Fuel Research Institute of South Africa

1930-1980

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Fuel Research Institute of South Africa

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Message from Dr the Honourable S W van der Merwe

Minister of Industries and of Commerce and Consumer Affairs

On the occasion of the golden jubilee of the Fuel Research Institute it is fitting to review the extent to which its activities have contributed towards the realization of South Africa's expectations.

In the three decades following the Second World War, coal systematically lost ground to fossil oil as the primary source of energy in most of the major industrial countries. When, in 1973, the world was caught on the wrong foot by unprecedented price manipulations in the petroleum products market, however, the use of coal acquired a new dimension virtually overnight.

It was then that the knowledge gained by the Fuel Research Institute over the years truly came into its own. On the basis of surveys conducted by the Institute, the Government was able to decide immediately which grades and volumes of coal could be made available for export, while the public and private sectors could take immediate decisions on the tremendous capital investments necessary for the exploitation, transportation and handling of coal. Without the information already accumulated by the Institute, and the services it could offer, developments in the industry could not have unfolded so swiftly.

South Africa's coal technology is in no way inferior to that of the rest of the world; in certain respects, in fact, the Republic is a leader in the field. In the production of liquid fuels from coal, for instance, the only commercially viable undertaking is still that of SASOL. Yet research into coal utilization continually faces new challenges; in research on coal conversion and dry hydrogenation, for example, breakthroughs are still to be made.

It is appropriate in these times to emphasize the need to rationalize objectives and services. The government has decided, accordingly, to integrate the Fuel Research Institute into the family of national research institutes of the Council for Scientific and Industrial Research. This integration must be seen in the light of the increasing importance of coal research to the Republic of South Africa.

I trust that the information contained in this Golden Jubilee brochure will serve to stimulate the interest of both local and overseas readers in the role of coal in the modern world.

August 1980

Introduction

The year 1980 marks the golden jubilee of the Fuel Research Institute of South Africa.

The Institute was formally established in 1930 and operated as an autonomous organization under the control of the Fuel Research Board until the 1st of January 1980, when its functions were entrusted to the Council for Scientific and Industrial Research (CSIR). The Institute is now controlled by the CSIR, with the Fuel Research Board acting in an advisory capacity. It will become a fully fledged national research institute of the CSIR as soon as the appropriate legislation has been amended.

This brochure contains a brief account of the growth of the Institute over the past 50 years and of its structure, mode of operation, and activities. Some milestones in the development of our coal resources and the history of the Institute are given in an appendix.

Birdseye view of Fuel Research Institute today.

Functions

The major functions of the Fuel Research Institute of South Africa, as set out in the Fuel Research Institute and Coal Act (Act 35 of 1963, as amended) are to -

- study and investigate the fuel resources of the Republic;
- test, analyse and grade coal and coal products;
- undertake research on all matters relating to fuels and fuel by-products in general;
- investigate any other matter which the Minister may refer to it after consultation with the Fuel Research Board.

The functions of the Fuel Research Board under the Act are to -

- formulate and control the Institute's policy along broad national lines;
- control the Institute in matters of finance and
- determine the nature and scope of its research

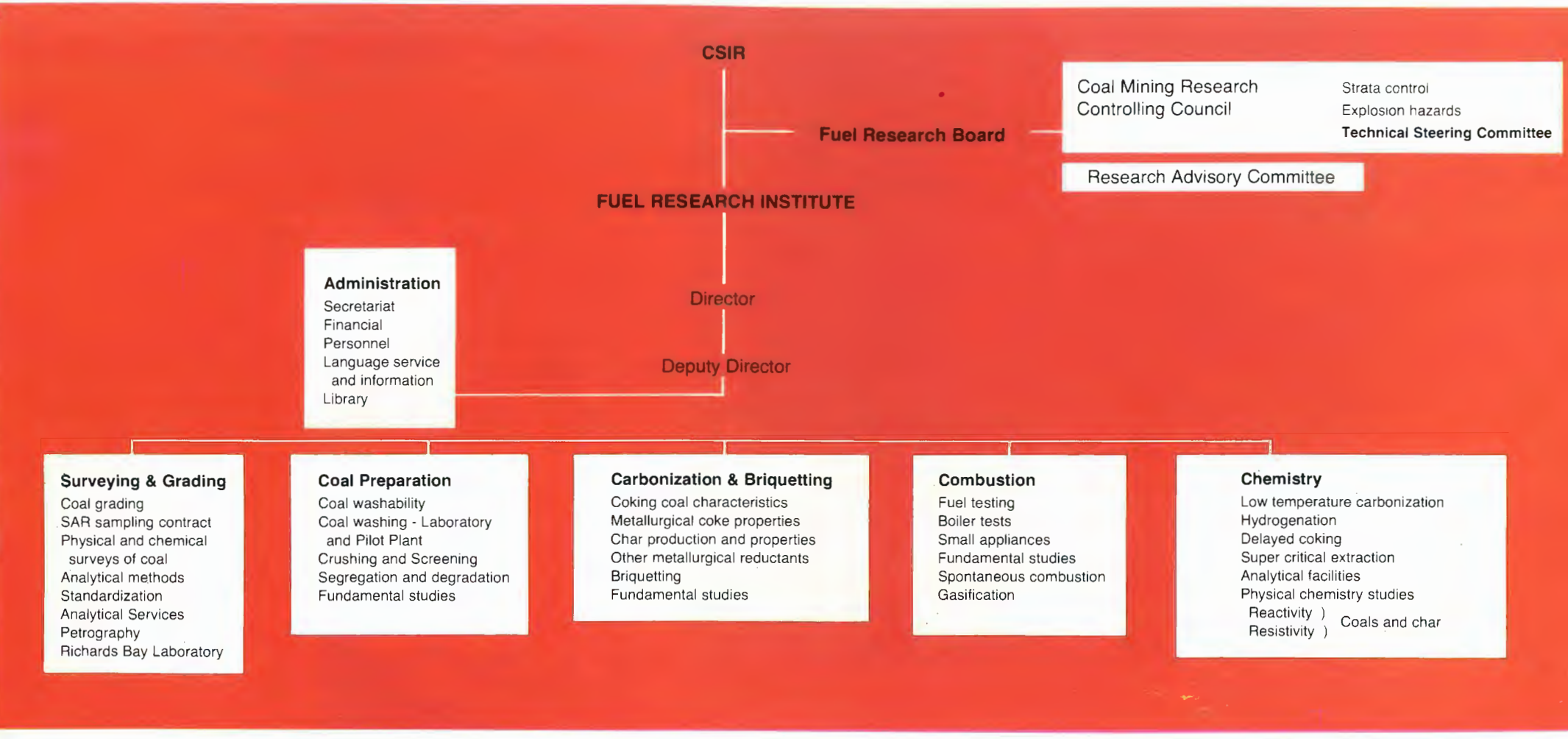
Organizational structure and financing

The organizational structure of the Fuel Research Institute is shown in the accompanying diagram.

Funds are derived from the following sources:

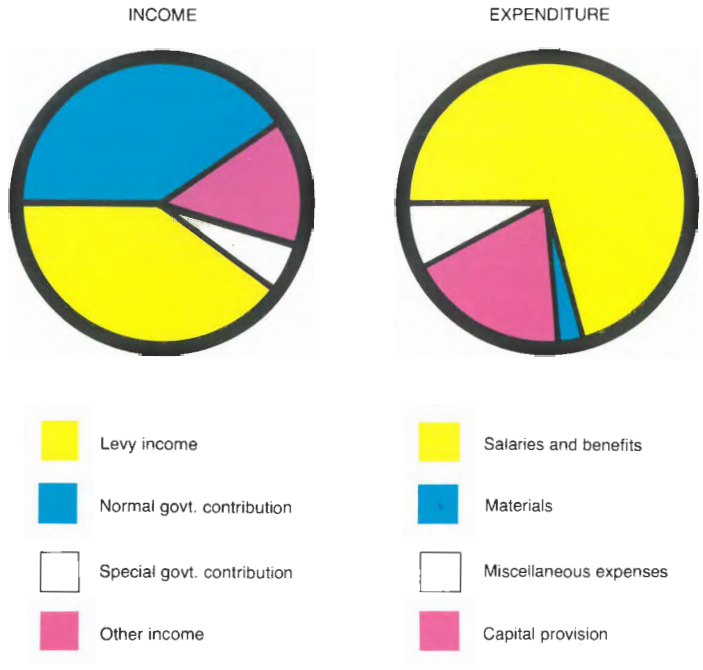
- Capital expenditure: Grants voted by Parliament or contributions from other sources.
- Running expenditure: A levy on the sale of coal (and certain other fuels) matched by an equal sum voted by Parliament.

In addition, the Institute is authorized to charge for any of its services other than those connected with the grading of coal (such as sponsored or partly sponsored investigations for private companies).

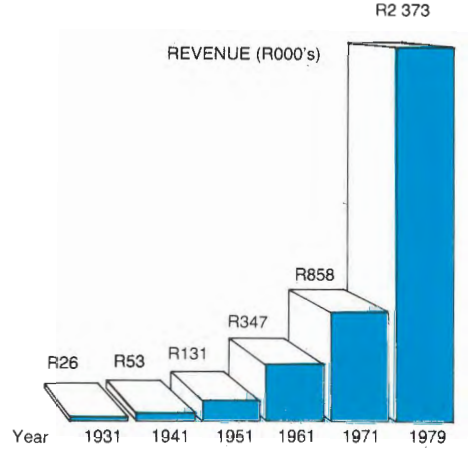

CSIR
Fuel Research Board
Coal Mining Research Controlling Council
Strata control
Explosion hazards
Technical Steering Committee
Research Advisory Committee
FUEL RESEARCH INSTITUTE
Director
Deputy Director
Administration
Secretariat
Financial
Personnel
Language service and information
Library
Surveying & Grading
Coal grading
SAR sampling contract
Physical and chemical surveys of coal
Analytical methods
Standardization
Analytical Services
Petrography
Richards Bay Laboratory
Coal Preparation
Coal washability
Coal washing - Laboratory and Pilot Plant
Crushing and Screening
Segregation and degradation
Fundamental studies
Carbonization & Briquetting
Coking coal characteristics
Metallurgical coke properties
Char production and properties
Other metallurgical reductants
Briquetting
Fundamental studies
Combustion
Fuel testing
Boiler tests
Small appliances
Fundamental studies
Spontaneous combustion
Gasification
Chemistry
Low temperature carbonization
Hydrogenation
Delayed coking
Super critical extraction
Analytical facilities
Physical chemistry studies
Reactivity
Resistivity
Coals and char

The Institute's total staff complement is 270. Most of the employees (170) are stationed at its main complex in Lynnwood Road, Pretoria (opposite the University of Pretoria), while the rest are stationed at the pilot plant in Pretoria West, the Institute's laboratory at Richards Bay, and the two sampling stations at Witbank and Durban.

Distribution of revenue and expenditure



Growth of the Institute's revenue over the period 1931 to 1979



Activities

The Institute's activities fall into four main categories - survey, engineering research, chemical research, and coal mining research.

Ash Fusion Temperature : View into furnace showing samples at different levels of fusion

SURVEY

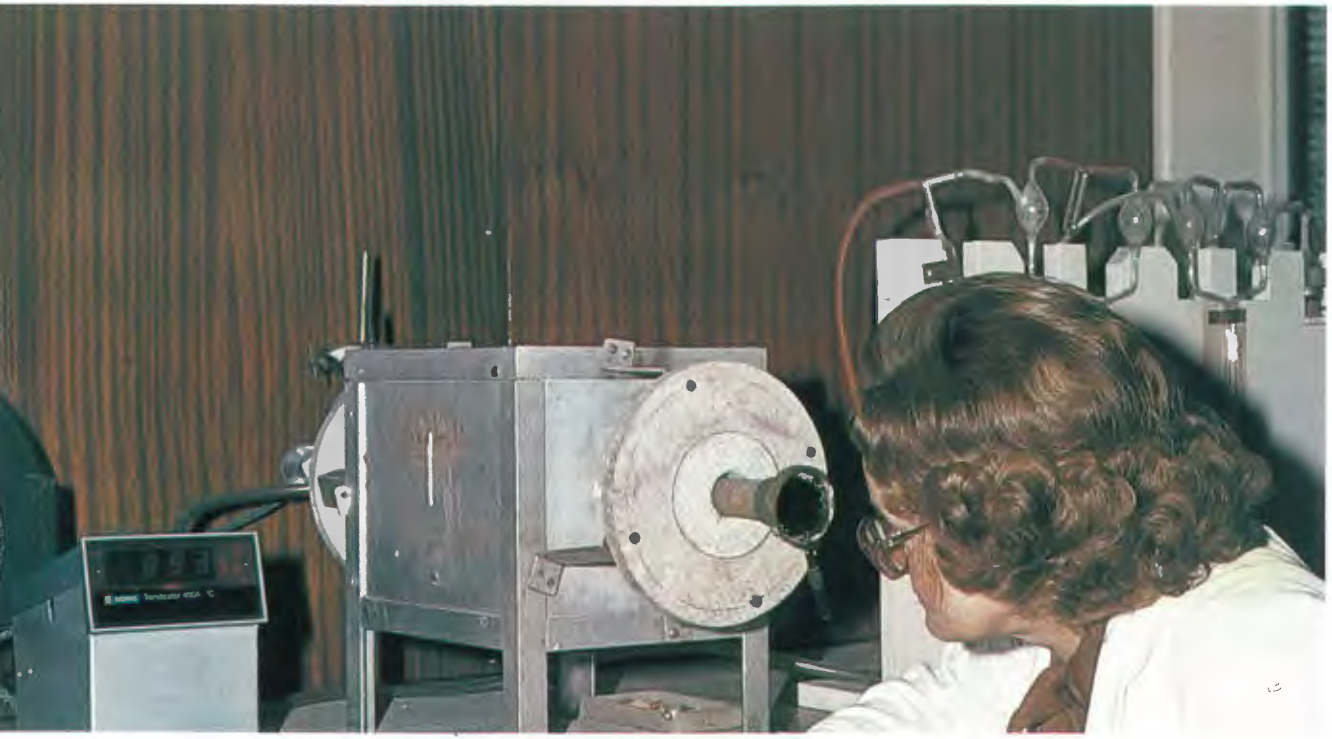
Grading

The Institute undertakes grading free of charge in terms of the Act which prescribes that no coal shall be exported unless it has been graded and an export grading certificate issued. Once a certificate has been issued the Institute must satisfy itself, by spot sampling of the coal consignments, that the specified grade is being maintained; if not, a new certificate is required.

The Fuel Research Board can only refuse the issue of a certificate if the coal is liable to spontaneous combustion, and cannot prohibit the export of coal on any other grounds.

While the Institute does not undertake quality control, it samples all size grades of coal marketed by most collieries at least once every quarter. As a service to industry the results obtained from the analysis of these and other samples are published in an annual bulletin setting out the average quality of coal from those collieries.

Ash fusion temperature : Apparatus



SAR sampling contract

The South African Railways Administration has contracted the Institute to sample and analyse the coal sold to it by the various collieries once a week. The Railways Administration provides facilities, where required, to facilitate the sampling.

Survey of coal resources

In terms of the Act, anyone intending to prospect for coal, oil shale, etc. must notify the Institute of his intention before doing so, and must in due course submit to it the results of such prospecting.

To obtain more complete records, the Institute co-operates with prospectors by preparing and analysing core samples and providing reference samples to prospectors. General survey work is performed free of charge as it is considered to be in the national interest.

Generally, the work on survey samples is confined to a study of density separation and its effects, proximate analyses, some elemental analyses, calorific value determinations, and in some cases the swelling number of the raw coal and/or float fraction. More detailed analyses, petrographic analysis, and the determination of constituents such as free quartz, phosphorus and trace elements. Such work is usually done by special request and on a contract basis. The determination of physical characteristics such as grindability and abrasiveness is done on samples specially taken or requested under contract.

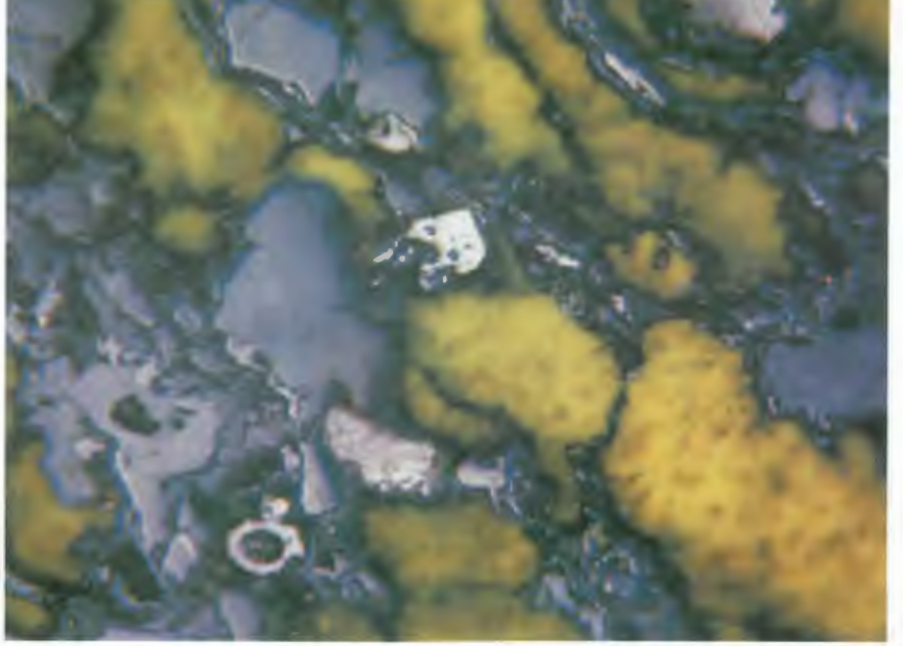
The information obtained from borehole core samples is treated as confidential and not divulged to third parties without authorization, although it is available on a confiden-

tial basis to the Government through the Geological Survey of the Department of Mineral and Energy Affairs.

By agreement the Institute concentrates on the chemical and physical properties of coal, while the Geological Survey deals with the geology and the economic geological aspects of coal. From time to time joint memoirs on coalfields are prepared by the Geological Survey and the Institute.

Sulphur determination in coal in LECO apparatus

Coal ash being fused with fluxing agent in a platinum crucible



Photomicrograph of kerogen (oil bearing) bodies in humic coal. (Magn. 240 x U.V. Light)

Richards Bay Laboratory

Richards Bay Laboratory

The Institute has established a laboratory at the Richards Bay Coal Terminal to analyse all coal exported through Richards Bay.

Coal consignments are sampled by a mechanised system to ensure compliance with international standards. The Institute assumes responsibility for the preparation and analysis of representative samples, and certificates of analysis are issued in respect of every export cargo. Coal arriving daily for export is also sampled and analysed.

Float and sink analysis of coal

ENGINEERING RESEARCH

The Engineering Division is the technological arm of the Institute. In additon to research it undertakes contractual, advisory, and consulting work on request. Its activities include the following:

Coal Preparation

Laboratory investigations: As coal seam characteristics are usually only partially known from borehole core analyses, the washability of the coal is determined on sized bulk samples. Washability relates the theoretical yield at various separating densities to factors such as the ash content and calorific value of the float and sink material. Liberation studies, in which the particle size is systematically reduced to determine the best practical separation of coal from its associated impurities, are also undertaken in many cases.

Pilot plant work: Once the washability of a coal is known, it is necessary to determine which type of equipment is best suited for its beneficiation, and what commercial product yields may be obtained. Bulk samples can be treated in the Coal Preparation Pilot Plant which contains a number of smaller commercial units.

The pilot plant is often used to produce bulk samples of coal to exact specifications for subsequent evaluation by prospective clients. In this way the Institute has been able to assist in securing large export orders for the coal industry on a number of occasions.

Part of the plant is being used to investigate the beneficiation of minus 0,5 mm coal, which is not always amenable to existing commercial techniques. Dense medium cyclones are used, and the technique is already finding commercial application.

Commercial plants: The commissioning of commercial coal preparation plants normally includes tests to establish whether the guaranteed performance is being met. As an impartial body, the Institute is often contracted to perform this task.

The Institute also monitors the performance of existing commercial plants, as it is important for such plants to maintain optimum performance.

View of cyclone

Dewatering screen

Magnetic Separator

Combustion

Work on combustion mainly centres round the efficient burning of coal and the efficient utilization of the heat generated.

Boiler testing: The Institute works mainly on small and medium boiler plant and offers advice and assistance to owners of such plant. Problems associated with the combustion of smalls of both normal and low volatile matter content in chain grate stoker-fired boilers are being studied in a boiler nominally rated at 3 200 kg/h saturated steam. Earlier work in a smaller boiler (rated at 1 800 kg/h) yielded valuable experience, particularly with regard to firetube phosphate deposits.

Fluidized bed combustion: Pilot scale studies of the shallow bed large coal fluidized bed system developed by the National Coal Board in Britain have been initiated by the Institute. Being capable of combusting low grade coal, the system is suitable for installation in shell type boilers. The unit, 0,5 x 0,5 m in bed section, can handle coal up to 25 mm in size. The possibility of automating the system is being investigated.

Basic research: The so-called combustion profile (a plot of the rate of mass loss versus temperature) which has the potential of characterising the behaviour of a coal prior to and during combustion, is currently being investigated. This research is undertaken to clarify anomalies in the relationship between the properties of certain coals as defined by normal analyses and their behaviour during combustion.

Small appliances: The Institute has concentrated its studies in this direction on the basic principles required to achieve efficient, smokeless combustion in small appliances, mainly for domestic use. The results of the investigations are available to all interested parties. The performance of commercially produced smokeless stoves is also monitored under practical operating conditions.

Test Boiler

Carbonization

Laboratory-scale work: The suitability of a coal or coal blend for blast furnace coke manufacture is initially assessed in the laboratory from the swelling index and the Roga index, the latter being a measure of the caking power. Other characteristics investigated include contraction and dilatation, changes occurring in plasticity during heating, and the plastic temperature range. When a coal is heated in the absence of air it becomes plastic and, depending on whether or not it swells during this stage, either coke or char is formed on further heating.

Pilot scale work: Promising results obtained in the laboratory usually require substantiation on a larger scale. Coke, for instance, is produced in a 7 kg oven when only small quantities such as borehole cores are available, or else in two larger experimental coke ovens of 300 kg and 400 kg capacity.

Tests conducted on the coke product include sieve analyses and strength, drop-shatter and abrasion tests. Other tests such as those for reactivity, porosity and density, as well as proximate analyses, are also carried out when required.

Experimental coke oven : coke being pushed

Chars: The National Char Committee has given the Institute the task of establishing the suitability of coals for char production, and also of determining the properties of the resulting chars. In the ferro-alloy industry, where strength requirements are not as stringent as those for metallurgical coke, char can be used as a reductant.

Whereas char can be produced in the three coke ovens described, the Institute's Salem-Brosius Rotary Hearth Carbonizer - believed to be the only pilot scale unit of its kind in the world - has become the principal research facility. Coal is fed to the outer perimeter of the rotary hearth and ploughed to the central soaking pit by means of four stationary rabbles. Heating is effected primarily by combustion of the volatile matter liberated. Operating conditions such as bed depth, residence time, and temperature can be varied to produce char of optimum properties. In addition to the properties determined in coke, electrical resistivity is also determined in the case of char.

Rotary carbonizer : nighttime view

Briquetting press

Briquetting

One outlet for fine coal is the manufacture of briquettes, using various binders, after which the briquettes are carbonized to yield formchar or, in certain instances, formcoke. The Institute is equipped with a hand press and two larger continuous roller presses for this work.

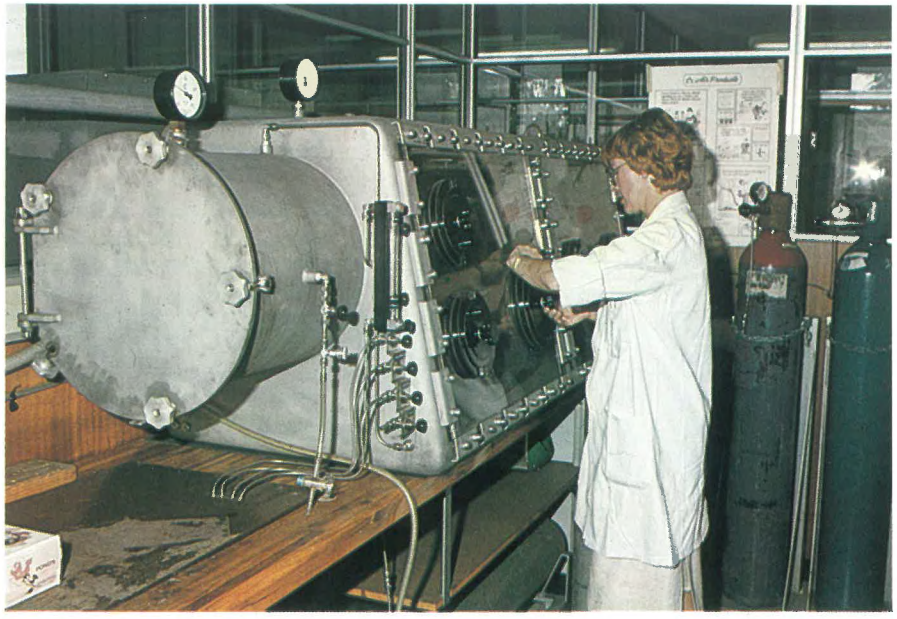
Projects involving various coals, chars and blends with different binders are being carried out both on a contract and a research basis.

Coal gasification

The generation of low calorific value gas by the fluidized bed gasification of coal is being investigated on a laboratory scale. Air alone and air and steam mixtures are both used as gasifying media. The importance of this project lies in the fact that it can provide an alternative to present producer gas plants with coal size problems.

CHEMICAL RESEARCH

Nitrogen atmosphere cupboard



The Chemical Research Division is primarily concerned with specialized applications of coal and coal-derived products. A secondary function is to supply supporting analytical services to the other divisions of the Institute.

Since 1973 the emphasis has been on laboratory and bench-scale evaluations of processes suitable for the production, directly from coal, of liquid or other products upgradable to fuels for transport applications. The effects of process parameters and coal characteristics on the following processes are extensively studied:

Low-temperature pyrolysis of coal in a fluidized bed reactor; this is probably the simplest method of obtaining liquid products directly from coal, albeit at relatively low yields.

Hydropyrolysis of coal, which is aimed at improving the liquid products yield. Hydropyrolysis involves the reaction of coal in the dry state with hydrogen at elevated temperatures and pressures. Although the investigations are currently being carried out in a semi-continuous bench-scale reactor (the so-called "hot-rod" reactor) all promising results obtained will be verified with the aid of a 1 kg/h continuous reactor.

Supercritical extraction of coal, which involves the reaction of the coal with a suitable solvent, maintained at supercritical conditions, to extract the soluble portion of the coal in the vapour state. The product thus obtained is not only upgradable to transport fuel (due to improved H/C atomic ratio) but, being ash-free, is also suitable for the manufacture of graphite electrodes. Both straight and hydrogen-assisted extractions are being studied in autoclaves and in the "hot-rod" reactor.

Other current projects include the following:

Electrode graphite

As imported petroleum coke is used for the manufacture of graphite electrodes suitable for industrial arc furnaces, there is a need for a coal-derived substitute for petroleum coke. Delayed coking offers a means of processing coal-derived products to the required specifications.

The effects of process parameters such as those determined by the pre-treatment of the feedstock on the quality of the product are being investigated in a pilot-scale delayed coker.

Minerals in coal

A study of the composition of the mineral matter in coal is under way to establish its potential as a source of valuable elements. This work is important also from an environmental point of view as certain trace elements leached out of ash dumps may cause hazardous pollution.

Other work

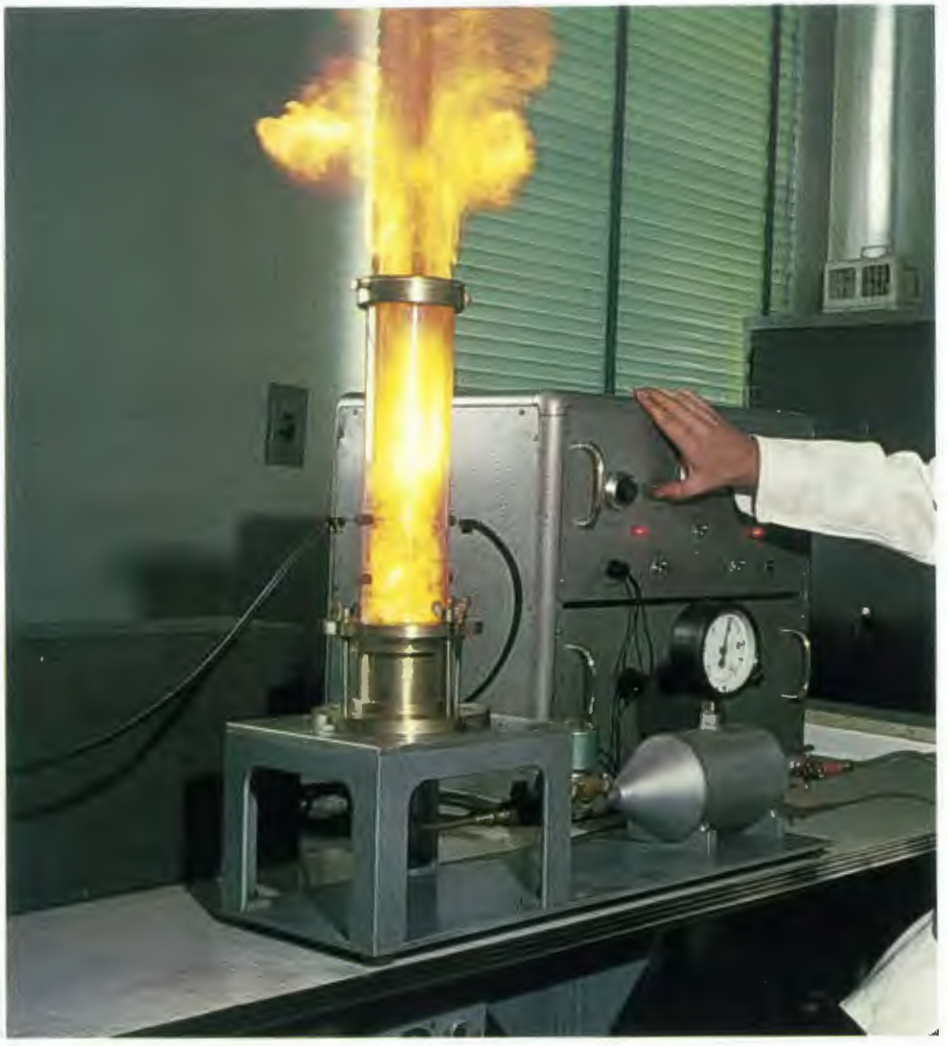
Other work includes routine analyses of gaseous and liquid products derived from coal conversion studies, the determination of the properties of solid reductants, size analysis of particulate matter, and related subjects. New or improved methods of analysis are continually being developed.

Application of nuclear magnetic resonance for the elucidation of organic structures

COAL MINING RESEARCH

A non-corporate body, the Coal Mining Research Controlling Council, was established following a colliery disaster in the early sixties. The Act was amended to make provision for a special levy on coal (and an equivalent Government contribution) to finance the activities of the Council.

The Council has a number of technical committees to advise it on research related to safety in coal mining. Research projects are contracted out to existing institutions such as the Chamber of Mines Research Laboratories and the Fuel Research Institute and other laboratories of the Council for Scientific and Industrial Research. The Fuel Research Institute's activities are concerned mainly with fire and gas hazards in coal mining and include studies on the emission of methane from coal and adjacent strata, the explosiveness of coal dust, and the early detection of incipient underground fires.



Explosibility of coal dust : Hartmann apparatus

Some milestones in the history of the Fuel Research Institute and the development of South Africa's coal resources

Coal was discovered in South Africa in the early eighteenth century near Franschhoek in the Cape, although there are signs that the Zulus used coal in Natal before the arrival of the White man. Coal mining proper started during the second half of the nineteenth century.

1864 South Africa's first recognized colliery is opened near Molteno in the Indwe district of the Eastern Cape. It is this coal that first fires South African industry.

1866 The discovery of gold on the Witwatersrand creates an increasing demand for coal, which leads to the opening of major coal fields in the Transvaal.

1907 Coal marketing associations, such as the Transvaal Coal Owners' Association, are created to resolve the cut-throat competition that has developed between coal producers.

1920 For the first time, coal sales exceed 10 million metric tons per annum; 28,4 per cent of this is exported or used as bunker coal.

1922 In an effort to control the export of coal and to ensure that a certain minimum quality of export coal is maintained, Coal Grading Committees are established in Natal and in the Transvaal under the Coal Act (Act 27 of 1922). The industry takes responsibility for this control.

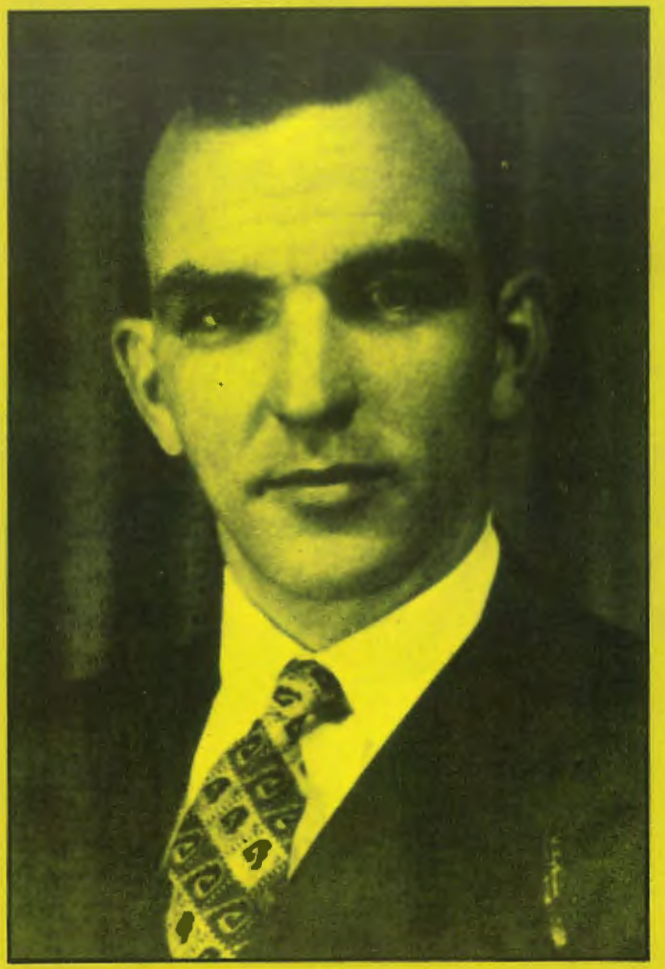
1925-1929 Drs F Meyer and P N Lategan, on returning from post-graduate studies abroad, propagate the concept of "fuel research" by the work they do and the reports they submit to the coal industry and the Government. These two men can justifiably be regarded as the fathers of the Fuel Research Institute.

1930

The Fuel Research Institute is established by promulgation of the Fuel Research Institute and Coal Act (Act 36 of 1930). The first Board, consisting of the Chairman, Dr J S van der Lingen, and four members, is appointed on the 17th of October, 1930, and meets for the first time on the 27th of the month.

1931

The first Director, Dr T E W Schumann, assumes office on the 1st of June, 1931. Initially, technical and research work is conducted in laboratories at the Universities of Pretoria and the Witwatersrand. The administrative section is housed in offices leased in central Pretoria.



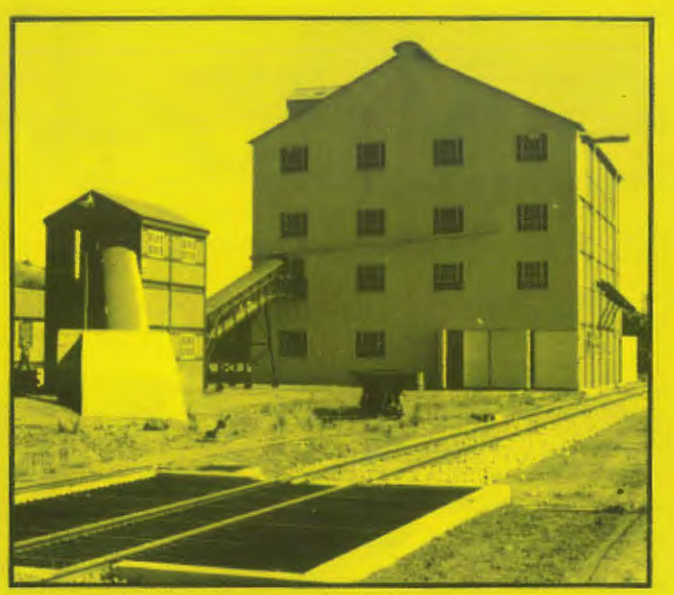
Dr T E W Schumann, First Director of the Fuel Research Institute.

1932 Construction of the first builiding complex at Lynnwood Road starts in the middle of 1932; the building is ready for occupation at the beginning of 1933.

1935 The City Council of Pretoria makes available a 4 ha site in Pretoria West for large-scale pilot plant operations.

1948 Active coking coal research necessitates the construction of an electrically heated pilot coke oven at the Lynnwood Road site. This facility is later to be replaced by gas heated ovens in Pretoria West.

1955 Generous financial support from Iscor, the coal industry and suppliers of equipment enables the erection of a versatile coal preparation pilot plant.



1957 The Coal Preparation Pilot is officially opened by the Minister of Economic Affairs on the 10th of June. An experimental boiler plant is erected in the course of the year.

1958 The construction of two gas heated pilot coke ovens with ancillary equipment is undertaken at the Coal Preparation Pilot Plant. These facilities are officially inaugurated by the Chairman of the Board, Dr B Gaigher, in February 1960.

1960 A colliery disaster early in the year leads to the establishment of the Coal Mining Research Controlling Council, on which the Government Mining Engineer, the Coal Industry, the CSIR and the Fuel Research Board are represented.

1969 A start is made with the construction of the Salem-Brosius rotary carbonizer (pancake oven) and the modernized briquetting facilities, complete with their structures and housing. The work is finalized in 1971.

1976 Important extensions are made to the dense medium coal washing facilities to initiate investigations into the beneficiation of minus 0,5 mm coal fines by dense medium cyclone.

Laboratories are established at Richards Bay to analyse samples of all coal exported through the terminal.

1979 Coal production in South Africa exceeds 100 million metric tons per annum.

1980 Responsibility for the South African Fuel Research Institute is transferred to the Council for Scientific and Industrial Research, with effect from January 1980.

Chairmen of the Fuel Research Board

DR J S VAN DER LINGEN
1930-1940

DR S H HAUGHTON
1940-1949

DR F J DE VILLIERS
1949-1958

DR B GAIGHER
1958-1974

DR A J PETRICK
1974-1977

MR H R P A KOTZENBERG
1977-1978

MR C F SCHEEPERS
1978-1980

DR J F KEMP
1980-

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