber geometry or material, that is, microbends of the fiber axis, irregularities of the core-cladding interface (wall distortions), fluctuations of the refractive index, and so on. To estimate the average transmission characteristics of optical fibers, it is very important to study the coupling efficiency (magnitude) of each coupling mechanism. But this is still not quantitatively understood.

Based on the above, this report examines the transmission effects due to wall distortions of step-index fibers among the above-mentioned coupling mechanisms, and a comparison of these properties with those due to other distortions was run and the results were examined in detail.

## **Neutron Diffraction for Liquids Using a 45 MeV Electron Linear Accelerator at Hokkaido University**

Takaaki MATSUMOTO, Norio OHTOMO and Masanori SENDA

(Received September 27, 1978)

### **Abstract**

A neutron diffractometer, which utilizes a time-of-flight (TOF) neutron diffraction method, has been newly installed in a 45 MeV electron linear accelerator at Hokkaido University. Using the equipment, measurements of structure factors for several polycrystalline materials and molecular liquids have been made with ease, and, especially, data of superior quality for liquids can be obtained. Thus, it has been shown that the TOF diffraction method is a powerful means for studying the structure of liquids, compared with the conventional neutron diffractometry using a steady reactor. The structure factors obtained for heavy water and acetonitrile have been demonstrated.

## Stopping Power for Deuteron in Deuterium-containing Materials

Tadahiko MIZUNO and Takashi MOROZUMI

(Received September 29, 1978)

### Abstract

The stopping power and the range of 10 to 100 keV deuterons were determined in the deuterium-containing substances, such as  $\text{TiD}_2$ ,  $\text{ZrD}_2$ ,  $\text{PdD}$  and  $\text{D}_2\text{O}$ . The evolution rate of neutron due to deuteron irradiation was measured as a function of the energy of the incident deuteron  $E_0$ , and the relation between them was analyzed to determine the atomic stopping cross-section  $S_t$  of the concerned atomic species by using the well-defined value of the reaction cross-section of the  $(d, n)$  reaction. The relationship between  $S_t$  and  $E_0$  for each atomic species was given generally by the equation  $S_t = kE_0^p$ , in which  $k$  was in a range from 1.20 for deuterium to 6.80 for palladium atom, and  $p$  from 0.3 to 0.4.  $S_t$  was approximately proportional to square root of the atomic number of the target atom for constant deuteron energy.

The range  $R$  was obtained by the integration of the observed inverse stopping power,

$$-\int_{E_0}^0 (dx/dE)dE$$

The estimation of the local distribution of neutron evolution by using the above experimental data indicated that the main contribution to total neutron evolution was limited within a relatively small depth-range, namely approximately 40% of the deuteron range.

## A Study for Effective Utilization of Carbon Dioxide

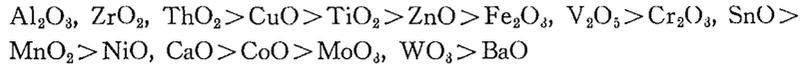
—The Synthesis of Carbonyl Sulfide and Carbon  
Monoxide by the Reaction of Carbon  
Dioxide and Carbon Disulfide—

Masatoshi SUGIOKA, Atsushi IKEDA and Kazuo AOMURA

(Received September 30, 1978)

### Abstract

The catalytic activities of various solid catalysts for the formation of carbonyl sulfide (COS) by the reaction between carbon dioxide ( $\text{CO}_2$ ) and carbon disulfide ( $\text{CS}_2$ ) were examined by the use of a conventional flow reactor at 300°C for the purpose of effective utilization of carbon dioxide. Several kinds of metal oxides showed catalytic activity for the formation of COS and the order of the catalytic activity was as follows,



However, the metal sulfides and metal carbonates were found to be inactive.

Furthermore, the catalytic activity of metal sulfides for the decomposition of COS, which is formed in the reaction of carbon dioxide and carbon disulfide over alumina catalyst at the first reactor, was examined at 400°C by the use of second reactor connected to the first reactor. Some metal sulfides showed the catalytic activity to form carbon monoxide and the order of catalytic activity was as follows,



One possibility of the CO production by the decomposition of COS, which is formed in the reaction between CO<sub>2</sub> and CS<sub>2</sub> over metal oxide catalysts, was proposed.

## **End-to-End Flow Control with External Discouraged Arrivals in Computer Communication Systems**

Toshihisa HONMA and Ikuo KAJI

(Received September 30, 1978)

### **Abstract**

It is important to analyze congestion phenomena in computer communication systems in order to have a full and effective utilization of computer resources. In this paper, we analyze an end-to-end flow control with external discouraged arrivals in place of conventional external constant arrivals, using a queueing network theory. External discouraged arrivals imply that external messages are transmitted at a rate in proportion to the number of external messages, so that consideration of external discouraged arrivals improves the character of an end-to-end flow control such as congestion, blocking probability, inhomogeneous external traffic density, number of stages, per cent improvement and control parameter. Furthermore, we find that character of external messages is improved to a much greater extent than that of link messages.

# The Formulation of the Wall Stabilization Problem of an Axisymmetrical Toroidal Sharp-Boundary Plasma with a Horizontally Elongated Noncircular Cross Section

Toshihisa HONMA , Masafumi KITO , Ikuo KAJI  
and Masaharu SEKI

(Received September 30, 1978)

## Abstract

In flat-ring cyclide coordinates, we formulate the wall stabilization problem of an axisymmetric toroidal sharp-boundary plasma with a horizontally elongated noncircular cross section which is considered approximately as an elliptical cross section. As a result of the formulation, the argument of the Wangerin functions, which are solutions of the Laplace equation in the flat-ring cyclide coordinates, is represented by the aspect ratio and the elongation ratio of a toroidal geometry, in such a way that we can treat the energy principle without an expansion in the aspect ratio. The energy principle can be expressed as a symmetric energy matrix which consists of a quadratic form. The problem of stability of a toroidal plasma is reduced to that of examining the eigenvalues of the energy matrix. Therefore, the plasma is marginally stable if the lowest eigenvalue is zero in parameter spaces (the toroidal perturbation number, the poloidal field, the aspect ratio, the elongation ratio, the plasma beta, and the wall shape). Furthermore, critical poloidal beta's in equilibrium are obtained analytically.