1. Direct Methanation of Coal

A. Effects of Weathering

1971

1.1 36013q Inhibition of the oxidation of coal by methane. Terpogosova, E. A. (Inst. Gorn. Dela im. Skochinskogo, Moscow, USSR). Khim. Tverd. Topl. 1971 (5), 55-7 (Russ). The oxidn. inhibition is due to the limited access of O to coal contg. CH_4. Vacuum degradation during 18 hr of Vorkuta coal contg. 7.1 ml CH_4/g resulted in a decrease in the CH_4 content to 5.4 ml/g and in an increase in the av. kinetic const. of O absorption at 25° during 50-250 hr, U25, and in its value during the initial 24 hr of oxidn., K, from 0.039 and 0.043 to 0.044 and 0.140 ml/g-hr, resp. After activation at 280° in N_2 which usually resulted in increased U and K values, subsequent satn. of the coal with CH_4 caused a decrease in the values to 0.038 and 0, resp. With the depth at which the coal samples were taken from the wall of the drift increasing from 0 to 0.30, 0.60, 1.00, and 1.20m, the K and U values increased from 0.042 to 0.041, 0.068, 0.083, and 0.101 and from 0.017 to 0.020, 0.029, 0.031, and 0.036 ml/g-hr in spite of the increase in the CH_4 content from 0.013 to 0.122, 0.550, 1.010, and 1.060 ml/g, resp.

Samples of coal were taken from a point in the mine where coal had been exposed for several months, and also from a fresh cut. The farther away from the wall, the less deactivation. For samples from fresh cut, activity is initially low, then increases as methane is liberated, and finally increases again as a result of oxidation.

1969

1.2 ESR Studies of Virgin Coals. Hideo Ohuchi, Masaru Shiotani, and Junkichi Sohma. Fuel, 48, 1969, 187-190. ESR measurements have been made on a range of Japanese coals taken from deep within the seams, exposure to air before examination being avoided. The intensities of the spectra at room temperature were increased when air was introduced and were not reduced when the samples were re-evacuated. This suggests that new spin centers had been produced by irreversible chemical reaction. The increment was greater for the coals of lower rank.

1.3 180-MW J. E. Corette Plant, Burns, Montana Subbituminous Coal. R. J. Labrie and H. E. Burbach. USBM IC8471 1969. The J. E. Corette Plant is located on the Yellowstone River at the outskirts of Billings, Montana. The unit has a maximum continuous net rating of 163,000 kw, but will produce 180,000 kw for 4 hr when operating at its peak rating. The plant is expected to operate at about 60 per cent plant factor over its lifetime and was sized to develop as much peak as possible with a standard frame turbine. It represented about 24 per cent of the system peak capability when it went on the line. The plant is described.

1968

1.4 ESR Study of Atmospheric Oxidation of Fresh Coals at Room Temperature. Hideo Ohuchi, Masaru Shiotani, and Junkichi Sohma. Kogyo Kagaku Zasshi 71, 1191-1195 (1968). ESR spectra were observed for the various kinds of fresh coal, none of which was contaminated with air. After the introduction of air to the fresh coals, the ESR intensities were found to be increased for all kinds of coal studied in this experiment. This fact means additional free radicals were produced by air oxidation of coals at room temperature. The increments ΔN_R of the free radicals were larger for the low-rank coals. Plotting the increment ΔN_R caused by air oxidation against O/C, the number ratio of oxygen to carbon, ΔN_R was increased with the ratio O/C. It was found that ΔN_R was increased proportionately with the fraction of volatile matters and moisture in the coal. These facts lead us to the conclusion that the radicals produced by the contact of the fresh coal with air are related to either aliphatic or alicyclic parts surrounding large aromatic-ring compounds. These experiments also suggest that two kinds of magnetic center exist in the coal; one is a kind of defect of the large aromatic compounds, the free radicals in the other being either originally trapped in the coal or formed by air oxidation of it.

1.5 122247p Hydrogenation of coal with carbon monoxide and water. Appel, Herbert R., Wender, Irving (Pittsburgh Coal Res. Center, Bur. Mines, Pittsburgh, Pa.). Amer. Chem. Soc., Div. Fuel Chem., Prepr. 1968, 12(3), 220-4 (Eng). Bituminous coals and lignite were converted to a C_6H_6-sol. oil and small quantities of volatile materials in the presence of CO and H_2O at moderate temps. and pressures. Bituminous coal, with an equal part of phenanthrene as solvent, and a half part of water, was converted in yields of 70-5% (moisure- and ash-free basis) (maf) in 2 hr at 425° and 1000-2000 psig (cold). In the absence of a solvent the conversion was 42%. Lignites were more reactive than bituminous coal. The best results were obtained at 375-400° and 1500 psig (cold). Conversion up to 92% (maf) were obtained within 0.5 hr. The S content was reduced from 0.7% in the lignite to 0.2% in the C_6H_6-sol. product. CO and H_2O, in the presence of 1:1 naphthol-phenanthrene as solvent, reacted with lignites faster than did H. After 10 min at 380° the conversions were 89% for CO-H_2O and 42% for H. Conversions with aged lignites were lower (77% with --100 mesh lignite exposed to the atm. for 4 weeks). Drying the lignite in air at 105° 24 hr reduced the conversion to 54%.

1963

1.6 Nature and properties of the bond of coal with methane and with carbon dioxide. Pierre Mainil. Rev. Universelle Mines 19(7), 273-82(1963). After reviewing previous work (33 references), M. concludes that relatively little gas is held free in pores and fissures, but that simultaneous soln. in the coal substance and adsorption on surfaces accounts for most of it. Gas pressures in Belgian coal seams are 0-42.5 kg./cm.^{2}, and the total vol. of voids is 0.021-0.123 m.^{3}/metric ton and bears no apparent relation to coal rank. The quantity of gas held and dilatation are directly related to gas pressure. Degassing of coal is slow, requiring about 70 days, the quantity of gas held is inversely proportional to the volatile matter content of the coal and, for a given quantity of gas absorbed, dilatation is greatest with coals of highest volatile-matter content. App. is suggested for further expts.

B. Effects of Structure

1973

1.7 94544m Flash pyrolysis of coal. Effect of nitrogen, argon, and other atmospheres in increasing olefin concentration and its significance on the mechanism of coal pyrolysis. Banerjee, Nara N.; Murty, Gumma S.; Rao, Hejamadi S.; Lahiri, Adinath (Cent. Fuel Res. Inst., Dhanbad, India). Fuel 1973, 52(3), 168-70 (Eng). Three Indian coals of widely differing origin and rank were subjected to flash pyrolysis at $\sim 1150^{\circ}$ for 30 sec in vacuo and in N, Ar, NH_3, and C_6D_6. The gaseous pyrolysis products were analyzed by ir and mass spectroscopy and by gas chromatog. Variations in gas compn. are discussed relative to the possible mechanism of effect of the pyrolytic atms. Pyrolysis in N, Ar, and C_6D_6 tend to enrich the product gas in CH_4 and more esp. in C_2H_4 and propylene. C_2H_2 and HC yields are also increased. The effect is esp. marked for Makum coal (Assam). Pyrolysis in N increases the C_2H_4 yield from 1.35% in vacuo to 3.01% and to 3.69% in Ar and 3.47% in C_6D_6. The yield of propylene is 1.28% in C_6D_6 compared with 0.66% in vacuo. Ir spectroscopy indicates that C_6D_6 does not participate in the pyrolytic reactions, there being no nonbenzenoid C-D stretching or bending frequencies in the spectra of the pyrolysis products.

1972

1.8 100266v Production of pipeline gas by hydrogasification of coal. Pyrcioch, E. J.; Feldkirchner, H. L.; Tsaros, C. L.; Johnson, J. L.; Bair, W. G.; Lee, B. S.; Schora, F. C.; Huebler, J.; Linden, H. R. (Inst. Gas Technol., Illinois

Inst. Technol., Chicago, Ill.). Inst. Gas Technol., Chicago, Res. Bull. 1972, No. 39, 225 pp. (Eng). The destructive hydrogenation of coal was studied, including batch reactor feasibility, reaction kinetics, petrog. process, and pilot plant studies to produce high-BTU pipeline gas. Pressures ≦ 3800 psig and temps. ≦ 2100 F with H, steam, and steam-H feed gases were used in hydrogasification. The reaction occurs in 2 stages; first the coal is converted to CH_4 by pyrolysis and hydrogenolysis. This stage is followed by a slower reaction of steam and H with the less reactive residue to form CH_4.. In countercurrent downflow tests it was possible to produce a 800-900 BTU/ft^3 gas from bituminous coal char and H. Typical conditions for prodn. would be 1600°F at the H inlet, 1200°F at the char inlet, 1000 psig; and a C conversion of 35-40%. However, 900-1000 BTU/ft^3 could not be produced in this manner because the product gas is dild. with unreacted H and with $(CO)_x$ arising from the O content of char. The plant capacity was $(82-90) \times 10^9$ BTU/day.

1.9 6355b Hydrogenolysis of Hokkaido coals under high pressure. Yoshida, Ryoichi; Maekawa, Yousuke; Ishii, Tadao; Takeya, Gen (Gov. Ind. Dev. Lab., Sapporo, Japan). Nippon Kagaku Kaishi 1972, (10), 1885-91 (Japan). A batch autoclave study of the hydrogenolysis kinetics of seven Hokkaido coals of different ranks shows that the reaction consists of 2 stages; the reaction rate was high in the 1st stage and low in the 2nd, and both reactions are of a 1st order with respect to coal remaining. The reaction produced an oil and asphaltene, which formed a 2nd oil. The rate consts. of the 1st-stage reaction decrease with increasing coal rank, and are closely correlated with classification parameters (related to thermal reaction) such as fixed-C content, volatile matter content, and fuel ratio. The rate consts. in the 2nd stage are correlated with the ether-oxygen bond in the remaining coal sample after removal of the constituents that appeared in the reaction of the 1st stage, and are not correlated with the rank of coals.

1.10 74604g Hydrogen in coal. 1. Genetic and structural development. Mazumdar, B. K. (Cent. Fuel Res. Inst., Dhanbad, India). Fuel 1972, 51(4), 284-9 (Eng). A plot of at. H-C ratio vs. rank highlights 3 broad phases in coalification with 2 changes in slope, one at ~84% and the other at ~92% C. Phase 1 relates to the evolution of lower-rank coals (C 62-84% dry mineral matter free) and is marked by the near constancy of at. H-C ratio at the level of 0.80 ± 0.03, from brown coal-lignites to 84% C bituminous coals. Phase 2 represents the evolution of higher-rank coals (C 84-92%) wherein at. H-C ratio continuously decreases in a rectilinear fashion with a minor break at ~89% C. Phase 3, the evolution of semianthracites and anthracites, is marked by a much faster rate of rectilinear decrease in the at. H-C ratio and is sharply defined from the beginning (~ 92% C). The first stage of evolution probably involved deoxygenation without appreciable change in the C-H matrix; the continuous decrease in the at. C-H ratio in the 2nd phase involved the onset of dehydrogenation and demethylation, the former predominating almost to the exclusion of the latter up to 89% C; and the 3rd phase was a relatively drastic process involving demethylation, arom. ring coalescence, and cyclization.

1.11 149589s Improvement of gasification of fine-grained coals in a fluidized bed under pressure. Sechenov, G. P. (USSR). Tr. Inst. Goryuch. Iskop., Min. Ugol Prom. SSSR 1972, 28(1), 97-106 (Russ). From Ref. Zh., Teploenerg. 1972, Abstr. No. 11R35. The conditions and the limits for a possible increase of the gasification rate of fine grained coals of 0-10 mm size in a fluidized bed under pressure were considered. The rate of gasification, all things being equal, can be increased through increase of the degree of expansion of a fluidized bed and sepn. of the oxidn. and redn. zones. A 0-0.5 mm size fuel as a water-coal suspension should be fed into the oxidn. zone, and 0.5-10 mm size into the redn. zone.

1971

1.12 56007c Direct methanation of coal. Zahradnik, Raymond L.; Glenn, Richard A. (Chem. Eng. Dep., Carnegie-Mellon Univ., Pittsburgh, Pa.). Fuel 1971, 50(1), 77-90 (Eng). 'In the kinetics of continuous flow methanation (Glenn, R. A., Donath, E. E., and Grace, R. J., 1967; Mosele, F., and Paterson, D., 1965) in addn. to gaseous pyrolysis products, an active, transient species in postulated which undergoes rapid reaction with H to produce addnl. CH_4. A simplified math. rate expression based on this postulate is used to derive a relation between CH_4 yield and H partial pressure, applicable over all ranges of H pressure. This relation provides a simple and reliable equation for process and equipment design.

1969

1.13 34149g Reactions of discharge-generated hydrogen species with coals and carbons. I. Primary reaction products and kinetics. Sanada, Yuzo; Berkowitz, N. (Research Council Alberta, Edmonton, Alberta). Fuel 1969, 48(4), 375-88 (Eng). Under conditions that suppress secondary (gas-phase) alteration of primary reaction products, interaction of discharge-generated "excited" H species with C delivers only CH_4 (and adventitious oxides of C). In contrast, coals generate CH_4 and various satd. higher hydrocarbons up to C_4— the latter apparently through reaction of H with nonaromatic "precursor" structures. Kinetically, the generation of hydrocarbons--whether CH_4 from C or $CH_4 + C_mH_n$ from coal--tends to be detd. by the reaction location. Reactions within the luminous zone of the discharge follow zero-order kinetics; but further downstream, rates of hydrocarbon formation consistently indicate that $n > 0$. This differentiation suggests that a substantially nondiscriminating reaction in the discharge gives way to a selective reaction outside the luminous zone, where most of the surviving H species have insufficient energy to react with other than "active sites."

1.14 6348b Thermal decomposition of coal. Nelyubin, B. V.; Alaev, G. P. (USSR). Izv. Nauch.-Issled. Inst. Nefte-Uglekhim. Sin. Irkulsk. Univ. 1969, 11(Pt. 1), 76-8 (Russ). The thermal decompn. of Kusbas coal was studied. The temp. rise was 5°/min to 900° in an inert atm. Three max. on the temp curv, 100°, 445°, and 710°, with some endothermic effects were found. In the sequence: telinite, collinite, micrinite, fusinite the wt. loss during thermal decompn. decreases from 25.7 to 18.8%, and the total yield of H_2 and CH_4 and other hydrocarbon gases decreases. Apparently gas coal consists of one basic macromol. type with varying branch chains, functional groups, and other unstable parts of the macromolecules.

1968

1.15 39600r Chemical characteristics of the thermal decomposition of bituminous coals. Oelert, Henning H. (Tech. Hochsch. Clausthal, Clausthal, Ger.). Fuel (London) 1968, 47(6), 433-48 (Eng). The residues from thermovolumetric expts. on a no. of bituminous coals were investigated by quant. ir spectroscopy and other methods. From these measurements, the distribution of C into Me, CH_2, OH, aromatic CH, and other groups was calcd. Up to the beginning of softening, smaller mols. which are relatively aliphatic split off from bituminous coals and peripheral alicyclic rings begin to break. The essential character of the highly aromatic polymer structure is unaffected up to this stage. During softening, polymers may reorient, accompanied by a further loss of smaller mols. and fragments. The main tendency in this period is for aromatization of hydroaromatic rings, which continues into resolidification. Also, substituents to aromatic rings split off continuously (phenolic OH, CO) or in a stepwise manner (Me). After resolidification, the level of aliphatic groups is so low that, in general, they do not contribute to the structure. Hence, the formation of new aromatic rings ceases, but reorientation of aromatic structures proceeds with gradual condensation and (or) a tendency to form a more complex network in the polymer structure. In the uninvestigated temp. regions above 500°, these reactions may continue further by an increasing loss of aromatic hydrocarbons to a totally integrated network, a reorganization in which the aromaticity changes little. Even at very high temps., attainment of an aromaticity of unity is never possible, but complete loss of all aliphatic and most of the O-contg. groups may occur.

1.16 98552z Nonisothermal reaction kinetics of coal pyrolysis. II. Extension of the theory of gas cracking and experimental confirmation on bituminous coal. Hanbaba, Peter; Juentgen, Harald; Peters, Werner (Forschungsinst. Steinkohlenbergbauver., Bergbau-Forsch.G.m.b.H., Essen-Kray, Ger.). Brennst.-Chem. 1968, 49(12), 368-76 (Ger). Theoretically, an equation is derived describing the rate of gas formation when heating homogeneous bituminous coal of different volatile matter content with a const. rise in temp. varying from 0.001 to 1°/min. It is assumed that gas formation is a 1st-order reaction and that the energies of activation and the frequency factors have a narrow Gaussian distribution around one or a few main centers. Expts. with 4 samples (10.0, 19.0, 29.0, and 39.5% volatile matter, resp.) and chromatog. detn. of C_{1-4} paraffins and olefins give a fair confirmation of theory, except for CH_4. Many data are given; energies of activation are in the order of 55-60 (ultimate 50-62) kcal./mole, frequencies of 10^{15}-10^{17} (ultimate 4.4×10^{14} to 8.7×10^{16}) sec. Hence, gas formation begins with rupture of aliphatic and alicyclic bonds. 19 references.

1.17 168493b Catalytic dehydrogenation of coal. III. Hydrogen evolution as a function of rank. Reggel, L.; Wender, I.; Raymond, R. (Pittsburgh Coal Res. Center, U. S. Bur. of Mines, Pittsburgh, Pa.). Fuel (London) 1968, 47(5), 373-89 (Eng). Dehydrogenation of coal with a catalyst contg. 1% Pd on $CaCO_3$ in the presence of phenanthridine as solvent yields almost pure H. The coal rank affects the H yield from the corresponding vitrain; for coals ranging from high volatile C bituminous to anthracite, the H evolution decreases gradually with increasing coal rank; lignites and subbituminous coals give less H than low rank bituminous coals. For bituminous coals, the H evolution (atoms H evolved/100 C atoms in the coal) is a linear function of the at. H/C ratio and also of the at. O/C ratio. Lignites and subbituminous coals deviate widely from this relation. Lignites and subbituminous coals may contain some cyclic C structures which are neither aromatic nor hydroaromatic; low rank bituminous coals may contain large amts. of hydroaromatic structures, and higher rank bituminous coals may contain increasing amts. of aromatic structures. 22 references.

1967

1.18 93569k Catalytic dehydrogenation of coal. III Hydrogen evolution as a function of rank. Raymond, Raphael; Reggel, Leslie; Wender, Irving (Pittsburgh Coal Res. Center, U.S. Bur. of Mines, Pittsburgh, Pa.). Amer. Chem. Soc., Div. Fuel Chem. Preprints 1967, 11(4), 348-64 (Eng). The dehydrogenation of coal by using a 1% Pd-on-$CaCo_3$ catalyst in the presence of phenanthridine gives almost pure H as the product. The exptl.procedure is described, and certain preliminary results are summarized. The rank of coal affects the yield of H from the corresponding vitrain; for coals ranging from high-volatile C bituminous to anthracite, the H evolution decreases gradually with increasing rank of coal; lignites and subbituminous coals give less H than do low-rank bituminous coals. For bituminous coals, the H evolution (atoms of H evolved per 100 C atoms in the coal) is a linear function of the H-C at. ratio and also of the O-C at. ratio. Lignites and subbituminous coals fall outside of the lines defining the bituminous coals. Some new ideas on the process of coalification are presented. It is suggested that lignites and subbituminous coals contain cyclic C structures which in the main are neither aromatic nor hydroaromatic; that low-rank bituminous coals contain large amts. of hydroaromatic structures; and that higher rank bituminous coals contain increasing amts. of aromatic structures.

1.19 101713y Hydrogen pressure and two-stage mechanism for hydrogenation of coal to methane. J. D. Blackwood and D. J. McCarthy (Div. Chem. Eng., C.S.I.R.O., Melbourne). Aust. J. Chem. 20(9), 2003-4 (1967) (Eng). CH_4 is produced during coal hydrogenation in a 2-stage process. In the 1st-stage, a rapid reaction occurs between H- and O-contg. portions of the coal structure; in the slower 2nd stage, H reacts with the residual char. Up to $\sim$40 atm., the total yield of CH_4 increases approx. as the pressure squared; above 40 atm., the CH yield increases linearly with increase in pressure. From this change in the role of pressure, it is inferred that the mechanism of attack of H on coal changes in the 40 atm. pressure range.

1966

1.20 Effects of temperature and ultra-high pressure on the coalification of bituminous coal. Lin-Sen Pan, Terrell N. Andersen, and Henry Eyring (Univ. of Utah, Salt Lake City). Ind. Eng. Chem. Process Design Develop. 5(3), 242-6 (1966) (Eng.). Artificial coalification of high-volatile bituminous coal was exptl. effected by heating the coal (at temps. up to 850°) at pressures of 30 kilobars. Such samples were compared with coal heated at atm. pressure and also with standard coal samples of various ranks by means of ultimate analysis, x-ray spectroscopy, ir spectroscopy, and electrical resistivity. The above tests indicate that heat breaks off fragments ("volatiles") of the coal structure, and drives them off as gases, while high pressure causes retention of many of these products through retardation of bond breakage or through reactions which condense them onto the coal structure. The structure of coal, subjected to elevated temps. and pressures tends toward that of higher-rank coals, while the product of low-pressure heating tends toward coke.

1.21 4758j Kinetic study of the pyrolysis of a high-volatile bituminous coal. Wendell H. Wiser, George Richard Hill, and Norbert J. Kertamus (Univ. of Utah, Salt Lake City). Ind. Eng. Chem., Process Des. Develop. 6(1), 133-3 (1967) (Eng).

30845j A kinetic study of the pyrolysis of a high-volatile bituminous coal. Wendell H. Wiser, George R. Hill (Univ. of Utah, Salt Lake City), and Norbert J. Kertamus. Amer. Chem. Soc., Div. Fuel Chem., Preprints 10(2), C-121-C-129 (1966) (Eng). Const.-temp. data are presented for the pyrolysis of a Utah high-volatile bituminous coal at temps. ranging from 409° to 497°. The reactions are approx. 2nd-order for the 1st 60 min., with an activation energy of 36.6 kcal./mole. This region is followed by a period of $\sim$100 min. during which the reaction is observed to be 1st-order, with an activation energy of 5.36 kcal./mole. A zero-order reaction is observed at times above $\sim$300 min., and extends throughout the balance of the observations; in some cases, it is observed at $\leq$1500 min. Apparent entropies of activation, including the unknown factor of reacting surface sites, were calcd. to be -63 entropy units for the 1st-order region and -12 entropy units for the 2nd-order region. A model is presented which relates the change in reacting sites to entropy change. Finally a model for the pyrolysis of high-volatile bituminous coal is presented.

1.22 30844h The kinetics of CH_4 and CO formation during pyrolysis of coal in the temperature range 570 to 670°. N. Berkowitz and W. J. Mullin (Univ. Alberta, Edmonton, Can.). Amer. Chem. Soc., Div. Fuel Chem., Preprints 10(2), C-110-C-120 (1966) (Eng). A gas-chromotographic method previously used to explore the formation of elemental H and water during coal pyrolysis at temps. in the range of 650° to 850° was used to investigate the kinetics of CH_4 and CO formation in the interval between 570° and 670° (in which these gases represent the principal, volatile products of pyrolysis). In both cases, disengagement from the char can be described by a pseudo 1st order law. But at temps. $>\sim$600°, CH_4 and CO appear each to derive from at least 2 initially simultaneous reaction sequences. One of these is of relatively short duration and allows evolution of CH_4 (or CO) at rates which imply chem. kinetic control, i.e., apparent activation energies lie in the range 30-60 kcal./mole. The other, more extended, sequence leads to apparent activation energies of < 5 kcal./mole and effective control may here be exercised by diffusion.

1.23 High-pressure gas generators. Reinhardt Schmidt (VEB Kombinat "Otto Grotewohl," Bochlen, Ger.). Paliva 46(7-8), 245-8 (1966) (Czech). High-pressure gasification by O is superior to other processes of gas production from solid fuels. Briquets are preferable to granular coal. Improvements that lead to higher output and lower cost are described.

1.24 Changes of combustion properties of gas produced by means of pressure gasification of coal after carbon dioxide removal and carburetion. Fritz Schuster (Tech. Hochsch., Aachen, Ger.). Paliva 46(7-8), 267-70 (1966) (Czech). Gas compn. is dependent on the type of coal. Coal with higher O content gives higher CH_4 and CO_2 contents. Gas from lignite can be used without carburetion. Otherwise, it is necessary to include CO conversion between CO_2 removal and carburetion.

1.25 Mechanism of hydrogenation of coal to methane. J. D. Blackwood and D. J. McCarthy (C.S.I.R.O., Div. Chem. Eng., Melbourne). Australian J. Chem. 19(5), 797-813 (1966) (Eng). The overall kinetics of hydrogenation of coal was explained on the basis of a 2-stage reaction mechanism. The 1st stage involved the very rapid reaction of H with groups in the coal which were assocd. with O, and could be considered to be instantaneous. At temps. in excess of 700°, the yield of hydrocarbons from the groups in coal was limited by equil. of the water gas shift reaction. Hydrogenation of the volatile matter results in the formation of a less readily hydrogenated structure, which is predominantly C. The rate of hydrogenation of the residual C can be expressed in the same form as that for the system C-H-CH_4. The β -graphite equil. also applies to the system char-H-CH_4 and is independent of the reactivity of the char. This fact was used to simplify the rate expression and to write the consts. in terms of ratios of quantities which could readily be measured from a knowledge of the rate of the forward reaction for the test char, and the forward and reverse rates for a reference char. High initial reactivity was observed when a devolatilized char was hydrogenated at a high temp. after it had been exposed to H at low temp. The initial activity was assocd. with a rapid desorption of (CH_2) complex from the surface of the char when the temp. was raised. When the char contained an appreciable quantity of volatile matter, the hydrogenation of the residual volatiles would also contribute to the high initial rate.

1.26 The influence of carbonization gases on bituminous coal under pressure. Georg Huck (Deut. Ges. Mineraloelwiss, Kohlechem., Hanover, Ger.). Erdoel Kohle 19(8), 572-4 (1966) (Ger). The reactions of bituminous coal with CO_2, H, CO, CH_4, and He under pressure were studied at ~300°. The total gas yield, including CH_4, of a 50-g. sample at different temps. was dependent on pressure. With a residence time of 20 hrs., 10 atm., and at 340°, 600 ml. of gas was obtained, compared to 420 ml. with 200 atm. at the same temp. The gas yield was also affected by inert gases. Addns. of He produced less gas than equal amts. of CH_4. More gas was obtained by increasing the grain size of the coal.

1.27 Aliphatic structures in coal. B. K. Mazumdar, S. Ganguly, P. K. Sanyal, and A. Lahiri (Central Fuel Res. Inst., Jealgora, India). Advan. Chem. Ser. No. 55, 475-92, discussion 492 (1966) (Eng). From C-Me contents detd. in coals and reduced coals by the Kuhn-Roth method, it appears that more Me groups are present, esp. in higher-rank bituminous coals ($C > 86\%$) than previously believed. Me groups were detd. by interpreting the pyrolysis behavior (at 600°) of coal. Studies on a series of coals, dehydrogenated coals, and reduced coals are given, and probable mechanisms of CH_4 formation during pyrolysis are discussed. Most of the CH_4 formed during low-temp. pyrolysis is a max. measure of the Me content in coals. The total distribution of C in coal is discussed; the aliphatic side chain is consists mainly of Me groups. 28 references.

1965

1.28 Rapid high-temperature hydrogenation of coal chars. II. Hydrogen pressures up to 1000 atmospheres. F. Moseley and D. Patterson (Midlands Res. Sta., Solihull, Engl.). J. Inst. Fuel 38(206), 378-91 (1965) (Eng); cf. CA 62, 8897a. Char prepd. from coals and contg. $< 19\%$ volatile matter reacted with H at 600 atm. and 1100° in a transfer-line reactor. Active groups in the char promote an extremely rapid reaction between char C and H to yield CH_4 at a rate proportional to the H pressure. These active groups are largely lost from the char in < 1 sec. at 1000°, but their rate of loss depends only on time and the nature of the original char and is independent of the extent of C conversion to CH_4 or the H pressure. C (70%) in the char has been converted to CH_4 in 0.5 sec. at 500 atm. and 1000° in the presence of excess H; a lignite has been completely gasified at 350 atm. At a 2:1 molar H-C feed ratio; the product gas contained 36% CH_4. More active chars and coal agglomerated and caused flow stoppages; the exptl. data indicate the possibility of producing an equil. gas from the more active feeds with complete gasification of C at 500 atm. in < 1 sec.

1.29 Kinetics of the rapid degasification of coals. W. Peters and H. Bertling (Bergbau Forschung G.m.b.H., Essen-Kray, Ger.). Fuel 44(5), 317-31 (1965) (Eng). The very rapid devolatilization of coal particles is described. The yields and the nature of the volatile products are very different from those obtained by normal slow carbonization (Fischer Assay); the yield of volatile products is considerably greater in the rapid process; secondary reactions are minimized, there is less gas but much more tar, and the yield of pitch is considerably greater in the rapid process. The rate of devolatilization as a function of time is discussed and the apparent similarity to the coke-drying process is noted. Consideration is given to the significance of the observed product distribution with respect to coal structure.

1.30 Obtaining acetylene by coal pyrolysis. Carl Kroeger and K. Seshagiri Rao (Tech. Hochsch., Aachen, Ger.). Brennstoff-Chem. 46(5), 129-33 (1965) (Ger). Batches of coal fines (0.08-0.18 mm.) were charged at feed rates of 0.3-1.3 g./min. into a 510-mm., 28-mm. bore, ceramic tube and heated at 1200-1900°K. Before the heating, air was flushed out with N. Heating and gasification took place quickly. A Ruhr gas-flame coal and a noncaking, high-volatile Indian nut coal were tested. Yields of C_2H_2 rose with temp. For the gas-flame coal at 1893°K. and a feed rate of 0.38, the yields were 2.1% of the coal and 11% of the gases. The C_2H_2 yield fell with increasing feed rate. Particle size was practically without effect. Reaction mechanisms are discussed for formation of C_2H_2 by splitting of CH_4 and C_2H_4. Soot formation reached a max. for the gas-flame coal at about 1740°K., but remained practically const. for the Indian coal at 1200-1600°K. For a const. feed rate and particle size, the yield of gases rose independently of the coal type used. Soot and gas formation are explained as arising not only from the aliphatic and alicyclic parts of the coal, but also, with increasing temp., from the aromatic part. C_2H_2, however, arises mainly from the aliphatic or alicyclic portion.

1.31 Rapid high-temperature hydrogenation of coal chars. I. Hydrogen pressures up to 100 atmospheres. F. Moseley and D. Paterson (Midlands Res. Sta., Warwickshire, Engl.). J. Inst. Fuel 38(288), 13-23 (1965) (Eng). The reaction between H and coal char, prepd. from a high-volatile coal by heating in N to 700°, to produce CH_4 has been investigated at 600° to 1000° and pressures to 100 atm. The initial rate of hydrogenation is high but rapidly decays to a const. low value. The decay is independent of the extent of C gasification, depending only on time at temp. and on the loss of volatile matter. The rate of CH_4 formation is directly proportional to H pressure over the range of residence times, 15 to 150 sec., investigated.

1964

1.32 Hydrogen distribution in coal. B. K. Mazumdar (Central Fuel Res. Inst., Jealgora, India). Fuel 43, 78-9 (1964) (Eng); cf. following abstr. When statistical structural units of coal were used to represent the coalification process (dehydroxylation, demethylation), the H distribution did not correspond to the exptl. detd. values. The van Krevelen model was unsuitable from a chem. standpoint because Me groups were still detected in coals with a higher degree of coalification according to the Kuhn-Roth reaction. In contrast, the presence of OH groups was doubtful.

1.33 Hydrogen distribution in coal: reply. D. W. van Krevelen (Allgem. Kunstzijde Unie N. V., Arnhem, Neth.). Fuel 43, 80-1 (1964) (Eng); cf. preceding abstr. The structural model of coal, designated as an av. structural unit, was presented as a statistical concept. It is to be considered as a reaction model, not as a structural formula. The model was constructed on the basis of the av. anal. data of a coal with a H/C ratio of 0.78, and an OH/C ratio of 0.055. These parameters are usually established with a C content of 83%. The demonstration of the coalification using this model does not assume that the reaction pathway is always the same. The reaction of the OH or Me groups should be considered only as reaction possibilities. The structural model represents only a part of the whole molecule. Many such parts could combine in various reaction stages to form a larger molecule.

1.34 Normal alkanes from coal hydrogenation products. Mei-Jen Shih, Hsueh-Jen Yang, and Shao-I Peng. K'o Hsueh T'ung Pao 1964(9), 808-10(Ch). Seven each of C_{9-15} and C_{12-18} *n*-alkanes were identified in coal hydrogenation products having b.ps. of $<$ 200° and 200-320°, resp., by vapor-phase chromatography. Nine 2-methylalkanes (C_{10-18}) were also identified in the above fractions. Higher-boiling fractions obtained from coal hydrogenation, b. 320-400° and 400-500°, possibly contained C_{19-20} *n*-alkanes as well as 2-methylalkanes. The plots of relative retention time vs. no. of C atoms for *n*-alkanes and for 2-methylalkanes were parallel. The *n*-alkanes are not present in untreated coal, but are found after the coal is hydrogenated either by the breaking of side chains of aromatic hydrocarbons, e.g. ArO(S)R or $ArCH_2R$, or by ring opening of heterocyclic hydrocarbons, e.g. 2-alkylpyridine.

1.35 Methane formation during gasification of the Velenje lignite. T. Kovac (Kemijski Inst. Borisa Kidrica, Ljubljana, Yugoslavia). Vestn. Sloven. Kem. Drustva 11(1-4), 7-11 (1964) (Slovenian). Gasification of Velenje lignite samples was carried out in an app. allowing the control of the pressure at ≤30 atm. and of the temp. at ≤1000°. The lignite samples were ground to a 1-3 mm. fraction, dried (water content 14.5%), and charged into the app. O, H, and CO_2 were used as reaction gases. The gas was passed at the rate of 3-5 l./hr. in all expts. The max. yield (21.2%) of CH_4, in expts. with O was obtained at normal pressures and 600°. The amt. of CH_4 decreased with increasing temp. and esp. under high pressures. Only 1.2% CH_4 was produced in expts. at 20 atm. In expts. with H, the highest yield of CH_4 (26.0%) was also obtained at normal pressure and at the same temp. (600°); at 20 atm., the yield of CH_4 decreased below 1%. Expts. with CO_2 were made for orientation purposes. The max. CH_4 yield was obtained at 15 atm. and 750-900° (8.0-8.4% CH_4). The yield of CH_4 at all pressure ranges varied from 5 to 8%, and evidently did not depend greatly on temp. and pressure. The yield of CH_4 was max. at normal pressures and 400-600° with H as the best gasification medium.

1963

1.36 Extraction of a vitrinite and chemical analysis of the fractions. A Halleux and H. de Greef (Union Carbide European Res. Assocs., Brussels, Belg.). Fuel 42, 185-202(1963). An objective evaluation was made of existing correlations between a vitrinite and its various parts. A fractionation scheme consisting of solvent extn., adsorption, and vapor-phase chromatography was developed, and the materials thus obtained were characterized by elementary analysis, av. mol. wt., d., and n. The distribution of O in its various functionalities was detd. chem. Extensive use of ultraviolet, infrared, and proton spin resonance spectroscopy was made for comparison and identification purposes. The presence of heterocyclic O in several vitrinite fractions was confirmed by ether cleavage and by proton spin resonance spectroscopy. The absence of a significant amt. of single methylene bridges was observed in all but one of the vitrinite fractions sol. in C_6H_6. Apart from a small amt of purely aliphatic materials, most materials bear a significant degree of similarity to each other with resp. to aromaticity and av. size of aromatic clusters. Further qual. similarities were found in the spectroscopic characteristics of the fractions and of vitrinite. The hypothesis that some of the light fractions investigated might represent the tail end of the mol.-wt. distribution in the coal "copolymer" cannot be dismissed. Single mol. species identified were few; they include naphthalene and several of its Me derivs., diphenylmethane, and dibenzofuran and its alkyl derivs. 44 references.

1.37 The chemical structure of bituminous coal. Peter H. Given (Pennsylvania State Univ., University Park). Am. Chem. Soc., Div. Fuel Chem. Preprints 7(1), 83-93 (1963). Those chem. characteristics of vitrinites that have the greatest influence in detg. the behavior are: the relatively small aromatic nuclei, which account for 65-90% of the C; the phenolic OH groups, which account for 45-70% of the O; and the hydroaromatic rings, which serve to link together the aromatic nuclei in the construction of mols. On pyrolysis, most of the OH groups and hydroaromatic H are eliminated between about 400 and 450°. Exinitic components are less oxygenated and less aromatic and contribute a greater proportion of aliphatic and side chain-substituted materials on pyrolysis. The other petrological components can make little contribution to the by-products of coking. The relevance of the above information to the production and recovery of by-products is discussed.

1962

1.38 The reactivity of Korean anthracites. Tae Hee Hahn, Chai-Sung Lee, and Sung Sik Shin (Seoul Natl. Univ., Korea). J. Korean Chem. Soc. 6, 47-53(1962). The reactivity of anthracite was measured in terms of the reaction rate const. in the redn. of CO_2. A specially designed reactivity-testing app. was used at 750 to 1100° with pulverized coal from 1 to 10 mm. in diam. The reactivity of the anthracite was not appreciably affected by particle size but was a function of reaction temp. alone.

1961

1.39 Chemical structure and processing of coal. George Richard Hill (Univ. of Utah, Salt Lake City), and Lloyd B. Lyon. Am. Chem. Soc., Div. Fuel Chem., Preprints 1, 249-55 (1961). A new structural model for high-volatile bituminous coal is presented, based upon recent world-wide research findings. The relative abundance of bonding groups (functional O and S, aliphatic bridges, tetrahedral bonds), the aliphatic and aromatic portions of the coal, and various peripheral elements and their importance to coal processing are outlined. The applicability of newly developed catalytic hydrocracking-hydrotreating processes to coal conversion processes and their importance in the development of coal as a source of liquids and of metallurgical coke are discussed.

1959

1.40 Aliphatic hydrogen in coal. J. N. Bhowmik, P. N. Mukherjee, A. K. Mikherjee, and A. Lahiri (Central Fuel Res.

Inst., Jealgora, India). Proc. Symp. Nature Coal, Jealgora, India 1959, 242-4. The H in coal appears to be predominantly aliphatic, occurring as Me groups directly linked to aromatic nuclei. Coal samples were chlorinated with gaseous Cl at 160-200° and then hydrolyzed with 2.5N KOH, producing COOH groups from Me, CO groups from CH_2, and $\bar{O}H$ groups from CH. A significant loss of C, believed to have been of aliphatic nature, was observed during chlorination.

1.41 Carbon-bound methyl groups and the mechanism of coalification. F. Kaiser, H. S. Rao, and A. Lahiri (Central Fuel Res. Inst., Jealgora). Proc. Symp. Nature Coal, Jealgora, India 1959, 245-52. Although there is much evidence that coal is basically a complex structure composed of aromatic and alicyclic nuclei with aliphatic side chains, the identity of the side chains has remained in doubt. An est. of the side chains in coal has been obtained by application of the Kuhn Roth procedure for detn. of Me groups. The method depends on the fact that every side chain contains only 1 Me group and that every Me group can exist only as the terminal C of a side chain. The variation of Me content with increase in rank (C content) has been studied and a free-radical mechanism is postulated for the coalification process. The mechanism explains the 2 most important facts assocd. with the metamorphism of coal; the increase in aromaticity and the evolution of CH_4 during coalification. Theoretical considerations and calcns. indicate that the amt. of CH_4 evolved during coalification is of the order of 28 cu.m./ton of coal.

1958

1.42 Hydrogenation of coal. Wilburn C. Schroeder (to Fossil Fuels, Inc.). U.S. 3,030,297, Apr. 17, 1962, Appl. Mar. 11, 1958; 8 pp. Dry pulverized coal is entrained in a stream of H at 500-6000 lb./sq. in. and passed through an elongated heating tube to heat the stream in <1 min. to 600-1000°. The heated suspension is passed through a heat-insulated elongated reaction tube in ≤ 1 min., and the reaction products are cooled immediately to produce a light oil (predominantly aromatic) and a gaseous stream (primarily CH_4). The process differs from conventional coal-hydrogenation processes in that the reaction time is much shorter, the conversion tof coal to liquid and gaseous products is much higher, and the liquid product contains a much higher % of aromatic hydrocarbons.

ADDENDA

1973

1.43 149564e Paramagnetic absorption in anthracites. Nedoshivin, Yu. N.; Frolova, N. V.; Kasatochkin, V.I.; Posyl'nyi, V. Ya. (Inst. Goryuch, Iskop., Moscow, USSR). Khim. Tverd. Topl. 1973, (1),141-3 (Russ). There are different types of paramagnetic centers in the anthracite samples contg. 0-15% ash and having a particle size of 1-3 mm. Paramagnetic absorption signals obtained in a vacuum were not equiv. to those obtained after heating at 300°. Milling of the samples led to the change of the shapes of EPR signals and to the formation of new radicals. The unpaired electrons detected by EPR were π-electrons.

1972

1.44 77647p Mechanism of the low-temperature oxidation of fuel minerals based on thermochemical data. Petrenko, I. G. (Inst. Goryuch, Iskop., Moscow, USSR). Khim. Tverd. Topl. 1972, (3), 112-18 (Russ). A thermochem. study of successive stages of oxidn. of the simplest hydrocarbons was carried out. The chem. bonding of C, H, and O atoms in complex mol. structure of fuel minerals was discussed in terms of bond energy. The probable mechanisms of the low-temp. oxidn. of the principal structural units were suggested, and the respective values of reaction heat were calcd., taking into account the intermediary formation of peroxidic compds. The most difficult stage of oxidn. is the initial incorporation of mol. O into the molecule. The reaction then proceeds most easily at sites which already have a bound O atom, e.g., within the structure of partially oxidized coals.

1.45 Thermal dewatering of brown coal, Part 3. J. B. Murray and D. G. Evans. Fuel, 1972, October, 51, 290-296 (Eng). The mechanism of a process for removal of water as liquid from soft brown coals has been investigated. Coals were heated in water under pressure to temperatures of 150 to 300°C, and the yields of dry coal, water, organic functional groups and inorganics in the product were measured. The earlier conclusions by coalification chemists on dehydration and decarboxylation under these conditions have been confirmed by the functional group analyses, and it was shown that the removal of liquid water is initiated principally by a disruption of the coal/water interactions caused by the thermal destruction of functional groups. The process is then completed by expulsion of water by the carbon dioxide evolved, and by changes in the surface wettability and shrinkage of the coal gel. At temperatures of 250-300°C approximately three quarters of the water originally present in the coal is removed. If the coal is allowed to cool in the water after treatment at 150°C complete reabsorption of the water occurs, but as the treatment temperature is raised progressively less reabsorption occurs. Alkali and alkaline-earth metals, chlorine and sulphur are also partly removed by the process, whereas iron, aluminum, and silicon are little affected.

1.46 Studies on the structure of coals: Part 1. The nature of aliphatic groups. S. K. Chakrabartty and H. O. Kretschmer. Fuel, 51, #2, April 1972, 160-163 (Eng). The presence of n-propyl and n-butyl groups in coals was demonstrated by treating coals with sodium hypohalite at 60°C and measuring the yields of acetic and propionic acids. It was shown that these alkyl groups are fairly stable up to at least 550°C. A minimum of 3-5% of the total carbon in any coal is shown to exist in n-propyl, while n-butyl accounts for less than 1% of the total carbon in low-rank coals and about 2% in high-rank ones. In low-rank coal at least 17% of the total carbon is present in activated $-CH_2$ and/or $-CH_3$, and a similar proportion can be activated through nitration of high-rank ones. Detection of formic acid in the oxidation products indicates the presence of similarly activated $-C_2H_5$ groups but a quantitative estimation of such groups could not be given owing to precise analytical difficulties. It is also shown that 550°C chars are not completely aromatic, at least 14% of the total carbon being non-aromatic ($-CH_2-$) and 3-4% being contributed by n-propyl and/or n-butyl groups (not the corresponding alkanes).

1971

1.47 16455g Initial oxidation phase for coal and lignite. Veselovskii, V. S. (Inst. Gorn. Dela im. Skochinskogo, Moscow, USSR). Khim. Tverd. Topl. 1971, (5), 51-4 (Russ). The theory and generalized exptl. observations are given for the initial oxidn. phase responsible for the self-ignition of coals, the deterioration of the quality during storage, and the evolution of firedamp. Oxidn. was studied by keeping coal charges in a hermetically sealed reactor filled with air at a controlled temp. The oxidn. rate was measured by the decrease in the O concn. of the air. At room temp., all coals absorbed O from the air, evolving very little gaseous product and binding most of the O so that it could not be extd. in vacuum. Equations describing the oxidn. were derived. The kinetic const. of the O sorption rate, U, can be calcd. from the equation $-V \ln(C/C_0) = U\tau$, in which V, τ, C_0, and C are the vol. of air in ml/g of coal, the time of oxidn. in hr, the initial O concn. in the air in vol./vol., and the O concn. after time , resp. The rate of the decrease in the U value, H, was calcd. from the equation $U_0 - U = M(1 - H)/C$, where M and U_0 are the amt. of absorbed O in ml. and the initial U value, resp.

During the oxidn., deactivation of coal took place, but it could be reactivated by heating in the absence of air. The heating resulted in evolution of oxidn. products of compn. H_2O 93, CO_2 7, and CO 0.07%. In fresh coal, U increased with decreasing grain size, resulting in a simultaneous increase in H, and the increase in U was smaller than the increase in the coal-particle surface due to destruction of larger pores. In the equation $\log U = \log U_0 + Bt$, where t is temp., B = 0.0156 for all coals, and the usual U values are 0.15, 0.04-0.06, and < 0.015 for lignites, hard coals, and anthracites, resp. The heat effect of the sorption was 3 cal/ml O independently of the coal type, i.e. in all coals, the reaction $2CH + O_2 \rightarrow 2COH$ took place. The kinetics of the initial oxidation was explained by O diffusion as the limiting stage of the process. The lower activity of coals contg. CH_4 is evidence for the limiting diffusion stage. CH_4 is dissolved in the coals.

1965

1.48 Kinetics of coal oxidation within the temperature range 30-100°. Heinrich Muenzer and Werner Peters. Brennstoff Chem. 46(12), 399-407 (1965) (Ger). To det. the susceptibility of coal to autoxidn. and autoignition, the oxidn. speed (uptake of O) was measured under exptl. conditions resembling plant conditions, i.e. similar temp., concn. of O, pressure, and coal moisture; and was expressed in the form of oxidn. time as an isotherm. The schematic diagram of a sensitive, automated instrument was described. It allows several measurements to be undertaken in parallel. Probes are prepd. and inserted under N. The dependence of oxidn. speed on time is a hyperbolic function $d_{O_2}/dt = ct^{-n}$. The temp. dependence as characterized by activation energy is 12-25 kcal./mole. The dependence on the size of grain below 0.5 mm. diam. is negligible. The differences in the oxidn. speed of various coals range over more than a power of 10. The rate of formation of CO and CO_2 are detd. The activation energies of CO and CO_2 formation are 10 to 17 kcal./mole, the amt. of O in CO between 0.4% and 4%, and the amt. of O in CO_2 between 2 and 26%. The math. formulation of the kinetics of coal oxidn. by W. Peters also holds in the 30-100° range. Activated diffusion is the predominant reaction in coal oxidn.

1964

1.49 Reduced coals. II. Origin of coal tar. S. Ganguly and B. K. Mazumdar (Central Fuel Res. Inst., Bihar, India). Fuel 43(4), 281-8 (1964); cf. CA 61, 5406e. The validity of an earlier hypothesis of the origin of tar is re-examd. on the basis of pyrolysis studies (600°) on a series of reduced coals including an anthracite and a reduced semicoke sample. The yield of extra tar from the reduced materials is proportional to and nearly equal to the amt. of aromatic C rendered hydroaromatic: at least 85-90% (in some cases more) of this C appears to be involved in the formation of tar and the rest in the formation of gases. This finding is evaluated with respect to the prior hypothesis.

1.50 Fluidized-bed pyrolysis of coal. J. F. Jones, M. R. Schmid, and R. T. Eddinger (FMC Corp., Princeton, N. J.). Chem. Eng. Progr. 68(6), 69-73 (1964). To develop an economical process for converting coal to gas and liquids, and to upgrade the coal, fluidized-bed pyrolysis was investigated. An Elkol coal, a sub-bituminous B coal from Wyoming, was fluidized with N in a 3-ft. long, 3-in. diam. pipe. The conversion increased with temp. up to 1500°F. At 1500°F., the volatilization was 50% which is 1.3 times that predicted from the volatile content. Between 800-2000°F., the tar yields decreased from 17 to 1.5 wt. % at a rate of 1.3 wt. %/100°F. The tar was highly viscous and contained 9.8% O. To make the tar more suitable for transporting char, its viscosity must be reduced. Gas yields increased at the rate of 4.4 wt. %/100°F. To obtain both a high yield of liquid products and high volatilization, a 2-stage process is recommended. At 1200°F., a 4% higher volatilization was obtained with coal of -60 mesh compared with -16 mesh. As the temp. increased from 800° to 2000°F., the hydrocarbon content of the product gas decreased from 45 to 5 vol. %. The char produced at 1600°F. had a gross heating value of 13,750 B.t.u./lb.

1960

1.51 Dependence of gas quality on the moisture content of gasified coal. G. O. Nusinov, N. Z. Brushtein, and N. S. Miringof. Nauchn. Tr. Vses. Nauchn.-Issled. Inst. Podzemn. Gazifik. Uglei 1960, No. 3, 13-18. To det. the effect of moisture content of coal on indexes of a gasification process, a new lab. procedure was used which insured a const. ash content of the coal, const. elemental compn., and const. degree of fissuring. Coal blocks (length 400 mm. by diam. 100 mm.) were pressed from coal fines (1-2 mm.) under a pressure of 64 kg./cm. Gasification of Moscow coal contg. 1-35% moisture, 20.5% ash (on a dry basis), and a yield of 50.8% volatile matter (on the basis of combustible material) was done at a const. O feed of 3 l./min., which corresponds to an initial linear velocity of 2.5 m./sec.; gas samples were taken every 10 min. The effect of moisture content on the gasification process was evaluated by using 2 criteria: the av. heat of combustion of the gas for the entire expt. and for the 1st 75 min., i.e., until there was a substantial shift in the gasification zone. Within the entire test range of moisture (1-35%), a decrease in moisture caused an increase in the heat of combustion of the gas obtained. However, a change in the moisture content in the 15-35% range caused a considerably greater increase in the heat of combustion of the gas than a change in the 1-15% range; i.e., the 1st stage of drying of coal is of predominant importance.