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(54) Title: PROCESSES FOR FIXATION OF CARBON DIOXIDE

(57) Abstract: System and process are provided for fixation of carbon dioxide through fermentation. More specifically, the disclosure includes fermenting carbon dioxide into methane through methanogenic archaea and producing single cell protein nutrient supplement. The disclosure further provides the integration of methanogenic fermentation with additional processes to achieve improved carbon efficiency.



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2024/033518

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	C12P5/02	C12P7/06	C12P7/54	C12P21/00	C12P21/06
	C12N1/00	C12N1/20			
ADD.					
According to International Patent Classification (IPC) or to both national classification and IPC					
B. FIELDS SEARCHED					
Minimum documentation searched (classification system followed by classification symbols)					
C12P C12R C12N					
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched					
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)					
EPO-Internal, BIOSIS, COMPENDEX, EMBASE, FSTA, WPI Data					
C. DOCUMENTS CONSIDERED TO BE RELEVANT					
Category*	Citation of document, with indication, where appropriate, of the relevant passages				Relevant to claim No.
X,P	WO 2023/107901 A2 (CALYSTA INC [US]) 15 June 2023 (2023-06-15) claims 1-22 pages 9-15 pages 16, 18 page 26				1-22
X	-----				
Y	WO 2022/008478 A2 (UNIBIO AS [DK]) 13 January 2022 (2022-01-13) claims 1-5 page 12 page 16, lines 29-30 page 8, lines 20-27 page 1, line 35 - page 2, line 8 page 13, lines 30-31 page 19, lines 11-25 -----				1-3,5, 7-42 4,13-42
	-/-				
☒ Further documents are listed in the continuation of Box C.					
☒ See patent family annex.					
* Special categories of cited documents :					
"A" document defining the general state of the art which is not considered to be of particular relevance			"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention		
"E" earlier application or patent but published on or after the international filing date			"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone		
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)			"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art		
"O" document referring to an oral disclosure, use, exhibition or other means			"&" document member of the same patent family		
"P" document published prior to the international filing date but later than the priority date claimed					
Date of the actual completion of the international search			Date of mailing of the international search report		
3 January 2025			25/03/2025		
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2024/033518

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2018/015393 A1 (KRAJETE GMBH [AT]) 25 January 2018 (2018-01-25) claims; example 1 page 26 -----	4
Y	WO 2012/094538 A1 (UNIV CHICAGO [US]; METS LAURENS [US]) 12 July 2012 (2012-07-12) abstract; claims; examples paragraph [0196] -----	4
Y	WO 2018/144965 A1 (KIVERDI INC [US]) 9 August 2018 (2018-08-09) abstract; claims paragraphs [0250], [0257], [0386] paragraphs [0396] - [0416] -----	13-42
T	Anonymous: "Methanobacterium thermoautotrophicus", Taxonomy browser, NCBI, 3 January 2025 (2025-01-03), pages 1-3, XP093236466, Retrieved from the Internet: URL:https://www.ncbi.nlm.nih.gov/Taxonomy/ Browser/wwwtax.cgi?mode=Info&id=145262&lvl =3&lin=f&keep=1&srchmode=1&unlock page 1 -----	
A	LEE SEUNGHAN ET AL: "Apparent digestibility of protein, amino acids and gross energy in rainbow trout fed various feed ingredients with or without protease", AQUACULTURE, vol. 524, 735270, 1 July 2020 (2020-07-01) , pages 1-8, XP093235944, Amsterdam, NL ISSN: 0044-8486, DOI: 10.1016/j.aquaculture.2020.735270 abstract; tables 5-7 -----	23-42

INTERNATIONAL SEARCH REPORT

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:

1 - 42

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2024/033518

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2023107901 A2	15-06-2023	CA 3233940 A1	15-06-2023
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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-42

A process for converting CO₂ comprising fermenting a gaseous substrate that includes CO₂ and H₂ with methanogenic archaea to produce methane and fermenting the methane with methylotrophic bacteria

2. claims: 43-90

A process for converting CO and CO₂, comprising fermenting a gaseous substrate that includes CO₂ and H₂ with methanogenic archaea to produce methane, fermenting the methane with methylotrophic bacteria, and fermenting a gaseous substrate that includes CO with CO converting acetogenic bacteria to produce an alcohol

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2024/033518

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2025066716 A1	27-02-2025
		WO 2018144965 A1	09-08-2018
