PETROLEUM PROCESSING IN THE YEAR 2000

By

L. VAJTA

Department of Chemical Technology, Technical University, Budapest

Due to scientifico-technological revolution and to the very rapid progress in chemical industry, fixed funds in commercial production plants are doubled every 5 to 7 years.

However, manufacturing plants to be erected in the decade to come will still play a role by the end of this century.

Research in our Department is directed towards the elucidation of regularities the knowledge of which enables us to predict the most likely trends of future development.

Similar studies are being pursued all over the world. Those of Leon P. GAUCHER [1] extend far beyond the end of our century, and are concerned with the shaping of energy problems of the U. S. up to 2200.

Estimates mostly cover the period ending with our century; this was so also at the World Energy Conference, in June 1970.

But the developments in the field of petroleum processing are ever more subject to factors other than the increase of demands for energy. Besides the classical requirements, i.e. power, motor fuel, and lubricants, the importance of petrochemical products increases rapidly [2]. The expectable important changes in this respect will cause considerable changes also in the order of magnitude and the technological structure of refineries [3].

In the course of such estimation studies, the rapid increase of the demand for synthetic organic substances must be considered as the decisive factor in the alterations of the present structure of petroleum processing. According to M. LITIS, and M. J. MAZEL, [4] up to the turn of the century, production of various metals, of natural and of synthetic organic substances will exhibit the features presented in Table 1.

In Hungary, the National Committee of Technical Development fosters research under the general heading *Development of the National Economy by Chemistry* up to the turn of the century. This is closely connected with questions relevant to the trends in the development of petroleum processing in this country. In the elaboration of this theme, previous studies of the author and his group [5] are made use of.

Method of study

The explicit aim of this research was to predict long-term development problems of Hungarian petroleum refineries. The method adopted in this work was as follows.

1. Changes in energy consumption of the world, and of Hungary, and changes in the energy structure are analysed. In our Department, established hundred years ago, a profusion of relevant information is available; to keep this information up-to-date is one of our constant preoccupations.

As everywhere in the world, also in Hungary, one of the most important factors in the shaping of trends is the increasing importance of atomic energy. According to our calculations, the increase of the costs in petroleum produc-

Table 1

Global consumption of the most important materials

	1966	1970	1980	1985	1990	2000
Population, 10^9	3.4	3.7	4.6	5.0	5.6	7.0
Metals (Fe, Al, Cu, Zn)						
tons, 10^6	486	582	948	1204	1514	2335
kg per capita	143	157	206	241	270	362
cu.m, 10^6	64	78	129	167	215	384
litres per capita	19	27	28	33	38	55
Natural organic products (rubber, fibres)						
tons, 10^6	21.2	24.02	32.8	37.7	44.3	63.0
kg per capita	6.2	6.5	7.1	7.5	7.9	9.0
cu.m, 10^6	18.4	20.7	27.7	31.9	37.5	53.2
litres per capita	5.4	5.6	6.0	6.4	6.7	7.6
Synthetic organic products (plastics, rubber, fibres)						
tons, 10^6	25.5	40	130	273	467	1790
kg per capita	7.5	11	28	55	83	256
litres, 10^6	23.0	35	114	236	409	1584
litres per capita	6.8	9.5	25	47	73	224
Petroleum, 10^6 tons	1530	2000	2800	3400	4200	6200
Hydrocarbons, 10^6 tons, available for petrochemicals	32	50	162	340	585	2240
Petrochemical hydrocarbons, as percentage of total petroleum	1.95	2.5	5.8	10	14	36

tion — politically motivated price fluctuations being left out of account — will naturally effect a rapid progress in the utilization of atomic energy in the second half of the subsequent thirty-year period if production costs of this form of energy remain constant. Of course, this affects petroleum processing technologies in so far as it will restrict the market for heavy fuel oils with high sulphur contents.

2. The second subject studied is the trend of the demand for fuel for internal combustion engines. We presuppose a rapid increase of vehicle density in Hungary, which may be quintuplicated in the first half of the period, referred to the present state, and, during the second half, may be twice the figure of 1985. In the course of this study the probable alterations in engine-types, (the decrease of lead content, the application of novel types, e.g. that of Stirling-engines) were duly considered. The altered quality specifications for engine fuels to meet demands raised by these developments will affect the technological scheme of refining; in our studies due attention was accorded also to this aspect of the question.

3. Among the tasks facing the petroleum processing industry, fulfilment of the rapidly increasing demands for petrochemicals gains in importance. We have estimated the likely development of these demands and assessed its technological consequences. Briefly, the conclusions drawn from our studies state that certain fundamental petrochemical processes may also benefit the motor-fuel production of refineries, for instance, pyrolysis of naphtha produces valuable fuel additives for the improvement of octane-numbers, or, to take another example, preparation of pure normal paraffins very advantageously affects the properties of several products, e.g. that of diesel-engine fuels. On the contrary, some petrochemical activities may impair qualities, such as, for instance, the removal of aromatic compounds and of iso-paraffins, thus technologies ought to be modified so as to offset such deficiencies.

Conclusions

Integration of the discussed factors has led to the conclusion that to increase the order of magnitude of refinery capacities will be inavoidable also in Hungary.

Our results obtained by analysing general chemical-technological laws were well applicable to the evolution problems of the internal structure of refineries. The generally known chemical function of the increase of the order of magnitude of capacity against specific capacity-investment costs, has been applied to Hungarian conditions. It must be stated, however, that this function, when projected on to the future, should be interpreted in natural units, e.g. unit mass of steel needed for unit capacity, unit area of plant for unit

capacity: these can be well interpreted in future assessments as against calculations in whatever a currency since all are subject to inflationary changes inhibiting scientific treatment.

Without going into details of our studies, their results may be summarized as follows.

Integration

In the next thirty years, substantial extension of one refinery plant, and erection of another, in Hungary, will have to be considered. In the first item, a nominal order of magnitude of fundamental distillation capacities will advantageously conform to the series 1—2—3—6—6, a 25 to 35 per cent increase of their efficiency being inherently provided for. The production structure of the new refineries seems to be best served by a 3—3—6—6 series with the above possibility of intensification. It should be noted that these orders of magnitude do not represent upper limits [6].

Characteristic of the second half of this period will be the rapid increase of destructive capacities beside that of primary capacities. The development of the processes will be characterized by general features of chemical technology, viz. substantial expansion of the temperature and pressure ranges of operation, the increase of the specific output of apparatus. As a further likelihood, the integration of technological units within the plants and the concomitant substantial reduction of specific area demand may be safely predicted.

The great extension of production facilities at the two plants will impose heavy burdens of the protection of nature on industry. General use of air cooling should allow the construction of a closed system of water circulation, in other words, of a refinery without water pollution. This is especially important for the Leninváros site since the barrage system on the Tisza, to be completed in this period, will give this river the character of a still water, very sensitive to contaminants. Reduction of air pollution will depend on strict application of desulphurization processes. The resulting hydrogen sulphide could be converted into elementary sulphur even if this conversion seems not to be justified economically.

The outlined studies are based on detailed calculations which are now continued in order to increase the accuracy of the predictions to ± 15 per cent. Results of these studies retroactively affect the concepts underlying some earlier short-term plans elaborated for 10- or 15-year periods.

Some general conclusions deduced in these studies [7] are presented in Table 2.

Table 2

Fundamental consumer data
expected for the year 2000 in Hungary

Population	$12 \cdot 10^6$
Passenger cars	$3 \cdot 10^6$
Buses and trucks	$0.5 \cdot 10^6$
Passenger car performance 1000 km · year^{-1} · car^{-1}	12
Bus + truck performance 1000 km · year^{-1} · car^{-1}	30
Postulated specific *fuel consumption* passenger cars	10 litres for 100 km
trucks and buses	25 litres for 100 km
Petrochemical demand for gasoline	$3.5 \cdot 10^6$ tons
Capacity demand for petroleum processing	50 to 60 · 10^6 tons year^{-1}

Summary

The rapid development of the chemical industry necessitates the elaboration of methods suitable for making long-term prognoses. At our Department, regularities helping to forecast the trends of prospective development are sought for. Our working method has been based on the compilation of the trend curves of energy consumption, motor fuel consumption as well as the prospective changes in the demands on petrochemicals, with the subsequent analysis of their influence on technology. The work done up to present has established the capacity ranges and basic lines of technological units of refineries to be set up in Hungary up to the turn of the century.

References

1. GAUCHER, L. P.: Chemical Technology **3**, 153 (1971).
2. MOULIN, M. M.—MONTETY, J.: Revue de l'Association Française des Techniciens du Pétrole **198**, 251 (1969).
3. UHL, W. C.: World Petroleum **41**, 40 (1970).
4. LITIS, M.—MAZEL, J. M.: Revue de l'Association Française des Techniciens du Pétrole **197**, 73 (1969).
5. VAJTA, L.—SZIJJ, V.—KINDL, E.: Development conception of the Hungarian petroleum processing industry up to 1985. Budapest 1970, Hungarian Oil and Gas Trust (for official use).
6. FARRAR, G. L.: Oil and Gas International **8**, 32 (1971).
7. VAJTA, L.—KINDL, E.—SZIJJ, V.: Contributions for the study of the National Committee of Technical Development on the Development of the National Economy by Chemistry in 2000; (Manuscript, 1971).

Prof. Dr. László VAJTA, Budapest XI., Budafoki u. 8, Hungary