Projekt Orbit | Dr. W. Bidlingmaier | Bauhaus Universität Weimar | www.orbit-online.net

1 Basic mechanism of anaerobic reaction

General course of reactions according to the following pattern (Buswell):

$$organic\ matter \rightarrow CO_2 + CH_4 + (H_2S * NH_3 + PO_4^{-2}) + Energy_{(thermic+energetic)}$$

1.1 Degradation of carbohydrates

$$C_nH_aO_b + \left(n - \frac{a}{4} - \frac{b}{2}\right)H_2O \rightarrow \left(\frac{n}{2} + \frac{a}{8} - \frac{b}{4}\right)CH_4 + \left(\frac{n}{2} + \frac{a}{8} - \frac{b}{4}\right)CO_2$$

1.2 Degradation of amino acids to acetic acid, ammonia and carbon dioxide

$$CH_3CHNH_2COOH + 2CH_2NH_2COOH + 2H_2O \rightarrow 3CH_3COOH + 3NH_3 + CO_2$$

1.3 Degradation of fatty acids to acetic acid, hydrogen and carbon dioxide

$$CH_3CH_2COO^- + 2H_2O \rightarrow 2CH_3COO^- + H^+$$

$$CH_3CH_2COO^- + 2H_2O \rightarrow CH_3COO^- + 3H_2 + CO_2$$

1.4 Carbon dioxide - reduction to methane, water and heat energy

$$CO_2 + 4H_4 + H_2O \text{ + Wärmeenergie}$$

1.5 degradation of acetic acid to methane and carbon dioxide

$$CH_3COOH \rightarrow CH_4 + CO_2$$

1.6 Anaerobic metabolism on the example of glucose

$C_6H_{12}0_6 \rightarrow 3CO_2 + 3CH_4$ (- 421 kJ/mol)

Methanogen (Archaea):

$$4H_2 + CO_2 \rightarrow CH_4 * 2H_2O + Energy$$

Methanation

$$CO + 3H_2 \rightarrow CH_4 + H_2O$$

Methane reforming

$$CH_4 + 0{,}5\,O_2 \rightarrow CO + 2\,H_2$$

$$CH_4 + H_2O \rightarrow CO * 3\,H_2$$

Lactic acid fermentation

$$C_3H_6O_3 = CH_3 - CH(OH) - COOH$$

Hydrosulfides

$$2\,H_2S + 3\,O_2 \rightarrow 2\,H_2O + 2\,SO_2$$

2 Gas formation

Theoretical gas potential:

According to the law of ideal gases, a volume of 1.868 m³ gas is produced by the complete gasification of 1 kg organic carbon.

$$G_e = 1.868 * C_0 * (0.014\,J + 0.28)$$

G_e quantity of gas in m³ formed over a long period
J Temperature in °C
C_o organic carbon

Content of additional nitrogen (inert gas) [Tabasaran, 1994]**:**

$$C_{(N_2)} = 100 - 4{,}79 * C_{(O_2)} - C_{(CH_4)}$$

One should consider that the ratio of (air) nitrogen to (air) oxygen can change. In that case the formula cannot be applied.

Percentage of nitrogen in the air:

$$C_{(N_2)} \approx 3.79 * C_{(O_2)}$$

$C_{(N_2)}$	percentage of additional nitrogen (i.e. inert gas)	[Vol.-%]
$C_{(O_2)}$	percentage of oxygen	[Vol.-%]
$C_{(CH_4)}$	percentage of methane	[Vol.-%]
$4{,}79 * C_{(O_2)}$	percentage of air	[Vol.-%]

Projekt Orbit | Dr. W. Bidlingmaier | Bauhaus Universität Weimar | www.orbit-online.net

Maximum pressure:

$P_{max} = P_A * P_{ex}$ (maximum pressure)

P_A starting pressure
P_{ex} explosion pressure (for methane approx. 7.4 bar)

Explosibility of methane gas [Tabasaran, 1994]**:**

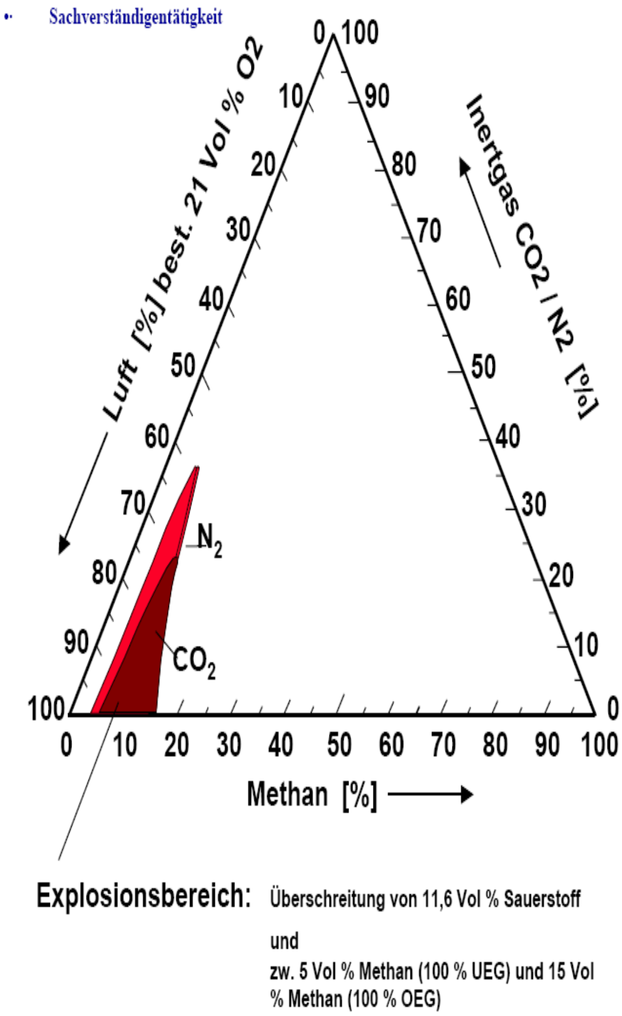
Methane mixed with air, can be brought to explode within a certain limit with the help of an ignition source .

z_u = approx. 5 Vol.-% z_o = approx. 14 - 15 Vol.-% Methane in air

z_u lower flammability limit
z_o upper flammability limit

peak value on mixing with inert gas

Nz = 35.6%
Sg = 5.93%



"ternary" diagram for the explosion range of methane/air/carbon dioxide mixtures and that for methane/air/nitrogen mixtures with given Volume % of mixture concentration with respect to the total weight (source: Tabasaran / Rettenberger (UBA –Forschungsbericht 12/1982, Nr. 10302207 Teil1)