THE BRICKWORKS IN THE YEAR 2000

by Frank Händle

1. Introduction

In casting my mind forward to what the brickworks will be like in the year 2000, my main aim is to develop a number of subject themes in the light of tendencies apparent today which may well become the realities of tomorrow.

It seems to me it is also now a matter of urgency to take into account the perspectives outlined above when defining our aims, deciding on policy and planning for the future. I shall first attempt to formulate 8 subject themes bringing into focus the essential perspectives and the problems with which we are confronted. A composite picture of the brickworks in the year 2000 will emerge from these 8 studies.

1.1 Energy

Tests conducted in the Federal Republic of Germany have shown that in ..... the average energy requirement of German brickworks for drying and firing was 2500 kJ per kg fired ware. An interesting feature of this investigation is the broad range of scatter found which cannot be explained merely by the wide variety of products and the different drying temperatures. It should also be observed that the share of total costs taken by thermal energy today in Germany ranges between 10 and 30 %, depending on the type of works and on the ware produced. It has been found from experience that in the final instance it is not possible to pass on the increased energy costs to the consumer by way of product prices. In the long run therefore, with the continuing rise in energy prices, the cost of energy may be expected to account for a higher percentage of total prime costs. One of the most pressing priorities therefore is to cut down on energy consumption. This naturally applies to electrical energy as well. Current consumption of electricity in Germany amounts to some 1500 kJ/kg fired ware. Advances in powered machine technology, in conjunction with more sophisticated control systems, can conceivably produce considerable savings on present-day levels of consumption.

Apart from the need to conserve energy however, we also have to keep a "weather-eye" on the consumption levels of competing construction materials. Prof. Pels Leusden notes that approximately 21 litres of fuel oil are required today to produce one square metre of brick wall 30 cm thick. For one square metre of concrete wall having the same structural properties 8 litres of oil are needed. To this must be added 5 litres of oil per square metre to give the same degree of insulation, i.e. altogether

13 litres of oil for one square metre concrete wall plus insulation compared with 21 litres for one square metre of brick wall - a difference of around 40 %.

A survey of specific energy consumption statistics for the Federal Republic of Germany between 1970 and 1976 reveals that people were now fully aware of the energy problem. A distinct decline is apparent, although savings in specific fuel consumption are partly offset by growth rates in electricity consumption.

What can be done to conserve energy? Pels Leusden has compiled some interesting check lists setting out the principal means of potential energy saving. Apart from the established practices (increasing drying and firing efficiency and reduction of heat losses), there is also the expedient of adding combustible components to the clay mix. The amount of energy which can be saved in this way is clearly apparent from a brickworks in the Federal Republic of Germany which is designed to use less than 420 kJ/kg for drying and firing. This is achieved not only by means of a modern dryer-kiln combined energy system but more especially by the admixture of clays having carbonaceous constituents.

A recent Russian research project furnished proof that savings of around 30 % were possible by use of colliery tailings as additives to the raw material. Fly ash and wastes from coal-fired power stations have long been successfully employed as additives in Yugoslavia, Belgium, Holland, England and Poland.

To return for a moment to the conventional possibilities. Tables 1 and 2 present a compilation of energy consumption and heat losses.

A Study by the Fraunhofer Gesellschaft in 1978 concluded that it should be possible to reduce fuel consumption per kg product in the brick and tile industry by 10 to 15 % in the medium term and by 20 to 30 % in the long term. The Study also observed that the demand for electric power may be expected to increase owing to progressive mechanization and higher standards of product quality. An increase to over 700 kWh/DM 1000.- turnover appears quite possible in the long term.

I personally think that by the year 2000, according to the data given for 1978, it should be entirely feasible to cut fuel consumption by an average of 50 % and electric power by around 25 % by exploiting all the known technical procedures at our disposal today. In individual cases where suitable materials and building plots are available,

it is even conceivable that brickworks themselves might become power stations, if for example the raw materials were to contain such a high volume of heat-generating constituents that the energy produced exceeded that required for drying and firing.

1.2 Size of the works

At the end of the Second World War there were approximately 2000 brick and tile works in the Federal Republic of Germany - today there are only about 350. In postwar Italy there were around 5000 brick and tile works, today - to my knowledge - the number has fallen to about 500. Comparable figures apply in nearly all European countries. Output of ceramic building materials however has remained relatively constant over the whole period of time.

This means that - taking the figures for Germany - a medium-sized works in 1950 was turning out 10 million units, whereas in 1980 the production figure was 35 million units. Within a span of 30 years the size of the works has increased three-fold if not four-fold. One of the latest brickworks to be built in Germany has a design capacity of 120 million clayware units.

What is the reason for these gigantic, highly automated works? If the capital investment required for a brickworks with a capacity of 50 million NF, i.e. standard bricks, per annum is compared with that for a brickworks with an output of 100 million bricks per annum, we can see that the capital costs of the latter are not doubled but only about 30 % more. If the manpower required for the two works is compared, it is also apparent that the additional personnel required for the larger works is only about 10 to 20 %. The same applies, if not so spectacularly, to the running costs. The optimum size of the works has to be decided individually in every case. The upper limit here lies at the point where the capital cost savings are offset by higher transport costs.

We estimate that the market areas served by a backing brickworks for Continental-type clay blocks, has a radius of approximately 300 km. Facing bricks however can apparently be transported to customers 400 to 500 km away.

This at any rate is the case in Western Europe. In the USA and some other countries facing bricks are delivered over distances of several thousand km. The exception confirms the rule in the case of specialized products and also supports the argument that economic pressures are the driving force behind concentration, i.e. larger production works. In this line of argument however a distinction must be made between two strategies, i.e. that directed

towards "market niche products" and that towards "product diversification". If you are going to produce stove tiles for instance, it is worth examining whether small-scale, only partly automated manufacture of products "made-to-measure" would not be more suitable for this market in regard to profit maximization than mass production, which is also recognizable as such from the aesthetic point of view. A "market niche policy" with a limited production volume can also be a highly successful strategy in the field of structural ceramics; as many examples prove.

"Product diversification" is another tactic for defending one's position against highly automated giant enterprises.

Such diversification is usually particularly advantageous in districts lying outside a major metropolis. Highly flexible, automated production processes are now available which permit of extensive product diversification.

To sum up on the theme "size of the works", I should like to comment that in the future there will be plenty of scope not only for highly-automated works but also for small- to medium-size, semi-automated production facilities, providing these concentrate on market niches or pursue successful product diversification policies.

1.3 Raw materials

The heavy clay industry in Germany requires approximately 25 million tonnes of clay a year and in many areas it is barely possible to meet the need; either for environmental protection reasons or because of a lack of suitable clay, in quantity or in quality, within reasonable economic distance.

Even assuming it is correct to say that there are virtually unlimited amounts of brickmaking clays available, in many parts of the world ceramic raw materials are in short supply. This applies not only to the traditional brickmaking countries, such as Egypt, but also to extensive regions of West Africa and South America in which the domestic clays are either of laterite quality which is only of limited use for brickmaking, or they have a high salt content which makes them too expensive to use for normal production.

Ceramic raw materials however are not only becoming scarce in quantity, the quality is also declining. In certain parts of Europe, e.g. in Holland, the situation has now become so serious that some works may be forced to close down because they find it impossible to obtain reasonably-priced supplies of clay. These circumstances and consequently the need to convert inferior raw materials into good ones are something we shall have

to consider much more fully in our plans in future. We must in particular substantially improve the clay preparation. It needs to be exactly "tailored" both to the initial raw material and to the end product.

1.4 Ideologies

In heavy clay technology, as in every other field of process engineering, there exist certain ideologies which have developed historically, often gained regional circulation and have spread throughout entire countries. The effect of ideologies is best summed up in the words of Berkeley "First we raise the dust and then we maintain we can see nothing".

One could go on discussing such ideologies for hours, e.g. on the pros and cons of stiff extrusion and soft mud brickmaking, wet versus dry preparation, the respective merits of side or overhead burners in tunnel kilns, the advantage of the tunnel dryer compared with the chamber dryer etc., etc. We all know that these ideologies can claim a legitimate origin, but they are not capable of universal application. Whether solutions are good or bad depends entirely on the raw material concerned, on the product and the technology employed. There is little point with the present energy situation in applying dry preparation or stiff extrusion to clays having 35 % moisture, such as occur in many European quarries, especially if large blocks are to be produced. For a shaly clay with a moisture content of 10 %, to be used for the production of façade bricks, dry preparation followed by stiff extrusion is certainly the most obvious solution.

1.5 Hours of work

The hours of work in Europe by the year 2000 will most certainly have been reduced to 35 hours per week, or possibly even 30 hours. We can also expect that annual leave, i.e. holidays, vacations, will also be extended. We should therefore have to bolster part of this expensive labour force, which is only available subject to limitations, by further automation. I share the view held by Bernard Coombs of the Redlands Company, who in his paper given in Vienna in 1978 empirically defined the economic limits of automation. We should not however overlook the fact that operations in many brickworks are automated not so much for economic reasons but because of the impossibility of obtaining manpower for certain jobs, or because employers are unwilling to accept the fact that the smooth running of such a capital-intensive process is dependent on unreliable personnel.

Some operations are technically easy to automate, such as setting and unloading. Others however do not lend themselves so readily to automation. These include all maintenance and servicing works which are becoming all the more important today as levels of automation at brickworks continually increase. For these jobs which are difficult to automate, no satisfactory answer has yet been found. If we are going to switch over to a 35-or even 30-hour working week we shall have to develop and design machinery and industrial processes with this problem in mind. For instance we might construct machines which require less maintenance and utilize more hardwearing materials with a longer service life, but we might also design machines with higher throughput capacities which would allow maintenance to be performed during normal working hours.

Generally speaking, I would put the ratio between the number of employees engaged on production and the annual plant output at between approximately 5 million NF standard facing bricks and up to 10 million NF standard backing bricks per year to one employee.

1.6 Market requirements

Market demands for ceramic building materials are going to increase and this applies to both facing and backing bricks. The backing brick in fact, for example in the form of the Poroton brick with its superior thermal insulating properties, is now enjoying a Renaissance on the Continent of Europe because of the demand for higher standards of insulation. Now that it has been established that a considerable amount of heat escapes not through the brick but via the joints, backing bricks in the future will be made to very close tolerances with a minimum of joints.

The demands made on façade bricks are likely to be mainly of an aesthetic nature. It seems to me that British brickmakers, as well as those in Belgium and Holland, are the world leaders today in this respect. I never cease to marvel at the rich variety of facing bricks offered by their leading manufacturers. We are all familiar with the production problems involved in such diversity. Our ceramic technology will have to master this situation in order to turn out products which satisfy market requirements both for their physical properties and their aesthetic design.

Apart from the traditional products - facing bricks and large-size clay blocks - I can still see some market gaps for ceramic construction materials. I am thinking here for instance of floors and ceilings - or again of partitions of which only very few are constructed of ceramic materials.

Another ceramic product for which a good market exists is the large-size unit, for example in the form already manufactured in France today by the firm of Guiron, Toulouse, or that planned in the Federal Republic of Germany with a so-called "plank brick", i.e. storey-high clay units, 60 cm wide.

In particular there will be a demand for blocks offering high thermal insulation which are economical to instal - and this where the brick and tile industry has its great chance on the Continent of Europe. It is essential however for the brick and tile industry to be active in informing people on its products, with a more self-assured attitude to these, and to be more articulate in presenting their advantages compared with other products.

1.7

The environment

We have become accustomed to observing ecological movements, which are a worldwide phenomenon today, with mixed feelings. This is not entirely right. For the fact is that many of our lakes and rivers are now contaminated, our air in some regions is seriously polluted, we are discharging too much carbon dioxide into the atmosphere and so on. But we also realize that it is an economic impossibility for many brickworks at the present time to comply with the stringent regulations draconically imposed today by environmental authorities. In the long run there is no way of avoiding compliance with them and it is up to us to devise solutions to this problem.

1.8

Round-the-clock or one-shift working

In the 1960s there were heated exchanges on the Continent beween advocates of round-the-clock operation and supporters of one-shift working. This discussion, which at the time ended in a victory for the one-shift faction, will have to be reopened today in view of the profits and energy situation. There is no question at all that round-the-clock operation, i.e. 24 hours a day, seven days a week and fifty weeks a year, represents the best solution from every point of view, economic, technical and, most especially, that of energy conservation.

The attendant social problems arising however are not so serious that such round-the-clock operation cannot be realized. We consider the following to be a reasonable solution, although I cannot go into all the detailed whys and wherefores here:

- one-shift working in the preparation, in which it remains to be seen whether the preparation shift should be during the day or at night to take advantage of off-peak power charges,
- two-shift working in the shaping and automatic conveying sections,
- naturally three-shift working in the kiln and dryer,
- two- or three-shift working for drying, depending on the operating conditions at individual works,
- within the preparation a five-day week,
- in the shaping, drying and kiln areas a seven-day week.

2.

The brickworks as a system

To return to my remarks at the beginning of this paper. One of the chief problems of the so-called industrial society, which will most certainly become more acute in the years ahead, consists in the relationship between
a) the so-called subsystems, for example a brickworks,
b) the component elements of the subsystems and
c) the so-called super-systems of society itself.

In view of their interdependence today scientists are now increasingly turning to system theory as a method of approach. Some of you may possibly know the Report of the Club of Rome "The Limits of Growth", which first gave wide publicity to the use of these techniques.

In the perspective of brickworks of the future, I should like once more to stress the need for us to be guided by this complex set of circumstances in formulating our aims, planning our works and making decisions on the actual design and execution. Potential conflicts, e.g. between technical requirements, economic viability and social demands can only be identified and reconciled today by system-orientated initiatives. In this context it is indispensable for the decision-makers, i.e. the heavy clay manufacturers, to draw up a more precise list of specific goals than hitherto and to have a clear idea as to which of these should be given main priority.

3. Conclusion

Let me now work out a blueprint of a brickworks in the year 2000, taking into account the above subject themes.

Take a works for facing bricks which is to be built in the year 2000. We assume that at the chosen location the optimum size of works has been calculated using an OR model (OR = operational research) for such a works with a throughput of 100 million DF (DF means thin format blocks). For a 7-hour day, a 7-day week and a 50-week year and with 2-shift working this gives an hourly output of approx. 21 000 DF/h. Incidentally, we assume that flexibility is a feature of such a works, so that it can manufacture not merely one product and one size, but many. The extruder is therefore fitted with variable-speed motors so that the operating speed can be altered according to different sizes and throughput rates. Substantial savings in electric power are possible here.

Another assumption we make is that such a works has acquired significantly greater refinement in the preparation facilities, so that, for example, five different basic materials can be used. If dry preparation is possible, we would regard the advanced hammer mill as the ideal preparation machine, thanks to design characteristics such as hardwearing materials with high

abrasion resistance, space-saving design and low investment costs. The throughput rate is 150 t fired ware/h, when the preparation is 1-shift working a 30-hour and 5-day week. The prepared basic materials are stored separately in silos and discharged via belt weighers in the correct mix ratio. We also assume that additives are used, e.g. to increase plasticity, for pigmentation etc., which are likewise exactly metered by special weighers.

A "must" for the brickworks of the future in my opinion is the constancy of the properties of the clay body for all material mixes respectively. In the brickworks of the future mixing will probably be a 3-stage process. In the first stage the material will be pre-crushed according to advanced methods of batching theory such as are usual in the cement industry, and stored in large roofed-over stockpiles. These stockpiles serve as buffers independent of the weather and permit large volumes of material, for instance during good weather, to be delivered by outside firms at short notice.

The second mixing stage after the preparation can be according to different concepts depending on the material conditions: Continuous and intermittent mixers will be employed. Measuring and monitoring systems will supply On-Line and Off-Line measured data on critical characteristics and will correct these when they deviate from the setpoint values.

The third mixing stage takes place inside the extruder or just before the extruder. This mixing stage is mainly concerned not with homogeneous and constant dispersion of the various material constituents but rather with the constancy of the physical and chemical parameters such as plasticity.

I do not imagine that after the extruder there will be any very great change in the cutting techniques. It is conceivable that a plastic clay column might be cut by laser. But why should one, where would be the advantage? The same applies to the setting machines and unloading of these. Most certainly the control systems will change, the machines will become more flexible, they will be faster, there will be less breakdowns and downtimes because the machine will have optical or tactile sensors to identify and reject stones thrown round, but there will be little change in the basic principles of operation.

Enormous progress will be made in the dryers and kilns. The decision as to whether brick will remain a competitive product will hinge on the range of dryers and kilns. The successes achieved here in recent years show that values of 420 to 1300 kJ/kg dried and fired ware are entirely within realm of possibility. Prefabricated systems in a wide variety of designs will supersede present-day kiln structures.

The monopoly of the tunnel kiln will give way to alternative continuous systems, such as roller conveyor kilns, depending on the products fired. The valiant efforts of certain firms, Hepworth in the UK, Wienerberger in Austria and Interlocking Tile in the USA indicate the general trend of kiln technology. These examples show however that fast-firing techniques require not only perfected kiln construction and exact process control but can only be realized when the essential preliminaries have already been taken at the preparation stage, i.e. homogeneous clay mixes, tailored to requirement.

The future will by no means be the preserve of giant works only. In many cases small = beautiful, especially when small = flexible. But this poses another pressing question. Large throughput capacities can be achieved either by enormous tunnel kilns, 10 metres wide, or by duplication of a number of small units. What is more important for the needs of the future? We need not come up with the answer today, so long as we keep an open mind and are constantly aware that such questions invariably arise again with the emergence of new technologies and needs.

Process control in all areas of the brickworks will not be an indispensable luxury, it will be an indispensable condition. The main field of activity here will be in the preparation and in the development of suitable measuring instruments which are not yet to be found on the market.

Apart from the technical details, the actual running of the brickworks as a whole in the year 2000 will take quite a different form than today. The energy shortage will then compel us, the energy consumers on the scale of a brickworks, to fit in with the energy structure of the respective region. This strong interdependence will represent one of the essential features of industry in the future.

Another factor is that autonomous, decentralized energy generation will become a much more attractive proposition. The coupling of power and heat, e.g. in the form of unit-type power stations, will probably be a frequent occurrence in brickworks in the year 2000.

As manufacturers of brickmaking machinery and equipment who aim still to be successful in the year 2000, we need more intensive research into the development of ceramic technologies and we need partners with a partnership mentality, that is, partners who will go along with us in striking out a new course in pursuit of common goals.