本号の研究論文要旨

平板を過ぎる非ニュートン流体の層流流れ（吉岡直哉・足立毅太郎・吉川捷二，化学工学，34，1169～1176（1970））　指数モデル流体の平板を過ぎる層流流れの理論的解析が示されている。考えられている主題は，中程度の一般化 $R_e{}^*$ 数範囲 $10 \leq R_e{}^* \leq 1000$ において，流れの抗力をいかにして推算するかということである。ニュートン流体の場合の Kuo の理論をこの問題に拡張すると，抗力係数と $R_e{}^*$ 数の間に次の関係が得られる。

$$C_D = A(n)R_e{}^{*-1/(n+1)} + B(n)R_e{}^{*-2/(n+1)},$$

ここで，$A(n)$ と $B(n)$ は，$0.5 \leq n \leq 1.0$ の場合に Fig. 4 と Fig. 5 で与えられる。

核沸騰伝熱の機構について（宮内照勝・与倉守英，化学工学，34，1176～1185（1970））　大気圧付近で比較的低い熱負荷（$q \leq 2\times10^5$ kcal/m²hr）の核沸騰伝熱機構の研究を行なった。まず，白金伝熱面を用い，沸騰伝熱係数の測定と同時に伝熱境膜の物質移動係数を拡散電流法により測定して，その比較から伝熱の律速段階は液境膜にあることを知った。次に伝熱機構について考察し，伝熱面上の発生蒸気泡によって誘起される液膜の強制振動に基づいて，沸騰伝熱係数の解析とデータの相関を行ない，Eq. (25)をえた。

エタノール水溶液の単蒸留における微量成分の挙動について（碇　醇，化学工学，34，1185～1192（1970））　微量の1-ブタノールを含むエタノール水溶液の単蒸留を行ない，留出液および缶液の濃度曲線を求めた。単式蒸留機のモデルを考え，若干の仮定を入れて，留出率，留出液および缶液の濃度を計算する式を誘導した。微量の1-ブタノールを含む液について計算を行なった。微量成分の濃度曲線の形は，主として仕込液のエタノール濃度によってきまる。分縮および缶への水蒸気吹込みの影響を論じた。実験値は計算結果とよく一致している。

Petlyuk らの蒸留システムに対する計算と収束法について（山田幾穂・斎藤日出雄，化学工学，34，1192～1198（1970））　Petlyuk らは多成分系分離に対する新しい蒸留システムを発表し，実験結果およびよく知られた Gilliland の相関，Underwood の式を用いた近似計算によって，熱負荷が通常の蒸留システムより軽減されることを指摘したが，蒸留計算に対する厳密な方法は例示されていなかった。

ここでは，彼らによって提唱された蒸留による分離の複雑なシステムに対して，有効な収束法とマトリックスによる計算手順が示され，3成分系分離の数値計算例から，分離の同一条件下で，通常のシステムに対して約20%の熱負荷が軽減されることを示した。

ぜい性材料の Work index と力学的性質の関係（八嶋三郎・神田良照・坂本宏・粟野修・諸橋昭一，化学工学，34，1199～1205（1970））　標準ミルによる W_i と力学的性質の関係を調べ，つぎの結果をえた。

$$(W_i \cdot \rho / S_t) = 0.632(Y_1/S_t)^{0.35} \cdot (B_r)^{0.15} \cdot (1-\nu_1{}^2)^{0.20} R_e{}^{-0.09} \cdot R_t{}^{-0.48}$$

ただし，ρ [kg/cm³] は密度，B_r はぜい性度，S_t，Y_1 [Kg/cm²] は引張強度とヤング率，ν_1 はポアソン比，R_e，R_t は円筒形と球形試験片の破砕産物と試験片の比表面積の比でどれも常速荷重下における値である。上式の W_i の単位は [Kg·cm/kg] であるから，4.05×10^4 [Kg·cm/kg]＝1 [kWh/ton] で換算すると通常の W_i の値となる。この関係はモース硬度 2～6.5 の材料に適用される。

撹拌反応槽における温度の均一化（水科篤郎・伊藤龍象・平岡節郎・渡辺純吉，化学工学，34，1205～1212（1970））　パドル翼，アンカー翼，ゲート翼，ヘリカルリボン翼を持った撹拌反応槽でスチレンの塊状重合を行なわせて槽内の温度変化を測定した結果，ヘリカルリボン翼が温度の均一化に最良であることがわかった。また次元解析により新しい混合無次元数を導出し，温度および濃度の均一化においてこの無次元数が撹拌翼の種類によらずほぼ一定値をとることを確かめた。最後に内部発熱のある場合の撹拌槽内の温度むらもまたこの混合無次元数に支配されることがわかった。

楕円板型および楕円リボン型撹拌翼の特性（水科篤郎・伊藤龍象・平岡節郎・村田泰一・山中健，化学工学，34，1213～1219（1970））　高粘性流体撹拌に適した楕円板型および楕円リボン型撹拌翼を試作し，混合時間，所要動力，境膜伝熱係数を測定した。これらの撹拌翼は従来用いられているヘリカルリボン翼と同等の諸特性を持っている。特に楕円リボン型撹拌翼は大きな撹拌所要動力を必要とするが混合特性がすぐれている。さらに金網つき楕円リボン型撹拌翼はすぐれた混合過程を示し，また楕円板型撹拌翼にスクレーパーを取付けることにより容易に境膜伝熱係数を大きくすることができることがわかった。

リサイクルを伴う多段気液反応器のフィードフォワード制御（佐藤志美雄・大竹伝雄・大沢俊行，化学工学，34，1220～1226（1970））　リサイクルを伴った多段気液反応器のフィードフォワード制御系について理論的検討を行ない，検出変量と操作変量を適当に選定すれば，反応器の単一ステージの動特性から設計可能なコントローラーによって，予期した外乱のみではなく，予期せぬ外乱に対しても有効な制御系が得られることを明らかにした。またこの種の反応器においては，リサイクル流量は有効な操作量となり得ることがわかった。

<化学工学データ>

酢酸＋水＋シクロヘキサン系および酢酸＋水＋n-ヘキサン系の液液平衡（井口昭洋・布施憲司，化学工学，34，1226～1229（1970））　酢酸＋水＋シクロヘキサン系および酢酸＋水＋n-ヘキサン系の25°Cの液液平衡を測定し，溶解度曲線とタイ・ラインのデータを得た。プレイポイントを

$$\log x_w : \frac{(v_w - x_w)}{x_w}$$

の相関関係を利用して求めた。ここで，x_w は炭化水素相内の酢酸重量分率，y_w は水相内の酢酸重量分率である。

また，低濃度範囲に対する平田プロット

$$\log \frac{y_w}{1-y_w} : \log \frac{x_w}{1-x_w}$$

による相関関係は，y_w の最大値近くまで良く成り立つ。

<寄書>

噴出口に水平方向の境界板を有するノズルから噴出する乱流噴流の研究（堀越長次，化学工学，34，1229～1231（1970））　噴出口に水平方向に一または二枚の境界板を有する水平ノズルから噴出する乱流噴流について，噴流の軸上の速度減衰，水平方向の速度分布，水平方向の噴流の拡がりを実験的に求め，これらの結果を自由乱流噴流のものと比較検討した。

並行2流体ノズルによる微粒化機構の遷移（佐賀井武・佐藤正之・鬼頭正和・杉山幸男，化学工学，34，1231～1234（1970））　液体の微粒化における機構の遷移について，並行2流体ノズルを用いて，瞬間かげ写真により検討をおこなった。液体の粘度が 45 c.p. より大きい場合には，ひも状分裂を示し，表面張力が 35 dyne/cm より小さい場合には樹枝状分裂がみられた。以上の範囲をのぞけば，波状流から噴霧流に移行する際には，膜状分裂の開始がみられた。種々の液体および操作条件について，遷移状態における相対速度を求め，次の無次元実験式がえられた。

$$\frac{W_{rt}}{W_l} = A1(R_e{}^*)^{A2}(W_e{}^*)^{A3}$$

$$A1 = 1.1\times10^5,\quad A2 = -0.32,\quad A3 = -0.78$$

SYNOPSIS OF ORIGINAL PAPERS

<Chemical Engineering Data>

Liquid-liquid Equilibria of the Systems Acetic Acid + Water + Cyclohexane and Acetic Acid + Water + *n*-Hexane, Akihiro Iguchi (Musashi Inst. of Tech.) and Kensi Fuse (Tokyo Inst. of Tech.)
Kagaku Kōgaku, 34, 1226~1229 (1970)

Solubility curve and tie-lines were determined for the systems acetic acid+water+cyclohexane and acetic acid+water+*n*-hexane at 25°C.

The concentration of acetic acid at plait point was obtained from extrapolation of the following correlation line,

$$\log x_w \quad \text{vs.} \quad (y_w - x_w)/x_w$$

where x_w is acid concentration (wt. fraction) in hydrocarbon layer and y_w is acid concentration (wt. fraction) in water layer.

The data for lower concentration region were well correlated to about maximum value of y_w by Hirata's plots,

$$\log y_w/(1-y_w) \quad \text{vs.} \quad \log x_w/(1-x_w).$$

<Short Communications>

Experimental Investigation of Turbulent Jet Emanating from the Nozzle with the Horizontally Bounded Plate at the Exit, Choji Horikoshi (Ibaragi Technical College)
Kagaku Kōgaku, 34, 1229~1231 (1970)

Concerning the turbulent jets emanating from the horizontal nozzle with one or two horizontally bounded plates at the exit, we obtained experimentally the velocity decline on the jet axis, the horizontal velocity distributions, and the horizontal breadth of the jet, and these results were examined by those of the free turbulent jet.

Transition of Atomization Mechanisms by a Parallel-flow Twin Fluid Nozzle, Takeshi Sakai, Masayuki Sato, Masao Kito and Sachio Sugiyama (Nagoya Univ.)
Kagaku Kōgaku, 34, 1231~1234 (1970)

The transition of the mechanisms of liquid atomization was investigated by means of instantaneous shadowgraph on a parallel flow twin fluid nozzle. It was noticed that when the viscosity of liquid is larger than 45 c.p. the mechanism was thready atomization and the surface tension of liquid is smaller than 35 dyne/cm, arborescent atomization was observed.

Excepting for the above mentioned conditions, it was observed that the liquid films began to break when the mechanisms changed from wavy jet to spray. The relative velocities at the transient conditions were studied on the various properties of liquids and operating conditions. A dimensionless empirical formula on the transient conditions was obtained as follows.

$$\frac{W_{rt}}{W_l} = A1(R_e^*)^{A2}(W_e^*)^{A3}$$

$$A1 = 1.1\times10^5, \quad A2 = -0.32, \quad A3 = -0.78$$

On the Relation of Work Index and Mechanical Properties of Brittle Materials, Saburo Yashima, Yoshiteru Kanda, Hiroshi Sakamoto, Osamu Awano and Shoichi Morohashi (Yamagata Univ.)
Kagaku Kōgaku, 34, 1199~1205 (1970)

By dimensional analysis method we obtained the following relation between Bond's work index and mechanical properties of brittle materials

$$(W_i \cdot \rho/S_t) = 0.632(Y_1/S_t)^{0.35}(B_r)^{0.15}(1-\nu_1^2)^{0.20} \cdot R_c^{-0.09}R_t^{-0.48}$$

where W_i [Kg·cm/kg] is the work index, ρ [kg/cm³] the density, B_r the brittleness index, S_t [Kg/cm²] the tensile strength, Y_1 [Kg/cm²] the Young's modulus, ν_1 the Poisson's ratio, R_c the ratio of specific surface area of fractured product to the cylindrical specimen and R_t the same ratio of spherical specimen under slow rate of compression.

Dividing W_i calculated from the above equation by 4.05×10^4 [Kg·cm/kg] we can obtain W_i having the unit of kWh/ton. The above relation can be applied to the region of materials having the Mohs' hardness of 2 to 6.5.

Uniformalization of Temperature Field in Agitated Reactors, Tokuro Mizushina, Ryuzo Ito, Setsuro Hiraoka and Junkichi Watanabe (Kyoto Univ.)
Kagaku Kōgaku, 34, 1205~1212 (1970)

The temperature variations in an agitated vessel with paddle, anchor, gate and helical ribbon agitator respectively for styrene polymerization were measured, and was found that the helical ribbon was superior to the other types in the temperature uniformity effect. A dimensionless number is derived from the dimensional analysis, and named "the mixing number". This is a constant which is independent of the impeller type in unifying temperature or concentration by mixing and also controls the temperature unequality in agitated vessels for heat liberating reaction.

Performance of Elliptic Board and Elliptic Ribbon Agitators, Tokuro Mizushina, Ryuzo Ito, Setsuro Hiraoka, Taiichi Murata and Takeshi Yamanaka (Kyoto Univ.)
Kagaku Kōgaku, 34, 1213~1219 (1970)

"Elliptic Board" and "Elliptic Ribbon" agitators which are useful for high viscous liquid are designed and the mixing time, power, heat transfer coefficient in the agitated vessel with those agitators are measured. The performances of them are as same as those of the ordinary helical ribbon agitator. Especially, the elliptic ribbon agitator is superior to the helical ribbon agitator in mixing time, though it consumes larger power. Furthermore it was found that the mixing performances of elliptic ribbon agitator could be improved by equipping lattices and also that the elliptic board agitator equipped with scraper easilly made heat transfer coefficient very large.

Feedforward Control of Multistage Gas-liquid Reactor with Recycles, Shimio Sato, Tsutao Otake and Toshiyuki Osawa (Osaka Univ.)
Kagaku Kōgaku, 34, 1220~1226 (1970)

The present work intended to synthesize theoretically the effective feedforward control systems for a multistage gas-liquid reactor with recycles.

Based on a linear mathematical model it was found that the control system of which detected variables were selected so as to compensate any predicted disturbance, for example any change in gas feed concentration, eliminated unpredicted disturbances such as changes in concentrations on any stage below the detected stage. Furthermore, it was shown that without a full identification of the dynamics, the controller for the effective control system could be designed from the elemental transfer functions describing the dynamic behaviour of a controlled stage. Finally, it was drawn that as a manipulative variable a recyclic flow rate was preferable to feed flow rate conventionally employed.

Also these theoretical findings were ascertained by analogue computer simulations.

Laminar Flows of Non-Newtonian Fluids past a Flat Plate, Naoya Yoshioka, Kitaro Adachi and Shoji Yoshikawa (Kyoto Univ.)
Kagaku Kōgaku, 34, 1169~1176 (1970)

A theoretical analysis for the laminar flow past a flat plate of fluids of Ostwald-de Waele model is presented. The main problem which is considered is how to predict the drag for the flows at the middle range of the generalized Reynolds number ($10 \le R_e^* \le 1000$). Extending the Kuo theory for Newtonian fluids to this problem, the following relation between drag coefficient and Reynolds number is obtained.

$$C_D = A(n)R_e^{*-1/(n+1)} + B(n)R_e^{*-2/(n+1)},$$

where $A(n)$ and $B(n)$ are given in Figs. 4 and 5 for $0.5 \le n \le 1.0$.

On the Mechanisms of Nucleate Boiling Heat Transfer, Terukatsu Miyauchi and Morihide Yokura (Univ. of Tokyo)
Kagaku Kōgaku, 34, 1176~1185 (1970)

The mechanisms of nucleate boiling heat transfer have been studied experimentally and analytically for the boiling regime of medium heat flux ($q \lesssim 2.10^5$ kcal/m²hr) under atmospheric or subatmospheric pressure. Heat-transfer and mass-transfer coefficients are measured simultaneously for the boiling liquid film by using the diffusion current method for a platinum heat transfer surface. The rate determining step for heat transfer is found in the transfer process of heat through the heat-transfer film on the heating surface. Oscillative local motion of liquid induced by cyclic formation and detaching of vapor bubbles on the heating surface is considered responsible to determine the thickness of the heat-transfer film. With this concept, Eq. (25) is obtained to correlate the experimental boiling film coefficients available so far.

On the Behavior of Minute Amount Component in Simple Distillation of Aqueous Solution of Ethanol, Atsushi Ikari (Kagoshima Univ.)
Kagaku Kōgaku, 34, 1185~1192 (1970)

The simple distillation of the aqueous solutions of ethanol containing a minute amount of 1-butanol has been carried out, and the composition curves of the distillate and residue in the still has been obtained.

On a devised model of the batch still and some assumptions, the equations have been derived for calculating the ratio of the distillate to the charge and the compositions of the distillate and residue in the still.

The calculated results for the solutions containing a minute amount of 1-butanol were presented.

The form of the composition curve of 1-butanol is principally determined by the ethanol concentration in the charge. The effects of partial condensation and steam blowing into the still are discussed.

The observations are in good agreement with the calculated results'.

On the Calculations and Convergence Method for the Distillation System of Petlyuk et al., Ikuho Yamada and Hideo Saito (Nagoya Inst. of Tech.)
Kagaku Kōgaku, 34, 1192~1198 (1970)

Petlyuk et al. proposed the new types of distillation system for multicomponent separation, and from experimental results and approximated calculation using Gilliland's correlation and Underwood's equation as well-known, they showed that the new system requires lower heat duty than the ordinary distillation system.

However, the rigorous calculational procedure for his system were not illustrated. In the present paper, the authors have shown the useful convergence method and rigorous calculational procedure by matrix method for the complex distillation system proposed by Petlyuk et al., and shown that required heat duty can be reduced about 20% compared to the ordinary system under the same condition, from a result of numerical example of ternary separation.