ENERGETICS IN THE SILICATE INDUSTRY

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Received April 7, 1977

The silicate industry is one of the most energy-intensive branches of national economy. It is responsible for 5.5% of the whole thermal energy consumption of the national economy and it is the fourth greatest of energy consumers after the metallurgy, the chemical industry and the energy production. Therefore energy saving in the silicate industry is both necessary and worthwhile.

Energy saving has always been of great importance in energy-intensive industrial branches. By way of introduction it has to be stated that energy is spoken of, independent of it is used in form of heat or electricity.

Besides this general statement there exist some factors making the problems of energetics and energy saving most timely from the mid-seventies.

Oil prices much rising since 1973 on the international market and in consequence of this the increased price level for energy carriers in general created a new situation and new requirements. The involved countries (all Europe but the Soviet Union, the USA, etc.) took steps primarily aiming at steadying the disturbed financial balance. Accordingly, administrative measures were taken in most places in form of administrative restrictions.

At the same time initiatives were taken for conscious and systematic determination of further steps, for example:

— *efforts* toward an independence in energy supply of expensive imported oil,

— increased utilization of domestic energy sources,

— increased exploitation of secondary, mostly local energy sources,

— more efficient utilization of energy sources, industry development toward less energy intensive technologies and structural materials,

— enhanced economy in energy carriers.

These are of course only general points of view. Decidedly, continuous care of energy is not a "fashion" but a fundamental technical and economic requirement.

Nevertheless all over the world, in this country, too, the rhythm of development accelerated, with the natural consequence that increase of energy consumption grows at a still higher rate than before.

This acceleration affects many fields: labour, basic materials, international relations, especially those with the COMECON countries; possibilities and reserves of socialist integration.

This acceleration also modifies earlier valid and generally accepted principles. Not so long ago, energy consumption level was the most reliable index of economic development. This principle is rapidly transformed in the last years to be replaced by specific energy consumption. Beside the global indices of overall energy consumption, the energy consumption per product unity becomes decisive.

In more and more countries, measures — often at top level — are taken to observe energy carrier saving in all domains of energetics, involving relevant technical, technological changes, technology changes or even economic and financial measures, sometimes administrative steps.

In consequence, energy carrier economy, more efficient and reasonable energetic activities have to be extended to all branches of the national economy, to anything likely to cause losses in the energy supply.

Economic development has to be considered from a much complexer angle of view, increase has to be assured primarily through a minimum of energy expenditure with vigorous reduction in specific energy consumption.

All this is imposed by causes other than "energy crisis", oil shortage, or the economic consequences of the Middle-East conflict.

Energy carriers are available even if not unrestricted. "However, the time of cheap energy carriers is irrevocably gone. The energy policy of each country, the possible ways of energetic development have to be chosen in its acknowledgement."

This quotation is one of the most important statements of the IXth Energy World Conference held in Detroit, September 1974. We face rising prices rather than energy shortage. And this is at the heart of most of the problems. Because without doubt if it depended only on engineering problems, on technology and science, the industrial world would have the intellectual and economic potential to take up these problems and to fight them to avoid decline of the economic life.

This does not depend, however, solely on science and technology but also on economic and political factors with impacts often more difficult to predict than to solve technological problems. This explains many aspects of the present confusion.

The chief problem of any science policy analysis is to explore the interaction between research — development and economical — political factors.

This analysis supplies the bases of energy policy, involving the possibilities of different technologies, the energy stock of, the economic and industrial structure in different countries.

Obviously a crucial component of each medium and long term energy policy or energetic goal is research and development.

The rate of energy consumption has always been determined by the needs of consumption. For decades, production could fully, — economically — serve the consumption.

On the other hand, the technical level of consumer technologies determines rather rigidly the structure of energy sources and predetermines it, probably for decades, imposing to think in large prospectives.

All these could create incertainty in our energy supply. The safety of our energy supply is due to conditions incomparably more favourable than in the capitalist world, thanks to the immense energy store of the Soviet Union and to the economic integrity of socialist countries.

Nevertheless the paramount consequence has to be drawn that economy of energy is a most important technical, scientific and economic task both in the near and the far future. It is therefore no campaign scope, but a systematic, planned, purposeful work.

This work is an essential part also of economic policy, strictly related to energetics. Energetics is based on economic policy decisions and so is the consumption.

Let us now consider the situation in the silicate industry.

There was and there is no favourable situation in the silicate industry. The post-war production of building materials, indispensable for the reconstruction of the country, started for the greatest part with very old, obsolete equipment. The old equipment was obsolete from the aspects of both specific energy consumption and general technical level, had a low performance, poor productivity and excessively unfavourable specific heat consumption.

The building authorities soon recognized this backwardness and made great efforts for decades to improve the efficiency of the technological procedures and to cut down the specific energy consumption per product unity.

This endeavour forced the leaders of the industry to use up-to-date energy carriers suiting adequately special technological requirements of each industrial branch and to purchase up-to-date machinery. So instead of the moist clinker burning, suspended heat-exchange burning systems are used; tunnel furnaces were built instead of the obsolete circular furnaces in the ceramic industry and in the glass industry; nearly the entire silicate industry switched over to up-to-date fuels, to oil and natural gas.

The early started research work was aimed at solving the following questions:

— switching over to up-to-date energy carriers,
— diminishing the use of specific thermal energy,
— modernisation of heat treatment equipment.

Planned research work and well considered investment served these scopes, and as a result the specific heat consumption by the cement industry, the greatest energy consumer, decreased from 1775 to 1300 kcal/kg clinker value since 1965.

Another numerical value is the 760 to 780 kcal heat consumption of the up-to-date furnaces of the Cement factory in Beremend to produce 1 kg of clinker.

The same tendency is observed in other industries. Especially good results have been obtained by the glass industry.

One may ask whether there exists a similarity between energy consumptions of the silicate industries of very different technologies.

Between the different types of furnaces in the silicate industry there are important differences, according to their purpose, construction and heating method.

There is, however, one common fundamental characteristic of silicate industrial technologies, the high temperature level of burning, melting, their most important process. In the most energy-intensive cement furnaces the chamber flame temperature is 1800 to 1900°C. Durability of the refractory lining exposed to extreme thermal and mechanical wear is a decisive factor of adequate exploitation and energetics of the cement furnaces.

Similarly, the special refractory lining of the melting furnaces in the glass industry is exposed to very high heat, mechanical and chemical influences because of the corrosive effect of the molten glass.

Also in the ceramic industry, the principal task during burning is to assure a high burning temperature, the retention of shape of the burnt product, the prevention of discoloration.

No matter how much the furnace types used in the different branches differ from each other, their most important parts have a similar function.

The electric power and the chemical energy of refractory materials is convertible to a great extent and so energy economy in the mechanical preparation (grinding, crushing, transport) can be taken into account with the same sign as calories.

The high burning (melting) temperature, taking also the heat transfer conditions into consideration, absolutely requires high-grade high-calory fuels. Of course, ways are sought for to assure at least a part of the heat consumption by low-grade fuels. This is why e.g. in the cement industry the three-phase burning (precalcination) has been introduced. This method is, however, not exempt from problems and also its economy is dubious.

Now let us consider the different industrial branches from the aspect of energetics.

In the *cement industry*, energy economy started by replacing the low-capacity kilns of extremely unfavourable energetics by up-to-date, high-performance, energy saving furnaces.

The first of them were the Lepol furnaces of the Danube Cement Works in Vác with a 850 t/day output and 1100 kcal/kg specific heat consumption. They were followed by the Dopol furnaces with an output of 1000 t/day and 900 kcal/kg of clinker specific heat consumption at the same Works.

This trend is followed by the 1500 t/day, 760 to 780 kcal/kg clinker specific-heat-consumption KHD furnaces of the Beremend Cement Works, the 2000 t/day Dopol furnaces with the same specific heat consumption of the Hejőcsaba Cement Works and the 1600 t/day furnaces of the Bélapátfalva Cement Works now under construction.

The fuel is natural gas or masut everywhere. From the point of view of energetics and specific heat consumption these furnaces have the common characteristic that independent of the type and the performance, their specific heat consumption is nearly identical: 760 to 780 kcal/kg of clinker.

Still some years ago, this trend of development was a fiercely debated question. Today it is out of question that the Hungarian cement industry took a correct direction, namely the dry-processing high-capacity calcining equipment. This trend coincides with the development of the cement industry all over the world and with the general interests of energetics.

Confronting, however, the limit of possibilities, the theoretical heat demand of 430 to 450 kcal/kg of clinker calcination, to the values of 760 to 780 (kcal/kg clinker) obtained in up-to-date furnaces, obviously there is not much more to be achieved in this respect.

Specific energy consumption has to be improved indirectly. Making better use of time, an undisturbed kiln performance, are indirect possibilities of energy economy, priority being due to refractory materials. The refractory kiln linings have to be chosen according to the actual exposure. Unsuitable quality of the refractory materials causes innumerable standstills. In addition to important production dropouts, frequent kiln standstills increase energy wastes.

Whatever the cause of the performance drop of the calcining equipment or of the standstill, the specific energy consumption — also the highest production cost factor — immediately worsens.

The same happens with grinding. The main point in energetics is the smooth feeding of the mill, the provision of raw materials of suitable grain size (precrushing), the right adjustment of the ball grading and adequate replacement corresponding to the wear. Fundamentally here too, smoothness and steadiness of the operation are a major prerequisite.

Thermal efficiency of *lime calcination* is better than that of clinker calcination. The theoretical heat demand for calcining one kg of CaO is 760 kcal, the necessary thermal level is 1000 to 1250°C. In up-to-date lime calcining equipment, specific values of 950 to 1000 kcal/kg of burnt lime have been achieved. Possibilities with old equipment are limited greatly by the technology.

Therefore for economy, productivity and energetic reasons, the economic and technical solution is expected from high-performance lime calcining equipment.

Two highly heat-intensive phases of the technology of the *brick and tile industry* are drying and baking. Putting aside the energetics of circular kilns, in up-to-date works the drying units have a specific heat consumption of 900 to 1300 kcal/kg of water, the specific heat demand of baking is 230 to 300 kcal/kg stoneware.

Thus the up-to-date drying and baking equipment used in the stoneware industry are working with a relatively favourable thermal efficiency, but it must not be forgotten that favourable energetics are due to the co-ordination of all the factors of a complex process.

Also in the stoneware industry, stability of operation is the first condition of good energetics. Changing chemical or mineral composition, moisture content of the material fed in the dryer or the kiln, the instability of the cooling air characteristics, varying volume of exhaust air in the drying kiln might unbalance or upset the system. The result is necessarily an increase of energy consumption.

The characteristic kiln for the up-to-date *glass production* is the continuous-type tank furnace. Its most important technological feature is melting at a high temperature level, with a great expenditure of thermal energy.

Theoretical heat demand of glass melting at 1500°C is 500 to 700 kcal/kg glass, depending on the glass type. The practically achieved most favourable specific heat consumption is 1350 to 1400 kcal/kg glass.

In case of furnaces used in the Hungarian glass industry, specific heat demands are 3000 to 3200 kcal/kg of glass for flat glass production and 2200 to 3000 kcal/kg glass for hollow glassware.

From the aspect of energetics, the most important goals are the following:

- Melting temperatures have to be raised, exposing, however, the refractory materials both in kilns and in heaters to still more severe conditions.
- High quality refractory materials are necessary.
- The specific melting efficiency has to be greatly increased.
- Complementary electric heating may add 40 to 60% to the kiln output, and flexibility to the tank furnace output.
- Furnace construction has to be developed, if necessary by buying patents.

At the high melting temperatures involved, obviously best economic and thermal efficiency, adequate heat transfer may be expected from up-to-date high-calory fuels. Thermal-intensive procedures in the *fine ceramic industry* are similar to those in the stoneware industry — drying and burning.

Mass drying is increasingly made by spray-drying. Its advantage is the continuous, completely automated operation, the exact control and the favourable specific heat consumption (950 to 1100 kcal/kg water).

In principle the modern burning equipment is entirely identical to that in the stoneware industry. The precious fine ceramic products are, however, more delicate to burning conditions.

The most important tasks are:

- exact following of an adjustable thermal diagram all along the furnace.
- uniform temperature distribution over the furnace cross-section,
- flexible temperature control,
- adjustable furnace atmosphere,
- air lock for moving kiln carriages in and out.

Energetics in the fine ceramic industry are provided by the best choice of raw materials processed at a maximum of technological discipline to end products.

Stress is laid on the technological discipline as primordial factor of energetics in the entire silicate industry.

Beside, however, much has to be done to update the range of dryer and burning (melting) equipment.

Of course the users' viewpoints are equally important. Investigation of this question belongs, however, to the scope of the building industry.

Let us pick out only that the increased thermal insulation of buildings results in an important energy saving. This approach replaced the previous one, namely that buildings need no thermal insulation beyond the so-called "thermal minimum", a principle taking neither the heating energy demand nor the consequences of energy economy into account. Confrontation of the investment costs and the running costs of the building results in the thermally optimum building that is economically projected from thermal aspect. The thickness of the thermal insulation of a "thermally optimum" building is the optimum thickness of insulation.

Based on the above and knowing the characteristics of the thermal insulating materials, the technically most suitable insulating material can be chosen.

Some important technical characteristics intervening in the selection of thermal insulating materials are:

- thermal characteristics (thermal conductivity, density, resistance to vapour migration),
- refractoriness or its contrary, combustibility,
- mechanical properties,
- water absorption,
- chemical resistance,
- durability,
- resistance to microorganisms,
- shape retention,
- workability.

From thermal and economical aspects the following can be said about insulating materials in general:

1. With decrease of the thermal conductivity also the insulation thickness of thermally equivalent materials diminishes.

2. Thermally equivalent but denser materials are bulkier, therefore less dense materials are more favourable.

3. One important criterion when choosing thermal insulating materials is flame resistance or refractoriness.

4. The range of applications of combustible synthetic materials is much narrower than that of inorganic materials. Where no effects of moisture are expected, fibre insulation materials are increasingly used.

Therefore in countries with a developed insulating materials industry, the specific use of inorganic fibre insulation materials much exceeds that of organic materials; an increasing trend.

In this way energetics bifurcates into a production side and a thermal energy economy side.

Summary

Energy economy and energetics are of an utmost importance in the silicate industry. The problem of energetics is quite timely; to deal with this problem everywhere and always is not a "fashion", but a fundamental technical and economic requirement.

Energetic problems in the cement and lime industries, in the glass industry, in the stoneware and fine ceramics industries are treated from this aspect. Beside technical development, energetica llythe most important problems are time utilization, breakdown safety, continuous operation of equipment.

The very great energy expenditure for the production of building materials stresses the energy conservation.

A most effective means is to apply suitable insulating materials and to develop adequate insulating methods for buildings and industries.

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