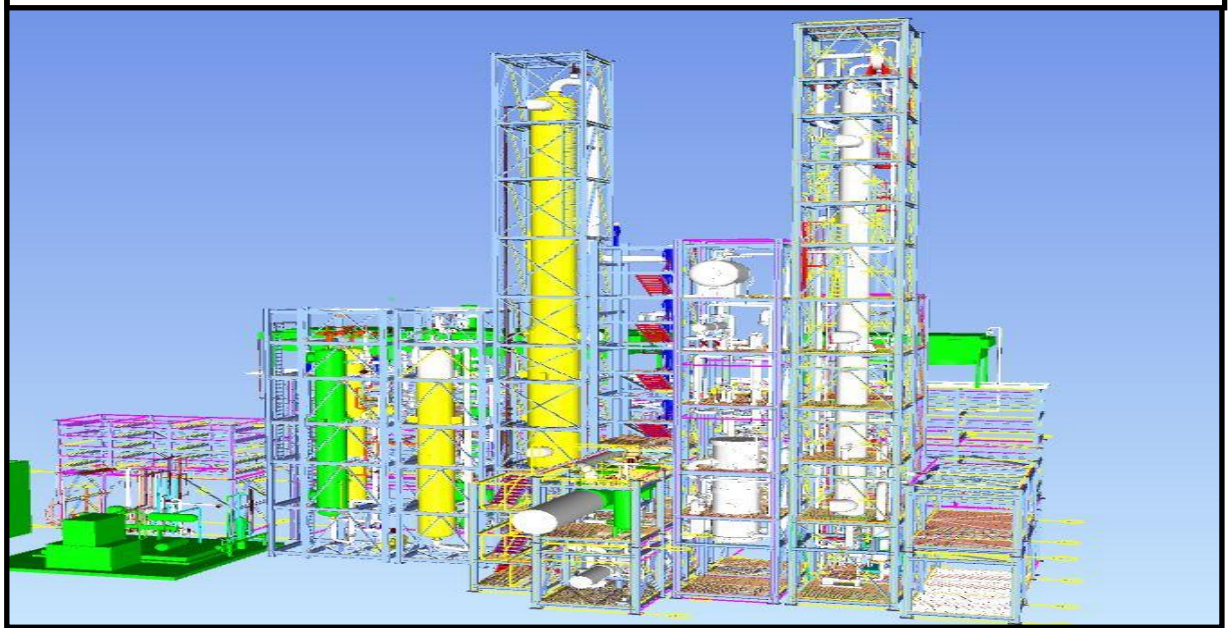
Go Modular

-Atul Choudhari.



Motivation:

Economic scenario of the world is changing rapidly. Due to the volatility in oil and natural gas prices, there is still uncertainty in supply, demand and pricing of chemicals. Considering advancements in technology, new investments are happening in remote areas which are close to either raw material sources or to the end user. Availability of skilled labours poses a major challenge in such remote areas. New projects are being sanctioned and executed with a very tight schedule. Project execution strategies are increasingly focused on completing projects in shorter time spans. Under these circumstances, and as an alternate methodology, modular plants are becoming viable options. Modular design concepts are, though not new, are hence again gaining momentum. Modular plants offer several advantages over conventional stick-built type of plants. This paper briefly discusses modular plant design concept and its applicability.

Modularization Concept:

Modular plant concept can simply be described as construction of an actual plant carried out off the actual site in such a way that after completion, it can be easily transported, erected and integrated with other required utility facilities. In simple words, plant is built in several pieces at a location other than its actual site. Modular plant concept allows for project engineering and construction activities to be carried out in parallel. While site infrastructure development and site construction is under progress, modules can be built parallel off the site. Compared to the sequential activities associated with conventional stick-built approach, parallel activities results in significant reduction in the project schedule. Entire plant is split in various modules so that individual module can be transported to site. Number of modules for the given plant depends on size limitations of transportation mode. Modules are complete with all equipments installed with its associated piping and necessary instrumentation with minimum work requirements at actual site. Modules are built so as to minimize site work which typically includes final interfacing or hook up with central utility systems and integration with site pipe network, interface with electrical and instrumentation wiring, integration with control systems, etc.

Drivers for Modularization:

Potential to complete projects in shorter time spans is one the major drivers for modularization. Prefabrication or construction of modules in workshops allows building a plant in parallel to site construction activities. This approach can significantly impact overall project schedules. For certain new products, (FMCG sector for example) agility is an essential element for product launch in order to get higher market share amongst competitors. Since, modular design concepts have potential to reduce project execution schedules; it is undoubtedly ‘go modular’ decision for such cases.

Many times the choice to go modular is dictated by availability of skilled labours at actual site. New discoveries in hydrocarbon industry in particular are observed to be located in remote geographies and such projects may be constrained by labour factor. Sometimes, political instability in specific states or locations makes it difficult to manage labours. Sometimes, it is not only the availability of labours but the affordability of labours influences overall project dynamics. Cost and schedule are the two major contributors towards success of given project and modular plants can offer both benefits. Generally, site construction is restricted to curtailed activities during monsoon period. Remote locations may offer severe weather constraints (Extreme heat and cols countries) restricting construction activities. Limited resources and infrastructure limitations on remote sites hampers overall efficacy of the project implementation plans and such cases are main drivers for going modular.

Quality of construction also influences the decision to go modular for certain projects. Fabrication shops often offer a controlled work environment that enhances quality of construction. Delays and issues related with work permits, material movement, crane availability, stoppage of work due to weather conditions can be best avoided and managed by going modular. Handling the construction waste could also drive the decision to go modular in case of remote locations. Repeatability of modules is also one of the main drivers for going modular way. A standard capacity module can be designed to act as a base module for base capacity and further repeatable units can be added to increase overall capacity. Significant amount of time can be saved by repeating 'off the shelf' modular designs and adding number of such modules to meet the capacity requirements helps in reduction of sizing, engineering time.

Advantages of Modular Designs:

Since process units can be fabricated in the controlled environment of a workshop, it is relatively a safer area for construction purposes. Typical site issues associated with working at heights, crane availability, work permits; etc can be tackled more effectively as the constraints of site infrastructure are not applicable. Due to the lower exposure to field related hazards, Modular approach increases workforce safety. Modules fabricated in offsite workshops are complete with all the equipments, its internals, connected piping and necessary pre installed instrumentation along with required supports, platforms, etc. Equipment and piping systems are already hydro tested at workshop. DCS or PLC system is also tested off the site. When extensive factory acceptance tests are required, it can be conducted at off site location with modular design approach. With this, there will be a minimum amount of site work (mainly hook up with site interfaces) that is expected before commissioning. This process can speed up the start up time.

Modular approach offers flexibility in terms of capacity of the plant. By running fewer modules when the product demand is less, it can be used to increase operational efficiency. Also, modules can readily be transported to any other site based on product logistics requirement. This feature is advantageous especially to various test facility set ups or pilot technology plants which can be easily moved from site to site. Standardized 'off the shelf' designs are easily repeatable. Due to the nature of modular design approach, project costs and schedules can be predicted more accurately as it is shielded from typical site disturbances like weather, labour availability, etc.

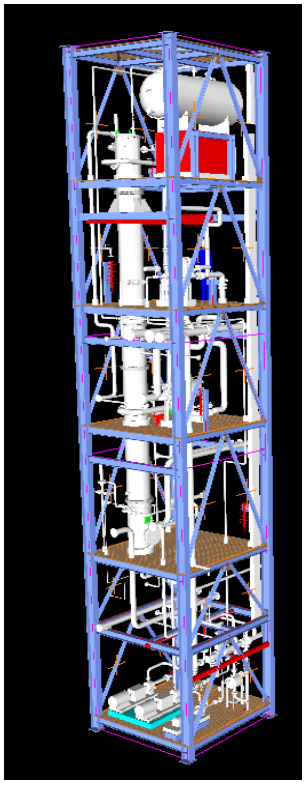
Modular plants can be advantageous when process technology is not yet matured or proven. To reduce economical risks of a large scale plant investment, initially, only smaller capacity plants in modular construction can be built which can be easily multiplied at a later date when proven or required.

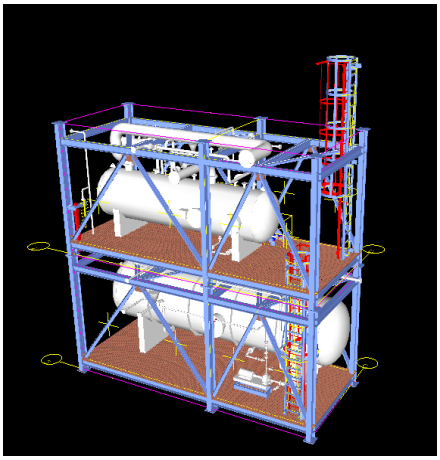
Disadvantages /Challenges of Modular Designs:

Since modular plants need to be transported to the actual site, Weight and size limitations as posed by transportation mode are applicable. An extensive route mapping needs to be planned and verified in advance to identify possible bottlenecks in transport route. Even after satisfying weight and maximum size requirements, transportation of modules may offer various difficulties such as condition of roads, permits, on the way fouling of modules with any overhead obstacles (Cables/tunnels, etc). Depending on the process requirements, rather than going completely modular, a hybrid approach may sometimes be necessary for fabricating few of the heaviest/largest equipments directly on the actual site. If not managed properly, at times, these difficulties may nullify schedule advantage.

Compared to conventional stick-built plants, Modular designs require more steel as modules are being subjected to different levels of stress while transporting and while erecting it on the site. Engineering and co-ordination activities need some more attention as engineering designs need to be frozen quickly to gain schedule advantage. Early availability of engineering data, catalogue data of various piping and instrumentation components for starting the module fabrication is real key to the success of overall project. Early closure of safety studies (Typically HAZOP) is one of the challenges but desired to freeze process design at an early stage. Tracking of material movement from vendors to module fabricator and material movement of free issue items to and from owner/site poses many challenges in terms of ensuring availability of material at scheduled time. Effective co-ordination between various stake holders such as vendors, Module fabricator, Owner, Engineering Contractor, Site team etc. requires use of modern technology.

Design Aspects:





Engineering and execution of modular plant designs certainly require a different approach than the conventional stick-build plant methodologies. While planning plays an important role in both types of projects, the milestone definitions in both approaches may vary. In modular approach, focus is on early completion of front end / process engineering activities followed by tracking or monitoring of various parallel activities on actual site and on module fabricators workshop.

Few additional studies are essential when modular techniques are chosen. At basic engineering stage, these studies include logistics study, transportation study, erection feasibility study, and structural feasibility study. At detail engineering stage, additional attention is required while splitting the plant in suitable transportable modules and for finalizing number, sequence of various modules. Loading/Unloading of the modules, shipping, erection and interface engineering studies are required at the construction phase of the project.

Word of Caution:

Though modular concept seems to be lucrative in terms of schedule and flexibility, projects can deviate from their schedule objective if not executed with proper planning. Since there are various agencies involved, a communication and co-ordination gap can significantly affect the project success. For example, schedule for availability of given modules on site should be sequenced carefully in logical order. A module arriving on actual site earlier than required schedule instead of some other module will only halt site construction impacting project timelines. Overall project schedule time should also sufficiently allow for proper planning and execution of modular projects. Orientation details at actual site and interfacing issues require co-ordinated efforts.

Concluding Remarks:

Success of modular design projects depends on several parameters. Though modern day technological tools like integrated 3D engineering, Inventory management, etc have surely made engineering, material tracking, feasibility, construction studies, etc relatively simpler; certain expertise are very much recommended for proper planning and execution of the overall project.

Leveraging on expertise in the field of project management, engineering, procurement and construction, *TATA Consulting Engineers Limited* have successfully executed several large and complex projects in India and abroad using modular design concepts.