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|  | Réactions | Taux |
| **Phase d’hydrolyses par les bactéries mésophiles MB** | | |
| 1 | Hydrolyse mésophile de C |  |
|
| 2 | Hydrolyse mésophile de P |  |
|
| 3 | Hydrolyse mésophile de L |  |
|
| **Phase d’hydrolyses par les bactéries thermophiles TB** | | |
| 4 | Hydrolyse thermophile de C |  |
|
| 5 | Hydrolyse thermophile de P |  |
|
| 6 | Hydrolyse thermophile de L |  |
|
| **Phase d’hydrolyses thermophiles des macro-molécules** | | |
| 7 | Hydrolyse de H par les actinomycètes thermophiles |  |
|
| 8 | Hydrolyse de CE par les champignons thermophiles |  |
|
| 9 | Hydrolyse de LG par les champignons thermophiles |  |
|
| **Phase d’hydrolyses mésophiles des macro-molécules** | | |
| 10 | Hydrolyse de H par les actinomycètes mésophiles |  |
|
| 11 | Hydrolyse de CE par les champignons mésophiles |  |
|
| 12 | Hydrolyse de LG par les champignons mésophiles |  |
|
| **Phase de croissances des bactéries mésophiles** | | |
| 13 | Croissance de MB sur |  |
|
| 14 | Growth of MB on (ammonification) |  |
| 15 | Growth of MB on |  |
| **Phase de croissances des bactéries thermophiles** | | |
| 16 | Growth of TB on |  |
| 17 | Growth of TB on |  |
| 18 | Growth of TB on |  |
| **Phase de croissance des actinomycètes mésophiles** | | |
| 19 | Growth of MA on |  |
| 20 | Growth of MA on |  |
| 21 | Growth of MA on |  |
| 22 | Growth of MA on |  |
| **Phase de croissances des actinomycètes thermophiles** | | |
| 23 | Growth of TA on |  |
| 24 | Growth of TA on |  |
| 25 | Growth of TA on |  |
| 26 | Growth of TA on |  |
|  | **Phase de croissances des champignons mésophiles MF** |  |
| 27 | Growth of MF on |  |
| 28 | Growth of MF on |  |
| 29 | Growth of MF on |  |
| 30 | Growth of MF on |  |
| 31 | Growth of MF on LG |  |
| **Phase de croissances des champignons thermophiles TF** | | |
| 32 | Growth of TF on |  |
| 33 | Growth of TF on |  |
| 34 | Growth of TF on |  |
| 35 | Growth of TF on |  |
| 36 | Growth of TF on LG |  |
| **Death of micro-organisms** | | |
| 37 | Death of MB |  |
| 38 | Death of TB |  |
| 39 | Death of MA |  |
| 40 | Death of TA |  |
| 41 | Death of MF  (le coefficienty z pour équilibrer l’équation) |  |
| 42 | Death of TF |  |
| **Lysis of micro-organisms (tiré de Oudart)** | | |
| 43 | Xi : C1.48 H1.5 O0.85 N0.12  Fi : coefficient de rendement : 0.305 |  |
|
| **Nitrogen cycle** | | |
| 44 | Nitrification by biological treatment processes book  (without N2O emission) |  |
| 45 | Denitrification |  |
| 46 | Death of autotroph biomass  \*La répartition du décès de la biomasse autotrophe entre M.I et RB est calculée dans les mêmes proportions que pour la biomasse hétérotrophe |  |
| 47 | Emission ammoniacale (transfert liquide – gas selon Sole-Mauri ?)  : Equilibre de l’ammoniac dissout avec la phase gazeuse  : Volatilisation de l’ammoniac |  |
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|
| **CH4 emission** | | |
| 48 | Methane generation  Oxidation of methane (limited by oxygen uptake rate) | Methane generation  Oxydation  Emission of methane |
|  |  | : Biomass yield  : Molacular weights of substrate S  : Molacular weights of microorganism X |
|  | **Growth limiting functions** | |
|  | Temperature   * Mesophilics i = 1, Thermophilics i =2 | |
|  | Dissolved oxygen | |
|  | Moisture content   * If H2O * If * If | |
|  | Ammonia -ammonium  is the concentration of in the liquid phase | |
|  | Substrate  is the concentration of i in the liquid phase | |
|  | Substrate availability   * Bacteria * Actinomycetes * Fungi | |
|  | Ammonium for nitrification  (kg.l-1) (T = temperature, C) (US EPA, 1975) | |
|  | Oxygen for nitrification | |
|  | Limitation of denitrification by NO3-  is the concentration of in the liquid phase | |
|  | Limitation of denitrification by temperature | |
|  | **Energy balance**   * Temperature of gas phase   (Verification if can be equal to Cp capacité calorifique)   * Temperature of solid-liquid phase   : heat transfer through container’s wall  : biological heat generation, proportional to the oxygen consumption rate | |

* A voir :
  + Bactéries autotrophes nitrifiantes – bactéries hétérotrophes dénitrifiantes
  + Emissions de CH4 dans les zones anaérobiques
  + Décès des MF et TF
  + Matières inertes ?
  + Valeurs initiales de la population microbienne <https://journals.asm.org/doi/epdf/10.1128/aem.45.4.1188-1195.1983?src=getftr>

The initial quantity of microbial biomass was supposed to be small enough and similar for all simulations (with the value of 0.05 g C 100 g−1 initial TOC (Zhang et al., 2012)

(Denes et al., 2015) : for biowaste and green waste mixture (fast and slow growing : 0,1 gC/100g TOC) (other values for for other waste type)

The densities of bacteria and fungi were adopted from Bakken and Olsen (1983) and were equal to 577 and 580 gC/L respectively (Vlyssides et al., 2009)

We can perform a sensitivity analysis on this value

* Liens :

<https://www.researchgate.net/profile/Arjan-Hensen/publication/228788699_METHODS_TO_ASCERTAIN_METHANE_EMISSION_OF_LANDFILLS/links/5411a6bb0cf29e4a232977ad/METHODS-TO-ASCERTAIN-METHANE-EMISSION-OF-LANDFILLS.pdf>

<https://www.frontiersin.org/articles/10.3389/fenvs.2022.907562/full>

<https://www.afvalzorg.nl/content/uploads/2018/03/Methane-from-landfill-Methods-to-quantify-generation-oxidation-and-emission.pdf>

<https://www.sciencedirect.com/science/article/pii/S1385894715005495#b0040>

<https://www.afvalzorg.nl/content/uploads/2018/03/Comparison-of-Methane-emission-models-to-Methane-emission-measurements.pdf>

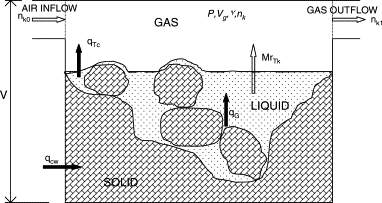
<https://www.sciencedirect.com/science/article/pii/S0956053X05003107#bib23>

<https://www.tandfonline.com/doi/full/10.1080/00207233.2021.1987060?needAccess=true>

<https://pubs.acs.org/doi/full/10.1021/acs.est.6b00415>

<https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1047&context=extension_histall>

<https://www.sciencedirect.com/science/article/pii/S0956053X11001279>



CH4Effect of aeration rate and non-aeration but turning (Jiang et al., 2015)

.[Hao et al. (2001)](https://www.sciencedirect.com/science/article/pii/S1001074215000819" \l "bb0040)ont rapporté que sans aération, le gaz s'accumule au cœur du tas de compost, ce qui entraîne des émissions de surface relativement faibles. L'aération accélère non seulement le processus de dégradation, mais favorise également l'échappement des émissions gazeuses du centre.

Calcul du potentiel méthanogène des différents substrats solubles (cf tableau excel)

**Calcul de l’oxygène dissous dans la phase liquide** (https://core.ac.uk/download/pdf/35285217.pdf)

In the interface gas-liquid, the concentration of oxygen in liquid phase can be calculated by the equilibrium equation of “loi de Henry”

Henry constant for oxygen (mol.m-3.Pa-1)

: Pa

in the gas phase (Jiang et al., 2015)

Assuming that the gas phase is a ideal gas:

kg.h-1

: kg.dm-3

and

Finally:

The Henry constant is a function of the temperature:

,

The volume of gas phase is :

**Calcul de NH3 émis dans l’atmosphère**

is the quantity of in the gas phase of compost matrix. It is calculated following the formula proposed by (Didier, 2013) :

Henry constant of (atm.l.mol-1)

: parameter of exchange between and . A value of 1 is taken according to Oudart’s result.

universal gas constant (atm.l.(mol.K)-1

temperature of composting material (K)

is a function of the temperature:

Volatilization of ammonia is defined as:

aeration flow rate (kgair.h-1)

: specific air density (kgair.m-3)

: Volume of gas phase (m3)

**Heat Balance**

The heat generated by biological activities:

(de Guardia et al., 2012)

: consumption rate of oxygen (mol.h-1)

: heat released per mole of oxygen consumed (kJ.mol-1)

(Lin et al., 2008)

Total growth rate of aerobic microorganisms (mol.h-1)

: Biomass yield on oxygen (mol.mol-1)

: growth rate of aerobic microorganism i (kg.h-1.kgTM-1)

Molar mass of microorganism i (kg.mol-1)

TM: Initial total mass of compost (kgTM)

The heat loss by the wall of the composting reactor:

The convective heat loss by air flow:

Specific heat of dry air (kJ.K-1.kg-1)

Enthalpie de l’air humide fonction de la T et de l’W

Air flow (kg.h-1)

specific heat of biowaste (kJ.K-1.kg-1)

<https://doi.org/10.3390/en16217271> : emissions for composting but unity per OM

<https://www.sciencedirect.com/science/article/pii/S0048969700004393#TBLFN2> :CH4 et N2O emissions of food waste

<https://www.sciencedirect.com/science/article/pii/S0048969718348757>

**Water balance**

: absolute humidity of the inlet and outlet airflow (kgH2O/kgair)

Humidité relative de l’air

Pressure of satured vapor (Pa)

Ambiant pressure

If we assume that the outlet airflow is satured, and Hr of the inlet is 0.4

Food waste composition <https://www.sciencedirect.com/science/article/pii/S2772427122000122#fig0005>

<https://www.sciencedirect.com/science/article/pii/S0921344919302721#bib0180>

<https://eprints.soton.ac.uk/359726/1/__soton.ac.uk_ude_PersonalFiles_Users_sh7_mydocuments_SHnow_Res_Papers_Kusch_713.pdf>