Optimising production scheduling in the batch industry

Process manufacturers are constantly under pressure to maximise productivity from their assets. Optimising production scheduling is critical to remaining competitive and a number of factors must be considered simultaneously, ranging from capacity and material limitations, batch dependencies, sequenced changeovers and scheduling of preventive maintenance. All of this must be done while minimising inventories and ensuring that customer orders are ready to ship on time.

Production scheduling challenges

The profitability of batch plants depends on the ability to exploit the full range of chemical production options, such as decisions made on what, where and when a material is produced and with which available equipment. Increasingly, producers must deal with more customer-specific products, which adds another constraint to the planning and scheduling process and forces them toward a more make-to-order production environment, rather than building inventory that can serve a range of customers.

While production planning determines optimal production over a longer period of time, such as 6 to 12 months, scheduling assigns resources to a sequence of activities over a shorter period of time and in a much greater level of detail. The scheduling problem becomes very complex due to numerous options and constraints that must be addressed in real time (i.e. changes in the availability of resources, additional orders, breakdowns and reconstitution of pieces of equipment, modifications to the schedules). Schedulers have responsibility for the performance of the plant, because poor scheduling decisions not only lead to higher inventories and delayed deliveries, but also to mutual blocking of steps, degradation of the products caused by lengthy storage times, high costs for equipment cleaning and reprocessing or even the disposal of entire batches of material.

For chemical processing plants, there are specific characteristics that have to be taken into account when scheduling, including shared resources, continuous units and limited connectivity by piping networks. Moreover, the way the plant is operated, as well as the existence of multiple recipes to make the same product, may impose additional complexities that must be taken into account:

- Change-over procedures.
- Maintenance procedures.
- Recycling streams.
- Scalable batch sizes.
- Resource and recipe selection.

Manufacturing organisations face these numerous challenges on a daily basis and are required to update production schedules regularly to increase productivity and minimise operating costs. Production schedules can significantly influence margins by identifying resource conflicts and determining time periods available for preventive maintenance, while ensuring that the required raw materials are ordered on time.

Batch production challenges

Batch production depends on the priorities in planning and the capacity in scheduling of manufacturing processes. In particular, scheduling systems rely on specific capabilities to be successful: easy-to-use interactive interfaces with the schedule; forward visibility of projected inventory positions based on the current production schedule and expected demand; the ability to model process manufacturing constraints like production rate that vary by assets and shared resources with enough fidelity to accurately represent reality.

Manufacturers are typically characterised by multi-purpose production units or multi-stage production. For batch or semi-continuous processes, a key challenge is that the units will have product change-overs from time to time. Here, the cost can move up or down with a typical sequence to avoid expensive transition and/or setup time. Special clean-outs may be needed between different families, as well as a schedule for special buffer batches. With multi-stage production, there may be limited or no immediate storage or even zero wait between stages with floating bottlenecks. Therefore, synchronisation is required to schedule these units.

Production is also characterised by shared auxiliary equipment. This could consist of pumps, filters, driers, tanks or even people. All of these factors need
to be taken into account in the scheduling process. Also important, and often a constraint, are purchase contracts. Purchased materials are not in unlimited supply, so certain contracts could be taken into consideration as part of the decision-making process. Purchase prices change and some plants have alternate ways of making the same product with different resources.

Chemical plants running at high asset utilisation and low inventory need to deal with every schedule variant as soon as possible. Changes such as production running behind or ahead of schedule, customer order changes, bulk carrier changes or purchase materials running late or arriving early can easily catch Schedulers off-guard if they have not planned for these scenarios. Optimisation processes may handle these issues in the long-run, but schedules must handle them in the short term. For example, as the scheduler attempts to resolve issues by re-scheduling and moving production to different production lines, they must take into account the specific operating conditions that differ between assets, such as production rates and yields, in addition to re-sequencing production on the new asset.

Key challenges summary:

- Plant capacity is dynamic and chemical leaders are utilising this knowledge when planning.
- Schedule complexity is overwhelming Schedulers.
- Hours of work to determine impact of production upset.
- Hours of work to react/adjust to production upsets.
- Scheduler schedules slack capacity to allow for production problems, consuming available capacity.
- Sales & operations planning solution does a good job for demand and supply planning at the enterprise level, but cannot cope with the complexity and the dynamics of plant planning & scheduling.

Legacy spreadsheet scheduling is not adequate given current plant complexities.

Visualising inventory levels

One of the most important areas of scheduling is managing inventories effectively. Plant scheduling software allows process manufacturers to visualise current and future inventory levels and show projected consumption of inventory over time as demand is fulfilled. It is crucial for the Scheduler to have the ability to easily identify problems in the schedule that results from limited raw material availability, equipment constraints and batch dependency. With a visual way to see the impact of schedule changes on inventory levels, Schedulers can eliminate the time consuming hunt for data and instead focus on optimising their production.

Many manufacturers have adopted the ‘Aspen Plant Scheduler’ family of products, which allow the schedule to be readily viewed and manipulated via an interactive Gantt chart. Drag-and-drop schedule modifications are accompanied by inventory projections and extensive exception reporting to assist the Scheduler in visualising the impact of changes. This is especially useful when dealing with non-routine events in real-time, such as unexpected spikes in demand, outages of raw material or equipment breakdowns.

Now, Schedulers can react to schedule changes in seconds. With the inventory projection tiles now available in ‘Aspen Plant Scheduler’, Schedulers can personalise their view to see multiple inventory projections simultaneously. This enables them to immediately see the impact of schedule changes for a common group of activities and facilitates the resolution of day to day business problems. When schedule conflicts, such as material flow violations or inventory run outs arise, Schedulers can make adjustments using the ‘active guidance’ function, which gives the user real-time assistance in making feasible schedule changes. The software optimises the production sequence to minimise unfavourable product changeovers and downtime due to setups. For chemicals companies, this limits wide specification production that produces inferior products, wastes raw materials and production capacity. Today, scheduling solutions scale to plants of any complexity and effectively simulate production capacity and evaluate scenarios for a wide range of scheduling problems.

Making profitable responses in scheduling

Many manufacturers often have ineffective production scheduling systems plagued by dysfunctional plans that are frequently ignored, where unreliable information is shared and where decision makers lurch from one crisis to another without the visibility of the entire system. Production scheduling software, therefore, is important for speciality chemical companies as it is designed to maximise the efficiency of their operations and reduce costs. A crucial feature of plant scheduling software is its ability to reconcile the differences between production plans and reality.

The typical impact of production scheduling could be summarised as:

- Customer service increased by 5-10%.
- Reduce inventory by 10-20%.
- Throughput increased by 5-10%.

As companies seek to optimise their operations to achieve competitive edge, supply chain optimisation software designed specifically for the process industries increases customer service levels, reduces inventory & overall supply chain costs and expedites profitable responses to unexpected market demands.