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The meaning of resource recycling for sustainable development as revealed by mathematical modeling

Andrzej L Wasiak

Białystok University of Technology, Poland

Every human constructed as well as natural object operates for limited lifetime. What happens to various technical objects after their end of life is reached? Frequently they are disposed somewhere in the nature and undergo slow degradation and fragmentation. The resulting particles are dispersed over the soil, atmosphere or ocean waters. Such dispersed matter, because of its very high entropy is practically impossible to recover, so it is irreversibly lost for the human community, in spite of that, it remains on the Earth. The scale of global production is so large that depletion of the resources becomes the real threat. The other problem connected to the dispersed matter is that majority of substances being dispersed in the environment are harmful for living organisms, including humans and therefore, bring damage to the global natural environment. Consequently, dispersing of substances should be avoided. The recycling of materials and other resources intuitively seems to be a remedy for both threats mentioned. Recycling, however, is a technological process, which also requires consumption of some resources and consumption of energy, what in consequence introduces similar threats as the other production processes. The mathematical model presented in this paper enables analysis of the effects of material recycling on productivity of primary technological process. It demonstrates effects caused using the fraction of recirculated material (resource), 'α', as well as the effect of the instant of time 't_z', when this fraction of the material is recirculated. The progress of a process in such a case is represented as:

$$x_m(t) = a \int_0^t nk\tau^{n-1} \exp(-k\tau^n) d\tau + \alpha a \int_0^t \{1 - \exp[-k(\tau - t_z)^n]\} d\tau$$

Where τ is a current time and a, k and n are parameters of a kinetic equation. The other subject concerns analysis of the choices of technological processes of recycling as well as summarizes criteria that should be fulfilled by appropriately chosen technological processes of recycling.

Biography

Andrzej L Wasiak is involved in several research topics belonging mainly to the area of production engineering. His interests are focused on experimental studies as well as mathematical modeling of various processes important for creation of materials, products or harvesting of energy, especially from renewable resources. In his approach, sustainability is idealized notion that can be realized only as asymptotic solution i.e., at any instant of time only with some limited accuracy. He is an active Academic Teacher and also Member of several Polish and international scientific organizations.

a.wasiak@pb.edu.pl
andrzej.wasiak@gmail.com