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ENGLISH

COAL GASIFICATION

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INDIA

Technical Report

Mission 4 to 30 November 1985

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ABSTRACT:

After briefing sessions in Vienna and Dehli I helped evaluating and applying kinetic data obtained from gasification runs carried out at the Regional Research Laboratories in Hyderabad. During my stay (11th to 29th November) my main duties as related to the job description included:

- Assistance in the performance of TGA - experiments
- Evaluation of kinetic data obtained in the TGA
- Advice of the RRL - team on theory and methods of coal gasification kinetics
- Preparation of software for further kinetic evaluation
- Advice on the usage of kinetic data for reactor modelling

Status:

While I was stationed at the Regional Research Laboratories, I found that the data collected from runs before my arrival showed discrepancies caused by fluctuations either in the gasifying medium flow rates or temperature course. Other difficulties encountered included nonreproducability of results, inability in evaluating the measured weight-loss curves numerically and determination of the boundary ranges in which the kinetic polynomial equation is valid. Besides these problems, I was very impressed with the way work was being carried out.

Report:

- Apparative changes and improvements:

  Because of the malfunction of the analogy temperature controller due to climatical conditions I replaced it with a digital one. Deviations in the temperature effected changes in the densities of the gasifying media. These changes are

normally corrected by the data acquisition program. In turn density changes effekt changes in the gas flow rates refered to as dynamic bouyancy. Now depending on the mole throughput and apparent pressure these effects may induce weight errors up to 10 mg which corresponds to 10 % of the initial weight of the sample thus rendering data evaluation incorrect. Replacement of the temperature controler proved worthwhile, since weight-loss curves obtained after were more representative of the process.

- Performance of the experiments:

In the case of high ash chars, it is essential to have the correct values of their ash contents and the weight of their residues in order to make the neccessary corrections to the weight-loss curves. Since the RRL - staff had only carried out partial gasification runs, the true ash content could not be determined through the weight of the residue, thus errors in calculating the instantanious carbon weight were experienced. While conducting non-isothermal experiments at temperature around 950 °C and burn-off values of 60 - 70 % the last weight recorded by the computer does not correspond to the weight of the residue. This is so, because carbon conversion also takes place during the lifting/raising of the sample from the hot reaction tube to the cold sample lock. These effects affect the accuracy of the reaction rate calculation and the reproducability.
Errors were also induced by the use of the wrong mesh/wire net for the sample basket. The net used experienced an increase in weight depending on the type of gasifying agent, pressure and temperature. Such errors are incorrectable. However I have managed to secure the correct wire nets which I have already sent to the RRL.

- Improvement of evaluation programs:

With the assistance of Mr. Prasad who is responsible for the experimental data evaluation at the RRL, I wrote a computer

program that enables the calculation of Arrhenius parameters at different pressures; these parameters are necessary in the modelling of technical reactors. It is now possible to determine these in different temperatures ranges for different reaction rate definitions. Because of the insufficient knowledge in computer programming at the RRL, I also took time to show Mr. Prasd the basics.
Furthermore I installed several smaller programs.

- Sorting the experimental results. Now the RRL team has the ability of getting lists where the experimental conditions are written in order of the partial pressures of the gasifying agents and of the temperatures if the mode of the run is isothermal. For each run values of the reactivity as function of temperature or burnoff are alsc printed. These list enable the evaluator to decide quickly whether or not there have been any mistakes during the run. The second feature of the program is the storage of specified run data in single files which can be read by other programs for further evaluation.

- Correction of disturbed weight loss curves.
  Fluctuations experienced in weight loss curves can now be smoothed by linear interpolation between boundaries of choice. Such a step is absolutely necessary if one needs to obtain the correct weight signals.

The main thrust of my work was the implementation of a non-linear regression analysis in calculating reaction rate constants as they appear in the normal or extended Langmuir-Hinshelwood expressions. The latter are needed to describe the inhibiting effects of single or combined product gases such as H_2 and/or CO. Luckily I had the program written before, so no time was spent in writing another one and I could use the time to make Mr. Prasad familiar with this special kind of evaluation.

Lectures:

I also managed to hold two lectures each lasting about two hours on (1) the influences of the different physical and chemi-

cal properties of the coals or chars on reactivity e.g. mineral matter, porosity, inner surface areas, accessebility of the gasifying agents and pyrolysis conditions as heat treatment temperature, soak time, heating rate and gas atmosphere. (2) the influences of product hydrogen and carbon monoxide on the reaction rate in steam and carbon dioxide, respectively. The dependence of the reaction rate on the degree of carbon conversion as a function of temperature and pressure was discussed.

Further programs:

We agreed on the future research work should be divided into two sections.

(1) Investigation of gasification kinetics using a high ash indian coal. The work should encompass the dependence of reaction rates on temperature, pressure, gas atmosphere and burn-off.

(2) Investigation of the influences of the mineral matter e.g. catalytic effects and the possibility of gasification rate inhibition due to the blocking of pores thus leading to the reduction of the accessibility to the reactant gases.

Recommendations:

In my opinion, indian scientists have made a remarkable progress as far as the handling of the TGA is concerned and are capable to evaluate the measured data correctly. However I would recommend that after one year another expert should visit the RRL team for further improvement in the evaluation of data and in the interpretation of the results.