Pricing Problems in the Chemical Process Industry

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In this short article we will describe two examples of pricing problems in the chemical process industry. For both problems there exists no satisfactory solution yet. The problems involve design subproblems, uncertainty and operative decisions. We hope to motivate the researcher to take these examples as a challenge.

Example 1



The product spectrum is characterized by a few intermediate products, many finish products and an even larger number of filled articles. The production costs are dominated by the raw material costs and production of intermediates. Using a few additives, these few intermediates are converted into a large set of finish products.

The production of the intermediates is a multi-stage production on only a few dedicated reactors. It takes a relatively long time. While the raw materials are very expensive the intermediates have low volume and thus transport and storage is rather inexpensive.

Compared to the time to produce the intermediates, the finish products can be produced and filled in short time using multi-product units subject to product-changes implying capacity loss and costs. The finish products are seasonal products. This implies that one has to produce prior to the season as there is a shortage of capacity during the peak season. The finish products have large volume and therefore transport and inventory are expensive.

The market is characterized by seasonal demand. The demand is very uncertain before the season. Orders have only a very short ordering lead-time time before their due dates. This causes the following problems:

The intermediates have to be planned and produced long before the season. The costs to produce the intermediates are high. Parts of the production of the finish products have to be finished before the season as the capacity is too low otherwise.

Among the decisions to be taken is which finish products should be produced to stock in what amount. Should one take those with the lowest production costs, or highest sales price or safest demand forecast? For which demands should one use or safe the precious intermediate? Which finish products are stored at what time in which inventory? Finally, there are location problems associated addressing where to have the market inventories, and where should the intermediates and finish products be stocked.

Example 2

This example involves a 2-stage production and raw material purchase subject to a very volatile spot price. There are different uses of the raw materials. The contracts fix a certain amount of raw material of a time interval with the price being a function of the spot price, e.g., the average of the spot price of the last three months discounted by some, a priori fixed, discount.

The storage capacity for the raw materials at the producer's and consumer's site is limited. Therefore, traders are heavily into speculation. Most of the production costs of the sales products are the raw material costs.

Instead of purchasing the raw material it is also possible to purchase the intermediates. Usually, the intermediates are converted into finish products, but it is also possible to sell them directly. For technical reasons, and as setup and shutdown of the intermediate production is very expensive, the intermediate production is subject both to minimal throughput. The capacity to store the intermediates is also very limited. Finish products are subject to strong competition and are sold into different markets. For the largest part the customer can substitute the finish products by alternatives. Demand is uncertain. Fluctuation in the raw material costs can be passed to the finish products only in a very limited amount.

The questions related to this problem are the following. What fraction of the expected raw material demand should be covered by contracts and under which conditions? When should one buy on the stock market? Is it preferable to purchase raw material on short-term or to cover oneself at longer term when prices appear appropriate? Which amounts of intermediates should be purchased or sold at a given market situation? Should one extend the capacities of raw material or intermediates?

On the market side one faces the problem of uncertain demands raising the question whether it is better to store the products if higher sales prices are expected or to sell them somewhat cheaper but immediately? Transport even complicates the problem as the market may changes while products are shipped from continent to continent.

Ideally, one would like to fix the sales prices in order to maximize profit. However, the relationship between price and demand is not known.