Coal preparation:

Coal preparation is a generic term that is used to designate the various operations performed on run-of-mine coal to prepare it for specific end uses, without destroying the physical identity of the coal. It is now recognized as a combination of science, art and engineering, recognized in its own right as a vital link between the production and the marketing of coal. It includes blending and homogenization, size reduction, grading and handling and, perhaps most important, beneficiation or cleaning.

Very dirty coals, those containing large amounts of incombustible material, could only qualify for substantial cleaning if the final selling price clearly justified it.

If these coals were used domestically, coal cleaning might not be considered economical and probably would therefore not be justifiable. For world markets, however, coal cleaning would improve market potential of the coal and reduce transportation costs.

Quality and cost of treated coals are highly dependent on the specific coal and the market for which it is aimed. In order to ascertain the amount of cleaning required, run-of-mine coal must be subjected to certain minimum qualitative and quantitative analyses, from which conditions of cleaning and information about ultimate quality can be obtained. Obtaining a representative sample of run-of-mine coal and carrying out such test work is a lot more easily said than done. Besides the need to satisfy quantity requirements, the representatives of the sample which relation to future run-of-mine coal is another difficult sources that are achieve. It is usually achieved by a combination of several data sources that are correlateable. Prospective coal reserves are drilled by open-hole and coring methods to a predetermined grid in order to obtain physical and chemical data. A relativity large bulk sample, of size-consist similar to that which would eventually be mined. This would then be tested to provide cleaning data, with corresponding quality determined for various fractions, following preparation of the sample to confirm to the treatment size-ranges required. This aspects is also covered later on because it makes virtually important contribution to the profits of the eventual total mining operations. Suffice to say, the analyses of the raw coal and prospective products of such parameters as ash, heat, volatile and sulphur, contents as well as elemental components of carbon, hydrogen, oxygen and nitrogen, will provide a good insight into market swelling index, fluidity and dilation of coking coals and Hardgrove grindability, ash fusibility and ash analyses for energy coals will further define the overall quality of coal.

Float-sink tests provide washability data, vital for assessing the probable performance of separation equipment, which depends upon density differences; and froth-floatation tests simulating the separation characteristics of the density separator provide valuable performance data for fine coal treatment.

All separation equipment has well-established empirically based performance characteristics which allow its performance to be determined once the washability data have been obtained. This predictability lends itself to computerization and facilities fairly rapid simulation testing. These predictions can be then be compared with the performance of other known installation of a similar type, thereby providing for confident selection of the correct cleaning method and accurate estimation of plant performance.

One of the disadvantages of coal cleaning by wet process lies with the fact that the ash removed by cleaning is to some extent replaced by water. Just as cleaning becomes more difficult with decreasing particle size, so too does moisture removal from the product. In some cases, fine coal sized below 500 µm may contribute a higher level of moisture than incombustible ash, and any additional beneficiation by decreasing either ash or moisture may still not render fines addition economical. In such cases, the fines are usually, rejected as uneconomical, although some countries, keen to conserve resources, are becoming increasingly anxious to eliminate such wastage.

So, we shall see that washability data provide a yield value which is akin to almost perfect cleaning conditions, and thus it is often called the theoretical yield. Actual yield of saleable coal, always poorer, will depend upon the degree of efficiency of the total plant when any form of cleaning is used.

First, coal cleaning is a continuous, dynamic process, not batch like float-sink tests, and cannot clean perfectly. In practice, this means that separator performance is affected by near-density material which could report to either stream depending upon the accuracy of the separator. Hence, some misplacement, i.e. coal in discard and vice versa, will always occur.

Secondly, cleaning becomes more difficult with decreasing grain size of the feed. This becomes increasingly acute when fines of minus 500 µm are treated, due to the combined effects of poorer efficiency and increasing moisture content.

Thirdly, ultrafine coal, even when beneficiated, may still be lost during the final dewatering process.

As we have already discussed, efficient and effective coal cleaning embraces the use of a number of coal preparation operations including handling, storage, blending, sizing beneficiation, comminution and de-watering, sometimes includes thermal drying. For each of these operations, there exists a range of equipment which is selected partly out of proven suitability, partly out of personal preference or confidence from previous experience, and partly, of course, for relative cost. For coarse-coal cleaning, Baum jigs and the more efficient dense-medium vessels are used. Dense-medium cyclones, water-only cyclones, tables and Feldspar jigs are for medium-size coal cleaning, Froth floatation is the most commonly applied methods for fine coal cleaning.

In order to ascertain the amount of cleaning required, run-of-mine coal must be subjected to certain minimum qualitative and quantitative analysis, from which conditions of cleaning and information about ultimate quality can be obtained. These analysis are:

1) Washability (Float and Sink) analysis, and
2) Size analysis.

Coal preparation includes blending and homogenization, size reduction, grading, screening and handling and, perhaps most importantly, beneficiation or cleaning. Selection of methods and corresponding degree of beneficiation required, significantly governs the cost of coal preparation, which is greatly determined by the market suitability of the product. Therefore, there are different levels of cleaning to which a coal may be economically subjected, according to its intended utilization. Very dirty coals (those containing large amount of incombustible material), could only qualify for substantial cleaning if the final selling price justifies it.

There is a wide variation in coal treatment which may be classified in accordance with level or degree of preparation. Five levels of coal preparation can be summarized below:

Level I — Crushing and screening only.
Level II — Coarse coal cleaning only.
Level III — Coarse and simple fine coal cleaning (down to 0.5mm).
Level IV — Coarse and fine coal cleaning plus cleaning of the minus 0.5 mm, with closed water recovery circuit.
Level V — Cleaning of all sizes of coal, multiple stages of sizing and crushing for maximum liberation, optimum yields and producing two or more clean products, closed water recovery circuits.

The demand for coal preparation will grow along with increases in production for various reasons, some of which are mentioned as follows:

1) Depletion of higher quality coal seams.
2) Mechanized mining which increases impurities in run-of-mine coal.

3) High cost of transportation, which makes it uneconomical to transport inert material.
4) Market demand for higher quality coal.
5) Higher mine costs, which make it imperative to improve coal washing techniques for optimized recovery.
6) Environmental requirement in regard to minimizing pollution.

Coal as mined is invariably associated with some mineral impurities which do not take part in the combustion and give rise to ash. High ash content means less carbon in the coke and more slag volume in the blast furnaces, which in turn means more coke per ton of iron and less iron productions. Thus the ash content of coke is a critical factor in the blast furnaces operations and even 1% increase in the ash content can affect the operation very adversely. Proper preparation of coals before carbonization is essential for the production of good quality coke.

Metallurgical coking coal is an important component in iron and steel production. It is converted into coke for use in blast furnaces as the heat sources and reducing agent for converting iron ore into pig iron. Modern by-product coke ovens are batch operation, slot- type ceramic ovens that carbonize or thermally crack the coking coal. A good coal produces large, strong pieces of coke, the two qualities that are required to support the enormous weight of iron ore in the blast furnace.

Only certain high rank bituminous coals are classified as metallurgical coking coals. Generally, only low-sulphur coals are acceptable which further reduces the range available for this special application. In certain cases, medium-sulphur coals are considered for coking because they can be beneficiated by extensive coal cleaning. This, in certain instances, can result in the production of two saleable products: a low-ash coking coal cleaned to acceptable coking properties, including low sulphur; and a medium-ash stem-coal obtained by cleaning to a higher separating density. Three products separations, i.e. low ash, medium ash and discards, are becoming increasingly common where coking coals are to be obtained from dirtier run mine coals.

Numerous tests have been developed to analyze potential coking –coals, some of which are traditional, such as free-swelling index, Grey-King coke number, coke strength and hardness and petrographic analysis. In addition to these are a number of tests that have become more recently adopted internationally with the onset of blending. These days, not many single-sources coals exists which can be regarded as adequate by themselves, and those that do obviously command a very high selling price. The shaded area in the center of the diagram is seen as representing these rare coking coals. Most coke makers, however would insist that the proof of the pudding was in the coking and pilot-scale oven tests are regarded as essential in finally obtaining important coking performance data.