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Appendix

Abstracts & Titles, No. 47—No. 51

BULLETIN
OF THE
FACULTY OF ENGINEERING
HOKKAIDO UNIVERSITY

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Temperature Distribution of Radiant Gas

—The Existence of Two Kinds of Gases with Different
Absorption Coefficients—

Hiroshi TANIGUCHI

Hitoshi ITOI

Abstract

It is recognized that a combustion condition in furnace is affected by the cooling rate of its surface and that the heat transfer between radiant gas and the surface is strongly influenced by radiation.

Various papers have been published on radiative transfer in furnaces. In general, a simplified condition of the same absorption coefficient is applied for a whole gas layer in furnace. However this condition may not be applied in the case of a luminous flame which exists in a usual furnace, inasmuch as the absorption coefficient of a luminous flame is greater than that of combustion gas. Furthermore, it is recognized that the gas radiates an emissive power in some regions of wave length and its absorption coefficient is affected by temperature.

The authors made an attempt to analyze the temperature distribution of radiant gas in a case where two kinds of gases with different absorption coefficients existed between two parallel infinite surfaces. It was shown that the analysis was also applicable to the case where the gases radiated emissive power in certain regions of wave length and that these absorption coefficients were affected by temperature. The calculations were conducted by the Monte Carlo method and programmed for electronic digital computation.

All examples in this paper were calculated by a computer. Reference data were used to compare the difference of analytical results between gray gas and real gases.

An Experimental Investigation to Produce Single Crystal of Fe-Si Alloy by Strain-Anneal Method (II)

—On the Impurity Effects—

Hitoshi NAKAE

Kōsuke TAGASHIRA

Toshiyuki DATEYAMA

Abstract

In growing single crystals of 3.25% Si-Fe sheets by strain-anneal method, it was found that the impurities had an essential effect on the growth. The oxide film which was produced on the surface of the material by wet hydrogen atmosphere at the primary recrystallization showed an effect comparable to inhibitor as sulphur in the growth of (110) [001] orientation, whereas the carbon decoration developed (100) [001] crystals. In this case, it was assumed that the carbon absorbed in the grain boundary, lowered the boundary energy to a negligible degree, which resulted in the grain growth based on surface energy difference.

Other effects such as the edge effect on nucleation and the temperature gradient on growth were also discussed on the basis of impurity diffusion.

The Effect of Space Charge on Gain Characteristics of CEF-Type Forward-Wave Amplifiers

Ichiro SAKURABA

Kojiro KOYANAGI

Abstract

This paper deals with the effect of space charge on the gain characteristics of CEF-type forward-wave amplifiers in a special case where

$$d = 0, \quad b = 0, \quad \beta_e \approx 20, \quad C \approx 0.05, \quad a = 0, \quad \text{and} \quad 0 \geq Q \geq -3.$$

The small-signal forward-wave gain was yielded by

$$\text{Gain (db)} \approx 10 \log_{10} \left[\left(1 - \frac{Q(2-Q)}{(1-Q)(4-Q)} \right)^{-1} \left(\cosh \cdot \sqrt{\frac{\beta_e C}{2(2-Q)}} \phi - \frac{Q(2-Q)}{(1-Q)(4-Q)} \cos \frac{\sqrt{2-Q}}{\beta_e C} \phi \right) \right]^2.$$

The first term is due to the growing and decreasing waves in the beam-circuit system and the second term is due to the characteristic ripple in the CEF-type focusing system. A plot of gain in db versus the electrical angle with the parameter Q shows that in the small Q region the second term is negligible and in the large Q region there is a spatial beating pattern.

Some Theoretical Considerations on the Bending of a Focusing Element "Gas Lens" as a Laser Beam Waveguide

Masaaki IMAI

Tadashi MATSUMOTO

Abstract

The electromagnetic field in the bending of a gas lens which is considered as a focusing element for laser beam waveguides was studied. The field was calculated by expanding input beams in terms of normal modes and summing them up at any points along the curved axis.

Thus it was shown that in the case of gentle bending of $R \gg 1/\sqrt{2} g^2 w_0$, the input Gaussian beam undulates following the locus of $x = -(1 - \cos gz)/g^2 R$, while in sharp bending of $R \simeq 1/\sqrt{2} g^2 w_0$, the input beam not only deviates from the center axis, but the spot size of the Gaussian beam is converted into an ellipses, giving the impression that the spot is pressed toward the outside of the curved axis. In other words it was shown that a mode conversion occurred in sharp bending of the gas lens.

Further it was shown that the dielectric distribution in a gas lens can be determined in such a way as to suppress the mode conversion by using the above mentioned method. The physical significance of the dielectric constant distribution obtained above was discussed, and lastly the limits of the region where this method is valid were investigated in detail.

Liquid-Liquid Extraction (V)

—A Study on Interfacial Concentration by
Measuring Interfacial-tension—

Masao KUGO
Yoshinori KUMAKAWA

Abstract

Interfacial tension was measured for two systems, one of which consists of two phases where concentrations of solute are in an equilibrium, and the other is of non-equilibrium where mass transfer is occurring.

The tension in either system decreased with increase of solute-concentration; the extent of decrease in non-equilibrium systems was smaller than that in equilibrium ones.

The tension in non-equilibrium system did not vary with time while concentrations in both phases were changing with mass transfer. This suggests a constancy of interfacial concentration of systems in which mass transfer is occurring and may be an evidence for that distribution equilibrium consists on the interface through which mass is transferring.

A Study of Mercerization of Native Cellulose by X-Ray Method

Sadayoshi WATANABE
Kikuya KIMURA
Tadayoshi AKAHORI

Abstract

A study was made to confirm the reaction type of mercerization. Ramie, cotton, cotton linter, and pulp were used; each specimen was prepared as fibrous samples or pulverized. The samples were first soaked for 2 hrs. at 20°C in a NaOH solution of various concentrations, and were then regenerated. The air-dried samples were analyzed by an X-Ray diffractometer. There were considerable differences of cell-II contents between fibrous treatment and pulverized samples.

Results 1) Crystallinity tends to increase in NaOH solution of low concentrations, (~8% NaOH), 2) The permeability is improved when the native cellulose

is mercerized in NaOH of low concentration (7%), 3) The reaction of mercerization is considered as a fibrous-heterogeneous-reaction accompanied by fibrillar-reaction.

Copolymerization of Acrylonitrile with Sodium β -Styrene Sulfonate and β -Styrene Sulfonamide

Kazuaki YOKOTA
Makoto TOMINAGA
Yoshiyuki TAKATA

Abstract

The copolymerization of acrylonitrile with sodium β -styrene sulfonate initiated by potassium persulfate-sodium bisulfite in an aqueous solution and copolymerization with β -styrene sulfonamide initiated by azobisisobutyronitrile in N,N-dimethylformamide solution were reported. The copolymer compositions were determined from the nitrogen analyses for acrylonitrile-sodium β -styrene sulfonate copolymers and sulfur analyses for acrylonitrile- β -styrene sulfonamide copolymers. The monomer reactivity ratios (MRR) for these monomers were evaluated by the Fineman-Ross method. The results obtained are as follows:

Acrylonitrile (M_1)-Sodium β -styrene sulfonate (M_2) (at 45°C)

$$r_1 = 6.1 \qquad r_2 = 0.16$$

Acrylonitrile (M_1)- β -Styrene sulfonamide (M_2) (at 60°C)

$$r_1 = 13.0 \qquad r_2 = 0.01$$

From the MRR values Alfrey-Price Q and e values for sodium β -styrene sulfonate were calculated to be $Q=0.10$ and $e=1.22$. The values for β -styrene sulfonamide are $Q=0.41$ and $e=2.62$.

The infrared spectra of copolymers were obtained by using Hitachi EPI-G 1 spectrophotometer and it was found that the infrared spectra in the 1600~2500 cm^{-1} vary according to the copolymerization with β -styrene sulfonyl derivatives. Although its reproducibility is poor, the adsorption band at 2050 cm^{-1} which is due to ketenimine linkage is obtained from acrylonitrile-sodium β -styrene sulfonate copolymers. On the other hand, the band at 1665 cm^{-1} which is due to the C=N linkage is always observed in acrylonitrile- β -styrene sulfonamide copolymers. The above evidence suggests that the penultimate effect of β -styrene sulfonyl derivatives might have some influence on the structure of acrylonitrile units in copolymers.

Instrumentation of an Ellipsometer and its Application to the Study of Metallic Corrosion

Kiyokatsu KUDO

Norio SATO

Go OKAMOTO

Abstract

Ellipsometry, a method of measuring thicknesses and optical constants of thin films formed on metals or dielectrics without disturbing the system, is a powerful tool for studying phenomena occurring on a surface. However, in spite of its versatility it has almost been overlooked in Japan because of its complicated theory and the tedious calculations required. With the aid of an electronic computer, however, the difficulties have now been overcome.

This report deals with the construction of a new ellipsometer, composed of a polarizer, Senarmont compensator, reflecting surface and an analyzer. Interesting information on passive oxide films by application of the new device on anodic oxidation of iron in a neutral solution were obtained.

After briefly reviewing the historical development and the optical theory of ellipsometry, we described the instrumentation of the ellipsometer and computation for analysis of measured values, and discuss the utility of ellipsometry for the study of the passivity of iron. The results obtained by this method indicate that the anodic oxide film on iron is not of the same composition as massive iron oxides but a kind of hydrated oxide containing an appreciable amount of water.

IN COMMEMORATION OF THE TWENTY-FIFTH ANIVERSARY
OF DEPARTMENT OF METALLURGICAL ENGINEERING

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Studies on the Recovery of Antimony from Lead Anode Slimes

Tokiaki TANAKA
Takeshi MIDORIKAWA

Abstract

This paper is an account of a detailed examination of kinetics for the selective oxidation of antimony in molten Pb-Sb, Pb-Sb-Ag and Pb-Sb-Bi melts in an attempt to establish rational improvements of practical operations in the treatment of anode slimes produced in the electrolytic refining of lead. The rate of oxidation was determined with a thermobalance. The results indicated that the rate of oxidation was controlled at the gas-melt interface with an activation energy of 25 ± 2 kcal per mole. A mechanism involving the intermediate gaseous compound SbO was proposed for the oxidation reaction and a rate expression was derived from this mechanism. The rates calculated from this expression are in good agreement with the experimental rates.

Fundamental Studies on the Pressure Leaching of Pyrite

—Electrochemical and Crystallographic Studies on the
Nature of Active Sites of Dissolution—

Tadao NAGAI
Hiromichi KIUCHI

Abstract

A considerable number of kinetic studies on the leaching of ores have been made to date. However, no detailed studies have been made on the micro-topo-

graphy or the nature of dissolution sites.

In the present report electron-microscopic observations were made on the etch figures of pyrites in oxygen pressure leaching and also in the cathodic dissolution of the mineral electrodes.

An unique etch pattern was observed at a {100} surface of the pyrite single crystal subjected to pressure leaching. The etch figure resembles a mass of pyramidal hills with four planes all indexed as {111} planes. Two possible explanations of the formation of the pyramidal hill figure are as follows: a) The maximum surface lattice energy of rate-determining species is attained at the {111} planes, providing that a large difference between the dissolution rates of iron ions and sulphur ions is assumed. b) An extension of Engell's oxide dissolution model to pyrite taking some crystallographic aspects into account, suggests that a change of the chemical potential of the surface ions may be related to the change of crystallographic index of the dissolution plane. This also explains the establishment of the maximum chemical potential of a constituent of pyrite at the {111} plane.

In the cathodic dissolution of pyrite, the well known mosaic pattern was observed. The mosaic plades were indexed as {100} planes which were not observed in the case of pressure leaching.

It may be concluded that the active sites in pressure leaching differ from those in the cathodic dissolution, since the directions of dissolution step motions differ. The dissolution steps travel along micro-planes differently oriented for both cases of dissolution.

In addition, it is suggested that the dissolution model in this paper was applicable to the problems on etch pit formation and crystal growth.

Studies on Oxidizing Roasting of Lead Anode Slimes

Tokiaki TANAKA

Abstract

Anode slimes from electrolytic refining of lead contain many valuable metals. Hence it is a matter of prime importance to recover these metals in lead refineries. This paper is an account of a detailed examination of oxidizing roasting of the main constituents in lead anode slimes in an attempt to establish rational improvements of practical operations in the treatment of the slimes. Oxidation behaviours of antimony, Sb-Bi alloy, ϵ' and ϵ in the Ag-Sb binary system and arsenic were

studied by thermogravimetric and X-ray diffraction analysis and the possibility of selective oxidation of arsenic and antimony were discussed.

Reduction of Fayalite

Katsuya WATANABE
Chikao YOSHII

Abstract

Reduction of fayalite was studied under a microscope and by the usage of thermobalance.

According to the microscopic observations, wustite in fayalite was less reducible than free wustite, while iron reduced from fayalite was finely distributed in the silica matrix. However it was noted that iron from wustite grew to large particles.

Fayalite mixed with carbon powder was heated at 5°C/min in hydrogen using a quartz spring thermobalance. At first, uncombined wustite was reduced to about 350°C, thereafter wustite in fayalite was reduced by hydrogen and carbon within a range of 900° to 1,100°C and finally silica in fayalite by carbon within a range of 1,150° to 1,400°C.

Reduction of a Mixture of Wustite, Silica and other Oxides

Katsuya WATANABE
Toru TANIMURA
Chikao YOSHII

Abstract

The effect of other oxides (CaO, MgO, Al₂O₃ and Cr₂O₃) on the reduction of fayalite was studied.

The compounds formed in the mixture were identified by the X-ray diffraction method. The mixture was reduced in hydrogen at a heating rate of 5°C/min using a quartz spring balance.

Wustite in the mixture of fayalite and other oxides with the exception of CaO was reduced at the same rate as pure fayalite. However, when CaO was introduced, the reduction of fayalite commenced from lower temperatures.

A mixture of wustite, silica and other oxides was heated for 24 hrs. at 1,000°C in Ar atmosphere and was then reduced in the thermobalace. By the addition of CaO, a large part of silica formed Ca_2SiO_4 and wustite was liberated. Thus the reducibility of this sintered mass was improved. By an addition of MgO, solid solutions of FeO and MgO, and of fayalite (Fe_2SiO_4) and forsterite (Mg_2SiO_4) were formed. These solid solutions were less reducible than wustite or fayalite. By an addition of Al_2O_3 or Cr_2O_3 , fayalite and hercynite (FeAl_2O_4) or chromite (FeCr_2O_4) was formed in the mixture. Hercynite or chromite showed a higher reducibility than fayalite.

Reduction of Dunite with Carbon

Kōji ATARASHIYA

Abstract

Dunite from the Horoman mines, Hokkaido consist of about 47 percent magnesia and about 43 percent silica. At present dunite is crushed and used as foundry sand generally referred to as "Olivine Sand". An attempt was made to separate magnesia from dunite as part of an attempt to find a higher usage for dunite. Previous investigations on the separation of magnesia from dunite or serpentine have been dealt almost exclusively with wet methods or acid dissolving treatments. But, in the present work dry methods alone were used.

Dunite, coke and burnt lime which was needed as a flux to form a slag were mixed. This was placed in an electric furnace, and the dunite was reduced with coke. The magnesium vapour and carbon monoxide gas were burnt off in the air. A finely divided powder of magnesia was formed in the form of fumes. Hence the fumes were led into a cyclone and bag filter trapping the magnesia powder. As a by product silica-lime slag and ferrosilicon were obtained by tapping.

The materials balance and the heat balance of this method were discussed. Various properties of the obtained magnesia such as chemical composition, specific gravity together with water soluble and acid insoluble components, adsorbed and combined moisture, BET-specific surface area, shapes and sizes of the powder and lattice constant were described.

A Study of Fe-Al-C Alloys

—On Isothermal Sections at 1000–1250°C and Compositional Sections with 2% and 3% C in Fe Corner—

Keizo NISHIDA

Abstract

In order to determine the properties of Fe-Al-C alloys at elevated temperatures it is necessary as a first step to ascertain the phase diagram at these temperatures. However, the phase diagram for this alloy is found to have many ambiguous portions at elevated temperatures as may be seen in previous reports. Thus isothermal sections of this system were investigated at 1000~1250°C for hardness, and by microscopic and X-ray examinations of the quenched samples from the specified temperatures.

The results obtained were as follows:

- 1) Isothermal sections at 1000°C are nearly equal to that reported by F. R. Morral except for the range of the K phase.
- 2) The range of the K phase appeared to increase with the temperature and to descend to the lower carbon side. However, its true boundary was not clear, inasmuch as the structure of the original samples has a considerable influence on the quenched sample.
- 3) Compositional sections with 2 and 3% C were also proposed and found to have (α +K+C) and (α +C) phases in both sections and a K phase in the section with 3% C.

A Study on the Synthesis of Daubréelite

Keizo NISHIDA

Tatsuya AOKI

Abstract

The effect of daubréelite (FeCr_2S_4), found in the sulfide scales of some Fe-Cr alloys, on the corrosion by sulfur has been discussed, but the nature of this cubic crystal is still unknown.

In this paper, therefore, an attempt was made to synthesize this cubic crystal in order to study its physical properties. The synthetic preparations were made

in the following manner: Fe and Cr powders were mixed at an atomic ratio of 1:2 and sealed in an evacuated quartz tube (in the order of 10^{-6} mmHg) with a block of excess sulfur. The powdered material in the quartz ampoule was heated at various temperatures in sulfur vapor (1 atm.).

After many trial runs, a two-step heating was found to be the best method. Namely, after heating at 1200°C for 40~50 hours the ampoule was maintained at 950°C for approximately 30 hours.

The cubic crystals of synthesized sulfides thus obtained were found to have the same lattice parameters in spite of different conditions of heating.

On the Synthesis of Cubic Sulfide Crystals Similar to Daubréelite

Keizo NISHIDA

Tatsuya AOKI

Abstract

Cubic crystals, similar to daubréelite, have been found in the sulfide scales of Fe-Al-Cr alloys.

In this paper, these crystals were synthesized by heating a mixture of Fe, Al and Cr powders in sulfur vapor under 1 atm. The structure of the crystal and other properties were studied by the X-ray diffraction method.

The results obtained were as follows:

1) Sulfides of the Fe-Al-Cr system and the Al-Cr system were found to be cubic and similar to daubréelite within a certain range of their compositions, but those of the Fe-Al system were quite different from the above mentioned crystal.

2) Al seems to enter into the B(16d) site in the crystals of the Fe-Al-Cr-S system, and into the A(8a) site in the crystals of the Al-Cr-S system.

3) The lattice parameter changed with the composition of a system, showing an increase in Al content regardless of the presence or absence of Fe.

**Electromotive Forces for Galvanic-cells and Concentration-cells
and some Thermodynamical Properties of Aluminium
Chloride in the Molten Aluminium Chloride-
Sodium Chloride System**

Toshio NARITA

Tatsuo ISHIKAWA

Rinzo MIDORIKAWA

Abstract

In order to obtain some information on the thermodynamical properties of aluminium chloride in molten aluminium chloride-sodium chloride mixtures, the equilibrium electromotive force for the galvanic-cells and the concentration-cells consisting of various concentrations (51~65 mole % AlCl_3) of the molten mixtures were determined at a lower temperature range from 110°C to 260°C.

When chlorine gas was introduced into the melt, a suitable cell arrangement was induced to compensate for the change of temperature and composition of the molten mixtures around the tungsten electrode.

As chlorine electrode materials, tungsten and glassy carbon were satisfactory, however platinum, molybdenum and the common carbon electrode could not be used due to their respective depolarization effect and/or disintegration.

It was found that a reversible chlorine electrode could be formed only when the W electrode became polarized to such an extent as to evolve a certain amount of chlorine gas and the anolyte became saturated with chlorine bubbling. Electromotive forces were thus obtained by means of extrapolation of the corresponding decay curves after switching off the polarizing current.

The thermodynamical properties of the molten mixtures, activity and other properties, calculated from the electromotive forces obtained, were found to indicate a considerable negative deviation from ideality.

According to the plots for the thermodynamical quantities vs. mole fraction of AlCl_3 in the molten mixtures, the dissolved state of aluminium chloride might change in three regions corresponding to the concentrations thereof.

The boundary concentrations of these regions were 62 mole % and 53 mole % of aluminium chloride, which agreed approximately with the eutectic and peritectic compositions on the phase diagram of the AlCl_3 -NaCl system.

The Effects of Temperature and Heat Flux on the Corrosion of Metals (I)

—Corrosion of Armco Iron in Acidic Solution—

Tomotoshi SATO
Tatsuo ISHIKAWA
Rinzo MIDORIKAWA

Abstract

In order to elucidate the effect of heat transfer on the corrosion of metals, the corrosion behavior of armco iron in an acidic solution was investigated by imposing heat flux through the metal perpendicular to its corroding surfaces. Suitable equipment for this purpose was devised to avoid non-uniform surface temperature distribution which would cause non-uniform corrosion distribution. Using this equipment, corrosion tests were carried out in a temperature range from 20°C to 80°C in the absence and presence of heat transfer.

It was found that the corrosion rate of pure iron with heat transfer depends not only on the surface temperature of the specimens but also on the magnitude of heat flux and its direction; in other words, the rate of corrosion reaction increased when the heat flux was in the same direction as the metallic ion transfer. The apparent activation energy of the corrosion reaction (determined from the slope of the logarithmic corrosion current vs. reciprocal temperature at constant heat flux graph) did not depend upon the magnitude or the direction of the heat flux.

An experimental equation, similar to the Tafel equation, was obtained relating the heat flux through the specimen and the corrosion rate of the specimen. It may be concluded, however, that the effect of heat transfer on metallic corrosion are due to indirect action of the heat flux affecting the number of active sites on the surfaces of the corroding metal.

Oxidation of Passivated Stainless Steel

Toshio SHIBATA
Go OKAMOTO

Abstract

The kinetics of oxidation of passivated stainless steel was measured in dry oxygen of 10 mmHg between 100°C and 400°C.

The surface of stainless steel was chemically passivated at 25°C in 1 N H₂SO₄ containing an oxidant such as Cu⁺², Ce⁺⁴, SO₈⁻² and CrO₄⁻², or was electrochemically passivated with anodic polarization at constant potentials of 0.2, 0.7 and 1.00 V (refer to s.c.e.) by means of a potentiostat.

From the weight gain-time curves obtained and their temperature dependence the oxidants used as a passivator can be divided into two groups, one being Cu⁺² and Ce⁺⁴ and the other being S₂O₈⁻² and CrO₄⁻².

The kinetics of oxidation of electrochemically passivated stainless steel is expressed by a logarithmic rate law and is interpreted by using a heterogeneous surface model which assumes that the active sites on the surface, change in nature with the potential of passivation.

Effect of Potential of Passivation Treatment on the Stability of Passive Stainless Steel

Toshio SHIBATA
Go OKAMOTO

Abstract

Oxidation of passivated stainless steel in dry oxygen of 10 mmHg in a temperature range of 405–474°C was studied and compared with the self activation of passivated stainless steel in 30% sulphuric acid saturated with nitrogen at 70°C.

The specimens passivated at a potential exceeding 0.4 V (refer to s.c.e.) in 1 N H₂SO₄ at 25°C exhibited a remarkable resistance to oxidation at each temperature examined.

It was observed that specimens passivated at 0.0 V for 60 min. also showed a resistance to oxidation, but in the case of a prolonged passivation of 1000 min. at the same potential the surface changed to an active state resulting in an in-

crease of the weight gain due to oxidation. The most active surface was obtained in the case of passivation at 0.4 V.

A critical potential around 0.4 V is found on the curve of selfactivation time against potentials.

The reactivity of the surface to dry oxidation and the stability against corrosion in acid solutions were compared with the behaviour of bound water in the passive film and the structure of the passive film was discussed.

Dislocation Structures of Deformed Tantalum by Electron Microscopy

Taro TAKEYAMA
Heishichiro TAKAHASHI

Abstract

Commercial tantalum deformed in various strain at room temperature was studied by means of a transmission electron microscope. The dislocation configurations showed considerable differences between the furnace-cooled and quenched specimens. The former specimens showed numerous precipitates and helical dislocations together with dislocation loops.

Dislocations were produced from precipitates as a result of stress concentration and tangle with dislocation loops or precipitates. Therefore, it may be said that cell structures are developed in the early stage of deformation.

While, in the quenched specimens uniform dislocation distribution persist even under higher strains. In this case grain boundaries may act as dislocation sources.

Recovery and Recrystallization in Tantalum

Taro TAKEYAMA
Heishichiro TAKAHASHI

Abstract

The processes of recovery and recrystallization were studied on polycrystalline tantalum by means of a transmission electron microscope.

The dislocation density decreases continuously during annealing and at the same time dislocations are rearranged into a stress-free stable network. Thus the

cell structures change to subgrains during recovery.

Isolated initial recrystallized grains are nucleated in small subgrains close to an old grain boundary and the growth of the initial recrystallized grain can be explained by the coalescence model.

This recrystallization phenomenon may be prevented by pre-herthing treatment due to the release of stored energy.

Structure of Quench-aged Fe-C-N Alloy

Taro TAKEYAMA

Takashi MATSUZAKA

Abstract

The aging of Fe-0.03% C-0.01% N alloy was studied in a range of 30-200°C, after quenching from 730°C. As the aging temperature is increased, the precipitate of this alloy changes from meta-stable precipitates to stable ones, and its habit plane also changes from $\{100\}\alpha$ to $\{110\}\alpha$.

In this alloy the dislocation are the preferred sites for precipitation. At low aging temperatures, the meta-stable precipitates make their appearance from a dislocation on all three possible $\{100\}\alpha$ planes, but at high aging temperatures they show only one $\{100\}\alpha$ plane.

A Study on Precipitation Phenomena of High Aluminium-Zinc Alloys

—Based on Direct Observation by an
Electron-Microscope—

Satoshi NAGATA

Keisuke MATSUURA

Katsuya WATANABE

Abstract

Age-hardening of Al-40 wt. % Zn and Al-60 wt. % Zn alloys was studied by means of measurement of hardness, optical microscope observation and the Debye-Sherrer X-ray method. Corresponding structures were directly observed by means of a transmission electron microscope on the Al-40 wt. % Zn alloy.

General precipitation and grain boundary reaction were continuously followed by aging thin foil specimens within the electron microscope.

A clear difference was recognized in the change of hardness between the specimens aged below and above a critical temperature. The critical temperature was 140°C for the Al-40 wt. % Zn alloy and 185°C for the Al-60 wt. % Zn alloy. The observation by electron microscope showed that spherical G-P zones were formed during aging below the critical temperature and intermediate precipitates α'_2 , formed during an early stage of aging above the critical temperature.

The equilibrium precipitates β were formed on the edge of the platelets of α'_2 and α' precipitates and grew by consuming them. During aging of the thin foil specimens, the β phase was also formed on the specimen surface, the edge of thin foils and on the dislocations which were formed during resolution of the α' phase into the matrix.

The electron diffraction pattern showed that the β precipitates, which were formed in an early stage of the aging, contained thin layer faults parallel to the basal plane of the β .

On the Electron-Microstructure of Grown Cast Iron

Kingo NAGAOKA
Makoto SŌMA
Akio KANAYAMA

Abstract

Though many theories have been proposed on the mechanism of growth in cast iron, it was proposed here that an irreversible migration of graphite during cyclic heating may be the cause which plays the leading role in the present problem. This concept which considers the growth of iron to be a metallurgical phenomenon is based on the microstructures in grown iron observed optically. In the present paper, an attempt was made to obtain a more detailed picture using an electron microscope with special reference to the changes in the graphite structure of grown cast iron.

It was shown that the fluffy protuberances growing from the sides of primary graphite flakes are neither fissures nor oxides, but are definitely fine graphite flakes redistributed in the matrix. It was suggested that the migration of carbon in heating cementite, as well as graphite, changes the characteristics and causes the formation of fine cementite particles. It was further noted in the electron-microstructures that fine cementite particles also appear near the mother graphite flake.

Hitherto considerable difficulty was encountered in the observation of the inner structure of graphite by an optical microscope. But in the present work using an electron microscope, it was shown that within the graphite nodule of grown graphite steel a porous portion may be observed near the surface. Further, it was confirmed by a quenching test of the steel that the outer layer of graphite nodule becomes porous as a result of dissolution of graphite into the matrix.

On the Creep of Al-4 wt. % Cu Alloy

Kuniyoshi ISHII

Keisuke MATSUURA

Seiki NISHI

Abstract

The creep behaviour of Al-4 wt. % Cu alloy was investigated by a high temperature microscope with a tensile apparatus in a temperature range from 200 to 300°C.

Despite the large instantaneous strain, the as-quenched alloy showed a considerably smaller steady-state creep rate than the aged alloy. In the alloy aged to contain intermediate precipitates, θ' , the specimen surface showed fine wavy features with the progress of the creep while no slip bands were visible. The behaviour of alloy containing the equilibrium precipitates, θ , was similar to that of pure Al in slip pattern and creep rate.

The steady-state creep rate of all specimens obeyed Dorn's equation, $\dot{\epsilon} = A\sigma^n \exp(-Q/RT)$. The activation energy of creep, Q , was 8-16 Kcal/mol and the value of n , 8.0 for as-quenched alloy, $Q=16$ Kcal/mol and $n=6.8$ for the alloy containing θ' precipitates, and $Q=15-32$ Kcal/mol and $n=5.8$ for the alloy containing θ precipitates. The values of n for each alloy were always independent of the creep temperature.

The Effect of Rolling Condition on Surface Texture of Mg Sheet

Yoichi ITO

Abstract

This is the first report on a proposed series of studies on the surface texture of the rolling sheet. The effect of rolling temperature and reduction per pass on surface texture of Mg sheets were as follows. 1) The spread in orientation of the basal plane is remarkably less at the surface than at the center of a hot-rolled sheet. 2) A marked spread in orientation of the basal plane at the surface of a hot-rolled sheet was seen in the rolling direction but at the center it was seen in the transverse direction. 3) The surface texture of a cold-rolled sheet shows little or no difference from the inside texture. 4) A sheet rolled at 300°C and 0.5 mm/pass has the highest developed surface texture. 5) The depth of surface texture slightly increases as the reduction per pass increases.

Stress-Strain Curve and Structure in 18Cr-8Ni Stainless Steel

Iwao HAGIWARA
Akihiro SAKAI
Yoshio TOMIOKA

Abstract

The effect of applied tensile stress and compressive stress on the stress-strain curves and microstructure of a commercial 18-8 stainless steel was investigated in a temperature of $-40\sim 200^{\circ}\text{C}$.

The results were as follows:

- (1) A comparison between compression and tension indicated a clear difference with respect to the stress-strain curve, and at equivalent strains the flow stress in compression was greater than that of tensile deformation. The difference increased as the temperature of deformation was lowered.
- (2) Striated structures produced by deformation showed a difference of morphology in tension and compression. In tension almost all striations were straight lines and in compression they became wavy above 50°C .
- (3) The α' martensite was formed abundantly by tension rather than by com-

pression, and this tendency increased remarkably at low temperatures. The M_d temperature was 50°C in both cases.

(4) The amount of ϵ' martensite decreased with the increasing temperature. A larger amount of ϵ' martensite appeared by compression rather than by tension above 50°C, and disappeared at 200°C in tension and at over 250°C in compression.

Phenomena of Gravity Segregation in the Transitional Solidification Zone

Iwao HAGIWARA
Tadayoshi TAKAHASHI

Abstract

In order to clarify the gravitational behaviour of the enriched solute element in the dendrite arm space of the partial solidification zone (Transitional solidification zone) between the liquid region and the solid region of an ingot, the present study was carried out using Al-4% Cu alloy. The results obtained were as follows: (1) The gravity segregation of the solute element was observed in the transitional solidification zone with fully developed dendrite arms. (2) The gravity segregation of the solute element increased when the freezing rate of the alloy in the freezing range was slow, and the amount of the solid phase became nearly equal to that of the liquid phase as a result of crystal growth. (3) The flow direction of the solute element through the dendrite space was downward and inclined toward the center of the ingot. (4) The enriched solute element due to the gravity segregation produced a new equilibrium relation with the surrounding solid phase, and consequently, the pre-existing dendrite arms in the transitional solidification zone were remelted away.

Effects of Niobium, Titanium, and Zirconium on the Grain Size of High Carbon Cast Steel

Fujitaka KAWANO
Kaichi MATSUBARA

Abstract

Niobium and titanium (up to 0.2%), zirconium (up to 0.8%), and aluminium (up to 0.7%) as a possible cast-grain-refiner, were added respectively to steels containing 0.5~0.8% carbon. The relation between the austenite grain size and the behaviour of the precipitations in the steels which were reheated from 900°C to above the melting point of the steel, were investigated by means of an optical microscope, an electron microscope, and an electron probe microanalyser.

The addition of 0.1% niobium or titanium proved to be effective cast-grain-refiners and the cast-grain size of the steel was controlled by electron microscopic carbides and nitrides in molten steel. On the other hand, the optical microscopic precipitations at grain boundaries prevented the grain growth of the reheated steel to below the melting point of the steel, but the presence of the precipitations resulted in a 2% decrease in the fracture strength of the cast steel.

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On the Characteristics of an S-shaped Beam Bridge without Intermediate Support

Noboru WATANABE

Kôichi SATÔ

Seizo USUKI

Abstract

An attempt was made in this paper to illustrate the various characteristics of an S-shaped plane beam bridge structure supported by only two free bending and torsion-resistant abutments.

Firstly, the authors have solved the static equations involved in this bridge in order to calculate the bending moment, shearing force, torsional moment, deflection and torsional deformation.

Thus, using a digital computer, the various statical diagrams for this bridge design were obtained.

Lastly, a model experiment was performed in order to prove the validity of the theoretical treatment. From the above treatment, the following characteristics were obtained.

1. The maximum value of the bending moment diagram due to a concentrated load depends on the central angle ϕ .

When $\phi \leq 110^\circ$, the maximum value decreases inversely with ϕ .

Generally the bending moment of the S-shaped beam is smaller than that of the straight beam.

2. When $\phi \geq 110^\circ$, negative bending moment occurs, and the absolute value increases proportionally with ϕ .

3. The maximum value of the torsional moment diagram increases proportionally with ϕ . Particularly when $\phi \geq 110^\circ$, the value increases rapidly.

The above mentioned characteristics are also well illustrated in the case of a fully and uniformly distributed load.

Hydrogen Evolution Reaction on Platinum Electrodes in Molten Alkali Nitrate Containing Potassium Hydroxide

Takenori NOTOYA
Rinzo MIDORIKAWA

Abstract

The hydrogen evolution reaction on platinum in an equimolar mixture of potassium nitrate and sodium nitrate containing a small amount of potassium hydroxide was investigated by means of a potential-sweep method. A current peak was observed on the polarization curves. The peak current increased linearly with the concentration of potassium hydroxide in a range of 10^{-4} to 10^{-2} mol fraction. The effect of the potential sweep rate on the peak current i_p and the peak potential E_p was examined. A small activation energy of 2.02~2.54 Kcal/mol was obtained for i_p . The plot of $(dE/dt)^{1/2}$ against i_p gave a straight line from which the diffusion coefficient of OH^- ion was calculated to be 1.70×10^{-6} cm²/sec. The polarographic waves obtained for the reaction were in agreement with the equation

$$E = E_{1/2} - (RT/nF) \ln (i/i_p - i)$$

A break was observed on a straight line of $E \sim \log (i/i_p - i)$ plot. The slopes of these straight lines, however, were both different from the value (57.0 mV) calculated assuming a two-electron transfer reaction ($2\text{H}^+ \rightarrow \text{H}_2 - 2e$). Reversibility and reproducibility of polarization curves were checked by alternation of anodic and cathodic potential sweeps. The cathodic processes on platinum in the melt, free of potassium hydroxide were also investigated.

A Contribution to the Study of Water Flow with Hydrogen Bubbles

Hiroshi SAKAMOTO
Mikio ARIE

Abstract

The present paper describes a contribution concerning the technique of flow visualization by the use of hydrogen bubbles, and its usefulness in fluid mechanics was illustrated. Some experimental data for the construction of the electrical circuits to produce a desirable amount of hydrogen bubbles were also given.

Performance Tests of a Centrifugal Pump

Shoichiro FUKUSAKO

Mikio ARIE

Abstract

The results of performance tests of a centrifugal pump in the cavitation region were presented in terms of the variation in head, driving power and efficiency. The effect of air leakage in the suction system was also examined. It was found, in the present experiments, that the existence of a prerotation showed its effect of improving the cavitation performance of a pump.

A Study on a Gas Turbine Plant Combined with a Heat Supply

Takeshi SAITO

Hiroshi TANIGUCHI

Takashi SONODA

Abstract

A power plant combined with a heat supply was adopted as a district heating plant or a power plant in a factory, in an attempt to utilize the energy effectively. This plant was constructed with a steam turbine or a gas turbine and an exhaust heat boiler.

The authors studied the gas turbine plant combined with a heat supply for the above-mentioned application. The characteristics of this plant was calculated in order to run a comparison with that of the gas turbine, which generates power only, in consideration of economical appreciation between power and heat. The optimum design data of main parameters, such as the inlet temperature of turbine, pressure ratio and so on have been obtained. This will be adopted in the planning of the gas turbine plant combined with heat supply.

An Analytical Method of Domain Characteristics in Gunn Diodes

Koji MATSUKI
Ichiro SAKURABA

Abstract

The propagating domain shape was calculated for Gunn diodes. The Kroemer $v(F)$ characteristic was applied to the Butcher-Fawcett-Hilsum model in the Gunn effect.

On the Mechanism of Amplification in Electron Beam Forward Wave Amplifiers

Masahiko SENDA

Abstract

The equations governing traveling-wave interaction between an electron beam and a slow-wave circuit were formulated in terms of amplitudes of circuit mode, and slow, synchronous and fast wave modes. The resulting equations were solved to find propagation constants that were used to calculate the gain of CEF-type amplifiers, in a special case where $\beta_e \approx 20$ and $C \approx 0.05$.

Frequency of Transistor Oscillator

Teiichi KUROBE
Kazuhiko AZUMI

Abstract

The frequency of a transistor oscillator is considered to be closely equal to the resonant frequency of the external circuit, however, the frequency of oscillation is lower than it because of transistor parameters.

In general the characteristic equation of transistor oscillator circuits is of a higher degree, rendering the solution difficult. The authors obtained the frequency of oscillation from the characteristic equation by assuming that the roots for the

principal mode are purely imaginary and by using the regularity which exists between the coefficients of the characteristic equation and the frequency of oscillation. Numerical calculations and experiments were carried out for Colpitts circuits which have a circuit determinant of degree four. The results of calculation and experiments were in good agreement.

If the diffusion capacitance and the junction capacitance in a transistor model are neglected, the calculated frequency is a somewhat higher than the resonant frequency of the external circuit. Such a model has no meaning, because the actual frequency is lower than it. As for nonlinearity of transistor parameters, only g_m (the mutual conductance) was considered. This approximation seems to be valid from the results of the experiments.

An Inexpensive Anechoic Room

Nobuyuki KODAMA
Yukihiko TAKEDA
Yoshimasa NAKAMARU

Abstract

An inexpensive anechoic room for acoustical experiments was designed and constructed in the department of electronic engineering. The acoustical properties of the room were determined and were found satisfactory for free-field measurements of electroacoustic devices.

Free-field measurements are normally made in an anechoic room conventionally equipped with sound absorbing wedges of glass wool, but the capital cost of such a chamber is very high. The room described here was designed to use glass wool mats as sound absorbing wall-materials, in an attempt to construct it at a much lower cost and to utilize larger effective space than the conventional type.

Statistical Analysis of Light Propagation in the Atomosphere with Rain or Snow

Katsuaki SAKAKIBARA

Nobuyuki KODAMA

Kōji KANAYA

Michio SUZUKI

Abstract

Rain or snow attenuates light, and its attenuating effect was considered by statistical mathematical and geometrical optic treatment.

It was assumed that propagating light is a cylindrical beam with a much larger base than the cross section of rain drops. Let the rain be a ball and snow be a plate. It was further assumed that rain drops were spherical balls and that snow flakes were plates then the attenuating effect of rain is

$$A_d = A_0 e^{-N_0 l \{ \langle \pi r^2 \rangle - \langle \pi r^2 \alpha(r) \rangle \}}$$

where

$$\langle \pi r^2 \rangle = \int_{r_1}^{r_2} \pi r^2 \rho(r) dr$$

$$\langle \pi r^2 \alpha(r) \rangle = \int_{r_1}^{r_2} \pi r^2 \alpha(r) \rho(r) dr$$

r diameter of rain balls

$\rho(r)$ density function of rain balls

N_0 density of number of balls in the atomosphere

$\alpha(r)$ transimtion coefficient of rain balls

l distance of light propagation

A_0 intensity of light at generator

A_d intensity of light at detector

And the effect of snow plates was obtained as a small modulated function.

Electrolytic Reduction of Lignin and Lignites in Alkaline Solution

Hironori ITOH

Tadao ISHII

Gen TAKEYA

Abstract

The present experiments were conducted in order to render low ranking coal, alkali soluble by electrolytic treatment under mild reducing conditions.

Powdered samples (Lignin, Tokachi lignite and Sohya coal) were suspended in a 1N-solution of lithium hydroxide or sodium hydroxide which served as the electrolyte. The cathode and anode consisted of lead and copper plates respectively. The applied current density of D.C. was 0.03 A/cm^2 . The temperature in the cathode vessel containing the sample suspension was $55 \pm 2^\circ\text{C}$. After electrolytic reduction for ten hours, the content of the cathode vessel was filtered and divided into two fractions, the residue (Res) and the alkali soluble products. These products were separated into two fractions. One was the acidic insoluble fraction (AI) precipitated by an addition of hydrochloric acid to pH 2 and the other was the methyl ethyl ketone extract (ME) which was obtained by MEK extraction from the acidic solution.

In order to elucidate the effect of the electrolytic treatment, the powdered sample was dissolved in an alkaline solution under the same condition of electrolytic treatment with no current.

Res, AI and ME obtained by electrolytic reduction were compared with the corresponding fraction by treatment with alkaline solution according to infrared spectra respectively.

The results were as follows:—

1. The yield of dissolved material in alkaline solution by electrolytic reduction of lignite tends to decrease with the ascent in coal rank. All three samples showed 10–13% higher yields by electrolytic reduction as compared with alkaline solution treatment.

2. It seems that this electrolytic treatment exerted a depolymerisation effect inasmuch as the acidic insoluble fraction as produced by electrolytic treatment was less than that produced by treatment with alkaline solution.

3. According to infrared spectra, electrolytic treatment was not always intensified in the absorption bands of aliphatic C–H vibration.

4. Moreover, the absorption band at 1700 cm^{-1} , which was due to C=O vi-

bration of COOH, was more intensified by electrolytic treatment than by treatment with alkaline solution. This seems to hydrolyse the ester in lignite. Thus, it was surmized that electrolytic treatment enhanced hydrolysis of ester in lignite.

ESR Studies on Chemical Bonding in the Copper-Complexes

Masaru SHIOTANI

Syuji MORIUCHI

Junkichi SOHMA

Abstract

It is a matter of interest to investigate the nature of the chemical bonding of the copper complexes in the amorphous state having different solvents by ESR. We observed the ESR spectra of the following copper complexes in some organic solvents at 77°K; cupric chloride in ethanol, the pyridine copper complexes, and methyl-hydroxamic-acid copper (II) complex. The observed ESR spectrum of the cupric chloride is simulated to give the best fit with the observed line shape and the adjustable parameters in Spin-Hamiltonian A_{\perp} , g_{\perp} and ESR line width parameter ΔH were found to be determinable. The "covalent" characters were evaluated quantitatively for the σ and π bonds in the three copper-complexes from the h.f.s. and g -values obtained by analysis of the ESR spectra of the complexes. And also, the same characters were evaluated from the extra h.f.s. of N^{14} for the pyridine and methyl-hydroxamic-acid copper (II) complexes.

Agreement between the two values of the covalent characters independently obtained by the two different methods were fairly good, but not satisfactory. The reason for this discrepancy was discussed.

Automatic Curve Tracing Method with Two Spots of Light Source (I)

—Curve Tracing Method Using
a Small Neon Tube—

Ikuo IKEDA
Tadashi OHTA

Abstract

The authors have attempted to construct an automatic curve tracing device. A detailed analysis on the characteristics of the reading head consisting of a Neon tube and a photoconductive cell was presented. The electric output was measured in terms of line thickness and tangent of line.

The possibilities of curve tracing characteristics were discussed.

Studies on the Longitudinal Diffusion of Water Flow in a Pipe (II)

—Mechanism of the Longitudinal Diffusion
and its Measurement—

Kenji ISHIZAKI

Abstract

In a previous paper, we reported a method of measuring the coefficient of longitudinal diffusion in a stream flowing in a straight circular pipe and the results obtained by the method.

In this experiment, by using a pipe longer in length and smaller in radius than the previous one, more reasonable values of the coefficient were obtained by the same method.

The distributions of concentration for time, observed on fixed points across the pipe, suggest that a longitudinal diffusivity has a simple relation to the distribution of concentration, variation in velocity over the cross-section and axial turbulent diffusion. It appears that the transfer of a soluble salt along the pipe due to turbulent diffusion is very small compared with that produced by convection.

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Study on the Turbulent Shear Flow Past a Circular Cylinder

Masaru KIYA

Abstract

A two-dimensional flow past a circular cylinder placed in a turbulent boundary layer was described, with special reference to the lift and drag forces acting on the cylinder. A theoretical analysis of the flow was made for the hypothetical inviscid shear flow with a linearly varying velocity profile, and experiments were performed with a circular cylinder placed in an artificially produced shear flow and in a turbulent boundary layer, respectively.

An explicit solution for the stream function that describes a uniform shear flow past a circular cylinder subjected to an interference of a plane wall was obtained. It was found from detailed numerical calculations that stagnation pressure decreases as the distance between the cylinder and the plane wall decreases, while in the case of uniform flow the stagnation pressure coefficient remains in unity. The lift force acting on the cylinder calculated by numerically integrating the pressure on the surface of the cylinder was found to be positive when there exists a certain amount of velocity gradient in the transverse direction of flow, which is similar to the case of a practical boundary layer that develops along a stationary boundary wall.

From the experiment performed in a uniform shear flow artificially produced by arranging a grid of rods in a wind tunnel, it was verified that an acceptable agreement between the theory and the experiment was found concerning the stagnation pressure and the position of stagnation point, respectively, provided that the clearance between the cylinder and the plane wall is not too small. It was also found that the experimental value of lift coefficient increases as the cylinder approaches the boundary wall, as qualitatively predicted by the theory.

The pressure distribution on the surface of the cylinder placed in an artificially thickened turbulent boundary layer of 60 mm in thickness was measured and was found to be integrated in the evaluation of the lift and drag forces. It was found that the drag and lift coefficients plotted against the ratio $\Delta/(2a)$, where Δ is the clearance between the cylinder and the boundary wall and a is the radius of the cylinder, were represented respectively by a single curve within an acceptable experimental error, the Reynolds number being in a range of $(0.99-3.78) \times 10^4$. With $\Delta/(2a)$ decreasing, the lift coefficient was found to increase monotonically from zero

to the maximum value of about 0.8 at $d/(2a)=0$, and on the contrary the drag coefficient decreases from 1.2 to the minimum value of 0.95 after passing the maximum value of about 1.3 in the vicinity of $d/(2a)=0.16$.

Thin circular cylinders were placed in the same turbulent boundary layer 30 mm apart from the boundary wall to measure the variations of mean velocity, turbulence and the static pressure in the wake. A complex interaction between the turbulence in the boundary layer and that generated in the wake was suggested. A drag coefficient computed from the momentum principle was found, within the limit of experimental errors, to be the same as that of a cylinder placed in an unbounded uniform flow. This fact suggests that the normal velocity gradient of the boundary layer exerts little effect on the drag coefficient of a thin circular cylinder, when the cylinder is not in the immediate vicinity of the boundary wall. It also becomes evident that the spread of the wake is greater towards the side of the smaller velocity than on the side of the larger one.

These experimental results were satisfactorily interpreted by the theoretical analysis that assumes the approaching flow of a constant vertical velocity gradient.

On the Formation of the Cube Texture in 50% Ni-50% Fe Alloy Sheet

Hitoshi NAKAE
Akira OKADA
Toa HAYASAKA

Abstract

The recrystallization process in cold rolled 50% Ni-50% Fe alloy sheet was studied by X-ray diffractometry.

In the cold rolled state, a considerable amount of the cube component was found of its $\langle 100 \rangle$ axis distributed around the rolling axis.

In the early stages of recrystallization, a slight increase of the diffractive intensity from the cube crystals occurred without a decrease of $\{112\}$ $\langle 111 \rangle$ components, and then the cube component continued to increase showing little change of its half height width.

It follows that the formation of cube texture could not be interpreted by inverse Rowland transformation, but by oriented nucleation from the cube component pre-existing in the rolled material.

Radial-Current-Prebunching Effects on Electron-Wave Interactions in CEF-Type Devices

Ichiro SAKURABA
Katsuhiko IWASAKI

Abstract

This paper deals with the radial-current-prebunching effect on electron-wave interactions in CEF-type devices in a special case where $b=0$, $d=0$, $Q=0$, $\beta_e \approx 20$, and $C \approx 0.05$.

The small-signal forward-wave output power was given by

$$P(\theta) = \frac{1}{2} R_{eqr} |i_r(0)|^2,$$

and the equivalent resistance was yielded by

$$R_{eqr} = \frac{16 \beta_e K}{k_e^2 C^3 (8 + \beta_e^2 C^2)^2} \left[\sinh(\pi CN \sqrt{\beta_e C}) + \frac{3}{\sqrt{2} \beta_e^2 C \sqrt{\beta_e C}} \sin\left(\frac{2\sqrt{2} \pi CN}{\beta_e C}\right) \right]^2.$$

The first term is due to the growing and decreasing waves in the beam-circuit system and the second term is due to the characteristic ripple in the CEF-type focusing system.

The equivalent resistance of the radial-current-prebunching case is larger than that of the azimuthal-current-prebunching case. Because the azimuthal-current-prebunching effect means only the existence of the initial r.f. component of ring charge density $\tau_1(0)$ at the input end and the radial-current-prebunching effect means that a radial displacement $r_1(0)$ and $\tau_1(0)$ exist at the gun end.

Dimerization of Propylene with Alkali Catalysts (I)

—Dimerization of Propylene with Alkali Metal Catalysts—

Takehiro OZAKI, Norihiko YONEDA, Kazuo AOMURA
and Hiroshi OHTSUKA

Abstract

Dimerization of propylene was investigated in the presence of alkali metal catalysts.

Under optimum reaction conditions (reaction temperature: 180°C, reaction

pressure: 200 kg/cm², reaction time: 5 hrs, amount of catalyst: 0.05 mol/1 mol propylene), the following results were obtained. propylene conversion rate: 84.7%, liquid polymer yield: 63.8% (feed propylene base), 75.4% (reacted propylene base), dimer content in liquid polymer: 94.4%. The conversion rate of propylene increased with the increase of reaction temperature and reaction time. However, under severe reaction conditions, unfavorable thermal decomposition occurred resulting in a decrease in liquid polymer yield and the migration of double bonds from the 1- to 2-position in the dimer molecules was observed.

By adding ethyl alcohol to the reaction mixture after the reaction, from which the unreacted propylene was expelled prior to this treatment, an evolution of an appreciable amount of propylene was observed. This result suggested the existence of $[\text{CH}_2=\text{CH}-\text{CH}_2:]^- \text{K}^+$ in the reaction mixture as a reaction intermediate.

Dimerization of Propylene with Alkali Catalysts (II)

—Dimerization of Propylene with Sodium-Potassium
Alloy Catalyst and Sodium-Potassium
Carbonate System Catalyst—

Takehiro OZAKI, Norihiko YONEDA, Kazuo AOMURA
and Hiroshi OHTSUKA

Abstract

The catalytic behaviors of sodium-potassium alloy and sodium-potassium carbonate system in the dimerization of propylene were observed.

Sodium and potassium carbonate themselves did not show catalytic activity in the dimerization of propylene. However, sodium-potassium alloy and heat treated sodium-potassium carbonate mixture showed good catalytic activity comparable to that of potassium metal.

In the case of sodium-potassium carbonate catalyst, the K ion presumably produced by the cation exchange of the carbonate was considered to play an important role in the catalysis. For a sufficient explanation of the high activity of the alloy catalyst, further discussion will be necessary. The alloy catalyst showed the highest activity around the eutectic mixture composition.

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A Study on Determination of S-Wave's Velocity by Soil-Penetrometer-Test

Yoshio SAKAI

Abstract

From a view point of earthquake engineering it seems essential to define or otherwise determine the so-called "Jishin-Kiban, or Seismic Foundation". Considering that the vertical distribution of elastic waves and especially the S-Wave velocity distribution have a strong influence in earthquake disasters, the author has the opinion that the "Jishin Kiban" should be adjudged by the velocity of S-Waves.

Now we have various methods to determine the velocity of S-Waves, but they require lots of special knowledges, so I have studied the practical method to get it easily from N-values of the soil-penetrometer-test and induced the simple practical equation and plotted it on the diagram by using the comparison with actual measurements and engineering judgements.

Here I have compared and investigated N-values of Standard-Soil-Penetrometer-Test and my Soil-Penetrometer-Test, and shown its diagram. I think, however, there still remain many problems; influences of percentage of water content of grounds, poisson's ratio, etc.

A Study on Vibration of a Cantilever Beam with a Rigid-Mass at the Free End

Yoshio SAKAI
Takeshi AOKI
Yutaka YAMAZAKI

Abstract

With regard to vibration of a cantilever beam with a rigid-mass at the free end, we found some difference between practical periods and bending theory's periods. Especially case of second and third mode periods this effect is very remarkable.

With respect to this point a theoretical equation was introduced in addition to the bending theory of beams considering the effects of moment of inertia and secondary stress of bending caused by the vertical force assuming that the beam has not small deformation. Model testing of the above was carried out. The

values of theory and test were in good agreement. We suggest that these considerations are indispensable when we calculate the high mode periods, in top-heavy structures.

A Study on Torsional Vibration of Structure by Seismic Waves

Yoshio SAKAI
Akimune HAZAWA

Abstract

It is well-known that at the time of earthquakes a vibration accompanied by torsion in eccentric structures appears giving rise to unfavorable stresses in some parts of the structure.

In this paper, to obtain data on the mode of selection of the shearing corrective coefficient with special consideration to the dynamic eccentricity in the planning of structures, an equation of vibration was proposed. These theoretical results were compared with the shearing corrective coefficient based on the present statical eccentricity and calculations were made on a one-story-single-span-structure.

It was found that the dynamic eccentricity showed a much higher increase over that of the statical eccentricity.

The present paper is a first step towards establishing the mode of selection of the shearing corrective coefficient.

Dry Shrinkage of Reinforced Concrete Mixed with CSA-Cements

Kazuo OHNO
and
Takashige HATTORI

Abstract

This paper presents the results of two series of observations on the change in length and crack distribution of reinforced concrete mixed with CSA-cements and the usual aggregates.

In the first series, a CSA-cement with 13% CSA was tested with the specimens

of rectangular plates for the convenience of observing cracks which would be caused by dry shrinkage.

The second series was a test on a CSA-cement with 10% CSA consisting of two parts. The first part was the repetition of the foregoing test with this cement and the second part was a study on the change in length by beam type specimens which enable the observation of the change in length from the first stage of hardening of concrete.

Each series of tests included some comparisons of CSA-cement concrete with ordinary portland cement concrete.

An Experimental Approach to the Torsional Resistance of Reinforced Concrete Beams with a T-shaped Cross Section

Kazuo OHNO
Takuji SHIBATA
Yoshio TANI

Abstract

Pure torsion tests on 6 reinforced concrete beam-specimens with a T-shaped cross section were carried out, where 3 beams were provided with shear reinforcement of $p_s=0.4\%$ in the webs and others had no transversal reinforcement in the webs and the slabs. In the former 3 beams the stirrups were extended well into the outstanding portions of slabs. The same longitudinal reinforcement was used in all specimens.

The test results may be summarized as follows ;

1) The initial cracking load can be estimated with the Bach's formula on torsional stress for T-beams substituting tensile strength of concrete regardless of whether webs are reinforced or not.

2) Ultimate torsional strength of plain concrete beams with T-shaped cross sections may be assessed with the fully plastic stress equation for the rectangular sections only neglecting the outstanding portions of the flanges. This result disagrees with the report by H. Nylander in 1945. Further researches will be carried out with regard to the effects of proportion of the cross sections, size of the specimens and strength of concrete, etc.

3) When the stirrups are extended well into the outstanding portions of the flanges, it may be expected that the beams will acquire remarkable ductility and higher torsional strength.

A Study on the Dynamic Behavior of a Sightseeing Tower of Reinforced Concrete

Kazuo OHNO
Mamoru OBATA
Osamu JOH

Abstract

The dynamic behavior of a reinforced concrete tower as shown in Fig. 1 is discussed. The proper value of this tower is theoretically analyzed and its natural period is compared with observed values of microtremour. Then, the elastic responses are computed by using records of four typical earthquakes. (EL-CENTRO 1940 NS, TAFT 1952 EW, OSAKA 205 1963 EW, SENDAI 501 1962 NS).

The results of the study may be summarized as follows :

- 1) The first natural period of this tower obtained by theoretical analysis is in good agreement with the results of observation by microtremour. The value is about 0.6 second.
- 2) The bearing capacity of a thin wall around the elevator shaft was neglected in the structural calculation. However, this wall has a comparatively large effect on the behavior of vibration.
- 3) The whipping phenomenon does not occur in the responses to any earthquake wave.
- 4) When the maximum acceleration of earthquake motion is less than about 180 gal, the stresses of the tower may not exceed the allowable stress.

An Experimental Study on the Heating Method for Constructions in Winter

Yoshiro KOH
Toru NAKAJIMA
Koichi KITO

Abstract

The effect of an improved heating system on the temperature distribution of room air and of concrete walls during construction was studied by applying a combination of a cylindrical duct system and an oil heater. Oil heaters have been widely used for heating the inside of enclosure at building sites in recent years.

The duct system is composed of a conical pipe fitting over the outlet of a blower type oil heater and stove pipes. Elbows, T-joints and perforated pipes are combined with straight non-perforated pipes. This heating system was applied for trial at two building sites, as a considerable improvement of temperature distribution was observed in an experimental small building.

Fatigue Rupture of Roofing Membranes at Joints in Roof Deck

Michio KOIKE

Abstract

Twelve types of roofing membranes were tested by tentative test methods for the purpose of evaluating their ability to withstand movements which take place in roof decks. Two types of vulcanized rubber sheetings showed very good resistance to movements. They might be, however, weak in resistance to ozone in the atmosphere under tensile strain. Thus, the application of vulcanized rubber sheeting should be determined in accordance with ozone resistance. Two types of plasticized polyvinylchloride sheetings withstood the movement from 0 to 1.0 mm. It is advisable to apply asphaltic membranes and fluid-applied synthetic membranes to the roofs where movements as small as 0.5 mm are expected to take place. Two of these are so weak to movements that they should be applied only to the roofs where almost no movements are expected. Since the ability for the membranes to withstand the movements in the roof deck is very important, establishment of standard test methods is an urgent necessity for improvement of roofing membranes.

Efficiency and Initial Conditions of Redevelopments with a Growing System in a Residential District

Yōzō UEDA

Abstract

Hitherto in Japan, the redevelopment of residential districts has been made on point-development and housing. In future, the regeneration of an entire living environment will be one of the important themes for residents in urbanized areas. From such a point of view, under the condition of a system in which the redeveloped area spreads from the first base-point to the surrounding area by absorbing the residences, this paper treats the following points quantitatively.

- 1) Calculated equations and conditions on this redevelopment system.
- 2) Analysis on initial conditions and the final redevelopment area.
- 3) Analysis of the size of the first base-point and the final redevelopment area.

A Study on Distribution Share Changes of Urban Activities in the CBD

— A Case Study in Sapporo —

Fumitsugu YONEMORI

Abstract

In developing a Central Business District future development plan, it is essential to forecast and to determine which kinds of activities should be provided for and how much space should be allocated to them. Careful analysis and supportable projects can greatly enhance the financial attractiveness of a Central Business District plan. Location demands and space demands of urban activities should be changed according to changes of economic and social conditions. This report is an outcome of an investigation on changes of distribution share of urban activities between the Central Business District and other areas in Sapporo City from year 1957 to 1966. Here, the number of persons engaged in various industries were used as an index to express urban activities. The industries were classified into 55 types based on the Standard Industrial Classification for Japan.

On Segmental Structure of Space Sequence-Experience

—Some Informational Aspect of Urban Space—

Katsuyuki IIDA

Abstract

In the field of Urban Design intended to create the comfortable human environment, spaces are concerned with the human experience. The phenomenological experience of physical environment is communicated by sense organs. In the information of experience of space, the role of visual information is the most important sense-data. Nevertheless, we have not so many methods of the analysis of space experiences, criteria of evaluation, and objective methods of composition on visual aspect.

In a sense, this paper is an attempt to make explicit the structure of the spatial character and scheme of values implicit in the analysis of visual information of space sequence experiences.

General experience consist of sense data, those minute neurological responses of individual human to the external world that are the unit of perception. Through the continuing process of grouping these units in variety of ways and combing them with new sense data, the mind formulates and stores general concepts regarding experience. Concept formation, the abstraction of ideas from reality, relies upon the capability of the human mind to reduce the minutia of any sensory experience which are the essential to the recollection and identification of the experience. Our understanding of the natural world around us derives from any indications of structure that the world suggests.

The changes in quality and quantity of informations of experimental spaces are intimately related, at certain nodal point, the quality purely quantitative increase or decrease gives rise to qualitative leaps, such as quantity being transformed into quality. We distinguish segmentation on the nodal point in sequence-experience of spaces. Sequential experience is constructed with successive experience of these segmentations grouping unit of visual experiences.

And this paper is attempt to explore the possibilities of application of information theory to the analysis of space sequence experience. This hypothesis is of particular interest because, if it can be substantiated, then the seemingly disparate and discrete world of physical phenomena, biosocial behavior, and humanistic creation can, at least from this point of view, be brought together and subsumed under a single fundamental principle the law of entropy.

On the Scale and Composition of Spaces for a Kindergarten

Takao YOKOYAMA
Rinko HATTORI

Abstract

Studies on the facilities for Kindergarten in heavy snow and cold regions, are few but nevertheless important. In this paper, the writers have attempted to set forth a guiding principle on the scale and composition of spaces for Kindergarten in Hokkaido. As the subject of study, facilities which consist of 4 classes which are standard scale in Hokkaido, were selected in Sapporo.

Through observations on the behavior of children in the playroom, nursery, corridors, playground, etc. in each Kindergarten, such manifestations as the extent, form, number, continuous hours, etc. of their activities in these spaces, were analysed quantitatively. The authors proposed a formula for the scale of playrooms, nursery, etc., based on the observation and the analysis.

On the So-called "American Style" in the Early Western Architecture in Japan

Takeshi KOSHINO

Abstract

As a preliminary part of a series of work on the early western architectural style in Japan, the so-called "American style" which is said to have been fashionable at the earliest time of the introductory process of the western architecture was studied.

Several references on the "American style" by Dr. Kingo Tatsuno and others were reviewed to consider the general characteristics (Chap. 1).

When, around the Meiji-Restoration in 1868, many Japanese builders, who had studied western architecture under the supervision of the foreigners, began to build in their own manner, they in fact created a new style. Two trends are apparent—one style-intending and another pragmatic. The former, represented by the Tsukiji Hotel in Tokyo (1868), is characterized by composition of the traditional and western features throughout the building. This seems to have flourished till about 1877. Whereas the latter, represented by many governmental offices and school buildings,

shows an articulated mixture of both features. This was adopted widely throughout Japan and it became a fundamental trend in the westernizing of buildings in Japan (Chap. 2).

The hypothesis defining the style "American" is not yet recognized. As a preparation for the definition are considered a few terminological problems of the word "American" (Chap. 3).

Basic Research on the Rating of Annoyance Arising from Noises

Goro HORIE
Akira NABESHIMA
Hideo WATANABE

Abstract

Some useful levels to determine noise criteria such as Loudness, dB A, NC-curves etc. are known. But a psychological scale of annoyance caused by noises is not yet available.

Here the masking effects of certain noises on the articulation of Japanese syllables are observed to find the degree of interference in speeches and the relation between annoyance and interference.

Thus a successive category method was adopted to determine the sensational responses of the listeners and their emotional responses to the testing noises.

The results obtained indicated that the rating of annoyance, which is related to various emotional responses, depends on the irregularity of pulses, transition of levels and frequency components as well as the over all levels of noises.

A Successive Integration Method for the Analysis of Room Air Temperature or Thermal Load Variations

Noboru ARATANI

Norikazu SASAKI

Masamichi ENAI

Abstract

The authors have proposed a successive calculation method of transient room air temperature or heating load variations, by utilizing the nature of an exponential function and the fact the thermal responses of the structure to a thermal input of unit step function are approximate to the sum of the exponential series.

The distinctive features of this method compared with existing methods are,

- 1) easiness in treating the problem of multiple rooms.
- 2) simpler and more accurate in calculations.
- 3) easiness in treating the problem in systems having columns, beams or walls at corners, which have to be treated as two dimensional heat flow problems.
- 4) it is possible to treat problems in systems having non-linear factors such as ventilation, surface heat transfer coefficient or radiation.
- 5) it is possible to calculate the influences of temperatures over a long period by changing Δt accordingly, when the daily changes of temperature are not periodic or when the thermal time constant of the systems is quite large.

It is also applicable to the analysis of integrated thermal characteristics of heating or cooling systems in its enclosure.

On Two Dimensional Steady State Heat Flows in Junctions of Insulated Walls and Other Members of Reinforced Concrete Constructions

Hiroshi HOMMA

Abstract

Various sites in wall structures produce two dimensional heat flows which values can not be neglected. Recently, a higher grade of insulation are being employed in outer walls thus heat losses caused by two dimensional heat flow increase in heating load calculations. Besides in colder districts such as in Hok-

kaido, if cold bridges are formed by a two dimensional heat flow the wall surfaces are often marred or causes dew formation.

In this report in an attempt to cope with these obstacles, certain representative patterns of junctions of insulated walls and other members in reinforced concrete constructions were chosen, and the two dimensional steady state heat flows in the sections of the junctions were calculated. The sections were divided into fine grids, and temperature distributions were computed from the "relaxation method". Then heat flows of the sections were determined from the temperature distributions.

These calculations were performed under various conditions of the sections. The sizes of the sections and insulating conditions are variables. The effect of these conditions are discussed in this report. Thus extra heat losses caused by the two dimensional heat flow were plotted in graphs, so that these values can be used for heating load calculations.