Corrosion and Deposits from Combustion Gases

Abstracts and Index

Jerrold E. Radway

Corrosion and Deposits from Combustion Gases

Abstracts and Index

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Corrosion and Deposits from Combustion Gases

Preface

Problems of deposition on and corrosion of boiler tubes and gas turbine blades caused by the inorganic impurities present in most fuels have been experienced for many years. The nature and severity of the problems have changed over time with the character of the fuels employed and the advancement in design of boilers and gas turbine equipment.

During the mid-1920s, problems with deposition were magnified by the introduction of equipment fired by pulverized coal; however, the first research reports on corrosion from combustion gases did not appear until 1942, when water wall tube failures became frequent. In that same year, the Boiler Availability Committee was formed in Great Britain to correlate the efforts of many investigators working on such problems. For nine of the 21 years of that group's existence, it was the sole center available to manufacturers, boiler operators, and researchers for exchanging information on corrosion and deposits from combustion gases. In 1951, the American Society of Mechanical Engineers (ASME) formed the Research Committee on Corrosion and Deposits from Combustion Gases. This group consisted of 21 members representing the entire spectrum of energy suppliers (fuel and equipment) and users, and it still endeavors to maintain this broad representation.

The ASME Committee was charged with: "(1) Improving and increasing the knowledge of the technology used in combating corrosion and deposits from combustion gases, (2) surveying the literature and publications and critically analyzing such materials to increase and coordinate the teachings for best use in the field of corrosion and deposits by combustion gases, (3) collecting, organizing, and publishing in usable form the best technical data available in the sphere of the Committee's activity, and (4) encouraging, organizing, supervising, and conducting research within the 'scope' of the Committee's activity and cooperating with the ASME and other societies, both domestic and foreign, in conducting research on basic engineering problems in the field of corrosion and deposits by combustion gases."

The Committee sponsored both an extensive review of the available data on corrosion and deposits and research efforts (by Battelle Memorial Institute) in 1962-1968 relating to the causes of those problems. These activities led to publication by ASME in 1959 of an extensive review of the status of fireside problems, several technical papers, and in 1970 of an abstract and index volume covering the 1,500 technically evaluated references resulting from the sponsored research at Battelle.

The ASME Research Committee became the primary center for exchanging information on such problems when the Boiler Availability Committee was phased out after the Marchwood Conference in 1963. Since then, the Research Committee has sponsored two international conferences (1977 and 1981) aimed at enhancing communications among technologists working on combustion-related problems.

Subjects addressed in those two conferences illustrate how the emphasis has changed since the Research Committee published its last abstract and index volume. The 1973 energy crisis led to increased use of poor-quality fuels containing increasing amounts of undesirable impurities. Concerns about

energy independence and environmental quality have encouraged combustion of refuse and new low-sulfur fuels such as lignites and sub-bituminous coals. New and unfamiliar impurities must be dealt with when burning these fuels and when using new energy conversion processes such as fluid-bed combustion, gasification, liquefaction, and magnethohydrodynamics (MHD).

While the emphasis changed, concern with the earlier problems remained. Considerable research was undertaken on liquid-film attack of metal at high temperatures by alkali sulfur compounds on coal fired equipment and alkali vanadium-sulfur compounds from oil. Concern with chloride attack broadened to include that derived from refuse as well as coal, and low-temperature-related problems of corrosion and deposits were broadened to include concerns with stack emissions and air pollution-control equipment.

In 1978 the Research Committee recognized that the rapidly expanding technical effort justified an updated abstract and index volume. It also concluded that a different approach was needed for a number of reasons:

1. Literature in the field had increased substantially resulting in about 250 technical articles per year versus 50 in the formative period.
2. Pertinent literature was much more widely dispersed by source and type of journal. Many useful references were being published in the environmental literature and in languages other than English. Thus, new and what might earlier have been perceived as peripheral, data bases had to be searched to be sure useful work was not overlooked.
3. New and evolving areas of technology (fluid bed, incineration, MHD, etc.) had to be addressed.
4. Broader distribution than had been achieved with the earlier publications was needed to encourage research and interchange of information. Such distribution could be more readily achieved through an international publisher with strong worldwide marketing capabilities.
5. Literature searching had become easier in some respects through the growth of computer data bases and more complex in others due to proliferation of literature and publications.
6. Compilation and publication of an abstract and index volume had become more complex because of provisions in the U.S. Copyright Act of 1976 that required negotiation of permission fees with multiple organizations.

The Committee soon recognized that the bibliography-updating project would require economic resources beyond those it could commit and sought financial support from the Electric Pov er Research Institute, (EPRI), the research arm of the U.S. electric utility industry. EPRI agreed to fund the work because it recognized that an updated bibliography could contribute to solution of the utility industry's problems with boiler availability and reliability. Making existing equipment more available and reliable affords a measure of safety in dealing with problems brought on by skyrocketing fuel and construction costs, ever-changing political and environmental constraints, delays in getting new units on line, and reduced load growth. The Committee gratefully acknowledges the support of EPRI in making this volume possible.

Because some key costs in preparing this volume could not be reliably estimated in advance of conducting the literature search, the project was implemented in stages. The Committee employed a consulting firm knowledgeable in the corrosion and deposits field, EnerChem Incorporated, to plan and coordinate the various tasks involved in preparing the volume.

Battelle Memorial Institute was selected to conduct the search, edit the citations, and prepare an index. Funding, timing, and the increased number of references generated did not allow for the thorough technical evaluation of references achieved with the earlier volume. Nevertheless, the expertise of part of the Battelle team responsible for the earlier research and the 1970 abstract volume was employed in the search planning and implementation.

Hemisphere Publishing Corporation was selected to publish the volume because of its international experience in marketing references on heat transfer and combustion (including proceedings of the 1977 Henniker Conference*).

ACKNOWLEDGMENTS

As editor, I would like to thank the many individuals whose efforts made this reference possible. In particular, thanks to Richard W. Bryers, past chairman of the Research Committee, who catalyzed, encouraged, and supported the project; David Poole and John Dimmer of EPRI, who perceived the value of an updated abstract volume and arranged financing; Neil Sullivan of ASME Headquarters staff; members of the Research Committee and associates; H. H. Krause of Battelle; William Reid (consultant); publishers of the various data bases (listed in the next section); William Begell and Mary Phillips Born of Hemisphere Publishing Corporation; Saul Hoffman of EnerChem Incorporated for their ideas and support; and Evelyn Radway, my wife, for her cheerful tolerance of the low priority given to household duties while this volume was being compiled.

Jerrold E. Radway

*Richard W. Bryers, ed. *Ash Deposits and Corrosion due to Impurities in Combustion Gases*, Hemisphere, Wash., 1978.

Organization and Use of This Reference

This volume of abstracts on corrosion and deposits from combustion gases is organized in a fashion similar to that published by the ASME Research Committee in 1970. It consists of three major sections:

1. A list of key words
2. Abstract reproductions and reference identification
3. Index of abstracts

The key list contains 328 key words, selected as being the most useful in guiding a literature search in the corrosion and deposits field. Three or four of these key words were assigned to each abstract and are italicized in the abstract. The index of abstracts, prepared by computer, is arranged alphabetically by key word.

The abstracts are organized alphabetically by senior author and numbered sequentially by letter group. In most cases, the abstract contains enough information in condensed form to tell the reader what the article is about, together with a full reference to the original publication. Arrangement by senior author will aid in finding the work of a specific researcher, but locating the publications of authors other than the senior one can be accomplished only by examining the index of abstracts for subjects on which they are known to have written.

Abstracts for documents written in a language other than English generally include a notation of that fact, and those that had been translated into English as of late 1981 are identified with the notation TR (and in some cases a National Translations Center number) after the identification code. Information on how to obtain copies of these translations at reasonable cost is also provided below. Since most of the 15 data bases employed in conducting the search required their identification as the source of the abstract used, each citation has been marked accordingly (see list of data bases below for identification of the various abbreviations). Those citations not marked with a data base code were either originally prepared for the 1970 volume by the ASME contractor or were prepared and submitted for this volume by committee members.

HOW TO USE THIS VOLUME

Using these abstracts and the index is simple.

1. Select the term or terms from the list of key words (pp. 1-3) that most closely describe your interest.
2. Locate the term or terms in the index of abstracts (pp. 387-575). Following each key word is a listing of all abstracts to which it was assigned. Each is identified by an alphabetic/numeric code giving its position in the abstracts section. The title of the paper and the other key words for that abstract follow the code. This information is to aid you in selecting the abstracts and to suggest other key words you may want to examine.
3. Using the code number, locate the reference in the abstracts section.
4. Review the abstracts and access those references of interest through your library.
5. Contact the National Translations Center regarding references published in languages other than English (see details below).

DATA BASE PUBLISHERS

Name	Address	Abbreviation
American Petroleum Institute	156 William St. New York, New York 10038, USA	API
Air Pollution Technical Information Center	U.S. Environmental Protection Agency Research Triangle Park North Carolina 27711, USA	APTIC
Chemical Abstracts	P. O. Box 3012 Columbus, Ohio 43210, USA	Chem Ab
Conference Papers Index	Data Courier Inc. 620 S. 5th St. Louisville, Kentucky 40202, USA	Conf Pap
Corrosion Abstracts	P.O. Box 218340 Houston, Texas 77218, USA	Corr Ab
Dissertation Abstracts	300 N. Zeeb Rd. Ann Arbor, Michigan 48106, USA	Diss Ab
Engineering Index	345 E. 47th St. New York, New York 10017, USA	Eng In
Energy Research Abstracts	P.O. Box 62 Oak Ridge, Tennessee 27830, USA	En Res
Enviroline	Environment Information Center 292 Madison Ave. New York, New York 10016, USA	Envir
Fuel and Energy Abstracts	Westbury House Bury St. Guildford, Surrey GU 5AW England	Fu En
Information Service in Mechanical Engineering	Data Courier Inc. 620 S. 5th St. Louisville, Kentucky 40202, USA	ISMEC
Metal Abstracts	American Society for Metals Metals Park, Ohio 44073, USA	Met Ab
National Technical Information Service	U.S. Dept. of Commerce 5285 Port Royal Rd. Springfield, Virginia 22161, USA	NTIS
Pollution Abstracts	Data Courier Inc. 620 S. 5th St. Louisville, Kentucky 40202, USA	Poll Ab
SciSearch	c/o Institute for Scientific Information 325 Chestnut St. Philadelphia, Pennsylvania 19106, USA	Sci S

TRANSLATIONS

In order to encourage broader use of research published in languages other than English, the availability of an English translation for all such documents was determined through the National Translations Center, a nonprofit organization administered by the John Crerar Library in Chicago. As of late 1981, approximately 25 percent of the 857 foreign language citations were found to be available in English at a nominal cost per copy. Some of these are in "cover-to-cover" translations of foreign journals which are available in many strategically located libraries. Others may have been translated privately and contributed to the National Translations Center or made available via the Center's exchange agreements with other groups throughout the world.

Copies of articles appearing in the cover-to-cover translations (coded with TR) may be obtained by contacting institutions shown in Table 1 as publishing or subscribing to the particular journal of interest. Table 2 lists the journals cited in this volume that are available in cover-to-cover translations, the appropriate abbreviation, and the translation title. Table 3 provides addresses for the publishers of the various cover-to-cover translations. Copies of other available translations (coded with TR plus another three or four letter identifier) may be obtained by contacting the organizations listed in Table 4.

Readers interested in one of the foreign language

citations that had not been translated as of late 1981 should check with the National Translations Center (or, outside the United States, with the NTC-affiliated groups listed in Table 4) before commissioning a translation. Since NTC adds data on about 1,500 new translations per month to its current file of over 800,000, an up-to-date "availability report" at a modest fee could save considerable expense.

Readers or their organizations who arrange to translate foreign language documents, whether pertinent to the corrosion and deposits field or not, might want to consider making them available through NTC. The benefits to organizations that contribute translations are more than advancement of the state of the art.

TABLE 1. Availability of Cover-to-Cover Translations

Universities	Elektr. Stan.	Energetika	Energomash-inostroenie	Fiz. Khim. Mekh. Mat.	Koks. Khim.	Metalloved. Term. Obrab. Met.	Probl. Prochn	Staub-Reinhalt Luft	Teplo-energetika	Tetsu To Hagane	Zashch Met.	Zavod. Lab.	Zhur. Prikl. Spektrosk	Fiz. Tekh. Probl. Razrab. Polezn. Iskop.	Khim. Tver. Topl.	VGB Kraftswerktechnik
Alabama				X					X	X						
Akron	X			X			X	X				X	X			
Arizona State			X	X					X			X	X			
Arkansas	X	X	X					X								
Cincinnati				X	X	X	X									
Drexel				X						X			X			
Georgia Tech			X													
Houston	X															
Ill. Inst. of Tech.			X									X				
Johns Hopkins				X		X					X	X	X			
Kentucky				X		X					X		X			
Lehigh				X		X	X	X	X	X		X	X			
Mass. Inst. Tech.			X													
Michigan State				X		X	X		X	X		X	X			
Minnesota	X	X		X		X	X	X	X	X	X	X	X			
Nebraska						X			X				X			
North Carolina State		X		X		X			X			X	X			
New York-Albany				X				X	X				X			
New York-Stony Brook				X		X			X		X	X	X			
Ohio University-Athens	X			X					X							
Pittsburgh				X		X	X		X	X	X	X				
Purdue			X	X	X	X		X		X	X	X	X			
Syracuse						X	X						X			
Tennessee		X		X	X	X			X				X			
Texas A & M		X			X	X	X		X			X	X			
UCLA				X		X	X		X	X	X	X	X			
Washington-Seattle		X			X	X		X				X	X			
Wisconsin-Milwaukee			X			X	X				X	X	X			
Publishers																
Allerton Press			X		X										X	
Iron & Steel Institute of Japan										X						
National Technical Information Service								X								
Pergamon Press									X							
Plenum Publishing Corporation				X		X	X				X	X	X	X		
Ralph McElroy, Inc.	X															
Scientific Information Consultants Ltd.	X	X	X			X			X							
VGB-Dampftechnik Gmbh																X
Other institutions																
Battelle-Columbus	X	X	X	X		X	X		X	X	X	X	X			
Carnegie Library				X	X		X				X	X	X			
Franklin Institute					X				X	X		X				
John Crerar Library					X				X							
Library of Congress	X	X		X		X	X	X			X	X	X			
Linda Hall Library					X			X		X		X				

TABLE 2. Cover-to-Cover Translations Cited in the Bibliography

Journal	Abbreviation	Translation Title
Elektricheskie Stantsii	Elektr. Stn. (E-71)	Soviet Power Engineering
Energetika	Energetika	Power Engineering Journal
Energomashinostroenie	Energomashinostroenie	Power Generation Engineering or Soviet Energy Machinery
Fiziko-Khimicheskaya Mekhanika Materialov	Fiz. Khim. Mekh. Mat.	Physical-Chemical Mechanics of Materials
Fiziko-Tekhnicheskie Problemy Razrabotki Poleznykh Iskopaemykh	Fiz. Tekh. Probl. Razrab. Polezn. Iskop.	Soviet Mining Science
Khimiya Tverdogo Topliva	Khim. Tverd. Topl.	Soviet Fuel Chemistry
Koks i Khimiya	Koks. Khim.	Coke and Chemistry USSR
Metallovedenie i Termicheskaya Obrabotka Metallov	Metalloved. Term. Obrab. Met.	Metal Science and Heat Treatment
Problemy Prochnosti	Probl. Prochn.	Strength of Materials
Staub-Reinhaltung der Luft	Staub.-Reinhalt. Luft	Stau-Beinhaltung der Luft (*in English*)
Teploenergetika	Teploenergetika	Thermal Engineering
Tetsu To Hagane	Tetsu To Hagane	Tetsu To Hagane Overseas
VGB Kraftwerkstechnik	VGB Kraftwerkstechnik	VGB Kraftswerkstechnik—English Issue
Zashchita Metallov	Zashch. Met.	Protection of Metals
Zavodskaya Laboratoriya	Zavod. Lab.	Industrial Laboratory
Zhurnal Prikladnoi Spektroskopii	Zhur. Prikl. Spektrosk.	Journal of Applied Spectroscopy

TABLE 3. Publishers of Cover-to-Cover Translations: (See Table 1 for the ones each publishes)

Allerton Press
150 Fifth Ave.
New York, New York 10011, USA

Iron & Steel Institute of Japan
Kaikan 3rd Floor
9-4 Otemachi
1-Chome
Chiyoda-KU
Tokyo, Japan

National Technical Information Service
Port Royal and Braddock Rd.
Springfield, Virginia 22151, USA

Pergamon Press
Maxwell House
Fairview Park
Elmsford, New York 10523, USA

Plenum Publishing Corporation
227 West 17th St.
New York, New York 10011, USA

Ralph McElroy, Inc.
2102 Rio Grande
P.O. Box 7552
Austin, Texas 78712, USA

Scientific Information Consultants Ltd.
661 Finchley Rd.
London NW2 HN, England

VGB-Dampftechnik GmbH
43 Essen 1
Klinkestrasse 29/31
Postfach 1791
Federal Republic of Germany

TABLE 4. Translations Centers/Services Organization and Address

National Translations Center
The John Crerar Library
35 W. 33rd St.
Chicago, Illinois 61616, USA

British Industrial & Scientific International Translations Service
The Metals Society
1 Carlton House Terrace
London SW1Y 5BD, England

British Library Lending Division
Boston Spa
Wetherby, Yorkshire LS23 7BQ, England

Express Translations Service
P.O. Box 428
296 Kingston Rd.
London S.W. 20, England

Canada Institute for Scientific & Technical Information
National Research Council of Canada
Ottawa, Ontario I1A OS2, Canada

V. E. Riecansky
22 Horseshoe Close-Balsham
Cambridge CB1 6EQ, England

Commonwealth Scientific and Industrial Organization of Australia

Indian Scientific Documentation Center

Council for Scientific and Industrial Research of South Africa

European Translations Centre in the Netherlands

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Key Words

absorption
absorptivity
acid deposition
activation analysis
additive:
  aluminum
  ammonia
  dolomite
  magnesium
  manganese
  silicon
adsorption
aerodynamics (*see* diffusion)
aerosol (*see* particles, small)
air filters
air heater
air pollution
air preheater (*see* preheaters)
alkali metal
alkalies
alkalized alumina
alloys
  aluminum
  chromium
  cobalt
  nickel
  titanium
alumina
aluminized
aluminum
amines
ammonia
analytical method
analytical techniques
  trace element
anthracite
ash
  brown coal
  coal
  fuel oil
  residual oil
ash analyses
atomic oxygen
availability

barium
beneficiation
bituminous coal (*see* coal)
boiler availability
bonding
bonds
boron
boundary layer
brown coal

calcination
calcite
calcium
calcium oxide
carbon
carbon dioxide
carbon monoxide
carbonates
carbonization
catalysis
catalytic
centrifuging (*see* water washing)
ceramic materials
ceramics
chemical analysis
chlorides
chlorine
chromium
chromium alloys
chromium-base alloys
cladding
classification (of coal)
cleaning
clinker
coal
coal ash
coal cleaning
coal fired
coal gas
coal-fired gas turbine
coal-oil mixtures
coal preparation
coatings
cobalt alloys
cofiring
coke
combined cycle
combustion
combustion air
combustion modification
complex sulfates (*see* sulfates)
composite tubing
composition
computer

condensers
conference
controls
copper oxides
copper oxychloride
crude oil
cyclone furnace

demineralization
deposition
deposits
design
deslagging
desulfurization
dewpoint
dewpoint meter
diesel
diffusion
dispersion
distillate fuel oil
dolomite (*see also* limestone)
dust

economics
economizers
electric fields
electrical conductivity
electrochemical
electrochemistry
emissivity
emulsions
enamel coatings (*see* coatings)
engines
erosion
eutectic
excess air (*see* low excess air)
extraction

ferric oxide (Fe_2O_3)
ferrous oxide (FeO)
fertilizers
films
flames
flue gas
fluidized bed
fluorine
flyash
fouling index
free energy
free radicals
fuel
fuel oil
fuel technology
fusibility

gas fired
gas stream
gas turbine
  alloys
  coatings
  superalloys
gases
gasification
glass coatings
glass tubes
gravimetric

hall effect
heat transfer
heating
heating value
high pressure
high temperature corrosion
  alloys
  gas turbines
  oil fired
  coal fired
humidifaction
hydrochloric acid
hydrogen
hydrogen sulfide

ignition
impaction
incinerators
indicators
inorganic chemistry
inorganic constituents
instrumentation
ions
iron
iron oxides (*see* ferric or ferrous oxide)

kinetics

lead
lignite
lime
limestone (*see also* dolomite)
liquid fuels
liquid phase (*see also* molten phase)
low excess air
low temperature ash
low temperature corrosion
magnesium
magnesium oxide
magnetohydrodynamics
manganese
mass transfer
materials
mechanisms

metal films (*see* coatings)
metal
mineral matter (*see also* inorganic constituents)
minerals
molten phase

natural gas
nickel
nickel alloy
nickel-base alloys
nitrogen
nitrogen oxides
nucleation

oil ash
oil fired
on-load cleaning
operating conditions (as a parameter)
optical measurement
organic sulfur
oxidation
oxide films
oxide layer
oxides
oxygen

particle size
particles, small
phosphate
phosphorus
pipelining
potassium
precipitators
preheaters
probe
pulverized coal
purifying equipment
pyrites
pyrosulfates

quartz

radiation
radioactive
radiometer
rare elements
rates (*see* kinetics)
reactions (chemical or physical)
recirculation
recovery boiler
reducing conditions
refinery
refractories
refuse
refuse derived fuel
reheater (*see* superheater)

reliability
residual fuel
residual oil

salt water
salts
semiconducting
sheathing
shielding
silica
silica ratio
silicon
silicon carbide
silicon nitride
sintering test
slag
slag adhesion
slurry
smokes
smut
sodium
sodium chloride
sodium sulfate
solvent refined coal
sonic
soot
soot blower
soot blowing (*see* on-load cleaning)
stacks
stainless steel
standards
statistics
steam (*see* water vapor)
steam turbine
steels
stoker
stress
studs
subbituminous
sulfates
sulfidation
sulfides
sulfite liquor
sulfites
sulfur
sulfur dioxide
sulfur oxides
sulfur trioxide
sulfuric acid
superalloys
superheater
survey literature
synthetic fuel

temperature (as a parameter)
thermal conductivity
thermodynamics
thermogravimetric
time
titanium
trace elements
transportation
trisulfates (*see* sulfates)
tube thickness

vanadates
vanadium
vapor phase
vapor pressure
velocity
viscosity

washability
waste
water
water soluble
water vapor
water washing
wettability
whiskers
wood

x-ray analysis

zinc
zirconia

Abstracts

A

A1 **The hydrocarbon corrosion of pyrolysis furnaces.** Aarna, A.; Velitskaya, O.; Mikhailova, E.: Soone, Yu. Izv. Akad. Nauk EstSSR, Khim., 1978, 27 (1). 31-35. The premature failure of tubes in the *radiation* section of furnaces used in the secondary pyrolysis of crude oils was studied in laboratory tests on steel OKh23N18, C < 0.08, 23:18 Cr-Ni at 700 deg C. Corrosion rates over a wide range, i.e. from 0 to 97 g/cm exp 2. In contrast to non-aggressive conditions, the aggressive conditions associated with a reduced content of unsaturated hydrocarbons and methane and an increased quantity of H in the pyrolysis gas, an increased deposit of coke, and a reduced content of heavy hydrocarbons in the pyrolysate. The occurrence of aggressive reactions of hydrocarbons is possible: firstly, the non-aggressive process in which cracking occurs with low production of H, and the formation of cokes contg. appreciable quantities of H by the compaction of aromatic hydrocarbons; secondly, an increased H content in the gas and the formation of cokes more like ash, contg. low H - this process is associated with the evolution of heat and the reaction proceeds in an explosive manner. Damage appears in the form of local melting of the metal with a hemispherical type of attack and an increased C content on the surface.
crude oil, coke, high-temperature corrosion, kinetics, reducing conditions Met Ab

A2 TR **Corrosion resistance of materials making up low-temperature heating surfaces and gas flues of boilers.** Abdurashitov, Sh. R.; Zaitsev, G. A; Khasanova, G. P. Energetik, 1977, (9), 33-6. Corrosion resistance of unprotected metals, metals covered with acid-resisting enamels and varnishes, sprayed-on corrosion-proof metals and their compds., and of nonmetallic materials (glass-fiber reinforced plastic, Perspex [9011-14-7], and ceramics) was studied at *low-temp.* surfaces and in gas flues of high-pressure boilers. *Ceramics* lasted for <3 yr in the TM-84 boilers when high-S residual-oil fuel was used. Under the same conditions the Kudinov Works ceramics were destroyed completely within 1-1.5 yr.
coatings Chem Ab

A3 **The *vapor phase* above the system *sulfuric acid*-water.** Abel, E., J. Phys. Chem., 50, 260 (1946).

A4 **Major, minor, and *trace element* composition of *coal* and *fly ash*, as determined by instrumental neutron activation analysis**, Abel, K. H.; Rancitelli, L. A. (Pacific Northwest Lab., Battelle Mem. Inst., Richland, Wash.). Adv. Chem Ser., 1975, 141, 118-38. A highly sensitive instrumental neutron activation anal. technique dets. 30-40 elements in coal and fly ash including Sb [7440-36-0], As [7440-38-2], Se [7782-49-2], Hg [7439-97-6], Zn [7440-66-6], and V [7440-62-2]. A comparison to National Bureau of Standards-Environmental Protection Agency fuel stds. shows that a high degree of accuracy and precision is attainable, allowing tentative conclusions to be drawn as to the origin of certain elements in the coal and their fate during *combustion.*
analytical techniques Chem Ab

A5 **Spectrochemical analyses of *coal ash* for *trace elements.*** Abernethy, R. F.; Peterson, M. J.; Gibson, F. H.; U. S. Bur. Mines-Report Invest., 7281, July 1969, 30 pp. Bureau of Mines made spectrochemical analyses of ash from 827 United States commercial coals for barium, beryllium, boron, chromium, cobalt, copper, gallium, germanium, lantheum, lead, lithium, manganese, molybdenum, nickel, scandium, strontium, tin, vanadium, ytterbium, yttrium, zinc, and zirconium; these 22 elements were detected in almost all of ash samples examined: in addition, arsenic, bismuth, cerium, neodymium, columbium, rubidium, and thallium were detected in many samples.
analytical techniques Eng In

A6 TR-NTC-77-11351 **Combustion of mazut with *vanadium*-containing ashes.** Abramov, V. N.; Ofitserov, S. I.; Khmyrov, V. I. (USSR). Probl. Teploenerg. Prik. Teplofiz. 1971, No. 7, 9-19. The calcd. and exptl. study on the effect of fuel combusion on the distribution of V in *ash* residue is presented. The combustion resulted in 4-5 times less V in the ashes than the fuel had originally.
residual oil Chem Ab