# EXECUTIVE SUMMARY

## 0.1 INDUSTRY OVERVIEW

There are 21 coking coal washeries in production both in private and public sectors. Production of clean coal in these washeries during 1989-90 was 12 million tonne and it is expected to go upto 14 million tonne during 1990-91. There are 2 washeries under construction now and these are expected to be completed by 1995.

Present washeries face problems in optimum production more on quality aspects than on quantity and it appears that trend of using imported coking coal of low ash to blend with indigenous high ash coal for steel sector requirement, may continue for some time to come on considerations of optimised steel production.

Besides the above coking coal washeries, Bina deshaling and Piparwar beneficiation plants are in preliminary stages of construction in non-coking coal sector. Future prospects of washeries for non- coking coal beneficiation, appear to be bright as, in view of sharp rise in demand for coal, there is increasing trend in mechanised mining of inferior seams resulting in deterioration in quality and consequent reluctance by consumers to accept the same. Planning Commission has taken the decision that non-coking coal meant for Thermal Power Plants situated far away from feeding coalfield, should be beneficiated. The benefits of low ash coal burning in boilers are realised but reimbursement of extra cost of beneficiation for washed non-coking coal needs to be considered.

## 0.2 OVERVIEW OF INDIGENOUS TECHNOLOGY AND APPLICATION

Indian washeries, so far, were restricted to beneficiation of coking coal only, due to difficulties in convincing coal industry the need for washing. Demand of this washed coal also was synonymous with development and requirement of steel sector resulting in growth of washeries.

Related characteristics of coal to coal preparation in washeries are grindability/friability, specific gravity and surface properties. Differences in these characteristics permit separation of coal minerals from coal substance. Present physical methods in India for achieving

these separations are gravity separation (dense medium and hydraulic washers), and froth flotation.

Essential technology-features of Indian washeries of 1960s are treatment of coarse and slack coal separately in Heavy Media Bath/Jig/Cyclone but without beneficiation of fine coal (-0.5mm) except in Kathara washery. Fines were dumped in ponds for recovery. Later periods saw introduction of beneficiation in fine coal also in almost all washeries including retrofitting in old washeries. Present trends are pre-washing sized raw coal, efforts to upgrade fines and production optimisation with recourse to recover additional cleans by beneficiation of middlings,and installation of instrumentation and process automation.

Out of existing 21 Indian washeries, 14 were of 1960s or even earlier and 7 of 1970s and 1980s. Most of these washeries are under modernisation and are now in various stages of implementation. Modifications relate to rectification in design deficiencies arising out of changed inferior quality raw coal feed to washeries, operational problems and also to some extent technological updating.

Washeries of 1960s were turn-key constructions by foreign suppliers including design, supply of equipment and transfer of production knowhow. Indian engineers were trained in foreign countries for operation and maintenance of above washeries. This trend was reversed and Indian firms came into picture for turn- key supply of washeries, initially, with dependence on foreign collaboration but now mostly indigenously. Whilst technology is still of foreign origin, indigenous equipment development has gained pace.

Computerisation in washeries is in developmental stages and two washeries are under trial. Depending on results in above washeries, promotional measures in other washeries will be evolved.

There is pressure on washeries on control in environmental pollution. Though, there is awareness but identification of causes for pollution and corrective actions need immediate attention.

There is scope of energy savings in washeries both in plant operation and disposal of waste products. Only fluid bed combustion application has been initiated for waste disposal but other internal energy saving measures need to be attended.

Training is receiving inadequate attention in washeries even though few selected personnel are foreign-trained. Continuous updating of knowledge and training of supervisors, operators and maintenance personnel are essential.

Efficient and competent cadre with devotion to washeries is necessary for operation and management of washeries. Acute shortage of coal preparation engineers with requisite experience and skill exists, and suitable personnel policy need to be evolved.

## 0.3 MANUFACTURING INFRASTRUCTURE FOR EQUIPMENT

There are atleast 5 private sector units viz: M/s Humboldt Wedag (I) Ltd., M/s. Triveni Engg. Works Ltd., M/s. Larsen & Toubro, M/s. McNally Bharat Engg. Co. Ltd. and M/s. Tata Robins Fraser who have collaboration agreements with renowned world suppliers for manufacture of washery equipment. Mining and Allied Machinery Corporation also have licence on similar basis. Basic infrastructure exists with these firms to supply any updated version of washery equipment available in the world after procurement of necessary drawings. However, sophisticated control gear and electrical/electronics are still imported.

## 0.4 INDIGENISATION

The indigenisation of washery equipment including spares is technically feasible at present but not economically viable in view of low order size, arising from low scales of operation in view of limited demand. Consequently, indigenous manufacturers themselves are not interested in any equipment or technology development to suit Indian conditions.

Need for development of spare for existing equipment is,however, essential and has been recognised by the companies operating the washeries due to economic compulsion to avoid import. One way is bulking of spares in a larger time-frame and equipment suppliers are encouraged to take up manufacture on basis of assured off- take. Additionally, SSI units in nearby localities are encouraged to develop and supply spare on basis of reverse engineering.

Regarding foreign equipment of modern version, it is noted that some firms fabricate static components indigenously on the basis of drawings procured, import rotating components and assemble the same for final supply indigenously with overall guarantee by foreign supplier.

However, maintenance and operation problems remain. One way to deal with this is to decide on the technology that may be most suited as per the past and current experience in the washery sector, and then standardise it.

## 0.5 INTERNATIONAL OVERVIEW OF PRACTICES AND EQUIPMENT

It may be a safe assumption that 50% of the world coal production is cleaned in some manner or the other, before it is used in some process. The general aim is to make, with or without washing, the coal, more attractive as an industrial fuel by improving the efficiency, convenience and cleanliness with which it can be handled and burned.

Foundation of coal washery industry was largely laid in Europe in 1915-1940. It was standard practice in a large washery to combine dense and medium washing for coarser size of coal with Baum jig for slack. The fines were low in ash and flocculation in ponds and recovery was considered sufficient. With mechanisation in mining and with increasing fine dirt, froth flotation, oil agglomeration and spirals complemented the gravity separation process. Magnetic and electrostatic separation offer useful means to removed pyritic sulphur.

The most commonly used coarse coal washers are HM baths and jigs while the slack coal washers are HM cyclones, Hydrocyclones, Batac and Feldspar Jig, concentrating tables and spiral concentrators. Froth flotation upto 35 mesh top size is done in Wemco or Denver cells either in single or in double stages depending upon need to remove the pyrite. In USA, based upon tonnages treated, 48% of coal preparation plants use jigs, 32% dense media system, 11.5% shaking tables, 5% froth flotation and 3.5% pneumatic and other methods. In UK, the figures are 60% by jigs, 25% dense media systems and 9% by other methods including flotation. In Australia, 45% use jigs, 45% dense media system and balance froth flotation, spirals and shaking tables. In Europe, 60% use jigs but in South Africa jigs account only for 23% and 64.5% by dense media methods and 2.5% by froth flotation. Some dry beneficiation methods like ore sorter, high gradient magnetic separation, dedusters etc. are being tried in a subdued scale, as they have limitations in application. With the lesser demand in steel sector, there are reductions in new washeries construction and stress is on modernisation of existing washeries.

Rapid developments have taken place in equipment, for example, in screening and dewatering. Stationary vorsiv screens of Poland, Rotating

probability screens of NCB, Deep cone thickeners, High speed solid/screen bowl centrifuges, Pressure filters and others are finding frequent use. Dewatering of fines and ultrafines remain an area of worldwide research and development in coal preparation. In equipment of main coal washers, newly developed three-product cyclones and triflow separators are claiming considerable success in certain applications.

Unlike conventional washery design in India, internationally the trend is towards modular construction in mobile units. Also low profile design constructed MONOPOL plant in Germany (West) has proved to be of many advantages, and is claimed worth emulating.

In last few years, it has been proven that computer technology applied to other industries can also be effectively used for coal preparation control. Installation of computer controlled systems in NCB washeries have ranged from powerful minicomputers for all tasks of monitoring, control and logging, to small microprocessors dedicated to precise particular duties. Distributed control philosophy is considered best, able to meet the variety requirements of washeries. It is envisaged that biggest pay-off will result from optimising of plant and processes, correctly ordering maintenance scheduling.

On energy saving and concern with environmental protection, application of fluid bed combustion for waste products disposal and pelletisation of damp fines to improve handlability are gaining importance. Prepared coal with water mixtures are promising means of increasing coal use in industry and its merit lies in shifting the burden of drying, away from washeries.

Regarding training and updating knowledge, coal preparation societies in leading countries play a vital role and through regular technical meetings and courses conducted at various levels, technical standards of washery people are kept a high level. Regular attendance in Coal Preparation Congress assist the industry people keeping abreast with latest developments.

## 0.6 DESIGN & STANDARDISATION

Earlier washeries in India were constructed on turn-key basis with the assistance of foreign firms. They exhibit deficiencies and defy standardisation in view of design limitations and multinational supplier. Basically, the foreign suppliers of turn- key constructions, installed

their own economic version of technology and equipment, independent of Indian operating environment. This trend continued till entry of Indian intermediary firms in the field. The country spent foreign exchange to promote these indigenous companies in the hope that they would acquire knowhow for further installation of washeries. Normally, there would have been a conscious drive towards horizontal transfer of technology to Indian firms, strengthening these organisation for use within the country, but the subsequent scenario has been that these Indian firms assisted by foreign collaboration, could not prosper further, and the industry presently, has different systems and design of equipment difficult to standardise. Option is to make a thorough study in choice of best technology and equipment available in the country, suited to our environment and encouraging the same for standardisation in all the washeries. However, this temporary solution is costly and may not serve the developmental needs of the industry. It may be necessary to start a central organisation to cater to coal preparation need, suiting Indian conditions, independent of committed collaboration for any technology or equipment. CPEI, recently started in CMPDI of Coal India Limited, operating major washeries in the country is suitable for the purpose and could emerge as prime engineering design and planning centre for washeries so as to standardise design procedures and equipment. Being a part of the industry they are in a better position to serve rather than the opportunistic services rendered by outside firms. Incidentally, CPEI may also undertake R&D activities for original design and development of washeries, as CMPDI has been recognised by Govt. of India as nodal agency for this purpose.

## 0.7 TECHNOLOGY GAPS

Liberation of coal constituents by crushing, improves the cleans yield. However, reduction to ultrafines size is not desirable in view of high energy cost, difficulties in slime water clarification and transportation problems of dust. Hence, preparation in sizes have come to stay in washeries. On the other hand, available tools/equipment for washing also have limitations relating to size. Matching both these factors, equipment in washeries are assembled and designed.

Regarding preparation of non-coking coal, run-of-mine coal is crushed and deshaled to remove undesirable stones and shales. Plants on different principles and in various sizes are conceived as follows for commercial exploitation:

| Technology | Size of coal treated(mm) |
|---|---|
| Inpit Deshaler | 1200-200<br>200-13/6 |
| Electronically controlled moving pan jig | 400-40<br>200-30 |
| Photometric Ore Sorter | 125-50<br>50-20 |
| Dry Shale Extractor | 200-100<br>100-50 |

Success of schemes mentioned above will open simple economic solution for non-coking coal washing.

Regarding washing of coking coal, upgradation of coal of size below 0.5mm always posed problems. Oversize in feed in the known process of froth flotation reduces efficiency. Difficulties in dewatering products and clarification of slime water are difficult to manage, leading to escape of solids posing pollution problems. Pilot plants for dewatering fines below 0.5mm obviating froth flotation, are conceived for installation as follows:

| Technology | Size of coal treated(mm) |
|---|---|
| Oil Agglomeration | 0.5-0 |
| Column Flotation | 0.5-0 |
| Slurry Jig | 3-0.1 |
| AED/FC Dry Process | 1-0.1 |
| Spiral Concentrator | 3-0.1 |
| Oleo Flotation | 0.5-0 |

Successful demonstration of above trial plants put to commercial use will greatly enhance cleans recovery and prevent problems of loss in fines, and pollution will be reduced.

Operation logistics of washery will be possible by adoption of automation for which two washeries, have already been selected for trial. Implementation in other washeries, depends upon results of above trial.

Modular concepts of washery construction to meet the limited reserves of coal in small collieries is also under demonstration/ construction at Lodna. This type of construction is easily dismantlable and possible to move to a different location, once reserves exhaust.

Commercial success of technology trials in the above is expected to enhance clean coal recovery and optimum operation of washeries, may become a reality.

A suitable modus-operandi for assimilation of foreign technology to be transferred to India need to be devised. The efficacy of technology/equipment that have proven their performance in the plants abroad, has to be assessed in the Indian context, and if these equipment are found to be successful in case of Indian coal, appropriately tailored versions of the same, may be developed by the Indian manufacturers for their introduction in the existing/proposed coal preparation plants.

Washeries to a great extent continue to depend upon imported knowhow for technology, either directly or through Indian firms. The responsibility for industrial proto-type development, leading to adoptable technology economically cheaper in Indian conditions either for process or equipment, has to be shouldered by the coal industry itself. Research laboratories and academic institutions have to play a valuable role in this context. (It is heartening to note that equipment indigenisation of foreign origin is gaining progress in phases on licensed drawings from suppliers. These equipment have to made available completely, indigenously.)

The major technology gap thus relates to identification of cost-effective process technology for non-coking coal, slime water clarification taking into considerations areas such as pollution loss, slurry management, energy conservation, application of modern on-line and off-line electronic controls.

## 0.8 RECOMMENDATIONS

0.8.1 Coal preparation should be recognised as a technological necessity for the coal industry in particular and that for the nation in general. This relates to non-coking coal, particularly.

0.8.2 Keeping in view the investments already made in washeries and likely to be made in immediate future, the coal washeries should be recognised as an industry with its own technology and skills entirely different from the mining industry, with consequent action and responsibilities necessary for the success of an industry.

0.8.3 CPEI under CMPDI being the technical consultancy organisation in the field of coal preparation should be strengthened so as to function as an apex body to coordinate various activities pertaining to pooling of information covering practical experience in the washeries, technology development and standardisation of materials/spares/process/equipment.

0.8.4 Challenges in regard to the deterioration in quality of raw coal because of emphasis on increased mechanisation/open cast mining, need to be met by coordinated efforts during the production to the extent possible, and then in coal washeries.

0.8.5 Detailed geological investigations should be conducted well in advance, and reasonably firm coal-linkages should be established for all the existing and future washeries, over a span of atleast 15-20 years, so that effective operational planning in washeries is possible.

0.8.6 Sufficient stress has to be given by the national laboratories and academic institutions in the country to interact with washeries and impart know-why. The industry itself should be encouraged to develop know-how for application of modern technologies. Necessary infrastructure by way of pilot plants should be built, to achieve the above purposes. Design of washeries and development of equipment should form part of the above know-how. The industry itself, should interact with development and research associations abroad on the above aspects. Standardisation of equipment in conjection with cement and paper research institutions, where common technologies are feasible should be given due recognition.

0.8.7 Regular interaction with consumers, particularly with steel plants and thermal power stations, is essential. Strategies for coal upgradation schemes may have to be developed based on economics of the coal blend. Conservation of coking coal will be possible if injection of washed non-coking coal of lower ash is applied at large scale in steel plants.

0.8.8 The selective preparation of coal is a dynamic approach for the production of better quality of coke from metallurgical coal either by

using inferior quality coal with lower reactive content, or non-coking coal in blend. It should be decided after successful trial at the pilot plant stage.

0.8.9 The present policy of award of turn-key jobs for installation of new washeries or for modifications, tends to multiply various types of equipment difficult to standardise. To build up a strong indigenous base, cost effectiveness, availability of spare parts and other considerations, standardisation of equipment is very desirable. All efforts should, therefore, be made in that direction.

0.8.10 Various recommendations made by earlier committees on washeries like strengthening of Coal Preparation Engineering Institute and cadre for operating personnel, start of a Central Training Institute, application of automation in washeries, firm linkages of input materials to washeries etc. should be examined, action taken and progress monitored.

0.8.11 CPEI of CMPDI, conceived as Central Organisation for coal washeries, should, initiate actions and monitor implementation of all issues connected with washeries with assistance, if necessary, from practicing professionals abroad, scientific and educational institutes in the country, washery administrators and equipment manufacturers, and decide on the future policies/courses of action, for rapid development of coal washeries in the country, in all its facets, keeping in view the interests of Coal Industry and the country.