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FUEL RESEARCH IN INDIA

THE establishment of a Board of Scientific and Industrial Research for India and the appointment by it of a Fuel Research Committee has brought more prominently to the fore the question of the establishment of a Fuel Research Department or Station in India. It is too early to say whether we may confidently look forward to the establishment of a separate Department but we may reasonably hope that a start will at least be made on organized research. In this matter of fuel research India lags behind nearly all other important countries of the world and particularly behind her chief competitor in the field of fuel, namely South Africa. The establishment in that country of a Fuel Research Institute by utilising the accumulated funds of the formerly-existing Coal Grading Board should be of special interest to those concerned in this very important matter. The Committee that has been formed in India will

presumably have to consider what schemes should be recommended for adoption by the existing workers or should form the basis of the work to be undertaken in the early stages by any Fuel Research Department that may be established.

Fuel research presents to the scientist a remarkably and temptingly wide field for investigation. The problems are manifold and cover such a wide variety of subjects that there is considerable risk of too many problems being tackled at one time, with consequent lack of co-ordination in the earlier stages and the necessity for later repeating of much of the work. Many important problems can have a considerable amount of light thrown on them by the investigations that have been and still are being carried out in other countries possessing greater resources than India. Some of the work that faces us cannot, however, be conveniently disposed off by mere reference to

and inference from the results of workers in other countries. It appears to the present writer that owing to the possibly limited finances of the Committee or of any body appointed as the result of its deliberations, only the important fundamentals should be tackled at present.

The present writer is particularly interested in coal utilisation research. His interest is not such as to exclude serious attention being given to utilisation of other fuels in India, but the problems facing the coal industry at the present time appear to him of such importance as to merit very early attention. The following appear to be the important matters requiring investigation, investigation that cannot be carried on without a large amount of practical work in or near the coalfields.

1. Systematic physical and chemical survey of the coals of the various coalfields in India, similar to the survey that has already produced such beneficial results in Great Britain.

2. Laboratory and medium-scale investigations of washability of second grade and low grade coal, and of slack coal of all qualities. (This would be carried out to a large extent along with No. 1 above.)

3. Large-scale briquetting tests, especially with a view to investigate the possibilities of briquetting without the use of a binder.

4. Examination of coking coals, including weakly-coking coals, in respect of swelling and subsequent contraction, with a view to aid experiments in blending.

5. Experiments on blending of coking coals with non-coking coals.

6. Investigation of the possibilities of the extended use of Indian coals, especially low grade coals, in gas producers.

An important section of the work under (1) would be a systematic investigation of the fusibility of coal ashes and a study of clinkering problems,

In addition to this fundamental work it is, in the opinion of the writer, necessary to make an immediate start on a comprehensive survey of the technical literature and the compilation of an exhaustive loose-leaf, or card, index of the bibliography, with liberal cross references, to be retained as a permanent feature in such a manner as to permit all interested scientific workers to benefit by periodical distribution of properly indexed abstracts.

An incidental result—it is to be hoped an early one—would be the devising of a system of valuating Indian coals with a view to encourage still further the purchase and sale of coal on analysis and to specification, with provision for penalties and premia for departure from the terms of specifications.

Another important feature of Section No. 1 would be the carrying out of complete ultimate analyses of all the coals surveyed, in consequence of which it would at least be possible with confidence properly to classify Indian coals according to an internationally accepted system.

It is, in the opinion of the writer, highly desirable that one centre for Fuel Research, mainly concerned with problems relating to the utilisation of coal should ultimately be established in India and that that should be the final aim before the Fuel Research Committee. It is possible, however, that funds will not permit early realisation of that aim. Until it is realised, therefore, it may be desirable to utilise for the time being the services of all competent interested workers, arranging for a central distributing agency to collect samples under proper standard conditions and, after laboratory sampling, distribute them to the different workers, receiving and correlating the results.

In the opinion of the writer the bulk of the work must of necessity be organized by qualified fuel technologists working in or near one of the major coalfields. In the event of an All-India Fuel Research Station

being established, that station should also, in the opinion of the writer, be situated at a place permitting of ready access to the coalfields and personal contact and co-operation with leaders and important men in the coal, coke and steel industries. For some of the work the facilities existing at the various collieries and coke plants in the matter of supply of power, gas for special furnaces, etc., would be of inestimable benefit to the work. Proximity to the coal fields will lessen the risk of inaccurate collection of samples and also facilitate ready correction of mistakes that may from time to time arise.

Another point of importance is that, at least in the opinion of the writer, there is greater necessity for studying the application in practical form of the discoveries of other workers in the field and of the results of their researches than of instituting academic research into highly complicated chemical and physico-chemical problems. The nature of the research work facing the fuel technologist in India is on the whole simple. The fundamental necessity is the gathering together and correlating of the available information and the supplementing of it for the sake of bringing up to date our knowledge of indigenous fuels and of sources of fuels. When we know better than we do at present about our fuels, and of the sources of fuels alternative to coal and oil, we can easily say with reasonable confidence what can be done with them.

As already stated, the above remarks relate more specifically to coal utilisation research. Such fundamentally important matters as low temperature carbonisation, complete gasification of coal, conversion of coal into oil, etc., and even safety in mines research include within their scope other equally important matters not primarily connected with the study of coal itself. Other important spheres of enquiry include

production of industrial alcohol, recovery of methane from sewage, utilisation of gaseous fuels in internal combustion engines, etc. All of these must in due course be taken up by workers in this country. So far as the other fuel problems are concerned much of the work already undertaken could well be continued by the present workers. Where large-scale tests and experiments are found necessary the coalfields will possibly prove to be the most suitable site for such work also. That, however, is a matter that can well be left for discussion with those especially interested. There is little doubt, however, that so far as large-scale tests on coal are concerned the advantages of proximity to the coalfields largely outweigh the advantages offered by other localities. Even in the matter of freight and ease of delivery of large samples there will be a very material advantage. In the coalfields coal costs from Rs. 2 to Rs. 4 per ton and many mining concerns are glad to supply coal free of charge for scientific investigations. Farther afield freight charges greatly exceed the cost of the coal and loading and unloading charges add to the cost.

The disadvantages of situating the centre of this proposed organization near the coalfields include (probably most important of all) the lack of technical literature for consultation. Two important educational institutions exist within reasonable distance of the coalfields, the Indian School of Mines with which the writer has been associated for over thirteen years and the Benares Hindu University. Both of these possess a useful range of technical literature and the nucleus of the equipment required for this work. Whether a Fuel Research Station should ultimately be directly connected with any existing institution, of course, is a matter for discussion. The Coal Mining Committee (1937), without adducing any evidence in support of their recommendation, and

without the matter being discussed, recommended, with respect to the proposed "Coal Research Board", that its staff should be distinct from the staff of any existing institution.

Although the context of the Report would appear to suggest that the Committee had in mind Safety in Mines Research rather than Fuel (Utilisation) Research, yet we may presume that they would have made a similar recommendation in respect of a Fuel or Coal Utilisation Research Board. Without entering into a discussion of the merits of their recommendation we may perhaps accept it as a basis for discussion and say that such a recommendation does not preclude the situation of the station at or near one of the major coalfields and if a decision is ultimately come to in favour of a completely separate new organization its situation close to one of the existing institutions would, in the opinion of the writer, bring great advantages, advantages that cannot be lightly dismissed.

It is natural that the writer should be disposed in favour of the establishment of the proposed research station at or near the institution with the direction of which he is himself concerned. It possesses the important equipment for the work, including crushing, pulverising and sampling equipment, electric and gas muffle furnaces, electric carbonisation furnaces (Lessing and Gray-King), electric combustion furnace, bomb calorimeters, pyrometers, gas analysis apparatus, the usual platinum crucibles and basins, pH value apparatus, etc., etc. It has a good library with valuable files of back numbers of important technical journals including *Fuel*, the journal of the Institute of Fuel, *The Fuel Economist*, *The Colliery Guardian*, *The Mining Magazine* and many other technical periodicals and the *Transactions of the Institution of Mining Engineers* of the Mining, Geological and Metallurgical Institute of India, and of other important

societies, etc., etc., and its staff have for years been steadily acquiring an intimate knowledge of the coals of the two major fields, those of Jharia and Raniganj. Whether or not that staff would actually play any important part in the work that would be undertaken, there is no doubt that they would be ready to co-operate to the full with the staff of the new organisation. There can be little doubt that they (as well as other workers throughout the country) would, at least in the earlier days of the work, take part in it and accept responsibility for the study of certain problems.

The case for the establishment of a fuel utilisation research body (Board, Station, etc.) appears to be somewhat as follows:—

1. Fuel, and especially coal utilisation research is urgently necessary in India for the more efficient development of her resources.
2. The problem is an all-India affair and should not be tackled entirely on provincial lines.
3. The ultimate aim should be the establishment of a completely separate organisation.
4. If funds do not permit of the immediate establishment of a separate central organisation, and even if it should later prove financially possible, some of the investigational work could well be delegated to workers already in the field. But a central organisation for the co-ordination of the work, with safeguards against undue restrictions on the individuality of the research workers, would be a necessity to ensure accurate collection and identification of samples (so far as coal utilisation research is concerned) and correlation of the results.
5. Two general lines of procedure appear to call for immediate action: (a) a comprehensive chemical and physical survey of the important coalfields, as distinct from the geological survey that has already progressed so successfully and profitably and (b) a

bibliographical survey of the subject with special reference to Indian conditions, under a scheme allowing for the dissemination of the results of the survey to all authentic workers, such a survey being continued as a permanent feature.

Finally, the writer would appeal to enthusiastic scientists and quasi-scientists throughout India not to fall into the harmful error of over-stating the case for the development of India's mineral (and other) resources and their dependent industries by the results of scientific research. There is, in his opinion, a regrettable tendency just at present to paint attractive pictures of the wonderful benefits awaiting the country if only research is sponsored, encouraged and financed, a tendency to assure the uninitiated that technical success in scientific research will automatically be followed by wholesale industrial development. The coal by-product question is a case in point. Much loose talk has been allowed to find a place in the press in recent months regarding the storehouse of beautiful dyes, wonderful disease-curing drugs and valuable synthetic resins locked up in a lump of coal. Following upon these articles there have been appeals, mostly genuine and in the best of good faith, to finance this and that research, in many instances such advocated researches being, upon investigation, little more than a repetition or extension of work already excellently and for the most part exhaustively done in other countries and requiring little more than intelligent application by commercial and industrial interests. Such popular writing is an undesirable type of "appealing to the gallery".

In too many instances, it is to be feared, have glowing accounts of the promise given by this and that research been followed by disappointing silence as to the results. The consequence has been to put into the hands of those who have been over-persuaded additional arguments against the encouragement of pure and applied research.

Such a statement is not to be taken as a wholesale stricture on the initiation of research. On the contrary, research should be encouraged and financed to the utmost capacity of the country and the writer himself has, ever since his arrival in the country, pressed most strongly for a sympathetic attitude on the part of government towards research. But we should be honest in this matter and truthfully say that pure research should be encouraged irrespective of any kind of guarantee of profit arising from the results. Research is the life-blood of the scientist and of the educationist and a country that persistently starves its research workers is doomed to remain in the background scientifically, educationally *and industrially*.

But let us be modest and dignified in our claims as scientists, restrained in our self-praise at scientific gatherings and in the press, cautious (outwardly at least) in our optimism, guarding against rushing into print with the ill-digested results of research work, and honestly, quietly and sincerely persistent in effort.

CHARLES FORRESTER.

[NOTE: The opinions expressed in this article are those of the author and are in no way to be considered as emanating from the department in which he serves or having the stamp of official authority.—C.F.]

DAMS AND THE PROBLEM OF MIGRATORY FISHES

BY

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STUDENTS of fish and fisheries in India are no doubt aware that since the sixties of the last century efforts have been made in this country to provide fish passes in the construction of dams so as not to interfere with the migration of the fishes ascending to their breeding grounds and afterwards on their return journey to the feeding grounds or *vice versa*. The available evidence goes to show that fish passes were and are still being constructed by the engineers who may be described as almost wholly ignorant of the habits of the fish that are meant to be saved from possible extermination. For instance, to save the extensive and valuable Hilsa Fisheries, the Government of Madras, at the suggestion of Dr. Francis Day, constructed fish passes, across anicuts, as early as 1869, but these proved ineffective, and after another exhaustive enquiry by Sir F. A. Nicholson in 1909, fish passes as a protective measure for Hilsa were finally abandoned, and for the preservation of the species the proposal for the construction of a Hilsa hatchery at the Lower Anicut on the Coleroon River was adopted instead. In a recent contribution on "Fish Ladders in the Punjab"¹ Dr. Hamid Khan has concluded that

"Most of the fish ladders in the Punjab are ineffective and their main defects are:—(i) the majority of them are too steep and too narrow; (ii) the upstream inlets are generally too severe to allow the smaller species of the migratory fish to ascend; (iii) the downstream openings in most cases are too small, and therefore too inconspicuous to be perceived by the ascending fish, that is to say, the fish ladders are not self-advertising; (iv) there is hardly any pool at the entrance of the ladders where fish could collect before ascending; (v) the water supply in the ladders is not available during the periods when the fish migrate; and finally (vi) the majority of them are not fish ladders but mere fish traps for catching fish.

"The effect of inefficient fish ladders in the Punjab is beginning to be felt in the higher reaches of the rivers and there seems to be no doubt that as a result of it the stock of fish in the Punjab rivers has decreased very considerably during the last fifteen or twenty years."

The effect of placing permanent or semi-permanent weirs across streams on the population of migratory fishes, such as *Mahseer*, was also referred to by Hora and Mukerji²

in the course of their studies on the fish of the Eastern Doons.

It is a matter of considerable interest, therefore, to know that the Western Division of the American Society of Ichthyologists and Herpetologists, and the Western Society of Naturalists jointly held a symposium at the Stanford University on June 29, 1939, under the Chairmanship of Dr. F. B. Summer on "Dams and the Problem of Migratory Fishes". The detailed report of the symposium, which has now been published in a special issue of the *Stanford Ichthyological Bulletin*,³ contains valuable information on all aspects of the problem. It is worthy of special note that all the members taking part in the symposium were, from experience, training and first-hand knowledge of fishes, best able to deal with the problems that were discussed. Dr. Willis H. Rich, who discussed 'Fishery Problems Raised by the Development of Water Resources' is now Professor of Biology at Stanford University and Director of the Department of Research of the Fish Commission of Oregon. Dr. Rich was in charge of the Division of Scientific Inquiry of the U.S. Bureau of Fisheries, 1922–26, and was Chief of the Bureau's Salmon Investigations, 1926–30. During his service with the Bureau, he directed very extensive marking and tagging experiments upon salmon. Mr. Harlan B. Holmes, who read a paper on "The Passage of Fish at Vonneville Dam", was Aquatic Biologist of the U.S. Bureau of Fisheries for several years, but was later assigned to the U.S. Army Engineers. In this capacity, he was the man who planned and saw to completion the gigantic fishways of the Bonneville Dam. Mr. Holmes also participated in some of the basic experiments upon salmon migration, in co-operation with Dr. Gilbert and Dr. Rich. Dr. Wilbert McLeod Chapman, who narrated "Fish Problems connected with the Grand Coulee Dam", was Scientific Assistant with the International Fisheries Commission at Seattle, and is now in charge of the fisheries investigations being made relative to the Grand Coulee Dam by the Department of Fisheries of the State of Washington. He has carried on extensive studies of the anatomy, physiology and