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PERSONAL ACCOUNT

Process Engineering – a tool for survival

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To justify the above title let us consider two similar cases of survival. Both these cases concern the survival of a biological species in the thermodynamically semi-closed system (semi-closed system is a system exchanging with its surrounding energy, but not matter).

The first example (Fig. 1a) concerns the cultivation of microorganisms in a batch bioreactor (a simple case is the production of alcohol by yeasts). The process of such cultivation always follows the four phases: the lag phase, during which the microorganisms get accommodated to the new situation they have been put into, then the log (logarithmic) phase ,when the microorganisms quickly (exponentially) multiply, later the stationary phase, when the amount of their food (glucose in the case of alcohol production) gets shorter, and the amount of harmful for them their own products (alcohol in the case of alcohol production) increases, and finally the death phase, when lack of food and excessive concentration of harmful products starts killing the organisms.

The second example (Fig. 1b) is the development of the human species on the Earth. For a very long time the amount of humans was very slowly increasing, and only in about 15th century it has started quickly to grow. Between 1500 and 2000 it increased from about 0.5 billion to about 9 billion. This exponential growth follows exactly the definition of the log phase. According to the demographic prognoses this rapid growth seems to slow down – it may be the beginning of the stationary phase.

Our most vital aim should therefore be to make the stationary phase as long as possible (thousand, ten thousand, or perhaps a hundred thousand years?).

A comparison with the described earlier first example shows the obvious reasons for the end of the log phase and the beginning of the stationary phase, these being: the diminishing amount of food (the cultivable areas are diminishing), and, above all, the increasing amount of harmful by-products, contaminating atmosphere (mostly carbon dioxide), lands and oceans (mostly macro and microplastics).

The above, although much simplified analogy, clearly shows what must be done to prolong the stationary phase as far as possible. There are four fundamental problems which must be solved, namely:

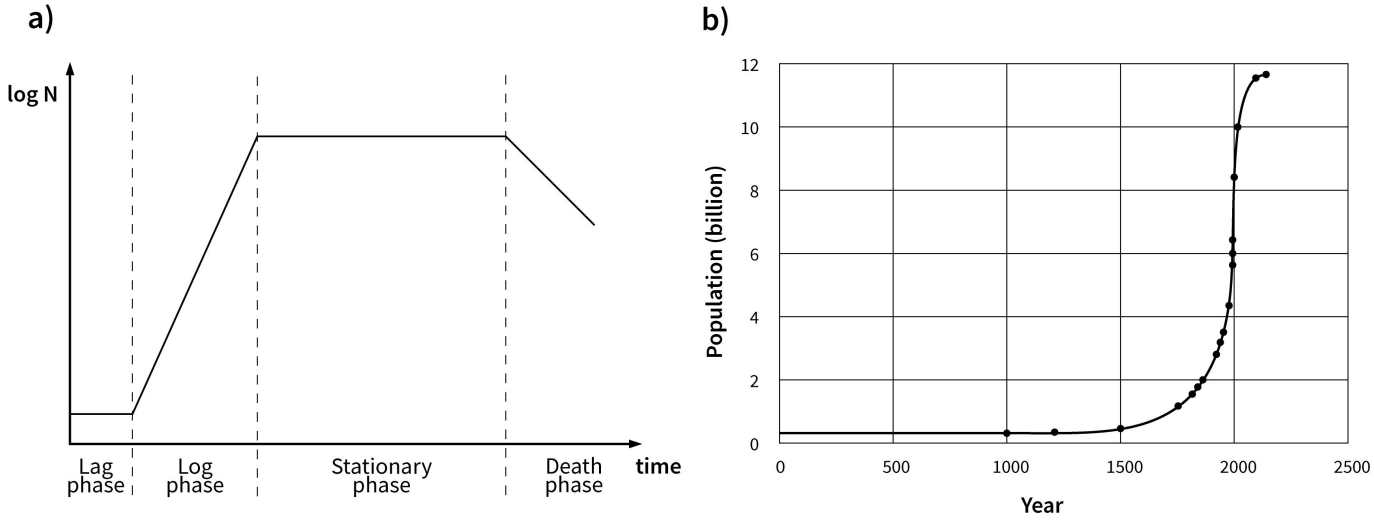

Figure 1. a) Batch cell culture; b) world population.

- shortage of energy,
- shortage of resources,
- shortage of food (including drinking water), and
- excessive environmental pollution.

Chemical (and biochemical) process engineering is indispensable to solve the above problems.

In the case of energy shortage it is necessary to develop (and produce!) new, more efficient photovoltaic elements. The amount of energy which the Sun supplies to the Earth exceeds 7 thousand times the amount used by the human race – more than enough if we can harness that.

The problem of resources concerns both the fossil fuels (gas, oil, carbon) and metals. The fossil fuels may be replaced by hydrogen – to this end we need new processes to produce, transport and store hydrogen.

As to the metals – it is necessary to continue the existing and develop new processes for their recirculation (particularly of the rare-earths metals, but not only them).

The shortage of food might be overcome by development of artificial photosynthesis – it would at the same time diminish the amount of carbon dioxide emitted to the atmosphere.

Very important is the question of drinkable water – we need new processes of desalination and cleaning of water (here, membrane filtration methods are promising).

Finally, extremely important is the question of environmental pollution, especially by the plastic waste (both macro and micro). It would be very desirable to develop new chemical or biological process of depolymerization, to recuperate monomers from waste polymers.

All the desirable new methods may be developed by chemists or biologists – but to be useful on the industrial scale, it will be necessary to develop new processes, which must be done by process engineers.

This is the justification of the title – process engineering is necessary for survival (or at least to prolongate the stationary phase).

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