Industrial minerals in thermoplastics – strategic gaps

by W. Schober*

Minerals seem to be simple materials compared with chemical and polymeric constituents as we have heard during the Moffis '91 conference. The term industrial mineral is a trivial name for a complex group of raw materials, which frequently make specification and identification beyond all doubt a difficult affair.

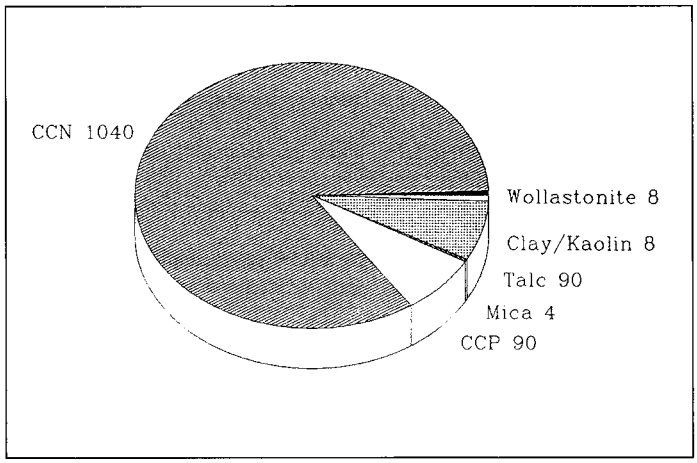
Besides the technical aspects we also have to reflect on the economic framework of this industry. The high concentration process on the supplier side and the importance of functional minerals in plastics call for a more careful investigation before basic decisions are made by the mineral consuming industry. Once the selection and decision are made, the product line will be fixed for years.

I would like to consider the following minerals – carbonates, mica, wollastonite, clays, and talc. *Figure 1* may give you an idea about the volumes in Europe.

Fillers are compounded in more than 20 different resins, but only four account for 90% of the total filler demand – PVC, polyester, polyamide and polypropylene. To look for the strategic aspects it is my intention to focus on following subjects –

- supply situation in minerals
- mineral selection criteria in the past and future
- geographic and resource sensitivity
- R&D capacities utilisation by the minerals producers and the compounders
- to offer some proposals to which more attention should be paid.

Figure 1. Minerals in thermoplastics. Estimated consumption 1,000 tpa in Europe (1990).



Selection criteria for industrial minerals

Industrial minerals are normally the less valuable constituents in plastics. Compounding with mineral fillers in eg. PVC was probably the most common and least expensive way of modifying plastics. At the beginning the cost reduction was the main target and carbonates always displayed a favourable availability at reasonable prices. The growing importance of engineering plastics and the breakthrough with PP and PA set up new outlets for smaller scale minerals, such as talc and mica.

Marketing people always look to the future, but we can also learn from the past. I would like to point out some typical developments at the PP-segment (to use it as a case study) which seem to be repeated with other newer polymer compounds.

During the start up period the minerals tested in these applications, such as carbonates, talc and mica in PP had been selected on a "what's available" principle. In the mid-70s and early '80s the mineral producing industry had heard only accidentally about these new things, which are called PP. Most of the minerals had been distributed through merchants or agents, where a great deal of accurate information had been lost and no technical input from the mineral side could be offered.

Data sheets and samples of existing products built up the only information base. Long lab-series using commonly available standard minerals had been carried at the compounders and led to a first group of blends and compounds. Many of them still exist.

A standard product range of 20, 30, and 40% filled polymers eg. in PP had been the rule, production was running on a large scale. The scarcity of silo-equipment and compounding screws at the main players is typical following the slogan: big is beautiful. But these jumbos blocked further intensive development work.

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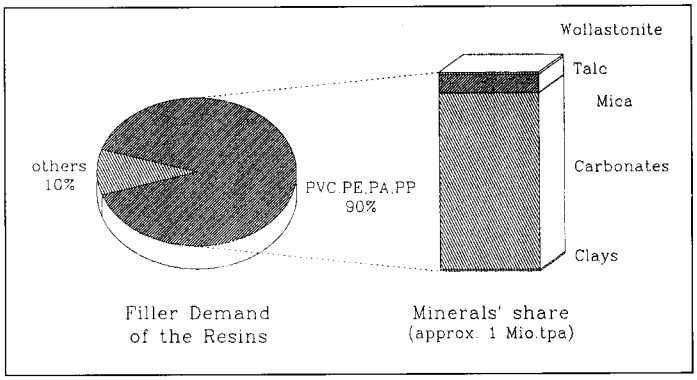
Figure 2. Filler demand and mineral share.



Growth rates between 10 and 20% per year over the last decade in mineral consumption was not exceptional for the speciality minerals. Almost half the growth in mineral consumption is estimated to be a result of mineral-reinforced plastics replacing non-polymer materials. The most well-known segments are certainly the automotive industry, the garden furniture segment and domestic goods applications.

During the last decade the major mining industry ran through a period of restructuring and more market oriented mineral suppliers took their chance and tried to create a story, where a unique situation could be built up, it was almost impossible for the compounding people to find better or a different argument. As a result a dominance in market shares of the mineral producing industry ensued, with only few alternatives.

But in fairness, some of the minerals' producer also invested in basic research work for product evaluation. As minerals differ widely from mine to mine, these results again represent the key players' types and do not always favour the consuming plastic industry.

It is also typical of this market segment that mainly international players in the compounding business had been able to develop "technical standards". Over the last five years quite a few of the bigger pioneers have again lost market shares, again in reinforced plastics, as the technology became more well known and flexibility in price and quality was required by the customers and the markets.

The market grew and highly sophisticated applications were required. In particular the automotive industry is keen on technical solutions, rather than in standard plastics only. These facts opened the door for newcomers, at a lower volume market at first, but with very individual solutions. The widespread Italian compounding industry is a good example of this expansion.

It looks like as if in the first half of the '80s everybody was successful:

- The compounding industry had introduced a standard programme of mineral filled grades and looked mainly for key account customers to generate economies of scale.
- The plastic consuming industry had a good performance, a large number of new applications could be found.
- The mineral industry had been satisfied as the approbation work was done and constant sales automatically ensued.

When increased competition did not occur a lot of flexibility was practised by the compounders:

- competition had been answered by price-wars
- lab-manpower had been cut to save costs
- officially all available mineral/resin combinations had been studied in the past, ignoring the newly developed grades and not having considered tailor made grades
- compounding plants showed highly limited enthusiasm to run trials again as the equipment was not adapted to bag size production quantities
- purchasing departments had to look for alternatives, but where could they go, as they had been used to meeting the demands of the technicians only and not many alternatives exist.

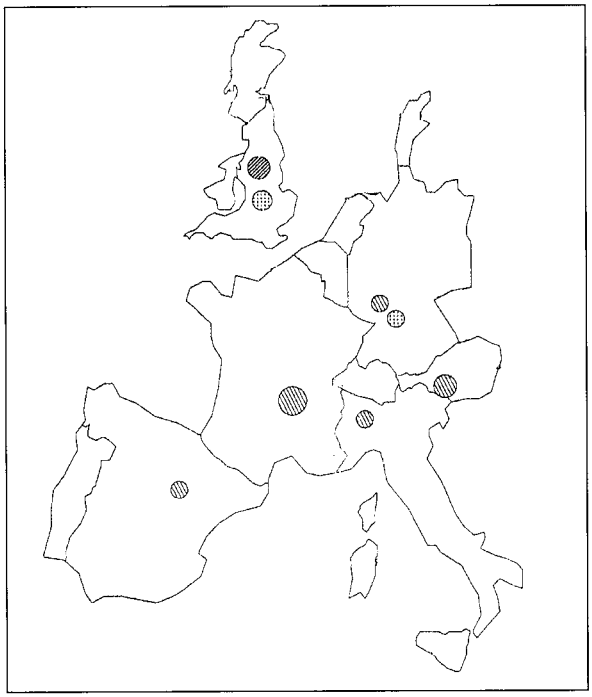
This resulted in a strong demand to look more carefully at optimisation of the use of minerals.

There are many possibilities which are not used and checked carefully enough, such as the types of grinding equipment. One of the catchphrases is "Micronisation with preservation of aspect ratio of a mineral." You will certainly understand that a tremendous influence on application techniques is obtained by varying the grinding system. Much more attention must be paid to these topics in future and R&D people from the compounding industry are recommended to use more of these advantages.

People from the compounding industry have to realize that equal results can be achieved from different mine sources by optimisation of particle size distribution and mineralogical composition. This requires a deep understanding of both the resins and the minerals and the know-how where to turn the switches.

When we look at the importance of thermoplastics for mineral producing industry you will also appreciate some risk factors for the plastics industry. These facts are recommended to be considered by the purchasing and R&D people, before fixing on raw materials for a longer period of time.

Figure 3. PCC production in Western Europe.



White carbonates represent by far the biggest share of all the minerals. Worldwide consumption in thermoplastics is around 22m. tonnes (without carpet backing); Europe's consumption is in the range of 1m. tpa. The major markets for carbonates are PVC and PP, PE.

The dry and wet-ground carbonate scene is dominated by the OMYA group. There are also other local producers in different countries, which help to maintain competition in favour of the consuming industry. Technical support either in tailor made carbonates or in machinery solutions help to introduce $CaCO_3$ more widely.

PCC also has a significant market share in PVC. Of the total 300,000 tpa PCC produced in 1990 about 30% was consumed in plastics. In general these ultrafine carbonates do not compete with the bulky $CaCO_3$. ICI and Solvay, important PVC-resin producers, have developed these applications to a high degree. The number of suppliers outside of the aforementioned corporations is very limited (see *Figure 3*). This leads to strong prices.

An enormous and still increasing sector is PVC plastisols. Here PCC is mainly used in automotive underbody coatings and sealants. This segment still has a good growth potential. Most of the PCC used in this field is stearate coated. We can expect that the further trend to PCC in paper applications will also create some surplus quantities which will be placed in the polymer market segment which will be very much appreciated by the market and break the oligopolistic gamble (see *Figure 4*).

Mica only has higher importance in North America and Japan. Western Europe is lagging behind in these applications. Under the hood applications dominate in terms of growth rates. Thermosets and thermoplastics take advantage of this highly lamellar mineral, with varying aspect ratio from muscovite to phlogopite-mica. In the USA about 12-13,000 tpa are consumed in thermoplastics. In Europe only a few compounders started to use mica as filler, and consumption is estimated to be not higher than 3-4,000 tpa in all plastics!

There are quite reasonable resources in Europe plus imports from the Far East, hence the quantitive supply condition cannot be the bottleneck for the low interest in Europe. The mineral industry seems to sell minerals instead of developing solutions for individual properties of engineering plastics. US companies gave us a good example how important basic R&D work is for the success of a mineral.

Figure 4. PCC production in Europe. Production 1,000 tonnes in 1990.

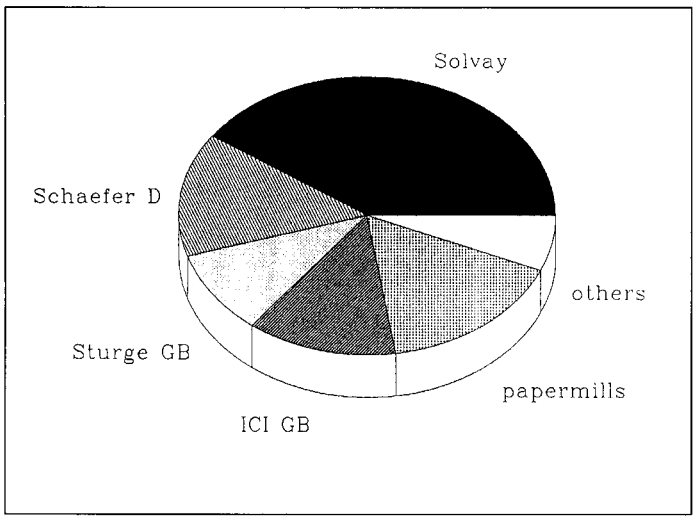
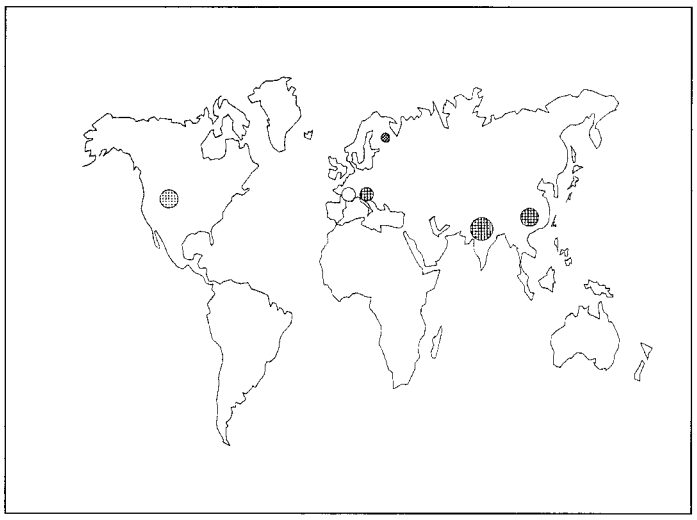


Figure 5. White talc sources (90-95) for plastics.



Silane treatments of wet or dry ground materials opened new doors. The understanding of chemical and surface reaction, combined with deep application know how by the compounder and for the end use, are inevitable to meet market requirements. Prices in Europe differ from those in the USA.

Consumption at a higher level will certainly open economies of scale and lead to price reductions. The breakthrough will come in Europe at that stage, when a mineral processor, backed by a mine, starts with industrial processing of real micronised grades (not 325 mesh as finest), involving chemists in product development and more active application technique support in the market.

Talc has been used in PP for more than a decade. This segment is the biggest outlet of this mineral in plastics. Total consumption in Europe is approximately 90,000 tpa. Of this about 7% is used in plastics. Talc can be divided into two groups by brightness – the whitest grades (>90) for white, crayon-colours and opaque PP, all the others for grey and black compounds.

Talc is not a very common mineral. For white grades there is a tremendous shortage in Europe's mines. A lot of these white talcs are imported from overseas, such as China and India (*Figure 5*). The particularly very well-known talcs from Golcha, India will certainly be available on a wider scale in future. The major talc-suppliers for PP in Europe are Val Chisone and IMI-Fabi, Italy as well as Talcs de Luzenac, France. Owing to consequent acquisition policy of the Luzenac group and the fact that Val Chisone became part of this group, their dominating market position increased and there are not many alternatives to the compounders.

Overseas competitors entering Europe will be very welcome. However, please also consider their reliability in supply. My recommendation for all minerals is as follows:

- Look for direct contacts to mining companies as the applications in PP call for a constant mineralogy and particle size distribution.
- Only a mineral producer of significant size in plastic grades can give security in quality and supply and the confidence for future developments.
- Companies which only buy lump talc on the spot markets or through barter trade are recommended to give as best case second priority. Most of them do not know what it is really like. In addition, they sometimes process using custom grinders. However, it is definitely not recommended to switch to suppliers for engineering plastics which are not directly backed by the mining companies.

The trend to finer grades in white and dark talcs is evident. Micronised grades for automotive PP-compounds are mainly supplied by the Luzenac group and IMI-Fabi. The trend is to finer grades, but only a few compounding machines are able to use these finer grades as they normally cannot evacuate the introduced air. A little bit more flexibility in this field would enable the plastics industry to use this significant advantage for the increase in mechanical properties.

As the term talc means chemically pure talc, chlorite talc, and carbonate containing grades it is sometimes difficult for compounders to find the right talc grade for the required profile of the compound. There is no justification possible for good or not good. The question is to know all about the Unique Selling Propositions (USPs). In former times this field lagged tremendously and resulted in quite different mineral selection criteria at the compounders between Italy and the other countries in Europe. Some advice given by external experts might help to find optimum technical and economical solutions. There is good potential given for optimisation.

Wollastonite is a relatively new mineral in thermoplastics. Protection of aspect ratio and needle shape during the grinding process is required and a chemical treatment necessary for good linkage to the polymer matrix. NYCO, USA pioneered the engineering plastics applications. There are some other suppliers available from the USA, but also Chinese, Indian and Finnish sources try hard. These types, however, are of more importance outside of the plastics segment.

The supply situation is not the best for compounding industry –

- mono- to oligopolistic producer structure of high quality grades, mainly for surface treated types
- no direct involvement of the European compounding industry to surface modification development
- not enough regular, direct contact concerning R&D co-ordination

This is certainly a field where a more concentrated European co-operation must be encouraged to create better alternatives in local supply.

Kaolin and clays failed to gain significance in the beginning. Polyamide was a good entrance for surface modified grades. Consumption is in the range of 3-4,000 tpa. More recent developments show that combinations of clay/binder/carbon black are very suitable for scratch resistant PP compounds as well. This market is undoubtedly in the hands of ECC, which also serves with basic R&D work in an excellent way.

Surface treatment

It is exciting to hear about all the chances which are opened by using chemicals for mineral treatments and surface modifications. The US literature had been full of notable results and many R&D people tried to jump on that train. Frankly speaking, I fail to see that exciting result in Europe yet. Considering that the surface treatment will increase the mineral price by 200-400%, we can imagine that a big change is necessary in the mining industry and chemists will have much higher importance in future.

Geographic aspects of supply

Quite recently we have learned a lesson from the Gulf war that international business is sensitive to conflicts. Oil prices have a strong influence on our type of business, affecting – the price of polymers, energy as the most important share in minerals processing, shipping costs of lump minerals from

overseas and transport costs for ground minerals inside Europe.

I personally believe that transport prices within Europe will increase substantially in the '90s, as political decisions and regulations will aim to avoid unlimited country crossing of low value commodities. This will be mainly forced by environmental considerations. The sea freight will not change with these aspects, but will suffer from fluctuating exchange rates of the US$. The opening of the Rhine-Main-Danube channel in '93 will help us to have more flexibility again within Europe. As engineering plastics become world products and good distribution is required just in time, the geographic aspect will have the highest priority.

Final proposals

'Market orientation' is the common catchword. This statement however does not express sufficiently that suppliers solely have to meet consumers' demands. The strategic aspect of the meaning is that producers from both ends have to understand the key parameters of the individual consuming industry and to take well-directed measures to meet these requirements. This type of partnership has to find higher acceptance.

We certainly need a new type of scientist in our labs and related departments.

- a specialist in his appropriate subject ie. in minerals at the mining company, the plastic formulation at the compounder and the chemical at the chemical supplier.
- understanding the features of the various minerals with each other.
- the final interference with the compounders formulation and end use
- feeling for various markets and segments, where minerals are not yet used.

The purchasing management has to pay more attention to concentration processes in the minerals business and development of alternative suppliers.

Minerals are the less valuable constituents in plastics. Nevertheless the long term supply situation has to be analysed carefully.

Individual industries and even multi-national giants do not have all the experts in-house. It is my recommendation to use more external experts to use all available sources, to look for alternative solutions, to avoid bad interference and to find the right track, where detailed R&D work and product development can be built up. "Strategic management" for purchase, R&D and marketing must be the slogan ■