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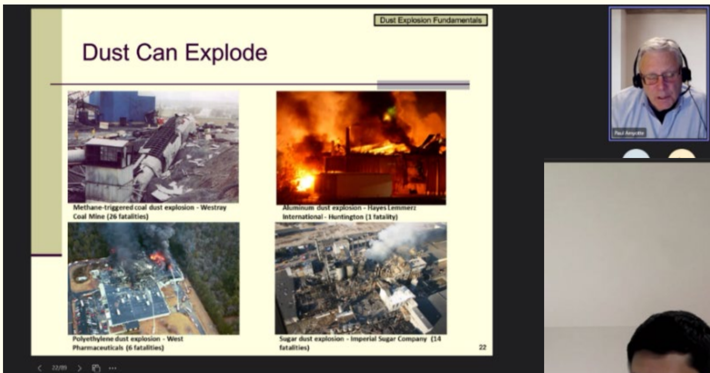
Activities of the Core

May. 18, 2023	The 79th HU-ACE Steering Committee Meeting.
May. 18-21, 2023	PR Exhibition Carbon Recycling Technology in the G7 Hiroshima Summit International Media Center.
May. 22, 2023	The 107th Hiroshima University Biomass Evening Seminar (co-organized).

117th HU-ACE Seminar（131th Mechanical Systems Seminar）

On April 21, 2023, the co-organized 117th HU-ACE Seminar （131th Mechanical Systems Seminar） was held as an online event. Professor Paul Amyotte of Dalhousie University (Halifax, Canada), gave a lecture entitled "Introduction to Dust Explosion: Understanding the Myth and Reality of Dust Explosion and Making it a Safer Workplace." In the lecture, he introduced the three elements of the fire triangle (fuel, oxygen, heat), the elements of a combustible dust explosion, which added two elements (Dispersion of dust, confinement of dust cloud) and the effect of these parameters on dust explosions, with various experimental results. It was a fruitful session in which participants could learn the basics of dust explosion and how to reduce the risk of dust explosions. We would like to thank everyone who was involved.



Related events

The 7th International Symposium on Fuels and Energy (ISFE 2023) will be held on July 3-4, 2023. Please visit the following ISFE 2023 website for more details.
https://symposium2023.isfe.hiroshima-u.ac.jp
Call for Abstract
Dead-line for submission of abstract: May 29, 2023

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Research Topics No. 42

Construction of efficient biocatalyst for valuable chemical production

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Research fields: Biochemical engineering
Keywords: Enzyme, Biocatalyst, Psychrophile

Abstract

Background

Biotechnology by use of microorganisms and enzymes has been considered as a method to produce valuable chemicals while saving energy. Many enzymes are expected to be used for industrial applications because they can carry out reactions under mild conditions (at normal temperatures and pressures) and can convert stereoisomers separately. However, several thousand kinds of enzymes in microbial organisms recognize their target substrates and carry out metabolic reactions. If microbial cells are used as catalysts for material conversion, many kinds of enzymes react simultaneously, which poses a problem for industrial use (Production of a single chemical in large quantities). Therefore, we have been conducting research to realize efficient bioconversion of valuable chemicals by constructing a “Simple biocatalyst”, in which only the enzymes necessary for material conversion function inside the cell by focusing on the temperature dependence of enzymes.

Methods/Results

The simple biocatalyst is constructed with microbial cells with a material conversion system designed to work at a different temperature range from the cellular metabolic system. To produce at normal temperatures (30-50°C), we chose psychrophilic bacteria that lose metabolic activity at normal temperatures as our host organism (Psychrophile-based Simple Biocatalyst: PSCat). We currently use the psychrophilic bacteria (*Shewanella* sp.) isolated from Antarctica, which has an optimum growth temperature of between 18 to 20°C. However, it cannot grow above 30°C. Therefore, psychrophilic metabolic enzymes lose their activities when treated at normal temperatures. On the other hand, a wide variety of mesophilic enzymes (about 90% of all enzymes) are known to work at normal temperatures, if derived from mesophilic microorganisms, plants and animals, and combining these enzymes makes it possible to create a synthetic pathway for chemical production. Microorganisms that express mesophilic enzymes for conversion pathways have been designed by heat treatment at normal temperatures before conversion reactions to construct microbial catalysts in which only the mesophilic enzyme functions. We have achieved high yield (90-100%) production of valuable chemicals (1,3-propanediol, 3-hydroxypropionic acid, aspartic acid, itaconic acid, etc.). Unlike conventional methods where enzymes were extracted from cells in a laborious process, this "simple" enzyme catalyst can select the necessary enzymes through simple heat treatment. Currently, we are conducting basic analysis about the effects of heat treatment on the structural changes of cells and cell aggregation so that the simple biocatalyst can be used as an efficient reaction field, and we are also conducting research on its application to the production of aromatic compounds, which are attracting attention as polymer materials that require durability.

References

[1] M. Mojarrad, K. Hirai, K. Fuki, T. Tajima, A. Hida, J. Kato: Efficient production of 1,3-propanediol by psychrophile-based simple biocatalysts in *Shewanella livingstonensis* Ac10 and *Shewanella frigidimarina* DSM 12253, Journal of Biotechnology, 323, 293-301 (2020)

[2] G. Luo, M. Fujino, S. Nakano, A. Hida, T. Tajima, J. Kato: Accelerating itaconic acid production by increasing membrane permeability of whole-cell biocatalyst based on a psychrophilic bacterium *Shewanella livingstonensis* Ac10, Journal of Biotechnology, 312, 56-62 (2020)

[3] M. Mojarrad, T. Tajima, A. Hida, J. Kato: Psychrophile-based simple biocatalysts for effective coproduction of 3-hydroxypropionic acid and 1,3-propanediol, Bioscience, Biotechnology, and Biochemistry, 85(3), 728-738 (2021)

[4] G. Luo, S. Fujii, T. Koda, T. Tajima, Y. Sambongi, A. Hida, J. Kato: Unexpectedly high thermostability of an NADP-dependent malic enzyme from a psychrophilic bacterium, *Shewanella livingstonensis* Ac10, Journal of Bioscience and Bioengineering, 132(5), 445-450 (2021)