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April 1988

Development and Improvement of Purification Preparation and Gasification Processes for use of Chilean Coal

DG/CHI/87/015/11-01

Republic of Chile

Prepared for the Government of Chile
by the United Nations Industrial Development Organization
acting as executing agency for the United Nations Development Programme

Based on the work of Professor Dr. Karl Heinrich van Heek
Chief Technical Adviser
(Coal Gasification and Related Technologies)

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Vienna

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Summary

From March 8 to 15 I have visited INTEC, Santiago de Chile and the University of Concepcion, Department of Chemical Engineering as Chief Technical Adviser of the UNDP funded project "Washing and Gasification of Chilean Coal". The project has just been started and shall be carried out over 4 years. The programme of the work is subdivided into 8 subtasks, which can be summarized into the three groups:

A: Washing of the raw coal and briquetting of the fines, including 3 subtasks

B: Gasification of coal, including 4 subtasks

C: Development of expertise in coal, including one subtask. This is general aim achieved by doing the project work, providing information by seminars and workshops and documentation of all facts and results.

The project work will be done mainly by the University of Concepcion (U.C.), Department of Chemical Engineering, one of its Professors, Dr. Gordon, being the National Project Director and a national research development institute INTEC, Santiago. Close cooperation is planned with the Compania de Gas in Concepcion and two coal mining companies. This cooperation is of high value for the future project work. The research is done to solve practical problems and the acceptance of the results by the relevant industry is high.

The tasks according to A will exclusively be executed at INTEC. The laboratory has performed projects in coal since more than 10 years. From these but also from its knowledge in ore treatment it is well equipped with respect to the project work. The objectives of the work programme are realistic and the results expected of high value for practice as they form a basis for the design of washing and briquetting equipment to be installed at the mines. The goals of the work seem also be achievable. At least for the time being no changes in the formulation of the aims are necessary. A visit of an expert in 1988 is desirable to provide the Institute with the latest technical status of coal washing equipment including an assessment of their practical performance. Also the study tour will concentrate to that subject.

Gasification work according to B will be done at the Department of Engineering of the U.C. in close cooperation with the Compania de Gas. The Department deals with coal analysis since a long time, gasification work started in 1984. It is quite well equipped with a bench scale gasifier, laboratory devices for kinetic studies and the coal analysis laboratory. Moreover, it has developed first versions of computer models describing the gasifier. Also in this field the objections of work plan are realistic and the results can be of high value to improve the gasification process as used in the country. The outputs expected seem to be equally achievable. An expert on gasification kinetics will visit U.C. in August 1988, a study tour to W. Europe is recommended for the National Project Director and a colleague to get information on the topics of task B.

The work programmes both of A and B have been discussed with the Chilean colleagues in all details, and we have agreed on some smaller changes or different emphasis of aspects as it is described in the text underneath.

Finally I have taken part in the meeting of the Technical Coordination Committee and explained there my findings and the results of the discussion of the work.

I wish to express my sincere thanks to Prof. Dr. Gordon, the National Project Director, Dr. Noriega, INTEC and all Chilean colleagues for the open information and the free discussion of background, status and future work of the project. The friendly atmosphere, the kind hospitality and the manifold assistance during my stay are very much appreciated.

1. TIME TABLE OF THE MISSION

- March 1988 -

Date	Day	Action
5/7	Sat-Mon	Travel to Santiago de Chile
8	Tue	**morning:** Briefing with the UNDP office: Mrs. E. Nielsen A.L. Gordon, Nat. Proj. Dir. J.G. Noriega, Group Head for Coal Research, INTEC - Discussion and agreement on the general programme of my visit - Organisation of the visit **afternoon:** Visit to INTEC (Project Partner) A.L. Gordon J.G. Noriega C. Molina - Overview over activities - Visit to the Laboratories relevant for the project work
9	Wed	**morning:** Briefing with UNDP Office - organisation of the visit INTEC J. Noriega, A. Gordon - information about coal in Chile **afternoon:** INTEC - Information about coal in Chile - Information about the project (general) - Detailed discussion of the subtasks on coal cleaning

10 Thur

morning:

INTEC

- Discussion of subtasks on coal cleaning (continued)
- Experts and training programme on coal cleaning

afternoon:

INTEC

- Briefing with
  Mrs. M.A. Moreno,
  Director de Comercializacion

Travel to Concepcion

11 Fri

morning:

Visit to the Laboratories of the University of Concepcion
A. Gordon, J. Pares, R. Reich,
D. Klattenhoff, B. Gorrini

afternoon:

Discussion and evaluation of subprojects on gasification
A. Gordon, J. Pares

12 Sat

morning:

Discussion and evaluation of subprojects on gasification
A. Gordon, J. Pares

Discussion and agreement on experts and study tours
A. Gordon

13 Sun

afternoon:

Discussion on experts and study - Gasification and general
A. Gordon

14	Mon	morning:
		Visit of the gasification plant R. Figueroa, Comp. de Gas J.C. Wulf, Comp. de Gas A. Gordon, J. Pares, B. Gorrini
		Briefing with L. Yaksic Gen. Manager of Comp. de Gas
		afternoon:
		Seminar on coal gasification at the University
15	Tue	morning:
		Meeting of the Technical Coordination Committee
		afternoon:
		Final discussion with the National Project Director
		Travel to Santiago
16/18	Wed/Fri	morning/afternoon:
		Travel to Essen via Bogota

2. SITUATION OF COAL RESERVES AND PRODUCTION IN CHILE

All coal reserves and production areas are found in the South of Chile, whereas the consumers concentrate more in the Northern territores in the region of Santiago. The total production is about 2,5 Mio t/year which covers about 12 % of the total primary energy. The general aim of energy policy in Chile and thereby also of the project is to replace oil by coal.

The coal is mainly high volatile bituminous and subbituminous, the latter having ash contents up to 20 %. The quality improves from South to North. Thus they are in general suitable for combustion, gasification and liquefaction, that means for the production of heat (electricity) gas and liquids (fuel and chemical feedstocks). They are not suitable for the production of metallurgical coke. Todays use is in powerstations (1/3) and in industries and mining of metal ores (2/3).

A typical coal price would be US $ 65/ton for a bituminous one and US $ 57/ton (6000 kcal/kg) for subbitiuminous.

Politically (geographically) Chile is devided into 12 regions counting from North to South. Coal is found and produced in the 8th, 10th and 12th region. A comprehensive overview over the information I received is given in the table (next page).

Table 1: Reserves Production and Characteristics of Chilean Coal

Region	8.	10.	12.
Distance to Santiago km	500	850 - 900	3000
Situation of mining	- traditional mining area - deep mining (700-900 m) - 4 "big" mines - total production 1.3 Mio t/year	- mining started 10 years ago - underground mining (30-80 m) - 2 small mines - total production: 0.1 Mio t/year	- mining since 1987 - open cast mining - 1 mine - total production: 1.1 Mio t/year
Reserves Mio t	300 (known)	20 (known) 2,500 (inferred)	800 (known) 5,000 (inferred)
Coal type	h. v. bit. A	subbit. A	subbit. A + B - bitum. C
Analysis			
vol. matter % d.a.f.	42 - 50	40 - 45	40 - 50
ash % raw	6 - 7	10 - 13	16 - 20
water % raw	1 - 3	14 - 16	18 - 20
C	80 - 82	75 - 77	70 - 75
O % d.a.f.	10 - 13	16 - 17	18 - 22
H	5.5 - 6.2	4.7 - 5.2	4.8 - 5.5
S % raw	1 - 4	0.6 - 1.5	0.4 - 3
Cal value kcal/kg d.a.f.	7,700 - 8,000	6,700 - 7,200	6,200 - 7,000
Ash fusion characteristics			
°C ox.	1250/1310/1450	1350/1450/< 1500	
red.	1050/1120/1200	1250/1350/1400	

Very important for the future production are the 12th region and the just opened PECKET mine. It belongs to the Company COCAR from which 45 % are hold by COPEC (Chilean Oil Comp.), 10 % by the World Bank, 36 % by ULTRA GAS (Chil. Gas) and 9 % by the British North Strip Mining Comp.

3. GENERAL OVERVIEW OVER THE PROJECT

3.1 Programme and Organisation

Under the general title

Washing and Gasification
of Chilean Coals

the project work shall be performed in the following sub-tasks:

1. Washing of Coal
2. Briquetting of Coal fines
3. Simulation and evaluation washing processes
4. Optimisation of the gasification process
5. Improvement of gas quality
6. Characterisation of coal with respect to gasification by reactivity tests
7. Modelling and simulation of the gasifier
8. Establishment of a group of experts in coal conversion

Thus it really splits up into the 3 groups:

A: Washing and Briquetting including subtasks 1 to 3

B: Gasification including subtasks 4 to 7

C: Development of Expertise in Coal, subtask 8 as a general result of the work performed in A and B.

A and B are independent from each other, although there are interconnections concerning the exchange of coal samples and relevant analysis data and the assessment of preparation with respect to gasification.

The work according to A will exclusively be done by INTEC and of B by the University of Concepcion both in cooperation with the Chilean industry (Table 2).

Project duration: 4 years (1988 - 1991)

Total funds: US $ 428.000

UNDP Founds: US $ 230.000

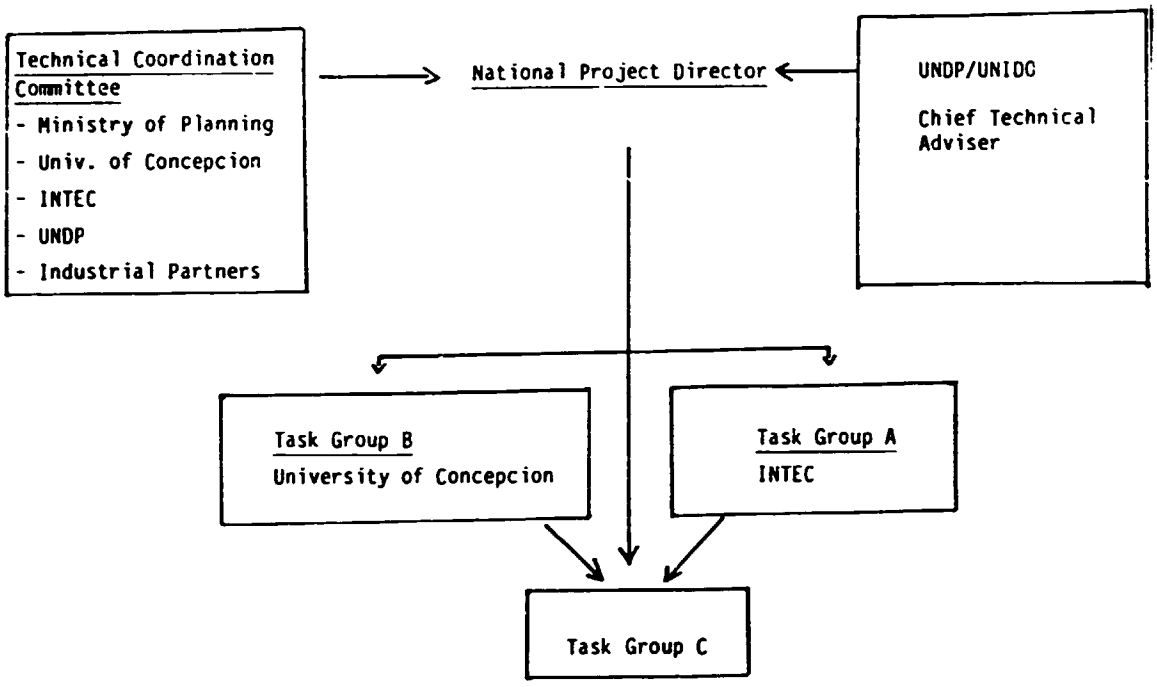
Chilean Founds: US $ 198.000

Table 2: Overview over the Project

Task group	A	B
Project partner	INTEC Santiago	University de Concepcion
Industrial partners	COCAR (12. Reg) Comp. Minera la Union (10. Reg) Carbonifera Schwager (8. Reg)	Comp. de Gas de Concepcion
Share of Funds %	40	60

The kind of cooperation and the coordination of the work was discussed briefly. Both will be performed along the lines of the organigram in Table 3. There will be annual reports in Spanish. It was agreed that an extended summary would be necessary for the information of the CTA. This will also be useful to inform experts from non-Spanish speaking countries.

Table 3: Organigramme



3.2 Information about the project partners

3.2.1 INTEC

General: INTEC is an organisation belonging to the National Development Corporation (CORFO) under the Ministry of Economics. The Institute employs about 120 persons, 45 to 50 of which with an academic degree and in addition about 100 persons with a time limited contract. The total is about 2 Mio US $/year and financing is done 100 % by contract work.

The institute covers a wide range of work in several departments such as electronics, environmental pollution, fruit treatment, metallurgy etc.

In charge of the project work is the Department of "Chemistry and Extractive Metallurgy", headed by C. Molina, the head of the coal group is I.G. Noriega, who is also in charge of the project work according to A. The group consists of 6 to 12 coworkers, other departments can be employed in the work if necessary.

Relevant installations and equipments:
The laboratory has performed projects in coal since 12 years and cooperated with institutions in the USA and in the F.R. of Germany (Bergbau-Forschung). From these but also from projects in mineral ore treatment it is well equipped with respect of the project work. The following laboratories and installations have been shown to me:

1. Coal characterisation
   - proximate analysis
   - ultimate analysis S, C, H (Leco); C,H (Heräus)
   - calorific value (Parr)

2. Coal petrography
   - automatic maceral analysis

3. General analytics
   - trace elemtents (AAS, Perkin Elmer)
   - gaschromatography (Varian, Perkin Elmer)

4. Coking tests
   - plasto-, dilatometer
   - Fischer assay including gas analysis

5. Coal preparation (washing, cleaning)
   - machines for crushing, milling, pulverisation and sieving of coal
     (10 - 200 kg coal/h)
   - hardgrove machine
   - separation devices like
     * spirals (commercial size)
     * cone and table concentrators
     * apparatus to characterise washability

6. Computer center
   Personal computers and terminals

7. Library and information center

3.2.2 University of Concepcion

General: The University has all faculties and is teaching about 10,000 students. It is located on a campus, so that the disciplines easily can cooperate with each other. This

is of importance for the performance of the Project where the Dep. of Chem. Engineering might look for support - know-how, manpower, scientific knowledge and apparatus - from the Dep. of Chemistry or Geology. Among the laboratories listed below I have visited the groups dealing with catalysis, organic chemistry, electronmicroscopy and others.

Relevant installations and equipment:

The Dep. of Chem. Engineering has a long tradition in coal analysis, which is done to the usual standards since 40 years. The Nat. Proj. Dir. holds a PhD in coal combustion. After some research in fluidized coal combustion, the Department started in 1984 to deal with gasification. The main incentive has been to work in a field relevant to the needs of the Nation and - moreover - of the gasworks of the city of Concepcion. Its gas production is based on the gasification of local coal (see 3.2.3). The interaction with industry, which is interested that research is done into the solution of their problems is highly appreciated.

The following laboratories and installations have been visited:

1. Bench scale gasifier - afterwards called "Pilot Plant" - for gasification of coal
   (1 bar; fixed bed; 3 kg coal/h; gasifying agent: air, steam and relevant mixtures)

2. Laboratory for kinetic studies and reactivity measurements
   - thermobalance (Kahn)
   - gaschromatography (Hach; Gow Mac)

3. Coal analysis laboratory

4. Small "combined bed" gasifier
   3 kg coal/h (not foreseen to be used in the project)

3.2.3 Industrial partners

From the industrial partners of the project as mentioned in 3.1 I have visited the Gas Works of Concepcion (Compania de Gas de Concepcion). The company is operating a plant for the conversion of local coal into gas, which is used in the city of Concepcion. The total capacity is 115 t of coal per day, corresponding to a gas production of 160,000 m^3/day

(3100 kcal/m^3). - The plant has been built by the French Company GAS INTEGRAL a subsidiary of the Austrian GAS INTEGRAL and was commissioned in 1985/86.

The gas production consists of two gasifiers which are operated at 1 bar. The conversion of the coal is done basically in 2 cycles:

- combustion of coal by air thereby heating the bed of the coke formed ("blast phase")
- gasification of the coke by steam streaming upwords through the bed and gasification by steam streaming downwards ("water gas phase")

Processes like this had been developed in W. Europe long time ago and been built and operated even in the 50ties, however not operated during the last say 25 years, when natural gas entered the market. Therefore practical knowledge got lost and had to be build up in Chile. Moreover, it had to be taken into account that the Chilean coal used showed other gasification characteristics as expected.

Even if the plant is doing quite well still improvements are necessary which concern:

- a better gasification efficiency of the gasifier,
- higher heating value of the gas,
- improved processes for the gas cleaning,
- environmental acceptibility.

It is of great value for the project, that the managers are research oriented and have great interest in a further development of their process. Thus the acceptance of results of laboratory-work and reactor modeling by the industrial partner is high.

4. WORK PROGRAMME ACCORDING TO TASK-GROUP A: WASHING AND BRIQUETTING

In coal technology the term "washing" is used for the physical removal of the inert material (minerals) mixed with the organic part of the coal in different degrees of inter-

growth. In this sense also the expression "cleaning" (depuracion) has the same meaning. - The problems of the mines in the 10. and 12. regions arise from the relatively high ash content of the coal. For the time being they are not equipped with preparation (washing) plants. A basis for the design depending on the coal characteristics relevant for this is to be established in the project. In the 8. region the main problem is to convert the coal fines into useful products. According to the project plan the following subtasks are to be performed:

4.1 Task 1: Washing of Coal

1.1 Selecting of samples of 1 ton each from seams in the 10. and 12. region, this includes visits to the mines and a thorough discussion with the geologists and miners to get reliable and representative samples. - My recommendation is, that these samples could well be included in some test performed in B especially in subtask 6.

1.2 Sampling of coal fines from 8. region.

1.3 Physical, chemical and petrographical analysis and technological characterisation of the samples.

1.4 Washing tests with 3 samples (according to 1.1 and 1.2) and 3 sizes (each)

1.5 Characterisations of the fractions (10 fractions i.e. in total 90 samples)

1.6 Composite samples due to market requirements and standards.

4.2 Task 2: Briquetting of Fines

2.1 Selection of fines and briquetting
- 2 samples, one of this will be of 8th region (1.2) and one from 12th region
- briquetting with a pitch binder

2.2 Characterisation of the briquettes
- Stability
- Ash, S, cal. value

2.3 Manufacture of larger samples (50 kg) to test performance in processes like gasification.

4.3 Task 3: Simulation and evaluation of washing processes

3.1 Selection of processes to be examined

3.2 Development and utilisation of a computer program for the selection of equipment and for the establishment of flow-sheets.

3.3 Establishment of flowsheets

3.4 Economic assessment of the alternatives

3.5 General feasibility of processes

3.6 Establishment of a manual to describe operations, equipment and procedures for future cleaning studies.

4.4 Experts and study tour

It was agreed that knowledge from outside is not necessary for task 1 and 2. However, as the performance of 3 should base on the latest technology, information has to be provided in

- apparatus and machines,
- their industrial performance and other experiences,
- manufacturing companies and
- costs.

For this purpose an expert should visit INTEC at the end of 1988 to discuss the needs and tasks. Thereby he also would assist to prepare a study tour - possibly of Dr. Noriega - to institutions and companies to complete the information.

To find this expert I will make suggestions after my return to Germany. Ideally it would either be an university professor, practically orientated and with good connections to the preparation industry or a member of an industrial research institute like Bergbau-Forschung. In any case it should be assured that he is in the position to consult free of a specific company.

The descisions about the two other experts, for which provision is made in the proposal (computer simulation and assessment of results from 3.3 - 3.6) can be made lateron.

5. WORK PROGRAMME ACCORDING TO TASK GROUP B: GASIFICATION

As mentioned before the work performed is directed to improve the operation and the efficiency of the gasification process used in the Gas Work of Concepcion. This mainly shall be achieved by experiments in the pilot plant and measurements in the industrial plant to get data on coal throughput and gas yields, experiments in laboratory scale to improve gas quality and the establishment of reliable kinetic data to be used in reactor modeling.

5.1 Task 4: Optimisation of the gasification process

4.1 Preparation of experiments in the pilot plant and of measurements in the industrial plant. This covers mainly the assessment of the possible variables which have importance for the gasifier. It can be done from the know-how available and using the existing computer model (see also 5.4). The most important are: kind of coal, flow of air, ratio of air and steam in the total cycle constroling the heat balance (heat consumed and heat produced).

4.2 Operation of the pilot plant and measurements in the industrial plant. The coals for the experiments in the pilot plant will be selected under the view points:

- same kind as used in the industrial gasifier
- coals from regions 10 and 12 which eventually will be used also in the industrial gasifier lateron and
- briquettes from INTEC

In the proposal main emphasis is given to such results, which are necessary to establish heat and mass balances and which lead to a maximisation of the gas yield. It has been discussed, that the realibility of the data could be improved, if more efforts are made to a better measurement of the tars. I have recommended to consider a replacement of the washing system in the pilot plant by

- an indirect cooling of raw gas to condensate the tar or
- an electrostatic precipitator.

Also for a selected number of runs a complete gas analysis including the higher hydrocarbons is useful. Furtheron, it was discussed that more emphasis should be given to aspects of gas cleaning and environmental protection of the gasification process. That means that the Dept. of Chem. Eng. should consider to

- analyse and characterise the plant effluents in order to have data available for waste water treatment;
- determine the amounts of H_2S and SO_2 in the different phases of the process as a basis for gas cleaning;
- characterise the tars with respect to their conversion into gas (as described in 5.2) or their utilisation as chemical feedstock after upgrading. For the latter aspects assistance could be given by the Dep. of Chemistry at the University or Institutes abroad like Bergbau-Forschung.

On the whole we have agreed to the principle that a thorough evaluation of the pilot plant experiments should be given priority to just a high number of runs.

4.3 Assessment of the results with Chilean industrial partners and outside experts. This will mainly done at meetings to which the University invites, but also on the basis of report and studies.

4.4 Documentations of the results. This task is very important as the documents could also be a basis if the process will be licensed in Chile or abroad.

5.2 Task 5: Improvement of gas quality

This task concerns mainly two aims:

- The improvement of the heating value of the gas, which now is done by "carburation" that means adding of propane to the gas. That is a standard measure to bring gasifier gas up to coke oven gas quality, where the grid is made for. In the gasification reactor it could only be achieved by increasing the amount of CH_4. Due to the state of the art this can only be done by rising pressure considerably to say 25 bar. There are no catalysts known to increase CH_4

formation during gasification under the conditions of the process.

- Conversion of the tars into gas, which has the advantage that the gas yield can be increased. Whether the CH_4-content can be increased considerably is at least doubtful.

5.1 Kinetics of CH_4 formation during gasification

Measurements shall be performed in the existing TG apparatus (Kahn balance) combined with a GC, simulating the CH_4 formation at different stages in the reactor. From the results perhaps measures can be derived to marginal increase of CH_4 formation.

5.2 Construction of bench scale reactor for investigation of partial methanation of the product gases

Methanation of CO and H_2 containing gases under pressure up to say 40 bar using a Nickel catalyst is state of the art. It is doubtful whether a success can be achieved under the pressure of the process of 1 bar among others for reasons of thermodynamics. Therfore it was agreed to proceed in the following steps:

- Definition of the conditions of the process especially quality of feed and product gases
- Study of the literature, whether new types of catalysts would allow a better performance of a partial methanation under the process conditions.
- Discussion with experts during a study tour.

After all that a decision whether or not to go on with construction of the apparatus and experiments

5.3 Catalytic and/or non-catalytic gasification of tar

As this is a general problem for all fixed bed gasifiers and also for coking processes in cases where tar is not a desired by-product, there exists a lot of information about possible processes in the literature. It is shown thereby, that a cracking of such tars is possible e.g. in beds of hot coke or char, in the presence of steam or product gases. As a preparation for further experimental work in the Project I recommended to proceed in steps:

- Assessment of the results on tar characterisation as suggested in task 4.2
- Assessment of the results of a Ph.D. study presently performed by a co-worker of Prof. Gordon in Germany under a DAAD-programme studying the behavior of model compounds
- Assessment of knowledge in literature and information received on a study tour
- Definition of conditions for a tar cracking process for the industrial plant

5.4 Discussion of results with experts

5.3 **Task 6: Characterisation of Coal with respect to gasification by reactivity tests.**

This task has the main objective to provide a reliable method to compare coals according to their relative reactivity. Moreover, it provides kinetic data which are needed f - the simulation of the gasification reactor by computer mc s.

6.1 Gravimetric measurement of reactivity of chars derived from different coals, against O_2, CO_2, H_2O and relevant mixtures

Measurements will be carried out in the existing balance at 1 bar under isothermal conditions whereby in the heating-up phase the reactor is flown through by inert gas.

It has to be taken into account that the chars investigated have the same qualities as those formed during the process in the reactor. Therefore it was discussed, that the following steps could be helpful to achieve a reliable basis:

- Investigation of chars formed in an oven under N_2 (standard laboratory procedure)
- Investigation of chars taken from different locations in the pilot plant after quenching of the reactor
- Comparison of the results and assessment whether the easier laboratory preparation of the char meets the conditions in the reactor or to what extent the values measured for the "laboratory char" have to be corrected to get "effective reactivity values" for modeling.

6.2 Determination of total and active surface area of the chars

This is done by standard methods measuring CO_2 adsorption and O_2 Adsorption at 100 °C.

6.3 Determination of kinetic parameters of the chars to be utilized for computer simulation of the gasifier

Generally thereby have to be considered

- the reaction rates against the single pure gases present in the gasifier
- the inhitition of the rates by the product gases
- the change (decrease) of the rates during conversion.

To bring all these dependencies into the computer programme may be at least in a first approach too complicated but could be taken into account by a correction factor. However, the knowledge of all these facts is necessary to get a feeling for the reliability of the computer simulation especially if it describes not the gasifier behaviour in a first approach.

6.4 Discussion of the results with experts

5.4 **Task 7: Simulation of the gasifier**

The Department of Chem. Engineering has already developed models describing

- moving bed, continously operating gasifier
- moving bed, cyclic operating gasifier

These models which are presently operated are a very good basis for the further subtasks.

7.1 Improvement of the models e.g. in a better reflection of the kinetics as discussed above

7.2 Information about experimental data from the industrial plant for comparison

7.3 Comparison of the industrial plant data with the results of the model

7.4 Assessment of the predictive ability of the models and of the validity and precision of the experimental data

7.5 Discussion of the results with experts

7.6 Possible reformulation of the model and/or improvement and completion of the experimental data from the industrial plant.

5.5 Experts and study tours for gasification

Provisions have been made in the project for 3 experts consulting an

- gasification kinetics
- operation and equipment of industrial gasifiers
- treatment of the tars by cracking or upgrading into chemical feedstocks

For the first topic Prof. Radovic from Pennsylvania State University, USA, is considered to visit the University in August 1988. He is a well known scientist in this field, can speak Spanish and is well suited for this job.

For the second topic an expert should be selected, aquainted with the operation of fixed bed gasifiers and/or with special knowledge of measuring equipment for gasification. Possible organisations which could provide such a person are

- Brennstoff Institut, Freiberg, German Democratic Republic, performing research and development for the fixed bed pressurized gasifiers
- Fuel research Institute, Bechovice, CSSR, also supporting the gas industry in the CSSR by research and development and having practical knowledge in the operation of fixed bed gasifiers
- British Gas (Lurgi), United Kingdom, which have a research center for the Lurgi type gasifier
- Bergbau-Forschung, Essen, F.R. of Germany, which mainly could help in the measuring systems.

As the visit of this expert in foreseen in 1989 the decision can be made lateron also taking into account the information gathered at the study tour.

The expert on the third topic, tar processing, is expected to visit Concepcion after 1989. Thus a decision on this also must not be taken now. The topic should be discussed with the expert on operation and during the study tour. An ideal person could be a professor of an university with a good sense for industrial applications.

A study tour of the Nat. Project Director has been discussed. Information has to be sought for the following topics:

1. Kinetics of gasification and related reactions like combustion and pyrolysis
2. Tar gasification (cracking) or upgrading into chemicals
3. Fixed bed gasifier operation
4. Gasification process instrumentation
5. General informations on gasification and coal conversion
6. Gas improvement by methanation
7. Reactor modeling

A study tour to Europe should include institutions or companies as listed below and I could help in making the arrangements.

Institution/Company	Topics/Remarks
Fed. Rep. of Germany	1, 2, 4, 5, 6, 7
- Bergbau-Forschung GmbH Franz-Fischer-Weg 61 D/4300 Essen 13	
- Universität Karlsruhe Lehrstuhl für Chemie und Technik Richard-Willstätter-Allee 5 D/7500 Karlsruhe	
* Professor Hedden	1, 2, 6
* Professor Schulz	6
- Universität Karlsruhe Institut für Chemische Technik Kaiserstraße 12 Postfach 63 80 D/7500 Karlsruhe 1	
* Professor Hüttinger	1, 2

- Universität Essen - Gesamthochschule - Postfach 10 34 67 D/4300 Essen 1 * Professor Bandermann * Professor Staude	 6 2
- Universität Bochum Universitätsstraße 150 D/4630 Bochum 1 * Professor Baerns	 2
- Rheinische Braunkohlenwerke AG Postfach 41 08 40 D/5000 Köln 41	5 (Winkler gasifier in operation)
- Ruhrkohle, Oel und Gas GmbH Gleiwitzer Platz 3 Postfach 6 40 4250 Bottrop	5 (Texaco gasifier in operation)
- Hüls Aktiengesellschaft Postfach 13 20 D/4379 Marl	5
CSSR	
- Brennstoff-Forschungsinstitut Prag-Bechovice 250 97 Praha 9 CSSR	2, 3, 5, 7
German Dem. Republic	
- Brennstoff-Institut Freiberg DDR-9200 Freiberg	2, 3, 5, 7 (similar to Prag)
United Kingdom	
- British Gas Corporation Research & Development Division Midland Research Station Wharf Lane, Solihull West Midlands B91 2 JW Great Britain	2, 3, 4, 6, 7
- British Coal Corporation Coal Research Establishment Stoke Orchard Cheltenham Glos. GL52 4RZ Great Britain	2, 3, 4, 5
Netherlands	
- University of Amsterdam Nieuwe Achtergracht 166 NL/1018 WV Amsterdam * Professor Moulijn	1, 6

If the tour is made in September 1988 the attendence of the Carbon Conference in Newcastle (UK) (Sept. 19th to 23rd, 1988) could be included. Contributions to this conference

deal with gasification kinetics, reactivities, surface measurements etc.

It should also be considered, whether the tour should be made by Prof. Gordon together with Prof. Pares, who is responsible for the pilot plant and the measurements at the industrial plant.

As Prof. Gordon besides being the Nat. Project Director is directly in charge of the work on gasification kinetics and modeling he plans a visit to Pennsylvania State University, USA (Prof. Radovich) in May 1988. The objectives will mainly be gasification kinetics. Moreover, some institutions which are doing research and development in gasification will be visited. Also this trip can be recommended.

6. WORKPROGRAM ACCORDING TO TASKGROUP C

Task 8: Formation of a group of Experts

8.1 Visit from experts and study tours of the partner and Chilean industry to centers which are well known in subjects of the project (as discussed in 4.4 and 5.5).

8.2 Documentation about coal and processes.

8.3 Seminars and workshops together with possible users of processes and developed technology.

7. MEETING OF THE TECHNICAL COORDINATION COMMITTEE

The meeting took place on March 15, 1988 at the University of Concepcion. It was attended by representatives of UNDP office in Santiago, the University of Concepcion, INTEC, the Ministry of Economics and the industrial partners as follows:

Name	Organization
Evelyn Nielsen	Programa De Las Naciones UNIDAS PARA EL DESARROLLO Santiago
Estela Singh	Programa De Las Naciones UNIDAS PARA EL DESARROLLO Santiago
K.H. van Heek	CTA, UNIDO Bergbau-Forschung GmbH Essen
A.L. Gordon	Universitario de Concepcion Concepcion Chile
J.G. Noriega	INTEC Santiago de Chile
Pedro Courard	Carbonifera Del Sur S.A. Santiago de Chile
Raul Canasco B.	ODEPLAN
Lorenzo Yaksic	Compania de Gas Concepcion de Chile
R. Figueroa J.	Compania de Gas Concepcion de Chile
G. Bobenzietti	Carbonifera Schwager S.A.
Tihomir E. Domic	Compania de Carbones Chile

As to my part, I have given a statement of about 50 minutes explaining my findings and suggestions as it also has been described in this report. In particular I have stressed

- the high value of the close cooperation between University, Research Institute and Industry
- the practical orientation of the project work and the results expected.

I have also expressed my opinion that the project aims are ambitious, that for the moment no major obstacles can be seen why the goals could not be reached, however.