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Design and construction aspects of mini coal flotation plant

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ABSTRACT

Due to recent economic liberalisation policy of Govt. of India, it is expected that core industries like steel, cement, etc. will get more attention to foreign investment and technology and the new industries will come up alongwith large scale modernisation of existing industries. These user industries will require good quality low ash coking coal to fulfil its needs. The existing washeries of CIL are not in a condition to meet such specific requirement of these industries. Further, fine coal circuit of these washeries are not efficient resulting in discharge of Slurry having ash ranging between 30-40% which can not be used as such by metallurgical and foundry industries. Moreover, discharges of slurry from washeries are polluting adjoining areas including nearby rivers.

To overcome these problems scientists of Central Fuel Research Institute, Dhanbad have taken challenging initiative and developed a novel close circuit process to treat these slurry to produce low ash coal. The process is adopted by some private entrepreneurs and constructed small plants based upon the technology developed by CFRI. Three such plants have already been set up and are under operation with full efficiency.

The present paper attempts to highlight the process, construction aspects and advantages of this type of Mini fine coal beneficiation plants which are producing low ash coking coal for use in the metallurgical industries.

Key words : *Design, Coal, Mini flotation plant.*

INTRODUCTION

The quality of raw coking coal being supplied by Coal India Limited has been deteriorated[1] and with such coal it is not possible to produce desired quality coke for metallurgical use. So, to fulfil the demand of low ash coking

coal some private entrepreneurs have set up the Mini fine coal preparation plant (5 to 20 tph) and been producing low ash coking coal from the waste slurry of washeries. Under present market condition, the demand is much more than its supply through these mini slurry beneficiation plants. Therefore, large number of such flotation plants are required to be constructed to fulfil the demand.

The raw material for this Mini fine coal beneficiation plant is coal of size below 0.5mm. The other materials required are reagents, chemicals and water, etc.

PROCESS

The process adopted for the production of low ash good quality coking coal in mini coal beneficiation plant is a specially designed[2,3] Froth flotation system (Fig1). The fine coal particles of size below 0.5mm are conditioned in a conditioner by using water and collector (like, diesel oil). Conditioned coal slurry is fed into a series of flotation cells where air bubbles are generated by the rotation of high-speed impellers of special design, with the help of a frother (like, Kabakol). The coal particles are adhered to the air bubbles and form froth at the top of the flotation cells. The ash forming mineral matter particles remain within the pulp and do not form froth and are discharged from the cells as tailings. The froth is sent to vacuum filter (rotary drum type with belt discharge) through launder, where concentrate (clean coal) is de-watered and separated as cake. The cleans have normally less than 15% ash and can produce coke of superior quality. The tailings from the flotation cells are collected in specially designed settling ponds which are located adjacent to the flotation plant, where solids settle and ultimately utilised in the briquetting plant. Clarified water[3] is collected in a well and re-circulated within the system. The process is having closed water circuit and thus environment friendly and process water requirement is low.

EQUIPMENT

The major equipment required for the mini coal flotation plants are listed below (Fig 4 to 9) :

1. Control panel, Electrical and electronic equipment (in control room)
2. Conditioner with stirrer
3. Flotation cell of special design with scrapper
4. Drum filter with belt discharge.
5. Filtrate receiver
6. Moisture trap
7. Vacuum pump

8. Emulsifier tank
9. Fresh water tank
10. Sieve Bend
11. Reclaimed clarified water re-circulating system
12. Pumps and Motors, etc.

CONSTRUCTION ASPECT

Generally, the Mini fine coal beneficiation plant can be constructed in about nine months time. However, from past experience it is seen that construction of such plants are often get delayed due to some infrastructural problems, such as acquisition of land, preparation of drawings, supply and erection of equipment, civil works particularly of concrete structures having long gestation period. These problems can be avoided to a great extent by taking the following measures :

1. Selection of site should be done taking into account power, water and approach road for steady supply of raw materials and availability of suitable space for disposal of rejects.
2. The Land should be free from all encumbrances required for the construction of plant and preferably be acquired well in advance.
3. Engineering design and drawing of the plant need to be completed before the start of the construction activities.

In absence of complete design and drawing, it is never possible to complete the project within the stipulated time. So, to avoid this delay elaborate computer aided design and drawings can be adopted. In order to reduce the construction period the entire building structure for such Mini plants are designed with modular concept having low height building and light steel structures, steel grating floors, etc. Concrete is used only for foundations and for mat concreting of the Ground floor. With this type of structures, it is feasible to complete the construction work within 6 to 7 months time. It is essential that all details are available before the starting of the construction activities. By the conventional methods of drawing/detailing, it is very difficult to complete the entire detailed engineering before the starting of the construction activities. With the extensive use of CAD it is possible to visualise the complete plant with all minute details. Any changes required during execution can easily be incorporated in the drawing with the help of CAD. The positioning of Chutes, vis-a-vis equipment can be checked before hand with 3D-diagram of the plant. This greatly helps in fabrication/ manufacturing without asking for any major rectifications. This also helps for quick erection of equipment.

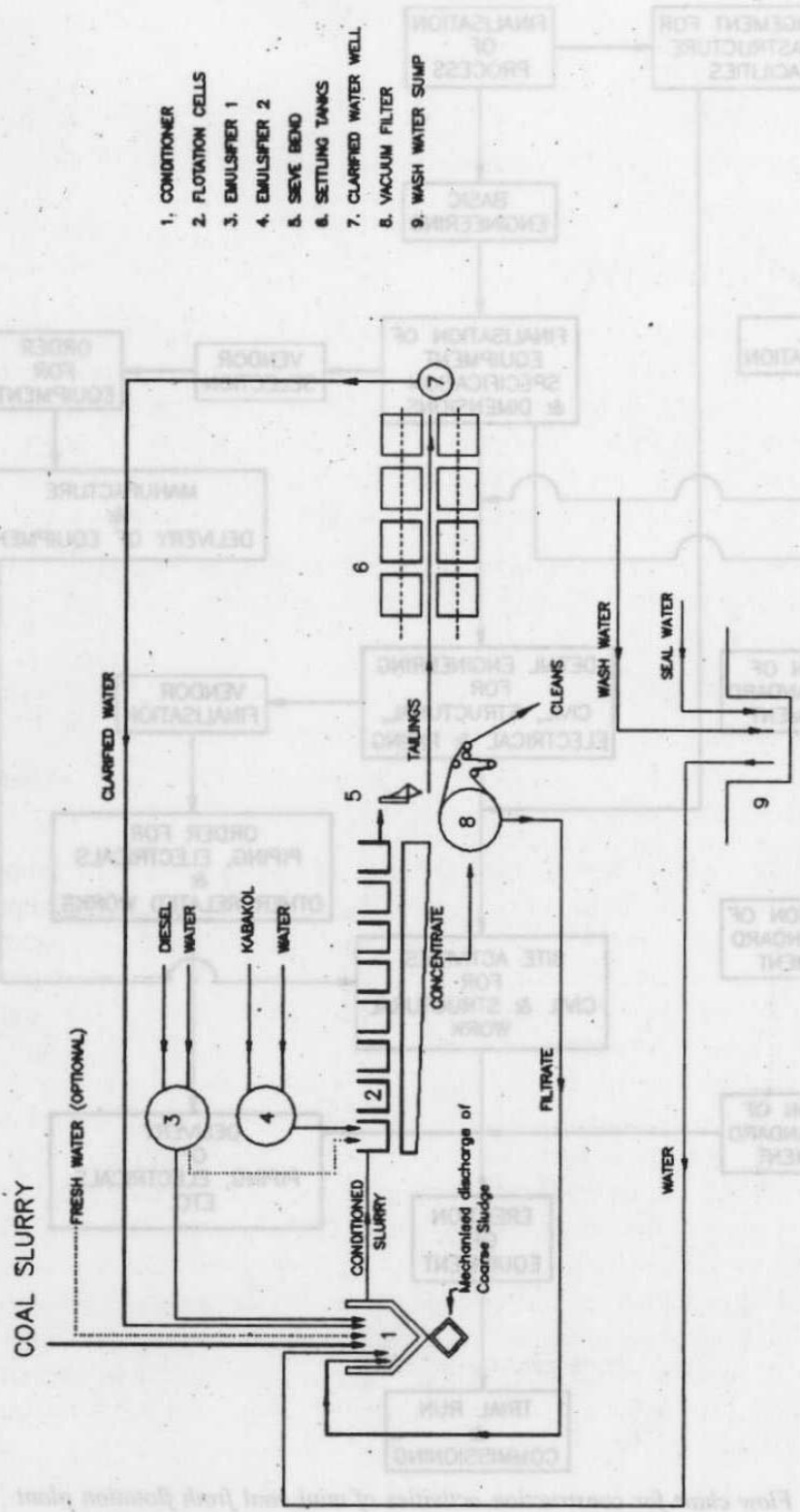

Fig. 1 : Flow sheet of coal froth flotation plant

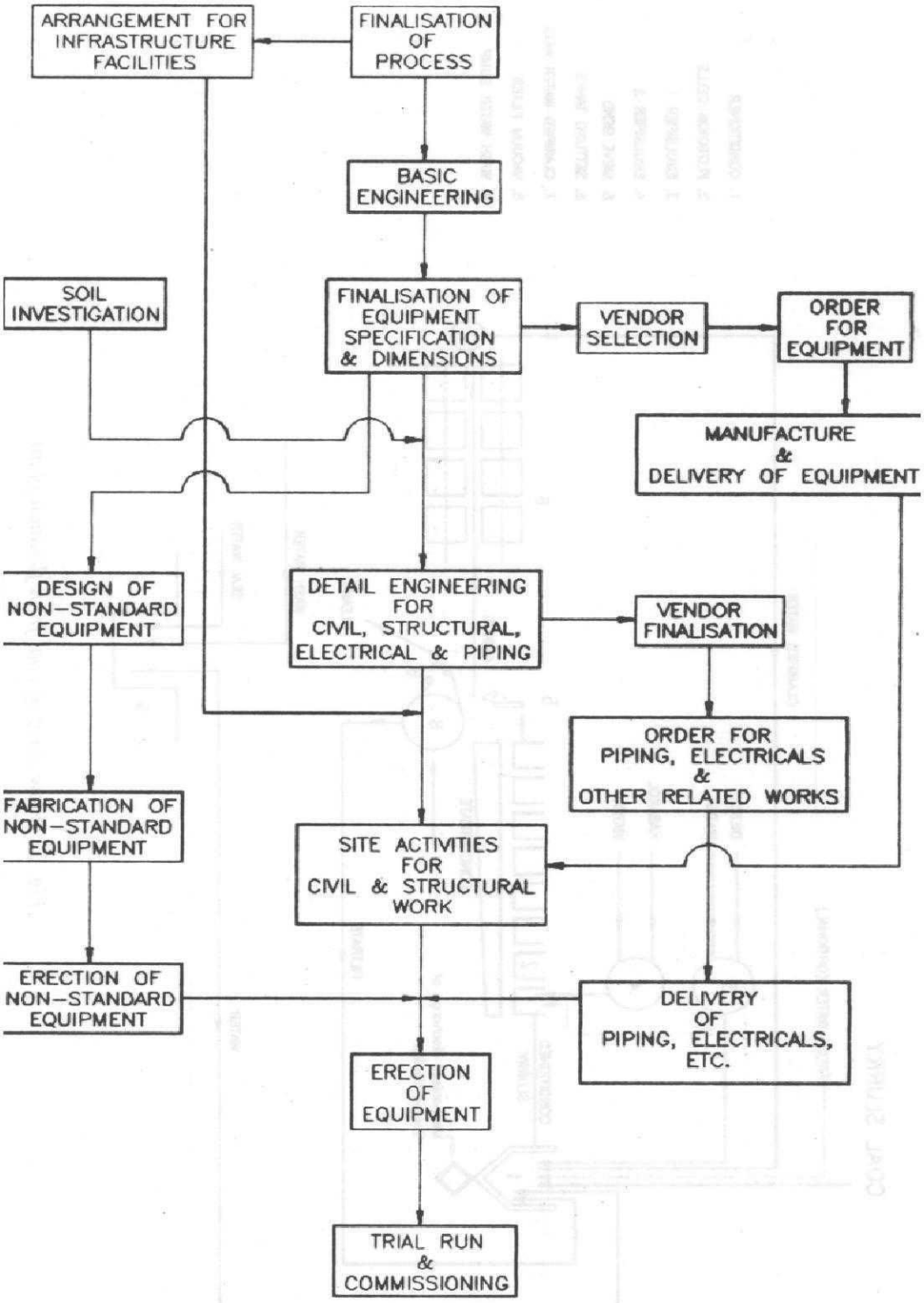

Fig. 2 : Flow chart for construction activities of mini coal froth flotation plant

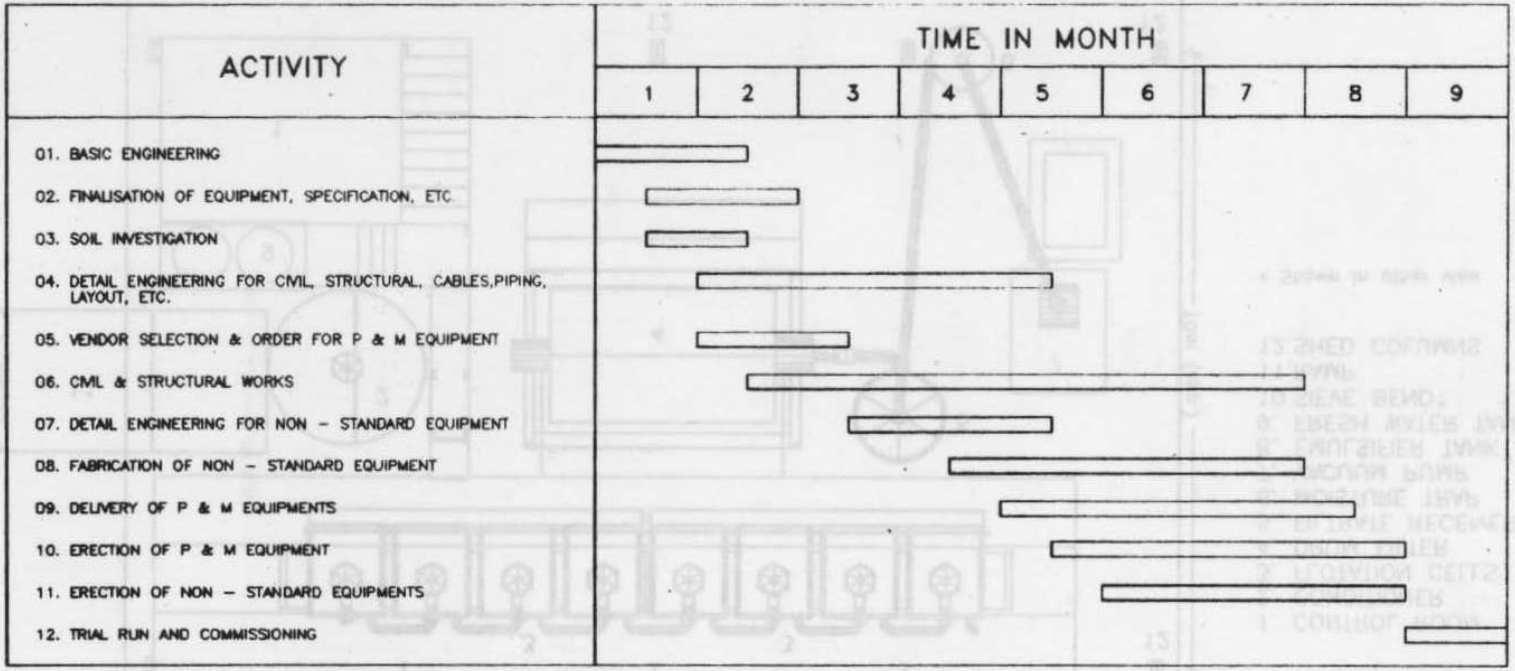

Fig. 3 : Project schedule for mini flotation plant

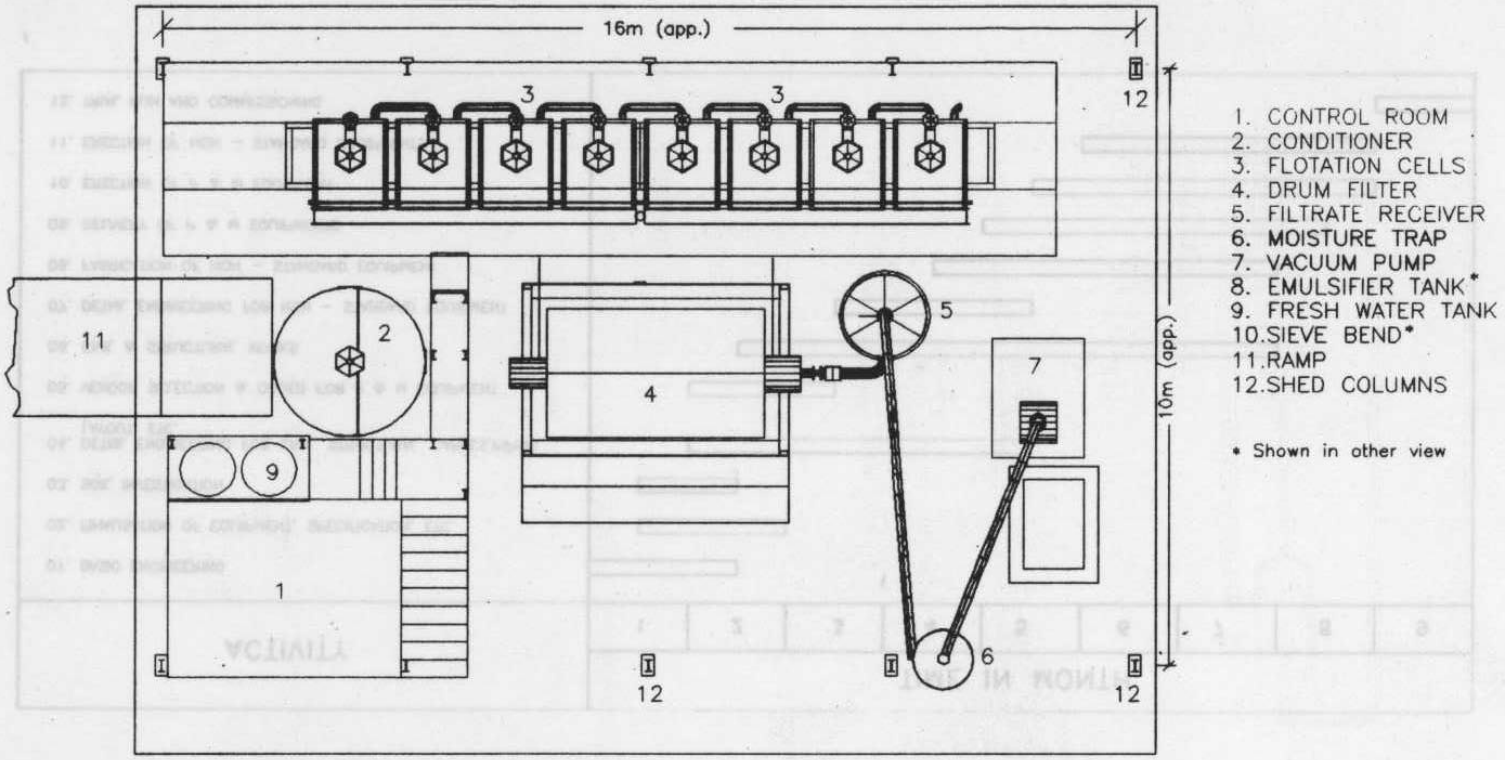

Fig. 4 : G.A. of a typical coal slurry froth flotation plant

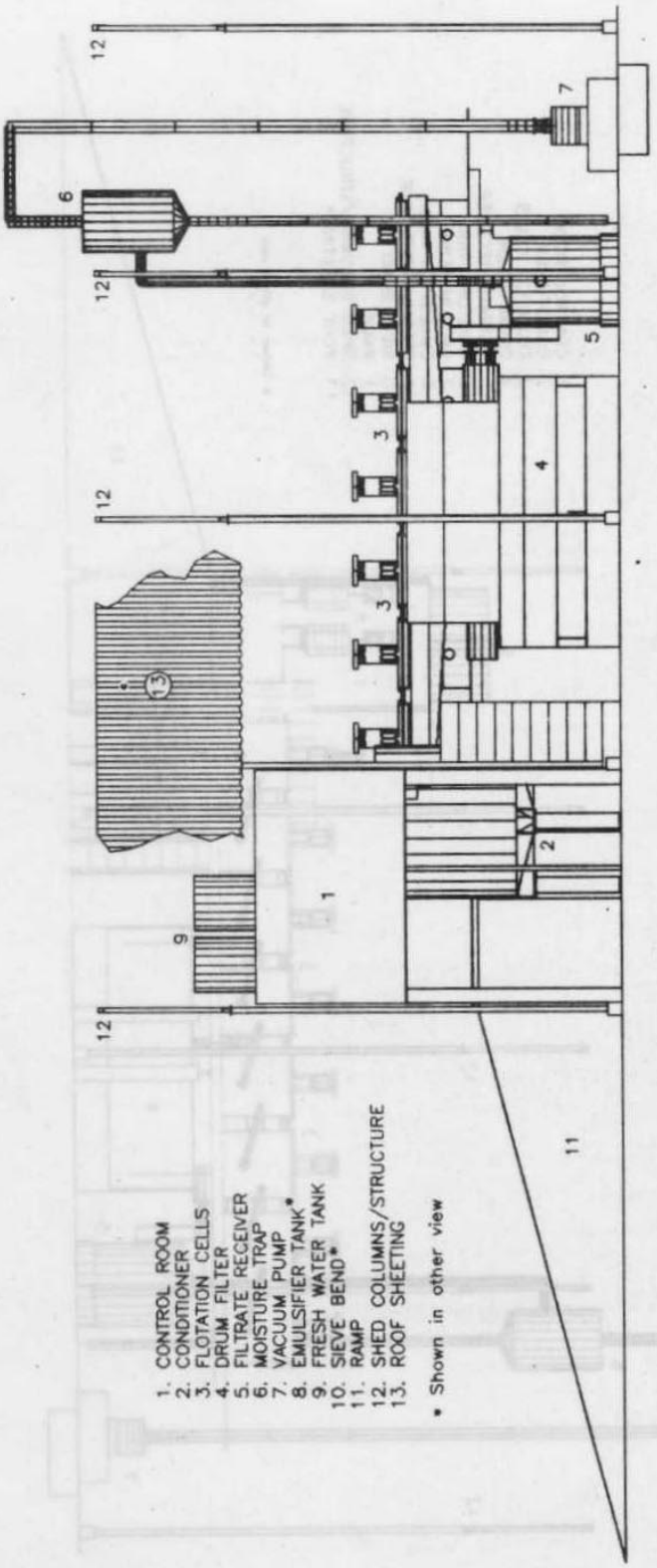

Fig. 5 : Front side view of a typical coal slurry flotation plant

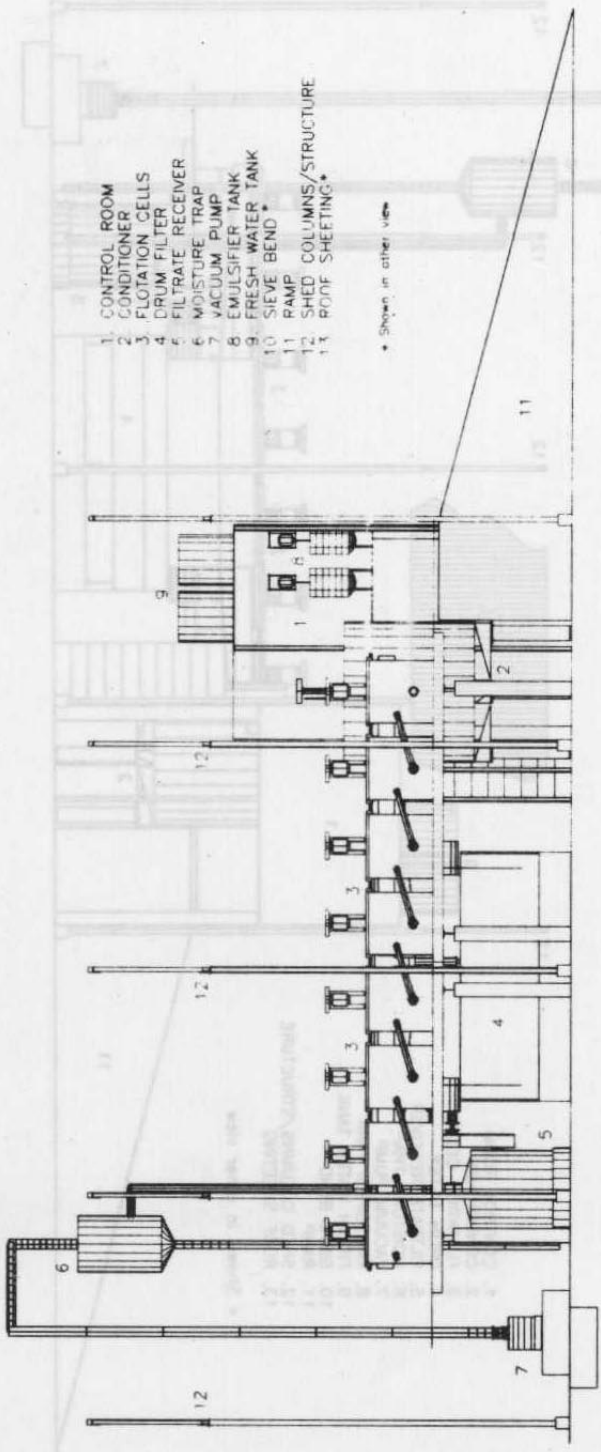

Fig. 6 : Rear view of a typical coal slurry flotation plant

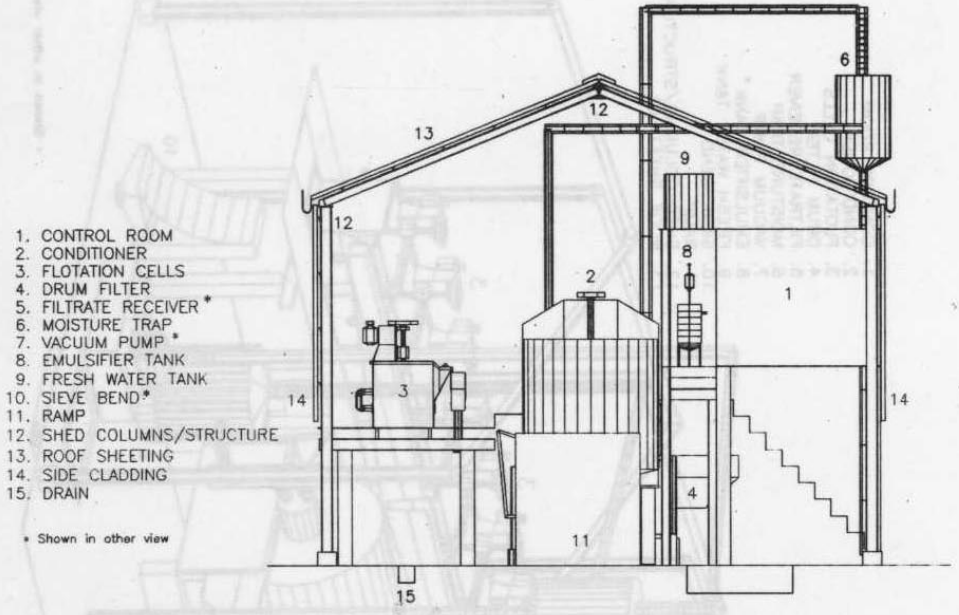

Fig. 7 : Left side view of a typical coal slurry flotation plant

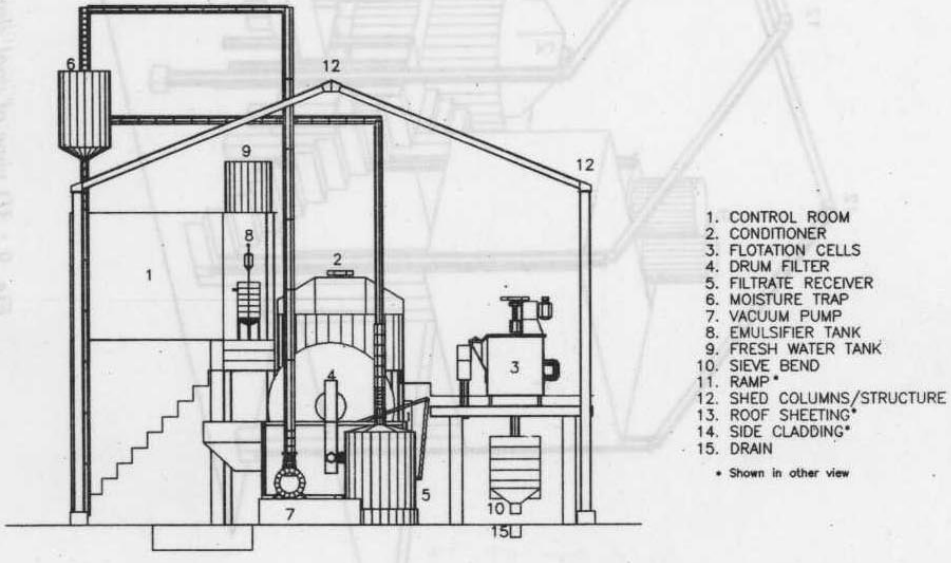

Fig. 8 : Right side view of a typical coal slurry flotation plant

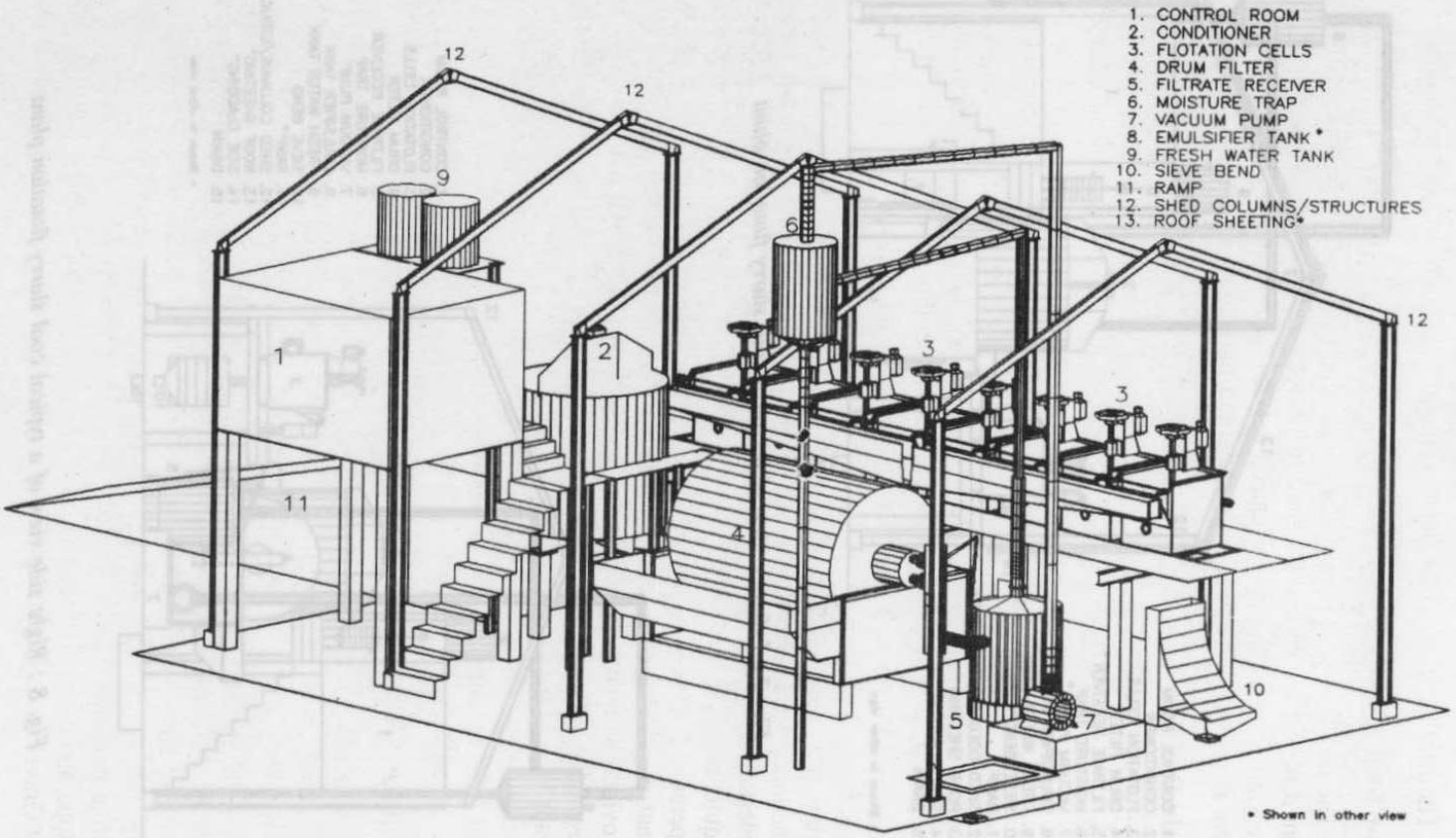

Fig. 9 : 3D view of coal slurry froth flotation plant developed by CFRI

The Mini fine coal beneficiation plant[4,5,6] has the following sections:

Raw Coal Yard

The raw coal yard is provided for storing raw coal slurry brought by trucks from different washeries. The yard is located besides the main building of plant. The yard is covered with corrugated galvanised iron sheets and sufficient head-room is provided for truck unloading and movement.

Main Building

The Main building which is the heart of the entire plant is a canopy type structure based on steel columns and joists with corrugated galvanised iron roof sheeting and necessary side cladding. All the major equipment such as conditioner, flotation cells, drum filter, moisture trap, sieve bend, etc. are placed and oriented in modular concept so as to reduce number of floors and height of the building. Control room, the nerve centre of the plant is also located in the main building in such a way that all the major equipment of the main building is clearly visible form it, which helps in easy and optimum operation of all the equipment. All the equipment of the plant such as Conditioner, Flotation cells, Drum filter, etc. are placed at required location (x,y,z) to suit the necessary functional demand for better performance of the equipment. Short columns and pedestals are provided for maintaining levels of the equipment as per process requirement. Walkways are provided for easy approach to the equipment for Operator/ Engineer, so that they can monitor operation of each and every equipment physically and reach the maintenance points easily. The walkways are provided with chequered plate flooring and are supported by steel structures. The base floor of the plant is of PCC (Plain Cement Concrete) with slope towards the drain located beneath the flotation cells. Drain is provided in such a way so that it can easily drain all the spillage of chemicals, water, tailings, etc. on the floor and floor remains dry. This drain also serves the purpose of draining the tailings to the tailings pond which is located nearby at convenient place.

Tailings Pond

The tailings from the flotation cells are taken to settling ponds. The tailings are settled in this pond and clarified water is percolated to a well from where it is fed back to the system for re-use. The tailings pond is located near the main building in the plant premises. It is positioned comparatively in low land, so that the tailings discharge can be easily drained into the pond by gravity through a channel constructed with brick masonry. Tailings ponds are constructed by excavating earth, with proper slope and depth. The walls of ponds are made of stone masonry. The floor of the pond is of special design having longitudinal slope and a cross slope from both sides towards the centre. Floor bed consists of Gravel / Clinker. The tailings from the process will enter the ponds at one end

through channel. The solids will settle over the Gravel / Clinker layer. The water will percolate through the layers of Gravel / Clinker and ultimately collected in a well through centrally located loose jointed SW pipes, laid on floor along the length of the pond. The clarified water, collected in a well located near the tailings ponds is re-circulated in the circuit. Excavators excavate the settled and dried tailings. Roads around the tailings ponds are provided for easy movement of excavator, etc.

Clarified Water Well

All the water, which is retrieved from the tailings in settling pond, is collected in Clarified water well, through an arrangement made by loose-jointed pipes in tailings pond with necessary slope and orientation. The Clarified water well is located near the tailings pond and it can be lined with stone or, brick masonry. The collected water in the well is re-circulated in the circuit through a pump. This process is useful in lowering the fresh water requirement and it also serves the purpose of environmental controls by zero discharge of the effluent out side the plant.

Over Head Tank

Ready-made portable water tanks mounted on steel structures are provided to meet the requirement of process water.

Laboratory Building

Laboratory building is located near the plant. A small flotation cell (prototype of the actual cell) and other accessories like laboratory filter, balances, furnaces, etc. are provided for better monitoring of desired product quality and monitoring of input quality of slurry.

Office Building

Office building is located at a convenient place in the plant premises preferably near the entrance. It is constructed with brick masonry, RCC roof slab and first class patent stone flooring.

Clean Coal Yard

Clean coal yard is located near the product discharge so that product can be easily taken to the yard. Approach road is provided for transporting the clean coal. The yard is covered with corrugated galvanised iron sheet roofing with necessary side cladding.

Conveyor Belt

Conveyor belt is used for transporting input slurry from raw coal yard to conditioner and also for transporting clean coal for truck loading. Conveyor Belt

also reduces the manpower, which in turn reduces the running cost of plant, resulting in better economy. Conveyor gantries are of steel structure, supported on steel trestles.

CONSTRUCTION

The inter-connected activities considered for construction of plant is shown in the flow chart (Figure 2). The time schedule of different activities is shown in bar chart (Figure 3) indicating completion of the plant within nine months. The entire plant is designed with modular concept. The length of material handling is kept minimum. As far as possible the layout of the plant is kept compact, which helps in quick construction. The layout is designed to suit the various plant features and technological requirement. The detail layout design is made simple and easily maintainable. Monorails are provided for all major equipment in the main building. With these features of layout and design it is possible to operate the plant with maximum efficiency and to install the plant in shortest possible time.

For a clear concept idea about the plant, Bird's eye view, plan layout and side elevations from various view points of the plant are shown in Figure 4 to 9.

CONCLUSION

This paper concludes with the following points: -

i. Infrastructure like land, water, power, approach road, etc. must be ready before the start of the project.

ii. Computer aided design and drawing is necessary for better planning, design and quick construction of the plant.

iii. Computer aided design and drawing is also useful for revision of drawing in case of any changes required during erection of plant.

iv. 3-D drawing using ACAD is very useful to visualise the position of equipment and other details of plant prior installation of the plant.

v. The structure of washery building is made of steel, which helps in early construction of plant, rather than concrete structure, which takes long gestation period.

vi. The washery plant building is of low height than conventional concept of high rise buildings. In this Mini flotation plant all the equipment are placed within a single canopy structure with small steel grated floors as per requirement.

vii. Control room is provided in such a position so that all the equipment are visible from the control room. In the control room all the electrical controls are installed so that one man can monitor the entire plant operation.

viii. Settling pond is made near the plant in low land (if possible) and of special design which helps in re-circulating the water collected in a well to meet the plant water demand. This system is full proof with 100% closed circuit operation and zero discharge.

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