LOCATION, SIZE, AND INTERACTION OF CHEMICAL PLANTS

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Abstract. Different factors governing the location of chemical plants are discussed. The influence of other factors on determining the appropriate size of a chemical plant is described. Interaction of such plants, especially cooperation within one industrial complex, offers important economic advantages.

Before tackling the problems of location, size and interaction of chemical plants, I want to state that in this context the term 'chemical plant' means a plant for the synthesis of a product by one or more chemical reactions but not a processing plant e.g. for the finishing of pharmaceuticals or the formulation of insecticides. While for the latter type of plant location and size are certainly no negligible factors, the three parameters in the heading of my paper are, for many real chemical productions, the decisive factors determining the fate of an existing plant in a highly competitive situation or of a project to build a new plant.

1. Location of Chemical Plants

The choice of the proper location depends upon several factors, mainly utilities, availability of raw materials, cost and time of transport of finished goods to the customers, disposal of effluents, availability of labour and key-personnel.

Let us first consider the influence of utilities.

Every chemical plant requires power, water, and fuel, many plants require also gas. When planning a new large chemical grass roots plant one can assume, based on average consumption figures in large chemical plants, that per hectar of built up land an installed capacity, in the final phase, of 10–15 t/h steam, 500–1000 kW and 100–200 m³/h water will be required.

1.1. Power

In the highly industrialized countries power is nearly everywhere available from the grid; in developing countries availability of power may be a problem. For many productions cheap power is imperative as will be seen from Figure 1.

Large electro-chemical or electro-thermal plants are hopelessly uncompetitive at locations with unfavourable power supply. Such plants are mostly located in areas with cheap hydroelectric power or with power generated from cheap lignite or hard coal e.g. the Alps, Norway, Central Germany or the Rhine/Ruhr area. Due to the inroads made by fuel oil as an energy carrier the picture is changing; Hoechst’s new phosphorus plant has been built at Flushing. With the growing use of fuel oil and when atomic power will become more competitive the choice of location even for chemical plants with important power consumption will become easier.
In principle, any well-sized chemical plant may also generate itself the power it needs. In general, this is only economical if power obtained by back pressure is a by-product of steam generation. A chemical plant will therefore only make as much steam as it requires itself, obtain the equivalent of power by pressure release to the pressure needed for its manufacturing processes, and buy the balance of required power from the grid. Generation of the relatively small amounts of additional power needed by condensation of steam would be uneconomical compared with buying it from the large-scale specialized power plants.

1.2. Steam

Steam cannot be transported over great distances; it has to be generated near the spot of consumption. Its price largely depends upon the price of fuel and its handling cost. Figure 2 shows how the prices of fuel oil, hard coal and lignite, expressed in DM/Gcal, developed after 1945. It explains why areas with abundant hard coal deposits such as the Ruhr area have lost much of their attractiveness as sites for chemical plants.

Fuel oil has to a considerable extent replaced coal. Unfortunately its price has increasingly become subject to political influences. Governmental authorities in the producing, the processing, and the consuming countries want to levy as much taxes thereon as possible and sometimes even restrict exploitation. Freight is an important

<table>
<thead>
<tr>
<th>Chemical Industry</th>
<th>kWh/t Product</th>
<th>% of Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>12500 - 13000</td>
<td>approx. 35%</td>
</tr>
<tr>
<td>CaC₂</td>
<td>3200 - 3500</td>
<td>approx. 35%</td>
</tr>
<tr>
<td>NaOH + Cl₂</td>
<td>1650 - 1700</td>
<td>approx. 45%</td>
</tr>
<tr>
<td>Al</td>
<td>16000 - 17000</td>
<td>approx. 35%</td>
</tr>
</tbody>
</table>

Fig. 1. Power cost in % for different chemical industries.