The Installation of a New Paper Machine

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The Installation of a New Paper Machine :

The basic object of everyone whether building a completely new paper mill or just adding a paper machine to an existing plant is to produce a viable installation capable of producing an excellent product coupled with making a profit for the Company. In preparing this paper I have been conscious of the fact that it is by an Engineer talking to those with many years experience of paper machines. Consequently I have refrained from dealing with those aspects of machine design with which the paper maker will be fully conversant. I have concentrated on the problems associated with the project design and administration.

A paper or board machine installation entails a very large capital investment running into many crores of rupees and it is an economic necessity that some return on this investment is made at an early date. This means that the planning stage must be well ahead before large financial commitments are made.

A clearly defind policy dictating immediate and future aims will provide an answer to the several questions of site, size and cost.

Site :

To make a project viable an investigation to determine the site for machine will require consideration of the following points :—

(a) Transport facilities for raw materials.

(b) Fuel costs in any particular area.

(c) Adjacent markets for finished goods.

(d) Availability of labour.

(e) Proximity to adequate housing accommodation/ammenities.

(f) Availability of water supplies in the quantity and quality required.

(g) Problems of effluent discharge.

(h) Ground conditions and type of foundations, drainage, access.

(i) Space for future development.

A full assessment of these points together with a study of market potetnial will allow a general policy decision on type and quaentity of production and where the machine is to be installed.

Many of the problems now to be considered will be common to the extension of an existing plant or to a new site, except that in the former case site layout and services will be influenced by existing conditions.

Preparatory Works :

The basic factors of the mill will be determined by the type, quantity and quality of the finished product together with the availability of raw materials. This will determine the type of pulp mill required, the stock preparation system, the type of wet end, the extent of the dryer system, capacity of the finishing department and raw material storage, the power required, water and steam requirements. A deteailed examination on the above points will decide the type of equipment required which in all probability will be examined by a joint planning group including Engineers and members of the production departments.

This group will be responsible to a senior member of management who has the necessary authority to make immediate decisions without which the tempo of the project is somewhat slowed. This group will study the follow

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ing facts on which detailed designs will be based.

Preparation Plant
Type, speed and Width of machine
Finishing Plant
Raw materials, storage and handling
Auxiliary plant, coating, sizing and smoothing etc.
Finished goods storage
Services such as steam, power, water and effluent
Personnel
Amenities
Administration and Accommodation

Each of these subjects calls for a detailed study and on a project of any magnitude such work can no longer be considered a part time job and necessary staff must be appointed either from. within or outside the orgnisation. All such personnel will be fully occupied throughout the planning and construction period but unless a continued programme of expansion is anticipated their further employment may be in question. It is in such a case that consultants can offer a service.

Once the basic fundamental questions of quantity, speed and methods have been established preliminary site plans, machine layouts, production, steam and stock flow diagrams can be prepared. Studies of power plant, steam, electrical, water distribution, compressed air services and instrument control systems can proceed. On this basis preliminary estimates can now be prepared in support of the original cost assessment. It is at this time that standards should be set for various items of equipment throughout the plant, to avoid too many items being duplicated and un-necessarily stocked as spares.

It is now that a clear picture of the project, its extent in time and money and the contribution to immediate and future profitability can be seen. Financing can now be arranged and approval given to proceed with the design and construction.

Planning and Coordination :

It is an economic necessity that the time interval between the granting of financial approval and the commissioning of the plant as a production unit be reduced to a minimum. To reach this objective, careful planning and co-ordination is essential, The most important requisite is that the design shall be finalised in every aspect, only then can specifications be prepared, orders placed and delivery dates agreed. A construction programme can then be prepared based on major delivery dates and contract time. This will give a broad base to the desired completion date, but this programme in turn must be broken down into considerable details to ensure that every aspect of the work proceeds in accordance with requirements.

The first essential is an engineering staff competent to handle the design, purchase, installation and commissioning. Reference has already been made to consultants, and such services used in whole or in parts must be associated with an organisation capable of maintaining close liaison with the companies operational and engineering staff. Basically the staff involved in managing a machine installation would comprise as follows :—

1. Chief Engineer or Project Manager
2. Consultants
3. Architects and quantity surveyor
4. Project Engineer
5. Mechanical Engineers
6. Electrical Engineers
7. Power Engineer
8. Instrument Engineer

To aid the above personnel there will be a group of assistants together with drawing office personnel, purchasing personnel, progressing and general clerical staff.

Contract Procedure :

The degree of controls exercised by the engineering staff will be influenced by the type of contractual procedure adopted. Three possible alternatives are:—

1. Consultants and/or Architects can be authorised to design, plan and manage the job.
2. A main contractor or contractors can be authorised to undertake the design and planning and to employ subcontractors.
3. An organisation having strong engineering and management staff can accept full responsibility for the design

and management. Letting all main and sub-contracts direct whilst retaining full control for technical design and job management.

I would just like to pass some further comments on point one and two. The arrangement mentioned in point one is most beneficial to those organisations which lack a staff possessing the necessary skills and the experience. The first requisite is a definite brief of the clients requirements. The second a readiness on the part of the client to delegate the necessary authority and to define the limits of responsibility and to interfere only on major issues.

With regards to item 2 such an arrangement calls for some form of payment for design and management over and above the contract charge.

Both these arrangements call for a minimum of supervision on the part of the client, but have the disadvantage that he can exercise little or no control over the speed with which the job is completed.

There are various forms of contracts which can be used for a machine installation project.

(a) Cost plus
(b) Unit price
(c) Contract sum

Cost plus has the virtue of enabling bulk orders to be placed for long delivery items immediately financial approval is given. It is also possible to progress the work in step with the completion of the design and permits alteration in plans as the work progresses. This procedure is not generally favourite because of the difficulity in determining in advance the probable cost and increases in the final total. It still has some use on jobs in which it is impossible to define the extent of the work and to estimate the cost.

The Unit price contract is applicable to structural steel work, civil work, mass/concrete and major pipe and cable installations where an agreed rate per ton per linear yard or per cubic yard can be adopted. Again this procedure permits an early commencement of work and the early ordering of long delivery items. With this type of contract it is possible to more closely estimate the final cost but it entails extensive measurement. Such measurements must be carried out with each stage of the work and agreed between the clients representative and the contractors.

Contract sum, is by far the most satisfactory arrangement and providing the planning is carried through with despatch, the total contract time should be no greater than with other procedures. It entails the completion of all design information essential for competitive tendering and it is incumbent on the client to finalise designs and to minimise last minute alteration.

However, exact the specification there will always be a divergence in both price and contractual coverage. Again I will stress the importance of the client finalising his design such that early orders can be placed without extending the contract period and also the contract price. In this world of soaring prices the validity of many quotations is only for one, two or three months as a maximum and a requote will often have an increase of 10% plus.

It should be noted at this stage a table of comparisons should be prepared and the price far below the general average viewed with suspicion. It should be noted that a contractor whose price is far below the average has probably made a mistake or is desperate to get the work. He will be equally desparate to make a pro fit and the customer will spend in supervision and litigation all that he had hoped to save on price.

Job Control :

Progressing of plant and materials in accordance with programmed deliveries is best achieved by personal visits to manufacturers. The importance of co-ordinating the efforts of manufacturers, main and sub-contractors is obvious to all, but it is not easily achieved. Site meetings at regular intervals are essential. To obtain the best results such meetings require firm handling and should be under the control of the site engineer. All main contractors should be represented and sub-contractors included as the progress of job demands.

Buildings :

For all, but the most elementary assembly systems the buildings should be designed about the process they are intended to house. The complete structure

has several functions :—

(a) To provide a firm foundation on which to mount the process plant.

(b) To insulate the plant and personnel from changes in temperature and humidity.

(c) To afford some degree of privacy.

(d) One thing which must not be forgotten, to satisfy the aesthetic requirements of the community.

The Civil Engineering and Building work includes foundations, load bearing structures, weather proofing roofs and walls, road, rail and river access. Most of this work must be completed before the installation of plant and services can begin. This completion is subject to all the exigencies of material deliveries, labour problems and weather. In this industry the choice of building is limited by the nature of the process and plant. The merits of basement versus first floor depend on the type of machine.

Pre-cast concrete construction has much to be recommended although vibration effects must be taken into account when preparing the design.

Power Supply :

In the Paper Industry the generation of Steam is accepted as part of the manufacturing process, there being no other source of supply. Such is not the case with electrical generation where the public system is invaribably available. The decision to purchase or generate electricity must, therefore be made after due consideration of all the factors, including steam and power, balance and running cost. A paper mill in common with one or two kinds of industries uses power in the form of steam and electricity in such proportions that an econmic thermo balance can be maintained. Such a balance together with a relatively constant load condition is ideal for thermal electric generation with its high overall thermal efficiency of 75–80%.

A large paper or board machine operating at a reasonable efficiency will have a steam requirement of :—

(1) 7,500 pounds of steam per ton of production for drying.

(2) 1,600 pounds per ton of production preparatory plant.

(3) (A varying quantity for space heating).

This may amount to some 200,000 pounds of steam per hour. Electrical demands may well be :

(1) For preparatory plant 200 Kw/ton of production.

(2) For main drives 260 Kw/ton of production.

Normally when electricity is purchased in quantity of this order satisfactory tariffs can be negotiated. Electrical generation can only be justified if the overall economics of steam and electricity are evaluated. If electrical generation is not to be undertaken, steam will then be generated using low pressure type of boilers or medium pressure economy boilers. These offer the advantages of :

(a) Simplicity

(b) High steam capacity

(c) Relatively low initial capital costs

Maximum economy costs, space, operation can be achieved by using water tube boilers of medium and high pressures. There are various industrial installations using pressures in excess of 1000 psi but with high pressure plant greater skill in operation and maintenance is required.

For a high efficiency thermal electric station the main generating equipment will be a back pressure turbines directly coupled to alternators generating at 6.6 or 11 KV. Such units operating on fixed voltage, frequency and back pressure, provide an output which can vary only when the increase or decrease in heat and power requirements are in balance.

Because out of balance does exist the provision of suitable means of dealing with daily and seasonal variations must be provided.

This is normally achieved by running in parallel with the Grid. This arangement has much in its favour because power can be exported or imported in accordance with demand, voltage and frequency are held steady and the inter-connections afford a stand by supply.

The question of boiler fuels must

be considered. For some years yet nuclear generation will be out of reach of the average plant. The choice then lies between oil and coal, and with the present price of oil I would think that coal has advantages but a great deal would depend on the location of the site.

Steam Distribution will be direct from the Low Pressure main in the Power Plant, with all welded mild steel steam mains being the usual practice. A carefully planned installation will make due allowance for suitable anchorage and expansion joints. Correct pipe sizing is important to minimise the effect of pressure drops. A suitable degree of super heat is essential in long runs to eliminate the possibility of wet steam. Steam trapping systems are a subject on their own but adequate capacity to clear maximum quantities at time of start-up together with full control at normal rates is essential. Maximum recovery of condensate free from contamination will minimise the need for boiler feed water make-up.

Machine Installation :

This starts with the preparation of the site, the determination of a datum and the marking out of foundations. The piling will be the responsibility of a contractor and there will probably be a variation clause dependent on the length of pile. It is incumbent on the site engineer to supervise the check drives. This consists of driving a pile until further penetration under a set series of loads is limited to a prescribed figure. Concrete for foundations, flooring and for structual work will be to a specification calling for a volumeetric measure of cement and aggregates and checks should be made and samples prepared in accordance with an agreed schedule.

Usually all foundation work together with structual steel or concrete must be completed together with a necessary weather proofing before the cranes can be installed. This is not always necessary in India providing that the various seasons can be counted on.

The machine erectors will be responsible for establishing their centre lines. These will be checked by the Project Engineer. The installation of sole plates will follow to be again checked on completion. The erection of the plant will proceed in parallel with the building of filters, chests and tanks and the installation of electrical equipment.

Careful planning of the installation is essential to ensure access for plant due at a later date. Close supervision of painting contractors is necessary to ensure nearness to the specification. All the lubrication systems and compressed air lines must be purged on completion, pipe systems must be checked for alignment and due regard paid to expansion and anchorage of all pipes subject to change in temperature. Pipe work must be freely supported and guided such that no strain is transferred to associated plant.

Basic Design and Development of Project

The basic design will influence the whole aspect of commissioning a new machine. A repeat of existing installations will call for an increase in personnel but will require a minimum of new technique or know-how, whilst a radical departure from existing units will entail the careful selection and training of supervisory staff, maintenance and operating personnel.

Organisation of Construction Programme and Trials

The progress of the project so that plant is installed and tested in the correct sequence will permit the operating personnel to become acquainted with the control of each section and will facilitate the final machine trials.

Commissioning

To commission a new machine a great deal of pre-planning is essential and much of the planning must proceed in parallel with the building of the machine, and the building completion date to which so much importance has been attached, is the starting point for commissioning.

The successful start-up of a new machine and the early attainment of a high level of operating efficiency are dependent on a number of factors such as—

(a) Careful selection and training of operating crew.

(b) Testing of plant as it is installed. This is normally carried out by the machinery manufacturers engineers who are

specially trained for this function.

Crew Selection :

Normally a new machine will include many new features, ranging from increases in operating speeds to a complete departure from orthodox sheets formation and stock preparation. This together with new techniques associated with instrumentation and automatic controls will require careful crew selection. The mental and physical demands of the various jobs must be analysed and the ability of the individual to measure up to these standards must take precedence over other claims.

Training of Operation and Maintenance Crew :

The men who are to maintain and operate the machine should be fully conversant with the geographical layout, the operational controls, the design principles underlying the construction, the plant capacities and any departures from earlier machines.

To achieve the desired results one or two leading hands should be seconded to the construction department for a period of not less than three months prior to completion of the project. They should have a broad programme of investigation and should prepare weekly reports which will form an invaluable hand book and history of the plant.

On a Project departing radically from previous concepts, some form of discussion and lecture will be necessary. This applies particularly to installation of automatic controls, instrumentation and the complicated electrical or electronic drives.

Training lectures should be prepared by a review of the project outlining the planning of raw material handling, manufacturing processes and despatch. These preliminary talks should be clear and simple, broad in their concept, limited in duration and designed to paint the picture of managements intentions, to install a feeling of confidence in the programme and to indicate the part the crew is to play.

The lectures should be of interst to everyone associated with the equipment and will ensure a general understanding of the process. A detailed knowledge required by the specialist will be built up by discussions and examinations by those directly concerned. During the commisioning period these lectures can be further enhanced by discussions with the machinery suppliers commissioning team.

Such a training programme demnds time and money, and to achieve the desired results should be under close management supervision.

Operating and maintenance procedures should be established well in advance by the production and engineering groups and put into practice on start-up. Both will act as a final check on plant condition prior to putting stock on the machine.

Start-up

Plant Checks :

As each unit is completed it will be checked mechanically and electrically attention being paid to directional control, limits of operation etc. This is the engineers confirmation of the effectiveness of his work. Only operational conditions will confirm the final results.

A machine running even at a reduced speed consumes a lot of valuable raw materials and presents a problem of broke disposal of considerable magnitude. Consequently the machine must produce a salable comodity as soon after start-upas possible. To this end the mechanical and electrical tests will be followed by water tests.

(a) To confirm that everything works.

(b) To enable the joints to be made up and various instruments to be calibrated etc.

It is also a good idea at this time to record the no load conditions for all drives, pumps, fans etc. The period of plant commissioning will be under the direct control of the project engineer with the co-operation of the operating personnel and machinery manufacturers representatives. To minimise delays and misunderstandings an overall programme should be prepared and daily discussions held.

Prior to the start-up as many contractors, their plant and surplus material should be cleared from the site. A programme of

inspection and cleaning of each section prior to testing should be put in hand. This should include such items as cleaning out of sewers, chests, water tanks and pipe lines.

Electrical over load protection should be set to the required values. Steam safety valves and pressure reducing valves should be adjusted ready for the official inspection

Safety

Increasing attention is being given to safety in all phases of industrial life. This is now extending to civil engineering work and safe methods and practices will be required on all new installations. This is additional to and quite independent of the normal safety precautions associated with the guarding of a new plant. To conform to the new requirements a safety officer should be appointed on all projects and his will be the responsibility for seeing that the installation work is carried out in a safe manner.

Conclusions

It is impossible on a project of paper machine callibre to start-up the complete equipment without having a number of minor items to be completed or corrected. This together with the agreement of bills of quantity and settlement of accounts may well take a further twelve months. During this time the whole of the plant inventory and plant history should be completed. The plant inventory should list under group headings details of equipment, date of purchase, initial cost of replacement and anticipated life. This latter item has been dealt with all so vaguely in the past and it is strongly recommended that considerable attention should be paid to this assessment especially for machines in outlying areas. For example, machine dryer installation and machine calenders, a life of 60 years or more can be anticipated whilst cutters and winders should be written off after some 30 years. Vats of conventional design may well give 25 years life whilst moulds, press rolls etc. will be replaced as revenue items. Considerable importance is attached to this life assessment as given suitable financial provision the problem of obsolescene and the decision to scrap and replace is more easily resolved.

Plant history should be in considerable detail. Each heading should cover a specific piece of plant, the details of its original order, reference to drawings, its capacity, method of drive, date of purchase should all be recorded and from this plant history maintenance schedules can be prepared.

In conclusion I would just like to highlight the items which are considered to make a good project :

(a) A first class feasibility study.

(b) The early assembly of a good production/engineering staff.

(c) A project manager who is given every authority to make final decisions.

(d) The early finalisation of the main concept of the project.

(e) A well co-ordinated erection programme.

(f) A pre-machine start-up training programme for operation and maintenance staff

(g) A planned maintenance programme implimented from the first day of start-up.

(h) Finally a well co-ordinated and planned start-up programme.