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A BRIEF REVIEW OF THE TECHNICAL WORK OF THE BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BY

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THE Board of Scientific and Industrial Research came into being in April 1940 as a result of the foresight of Sir A. Ramaswamy Mudaliar, the Commerce Member of the Viceroy's Executive Council. Its main functions were to advise the Government with respect to the granting of financial assistance to schemes of research in Government, private and university laboratories and to help in the development of industry generally by research. A number of Research Committees have been set up to make suitable recommendations to the Board on the schemes referred to them.

In a big country like India when one begins to organise industrial research the scope for work is immense. There are natural resources to be exploited, existing industries to be helped, and there is a great need at the present juncture for improvement in the production of articles and materials, for conditions no longer exist for easy transport of articles from one end of the world to the other, and as such a measure of self-sufficiency is desirable with regard to certain items.

The war has created peculiar situations in the country, and the three main effects which could be observed as a result are:—

(1) An accumulation of raw materials which formerly used to be sent abroad.

(2) Stoppage of import of finished articles.

(3) A demand now created by war for new kinds of articles on account of the country becoming a centre of supply for the Eastern Group of the Commonwealth countries.

Vegetable Oils.—As a consequence of the war and the pressure on shipping it was soon found that the market for oil-seeds overseas would be almost entirely closed. As a result of this, a large surplus of the vegetable oils was expected in the country. It was, therefore, thought desirable to find various applications by which the oil-seeds both as oil and seed cakes could be utilised. It is well known that vegetable oils have been in use in the soap industry for a pretty long period, but the entire output cannot be consumed by this industry, which is already producing superfluous quantities of soap. Work has been done on vegetable oils as lubricants in two different directions, (*i*) in admixture with mineral oils, for marine oils, spindle oils, etc., and (*ii*) by the addition of only suitable anti-oxidants. These have been found quite satisfactory, but the use of vegetable oils as fuels cannot be considered as a peace-time proposition as bulk for bulk the vegetable oils cost very much more. In cases of emergency, however, the position is different and as a matter of fact the use of vegetable oils as diesel fuel has been seriously considered. It is possible to use vegetable oils after cracking either by pressure as has been done in Bombay, or by chemical methods. In the former, one obtains degradation products which can be used as motor spirit or fuel, and their use as such will be of some importance if cetane and

octane values are of the right order; while the splitting carried out by chemical or enzyme methods, gives the higher fatty acids, like oleic and stearic acids. Researches on both types of work are being continued.

For denaturing alcohol, mineral pyridine is generally used, but as pyridine is not available in sufficient quantities in the country other sources have to be investigated. An investigation to find out whether the bitter principles of neem could be successfully employed in place of pyridine was carried out originally at Calcutta and has been subsequently developed at Benares. Both the oil and the seed cake have been tried but encouraging results have been obtained only with the latter.

Plastics.—On account of the increasing use of plastics in industry at present, attention has naturally been diverted to methods of producing plastics in this country as well. While synthetic resins are not available in this country natural resins and resin forming materials such as shellac, casein and oil-seed cakes are available in plenty. Satisfactory progress has been made with respect to the production of plastic materials from coffee beans, oil-seed cakes, bagasse and jute waste, but the subject of plastics is inexhaustible. Modifications of shellac wtih melamine and cyanamide have also been considered.

In order to develop synthetic resins, investigations were initiated to work out suitable conditions for the manufacture of formaldehyde by the oxidation of methyl alcohol, which is available in the country. Successful experiments on a pilot plant have already been carried out. The question of the recovery of methyl alcohol and the preparation of concentrated formalin from dilute formaldehyde solution have also been tackled successfully. Work on the large-scale manufacture of cyanamide and melamine is now being developed on the pilot plant scale. Waxes which can be used as substitutes for beeswax and carnuba, from different oils, have been produced from tallow, castor and linseed oils. Several types of resins have been developed starting with vegetable oils.

Molasses.—The growth of sugar industry in India has raised the question of the disposal of molasses. Molasses contains 40 to 50 per cent. of unrecoverable sugars as sucrose and hexose. Attention has been paid to the production of acids and alcohols by fermentation processes by the use of the right kind of culture. Semi-large-scale production of acetone has been undertaken already as a result of investigations in the laboratory. It follows as a corollary to work of this kind that there should be a collection of varied bacterial and fungal cultures and such a collection has been started at the *Indian Institute of Science, Bangalore.* Over fifty cultures have been isolated and identified, while approximately eighty-five still remain to be investigated. Preparation of yeasts and other moulds as sources of vitamin D and vitamin B-complex from molasses, have been carried out in the course of the year. Amongst other experiments of interest in this field may be mentioned the preparation of yeast and potassium salts. Two methods for the latter are being tested on the pilot plant for commercial feasibility.

Sulphur.—As is well known, the progress in industry of a country is measured by the amount of sulphur consumed by it. At the outbreak of the war, attention was paid to substitute sulphur by burning pyrites and also to the possibility of recovering sulphur from the coke-oven gases, smelter gases and from gypsum. Fortunately the discovery of huge deposits of sulphur in Baluchistan by the Director of the Geological Survey of India has shown that India has sufficient sulphur for many years' requirements.

Dyestuffs.—The Vegetable Dyes Committee which has since been merged into the Dyestuffs Committee, recommended that investigations on vegetable dyes might be confined to such dyes as will find use in the colouring of foodstuffs, in confectionery, cosmetics, hair oils, etc., so that even after the war is over, they could hold their own in the market. The fact that vegetable dyes cannot compete successfully with coal-tar dyes in commerce should be recognised and work in both the directions must be pursued having regard to their complementary uses. Barks of a few species, *e.g., Butea frondosa, Terminalia arjuna,* etc., are being examined for the preparation of tinctorial constituents in standardised form. A simplified method of preparing the colouring matter of *Kamala* has been developed and a dozen shades obtained from it.

A survey of the natural resources and the possibility of producing some of the more important coal tar dyes needed in the country will be the preliminary step before any recommendation as to the work performed can be made. Such a survey is being carried out, but in the interval a few schemes of research for producing vat dyes and others mentioned below have been in progress.

The basic material for the production of alizarine and anthracene Blue RSN etc., is anthraquinone which is an oxidation product of anthracene. It has been ascertained that anthracene is available in large quantities in India as a by-product of coal tar industry. Processes have, therefore, been worked out for the production of such dyes as can be made from the available raw material. A special plant required for this work, to give 10 lbs. of the dyestuff per day has been constructed.

A study of the literature points out that in the preparation of aniline from chlorobenzene and ammonia, the reaction could be effected in the vapour phase under pressure. This method has some advantages for one can dispense with corrosion-resistant autoclaves and use only tubes of diameter 1·5". Experiments of this kind are being carried out in Bombay and the optimum conditions for the maximum yield are being worked out.

In the synthetic dye industry, aromatic amines play an important part. As these are obtained by the reduction of nitrocompounds, the choice of the method of reduction depends on many factors. Of these the electrolytic reduction offers great scope, as it is neat, clear and controllable. The reduction of nitrobenzene to hydrozobenzene and then to benzidine has been effected using this method by the use of monel-metal cathodes. The yield of the latter compound is fairly high.

The conditions under which aniline and alcohols yield mono- and di-alkyl anilines and also the catalyst that gives maximum yield, are subjects of investigation at Calcutta.

Drugs.—Atoxyl and carbarsone used in the treatment of trypanosomiasis and amœbic dysentery respectively have been the subjects of investigation at Bangalore. For both the starting material is *p*-arsanilic acid which has been prepared from commercial nitric acid and white arsenic. Atoxyl, which is sodium *para*-arsanilate, has been prepared following the method of Yang and Lo. Using the atoxyl so prepared, carbarsone which is *para*-carbamino-phenylarsinic acid, has been obtained in good yields and suitable for clinical purposes.

The thyroid glands of Indian animals have been investigated at Madras. In the course of the investigations it has been found that

(1) the desiccated thyroid gland of Indian origin is richer in iodine than the specimens imported from abroad;

(2) thyroxin isolated is pure and crystalline.

Bhilawan shell liquid has been successfully converted to a resin which can serve as a base for lacquer varnishes, enamels, water proofing and insulating materials. Stoving enamel of exceptional qualities in point of gloss, adhesion, elasticity, heat and flame resistance has been prepared.

On the medicinal side a number of interesting products have been obtained from Bhilawanol. Special mention may be made of the arsenic derivative and the water-soluble sulphonamide prepared from the above, which have given interesting results on preliminary pharmacological investigations.

Agar-agar from a variety of *gracilaria* found along the coast of Travancore has been produced in the laboratory.

Work on the isolation of bitter active principles of the Neem-oil has progressed and as a result of this, yields of the order of 1 per cent. have been obtained as against the previous records of 0·1 to 0·2 per cent.

"Dettol" has been analysed and found to consist of soap, essential oils, alcohol and a chlorinated phenol. The right kind of chlorinated product has been obtained from coal-tar acids of Indian origin and the process is now available for exploitation.

Work on the active principles of chandni root has also been undertaken.

The preparation of yatren in the laboratory starting from phenol has been completed and the yield obtained is fairly high.

Scientific Instruments.—Vacuum and compressor pumps are the basis for an important class of scientific and industrial apparatus. Using indigenous materials, pumps as efficient as the imported variety, have been produced at Calcutta.

Investigations on X-ray transformers, especially useful for the hospital unit have been completed. Photographic plates and photosensitising dyestuffs are also being investigated.

A committee has been set up to give a fillip to radio research in India and such problems as the manufacture of valves, condensers, resistances and loudspeakers are under investigation.

Metals and Alloys.—At the instance of the Board, the *Tata Iron and Steel Co.* are now manufacturing stainless steel for the manufacture of surgical instruments of both sharp and blunt types. In addition to this steel, the same firm is making experiments to produce silicon-steel sheets for the electrical industry. Magnets are needed in the communication engineering, specially the radio and telephone industry, and also in the making of house-service meters. Manufacture of such magnets is being carried out by the *Tata Iron and Steel Co.*, at Jamshedpur. It is hoped that based on surgical steel, electrical steels and magnets as raw materials a host of new industries will develop in the country.

Essential Oils.—A comprehensive report on the essential oils industry in India has just been presented to the Board by the Exploratory Committee appointed by the Government. This report will be of great use for a planned programme of work in this field. A scheme of research which has already yielded results is the production of ionone from lemon-grass. There are two distinct stages in the experiments, namely, the preparation of pseudo-ionone from citral and acetone and the cyclisation of pseudo-ionone to ionone. Various condensing agents and different conditions of temperature and pressure have been employed to get the maximum yield.

Match Industry.—In Bangalore a process for the manufacture of potassium chlorate from salt bitterns has been developed to a pilot plant stage. Also owing to the shortage of phosphorus, yellow phosphorus from the phosphatic nodules of Trichinopoly has been investigated successfully.

Fertilisers.—Fertilisers can be either natural or synthetic depending on the source for the production of the chemicals. Of the natural fertilisers the nitrates and phosphates are the most important and in India, the former being almost non-existent, attention has naturally been diverted to making the phosphatic rock in easily soluble form. Since the P_2O_5 content rarely exceeds 23 per cent. in the rock, utmost care is required to be taken in getting the maximum amount of citrate soluble phosphate. Such attempts have been made at Bangalore and at Calcutta using different methods and they have been attended with some success. At Bangalore investigations have been carried out to manufacture ammonium sulphate from gypsum as one of the raw materials.

Of the synthetic fertilisers urea is one of the basic materials. Since urea is used in the plastics industry as well for the urea-formaldehyde resins, its importance as a basic material is still further increased. Pilot plant experiments on the manufacture of this material have been carried out at Bangalore.

Glass and Refractories.—Work on the purification of Indian Glass sands is being pursued. It was, however, found not possible to remove alumina and titania to any extent by following the older method. The Glass Committee also recommended that experiments should be tried at the *U.P. Glass Works, Bahjoi,* and the *Forman Christian College, Lahore,* to produce optical glass which was considered a shortage. Good progress has been made but the large-scale development has proved difficult owing to the difficulties experienced in removing veins, but the samples produced were considered fairly good.

The usefulness of refractory material which will resist high temperature and which are free from impurities like iron, cannot be over-emphasized. Kayanite and sillimmanite are found in great quantities in India, but investigations would be desirable to find a suitable binding material to hold these together, keeping in view the two points stated above. Towards this, experiments have been conducted, using

(1) Kayanite—calcined and ground, (2) Best grade—raw fireclay (Jubbulpore), (3) Ball-clay (Jammu) and (4) Bentonite. Out of these refractories, a few have been made, and have been found to stand the tests.

Graphite and Carbon Electrodes.—Graphite occurs in nature in some parts of India. If the carbon content is increased, carbon electrodes useful to metallurgical and chemical industries could be made.

Work has been continued on finding the suitability of carboneceous materials available in India for the production of large-sized carbon graphite electrodes. Tests carried out in the laboratory on these electrodes have been found to be satisfactory.

Similar experiments on small-scale electrodes for use in dry cells are also being conducted elsewhere. As a subsidiary to the work on the production of graphite electrodes, it was thought desirable to produce carborundum as an abrasive powder from silica and pure carbon, by heating it to a high temperature.

The method of flotation has been employed in the purification of graphite occurring in East Godavari and graphite of 99 per cent. pure carbon content has been obtained,

Rayon and Cellulose.—A grant has been made available for the production of rayon on a unit process. The plant has not arrived owing to war difficulties.

Meanwhile, by the use of a Kier investigations on the cellulose content of cellulose-bearing materials of India, such as bamboos, wood long, bagasse, wheat straw, etc., have been started. It is believed that such investigations would help in the choice of raw materials for the production of rayon, which is under contemplation.

Sodium Cyanide.—Starting with raw materials—wood charcoal, commercial sodium carbonate, hametite and nitrogen and heating at about 1000° C., a 60 per cent. yield of sodium cyanide has been obtained at Bangalore. This chemical has an important use in industry.

A large number of problems have been tackled in the laboratories of the Director of Scientific and Industrial Research which cover a vast field of industries. In the short space available here, it is barely possible to give a list of the various titles under which these problems may be classified. A number of these have reached a stage where commercial exploitation has been possible and some of these have already been assigned to various industrialists for commercial development. The following is a brief list of the various items investigated.

Air foam solution for putting out fires in petroleum storage tanks.

Laminated paper boards manufactured by the use of natural resin base.

Corrugated jute boards similarly made for use in structural work.

Laminated jute boards similarly manufactured.

Manufacture of black stoving enamel from Bhilawan nuts.

Unburstable containers suitable for throwing supplies to stranded troops frow low flying aircraft.

Laminated paper board containers for food and rations.

Identity discs, worn by members of the fighting forces for identification purposes.

Systematic study of wood impregnation by the use of indigenous and readily available resins.

Development of jute mill bobbins from treated woods.

Development of water-proof plywood for use in ship-building.

Use of vegetable oils as fuel oil in diesel engines.

Development of vegetable oil lubricants for use in internal combustion engines.

Development of vegetable oil and mineral oil mixtures for use in machine lubricants.

Manufacture of cork substitutes.

Development of wood substitutes.

Manufacture of luminous paints for use in safety-first activities and during black-outs.

Development of anti-gas cloth for wearing apparels used during gas-attack.

Anti-scatter treatment for glass windows.

Windolite substitutes for use in place of ordinary glass for reasons of safety during air raids.

Fire-proofing of fabrics such as tentage, camouflage netting, etc.

Manufacture of chlorinated wax for use in fire-proofing treatment and other applications.

Study of the composition of and products from South Indian wax.

Manufacture of furfural.

Manufacture of phthalic anhydride.

Manufacture of thinners for cellulose lecquers.

Sulphur from Indian coals.

Purification of rock sulphur from Mr. Khaitan.

Development of *Agmark* ghee adhesives.

Manufacture of chlorinated rubber.

Manufacture of carbon electrodes.

Development of a process for the manufacture of highly efficient depolarizer mixtures for dry cell manufacture.

Development of plastic compositions based on natural resins.

Development of bagasse resin and its products.

Manufacture of plastics from oil-seed cakes.

Manufacture of plastics from coffee beans.

Experiments on artificial wool from seed cakes.

Manufacture of barium chloride.

Manufacture of aluminium stearate.

Manufacture of leather from fish skin.

Development of healds varnish.

Development of the use of micaceous iron ore as paint pigment.

Manufacture of water-proof packing paper.

Development of substitutes for tin and aluminium foils.

Manufacture of cafein from tea waste.

Application of ultrasonics to industrial problems.

Manufacture of dimethyl aniline.

Development of transport organic gels.

Manufacture of alumina from bauxite.

Development of substitute finishes for binocular and other goods generally finished with fancy leather.

Manufacture of citric acid from citrous fruit.

Water-proofing composition for Indianite.

Manufacture of titanium tetrachloride.

Manufacture of substitutes for picker belts.

Development of vinyl resins.

Manufacture of glossy transparent paper.

Seaming varnish for anti-gas clothing.

Anti-oxidants for mineral waxes.

Pour-point depressants.

Calsolene substitute (wetting agent).

The following list gives the number of schemes being worked under the Board at various centres:—

Place	No. of Schemes
1. Aligarh ..	.. 1
2. Allahabad ..	.. 1
3. Bahjoi ..	.. 1
4. Bangalore ..	.. 12
5. Baroda ..	.. 1
6. Benares ..	.. 2
7. Bhagalpur ..	.. 1
8. Bombay ..	.. 9
9. Calcutta ..	.. 17
10. Delhi ..	.. 6
11. Hyderabad ..	.. 1
12. Lahore ..	.. 3
13. Howrah ..	.. 1
14. Madras ..	.. 2
15. Patna ..	.. 1

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