COST865 Spring 2008 meeting

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Immobilised Catalysts: Production and Application in Industry

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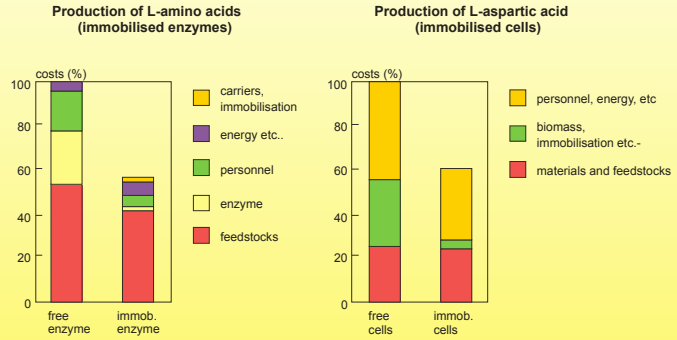
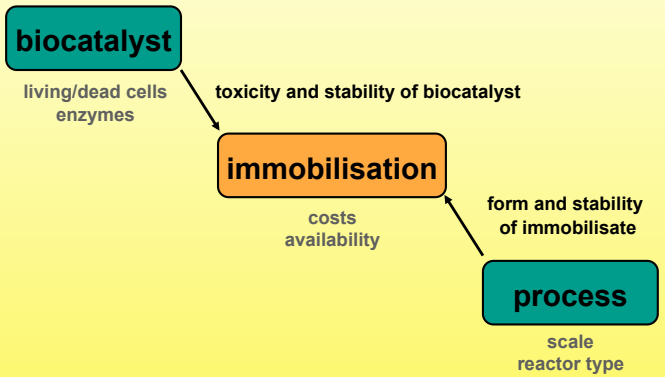
Immobilised Biocatalysts

Cost comparison

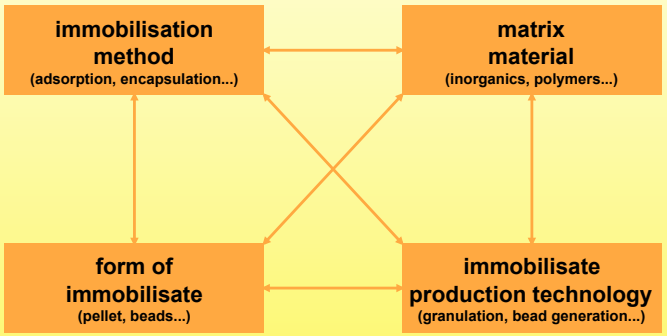


Immobilisation of Biocatalysts



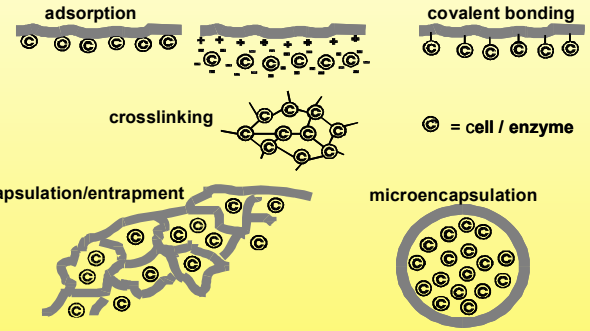
Immobilisation of Biocatalysts

Interactions in immobilisation procedure



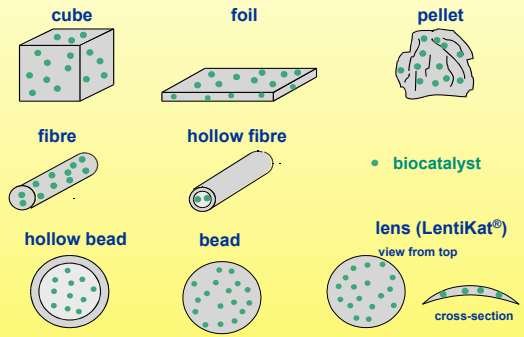
Immobilisation Methods

Overview



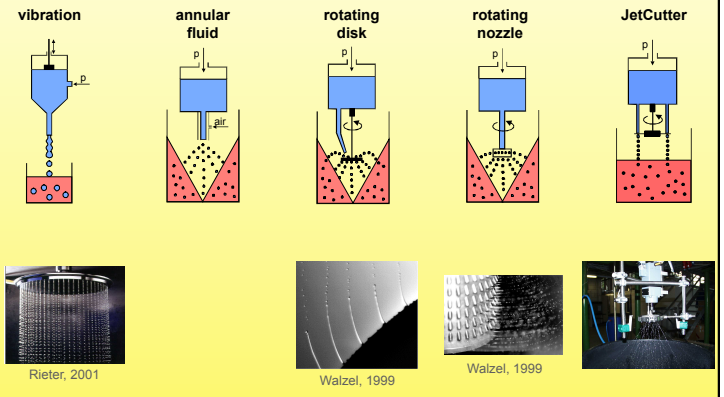
Forms of Encapsulated Biocatalysts

Overview



Bead Production Technologies

Industrial-scale technologies



Rieter, 2001

Walzel, 1999

Walzel, 1999

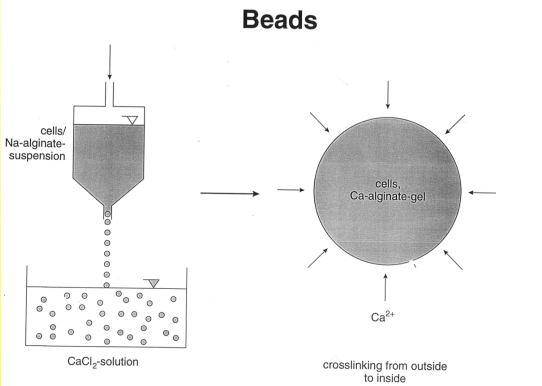
Materials

Ionotropic gels

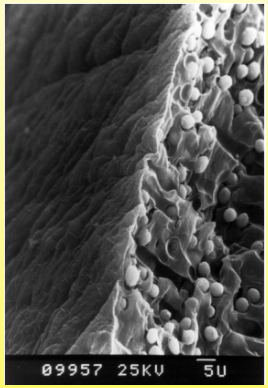
Ionotrope Gele

	Polyanionen	Gegenionen
COO^-	Alginat	Ca^{2+}, Al^{3+}, Zn^{2+}, Co^{2+}, Ba^{2+}, Fe^{2+}, Fe^{3+},.....
	Pectinat	Ca^{2+}, Al^{3+}, Zn^{2+}, Co^{2+}, ... and Mg^{2+}
	Carboxymethylcellulose	Ca^{2+}, Al^{3+},.....
	Carboxy-Guargum	Ca^{2+}, Al^{3+},.....
	Styrol/Maleinsäue	Al^{3+},.....
PO_3^{2-}	Phospo-Guargum	Ca^{2+}, Al^{3+},.....
SO_3^-	Carrageenan	K^+, Ca^{2+},.....
	Furcellaran	K^+, Ca^{2+},.....
	Cellulosesulfat	K^+

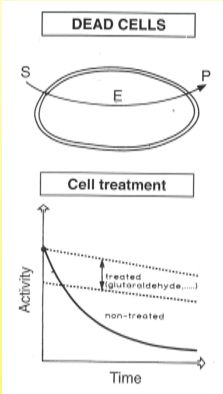
Ionotropoic Gels
Bead formation



Ionotropic Gels
SEM of Ca-alginate bead



Bioconversion
Dead cells



Immobilisation in Industry
L-malic acid production

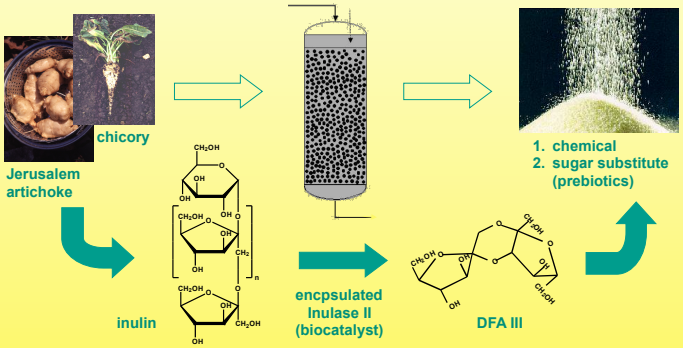
Comparison of Productivity of L-Malic Acid by Various Immobilized Preparations

Cell and Immob. Method	Operation Temperature [°C]	Fumarase Activity [µmol/h/ml of gel]	Operational Stability [Halflife; days]	Relative Productivity [%]
B. ammoniagenes Polyacrylamide	37	530	53	100
B. flavum Polyacrylamide	37	610	94	273
Carrageenan	37	900	160	897
Carrageenan + Polyethylenimine	37	980	243	1587
"	45	1420	165	2073
"	50	1670	128	1992
"	55	2160	74	1730

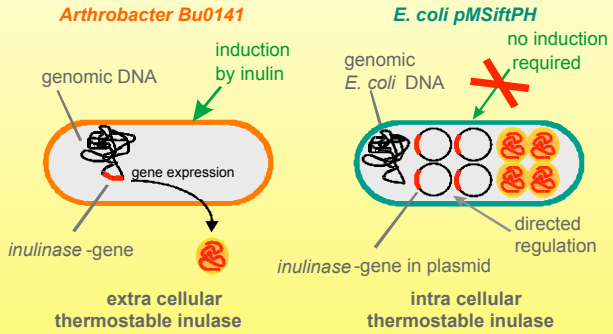
Yamamoto et al. 1976

Immobilisation in Industry
Pilot-scale processes – DFA III

encapsulated enzyme for the production of DFA III from inulin



Immobilisation in Industry
DFA III - genetic engineering

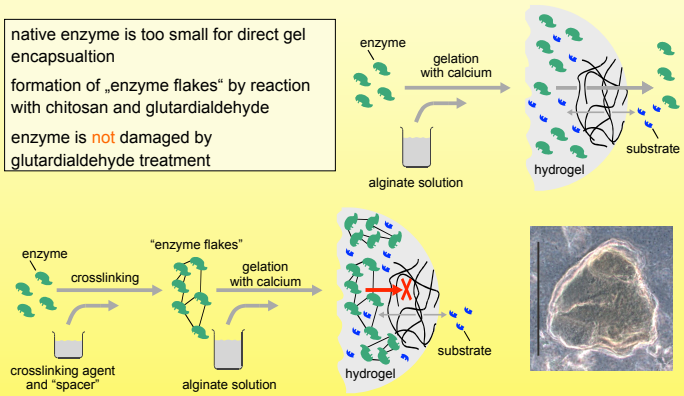


Immobilisation in Industry
Pilot-scale processes – DFA III

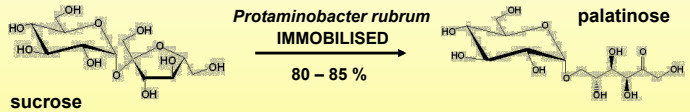
native enzyme is too small for direct gel encapsualtion

formation of „enzyme flakes“ by reaction with chitosan and glutardialdehyde

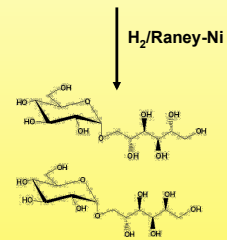
enzyme is not damaged by glutardialdehyde treatment



Immobilisation in Industry
Palatinit



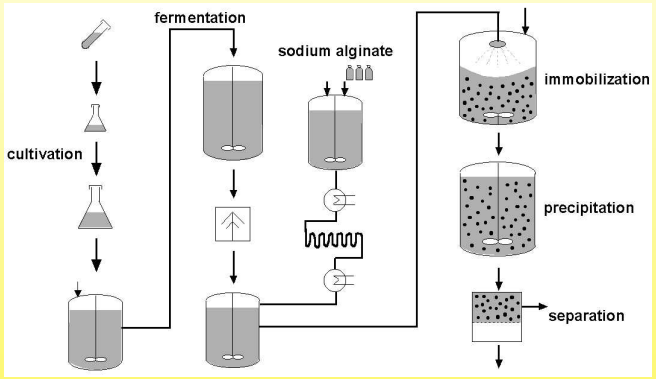
large process with immobilised biocatalysts (alginate-encapsulated dead cell)



sugar substitute Palatinit®:
sweetening power 45 – 60 %
suitable for diabetics
no problems with caries
only 50 % of sucrose calories

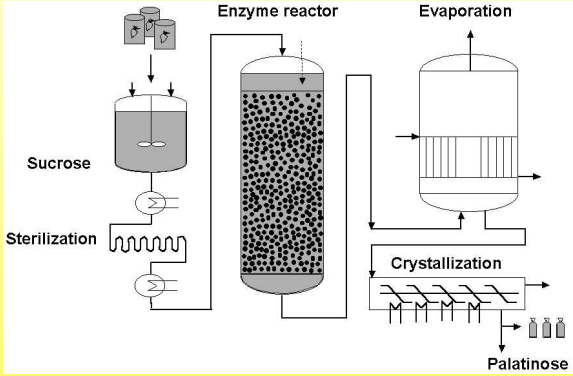
SÜDZUCKER

Immobilisation in Industry
Palatinit



Rose and Kunz, 2002

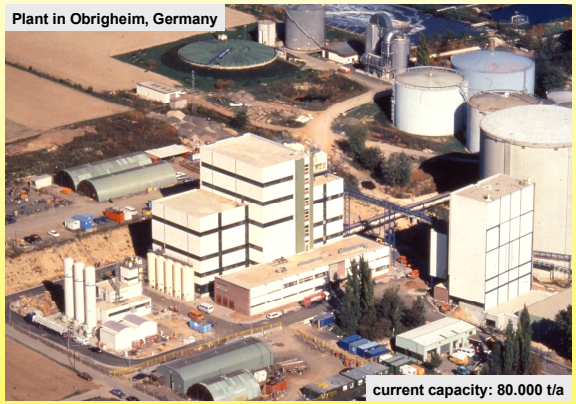
Immobilisation in Industry
Palatinit



Rose and Kunz, 2002

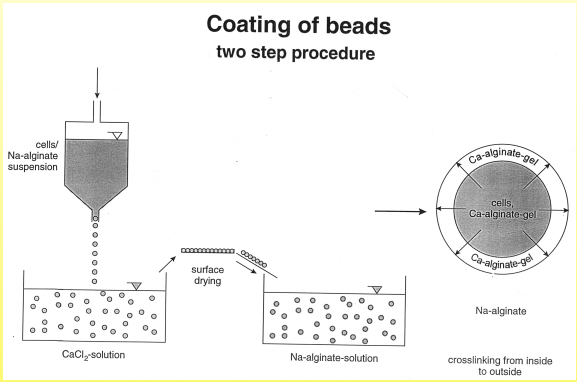
Immobilisation in Industry
Palatinit

Plant in Obrigheim, Germany

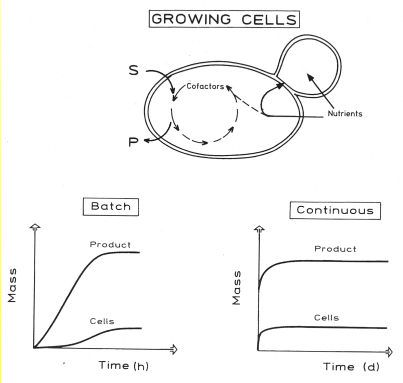


current capacity: 80.000 t/a

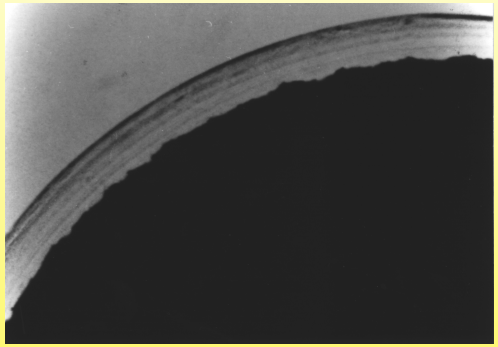
Ionotropic Gels
Coated beads



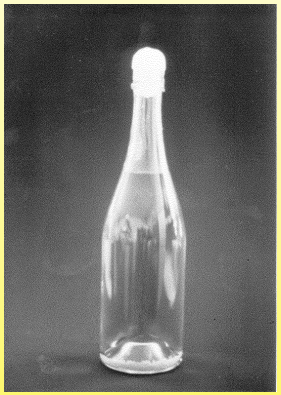
Bioconversion
Growing cells



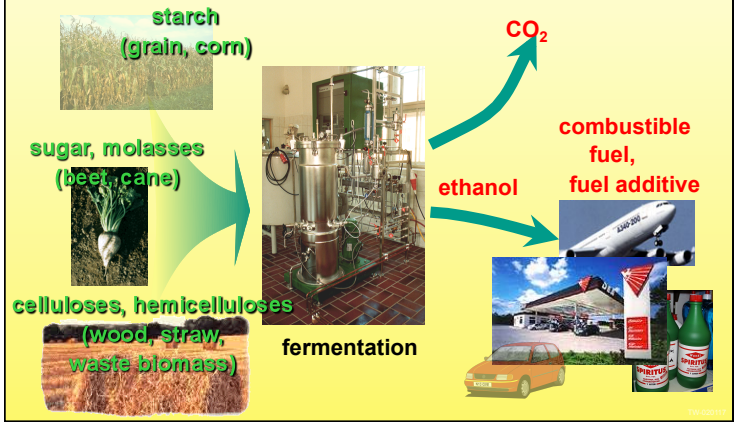
Coated Ca-Alginate Bead



Champagne Production
Coated Ca-alginate beads

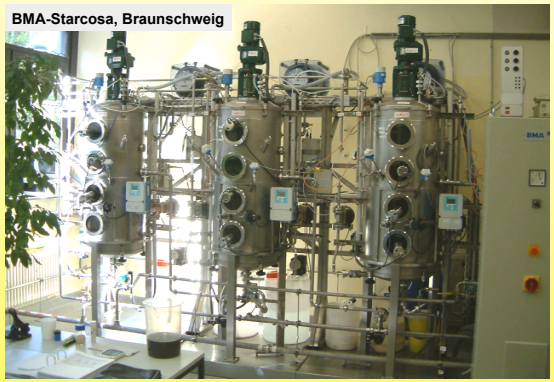


Immobilisation in Industry
Bioethanol



Ethanol-Fermentation: Pilot Plant

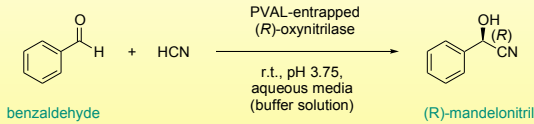
Immobilised cells, continuous, 3-stage



BMA-Starcosa 2003

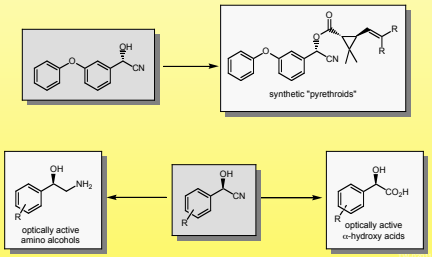
Immobilisation in Industry

Pilot-scale processes – chiral nitriles



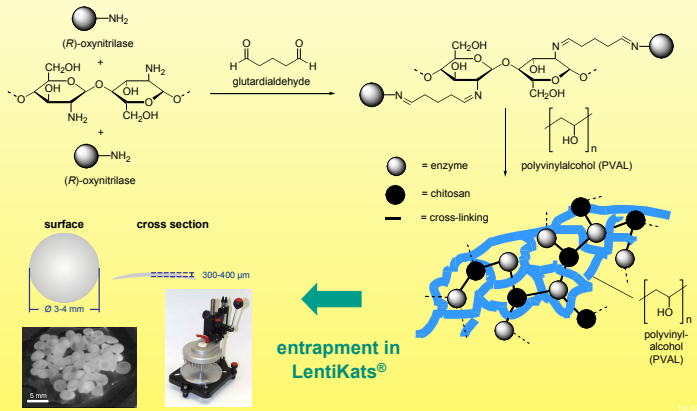
applications for chiral nitriles:

building-block for agrochemicals and pharmaceuticals



Immobilisation in Industry

Pilot-scale processes – chiral nitriles



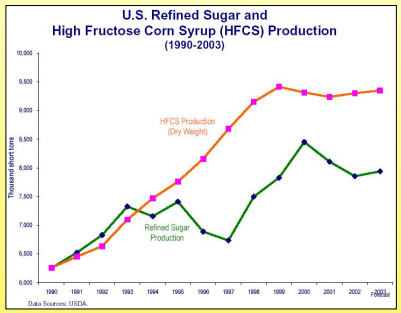
entrapment in LentiKats®

Immobilisation in Industry

Industrial processes - HFCS

HFCS = High Fructose Corn Syrup

worldwide largest process with immobilised biocatalysts



glucose isomerase, crosslinked with glutardialdehyde

worldwide production of HFCS:

1996: 10 Mio t/a
1998: 11 Mio t/a
2001: 11.6 Mio t/a

Immobilisation in Industry

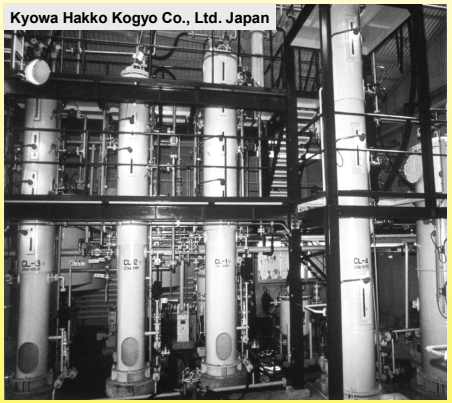
Bioethanol: free and immobilised yeast?

process cell type: *Saccharomyces ssp.*	conventional batch process free cells industrial	Melle Boinet (Brazil) cell recycling industrial	Kansai Paint (Japan) continuous process immobilized cells technical scale
cell conc. [g/L]	3 - 5	9.6	40
ethanol conc. [g/L]	100 - 110	55 – 80	85
yield [%]	85 - 86	85 - 86	89 - 90
productivity [kg EtOH/(m^3·h)]	1.3 – 1.5	1.38	10 - 12

Immobilisation in Industry

Ethanol pilot plant

Kyowa Hakko Kogyo Co., Ltd. Japan



Nagashima et al. 1984

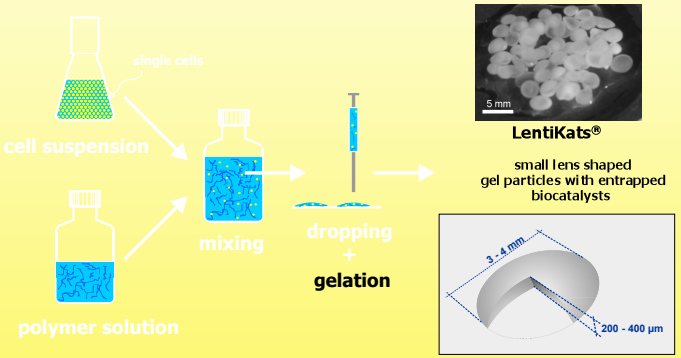
Immobilisation in Industry

Ethanol pilot plant: long-term behaviour

Nagashima et al. 1984

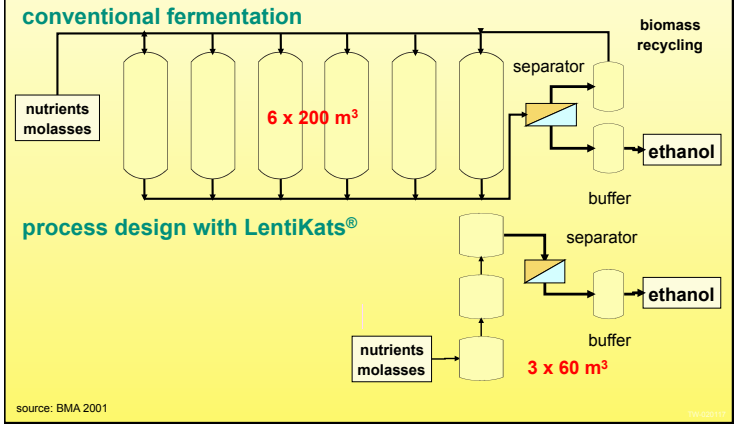
Immobilisation in LentiKats®

Principle



Ethanol Fermentation: Production Plant

Conventional or LentiKats® (immobilised cells)



source: BMA 2001