Un ejemplo integrador…

- REACTOR ANAEROBIO DE FLUJO ASCENDENTE PARA TRATAMIENTO DE EFLUENTES

¿CÓMO ENCARAR EL ANÁLISIS DEL REACTOR?

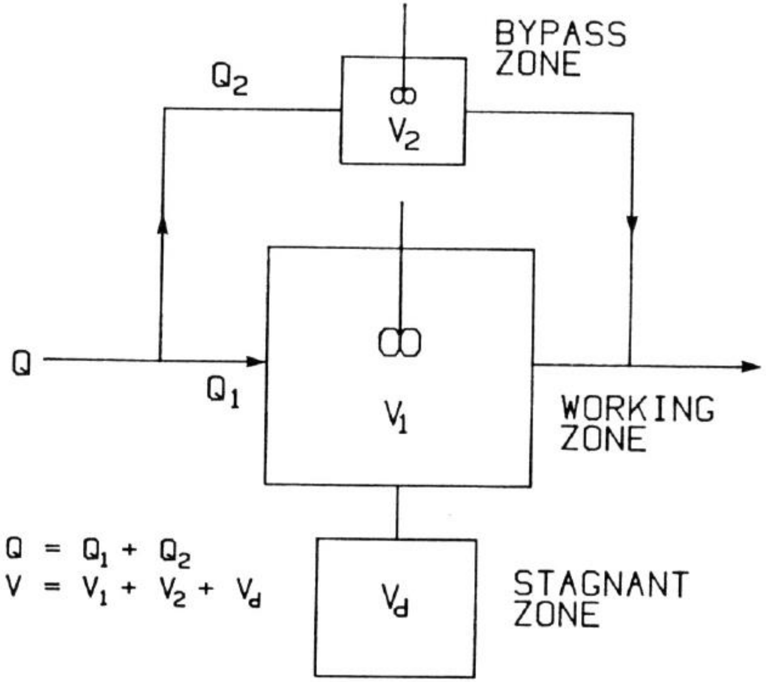
Tenemos que analizar diferentes aspectos:

- Modelo de Flujo
- Cinética
- Balances de Masa
- Fenómenos de Transferencia de Materia
- Fenómenos de Transferencia de Calor / Balances de Calor

WATER POLL. RES. J. CANADA:
VOLUME 20, NO. 2, 1985

NON-INTRUSIVE ESTIMATION OF ACTIVE VOLUME IN ANAEROBIC REACTORS

Eric R. Hall



$$\frac{C}{C_o} = \frac{\beta_1^{\,2}}{\beta_2} \cdot \exp - \frac{\beta_1}{\beta_2} \cdot \Theta + \frac{(1-\beta_1)^2}{1-\beta_1-\beta_3} \cdot \exp \frac{(\beta_1-1)}{1-\beta_2-\beta_3} \cdot \Theta$$

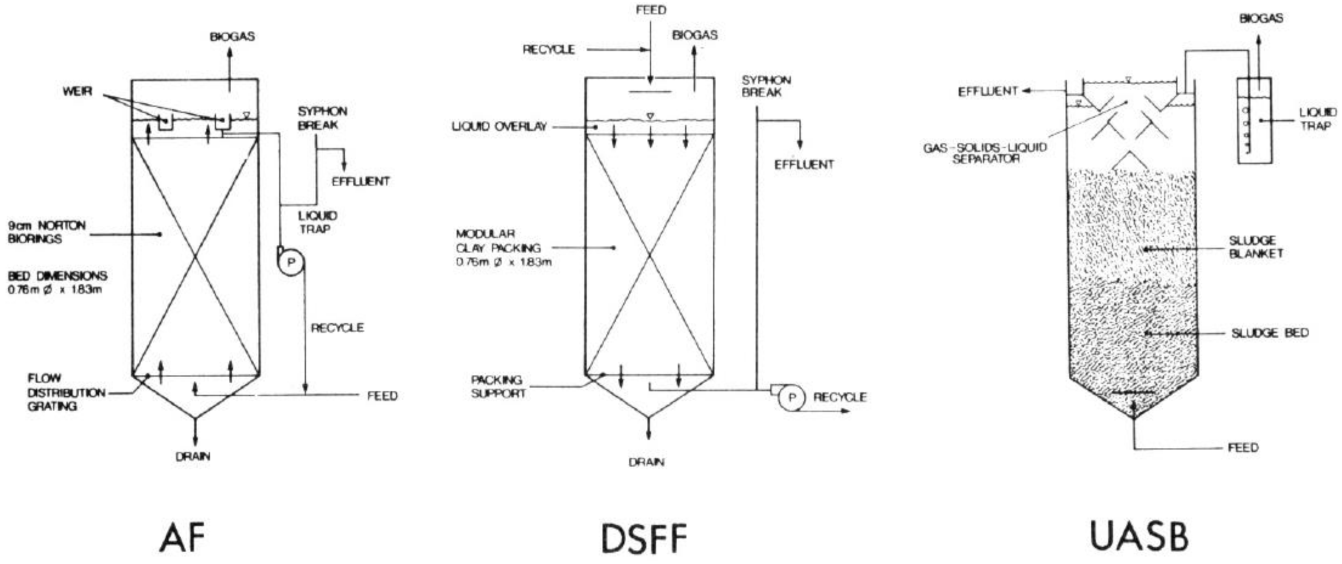
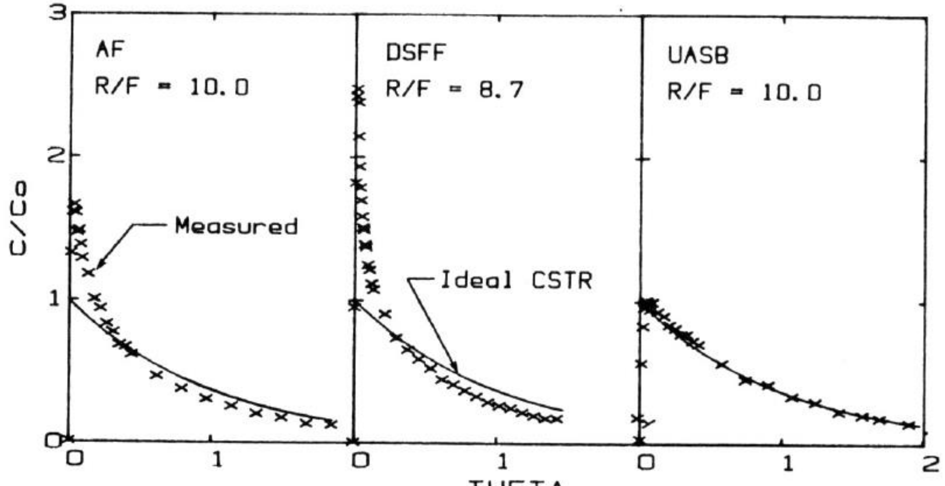


Fig. 2 Pilot scale anaerobic filter (AF), downflow stationary fixed-film reactor (DSFF) and upflow anaerobic sludge blanket reactor (UASB).

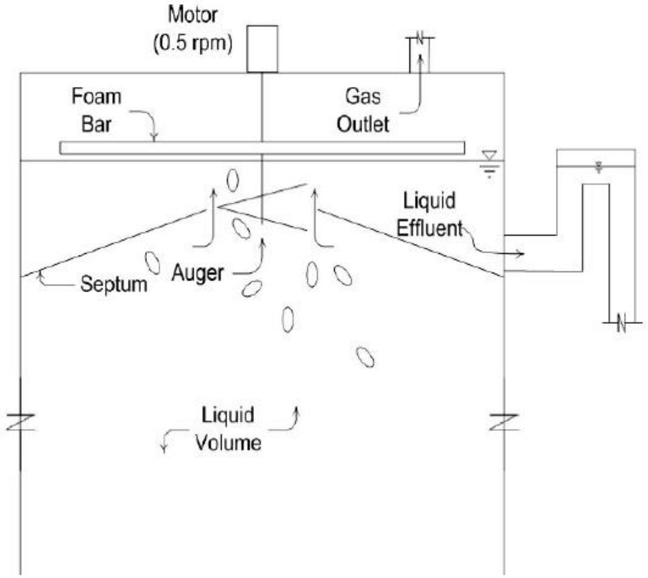
Reactor	Biomass Support	Volume (L) Empty Bed	Initial Void
AF	9 cm Norton Actifil	950	900
DSFF	Red Clay Blocks	950	620
UASB	-	1100	1100

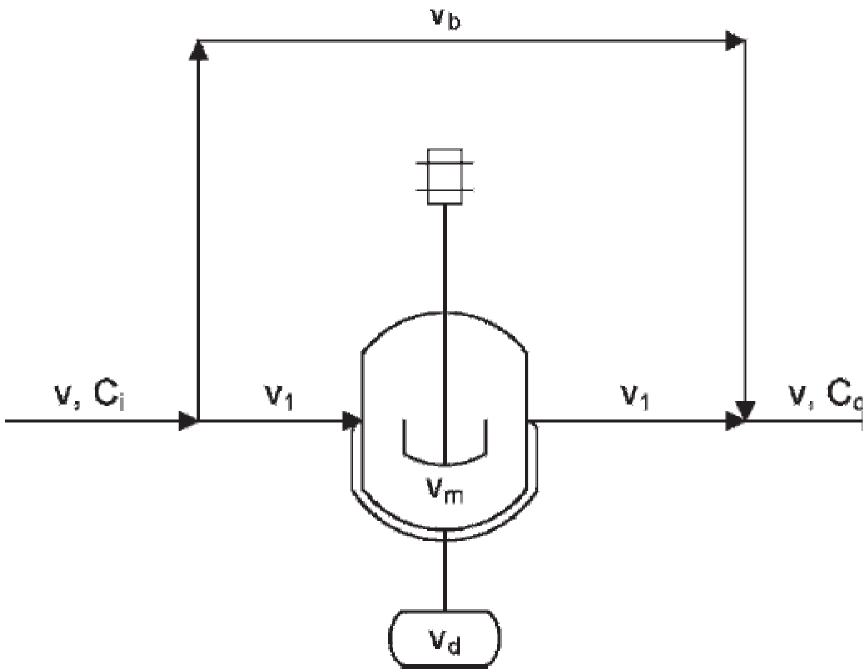


Completely Stirred Tank Reactor Behavior in an Unmixed Anaerobic Digester: The Induced Bed Reactor

J. Shaun Dustin[1]*, Conly L. Hansen[2]

Water Environment Research, Volume 84, Number 9





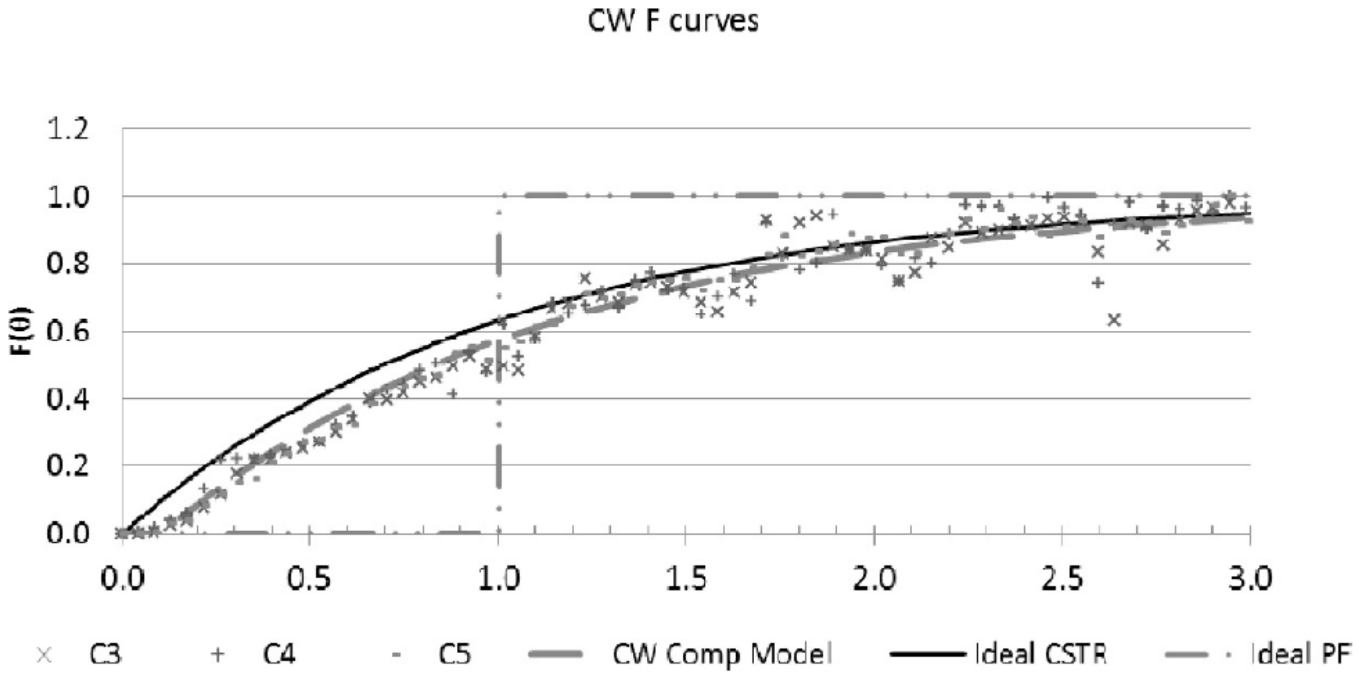


Figure 4—Cumulative residence time distribution (RTD) expressed as F-τ and contact time curves for clean water studies (no active digestion; Rhodamine WT tracer; 35, 45, and 55 °C).

Sludge Blanket Height and Flow Pattern in UASB Reactors: Temperature Effects

Kripa Shankar Singh[1]; Thiruvenkatachari Viraraghavan, F.ASCE[2]; and Debraj Bhattacharyya[3]

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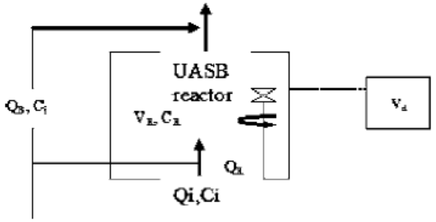

Fig. 7. Schematic diagram of UASB reactor for mathem analysis

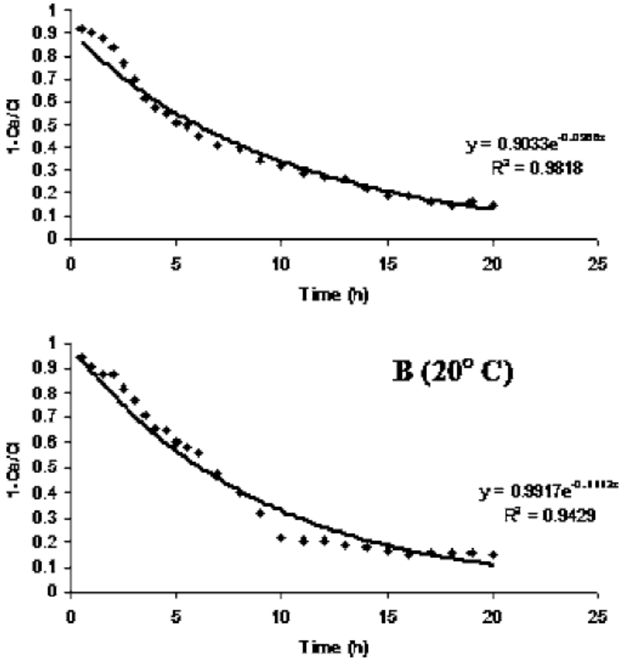

Fig. 8. Relationship between $(1-C_e/C_i)$ and time for the determination of bypass flow fraction and dead-zone fraction

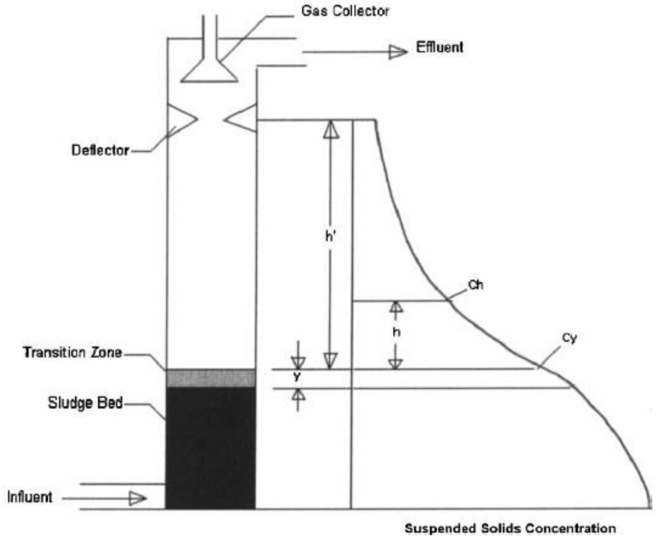

Fig. 2. Schematic of the UASB reactor showing the change in solids concentration along the height

Table 1. Bypass and Dead-Zone Fraction at Each Temperature

	Temperature (°C)	
Parameters	32	20
Dead zone (f_d) (%)	10.00	11.00
Bypass flow (r_b) (%)	9.67	0.83
Correlation coefficient	0.98	0.94

Understanding the Mixing Pattern in an Anaerobic Expanded Granular Sludge Bed Reactor: Effect of Liquid Recirculation

Debraj Bhattacharyya[1] and Kripa S. Singh[2]

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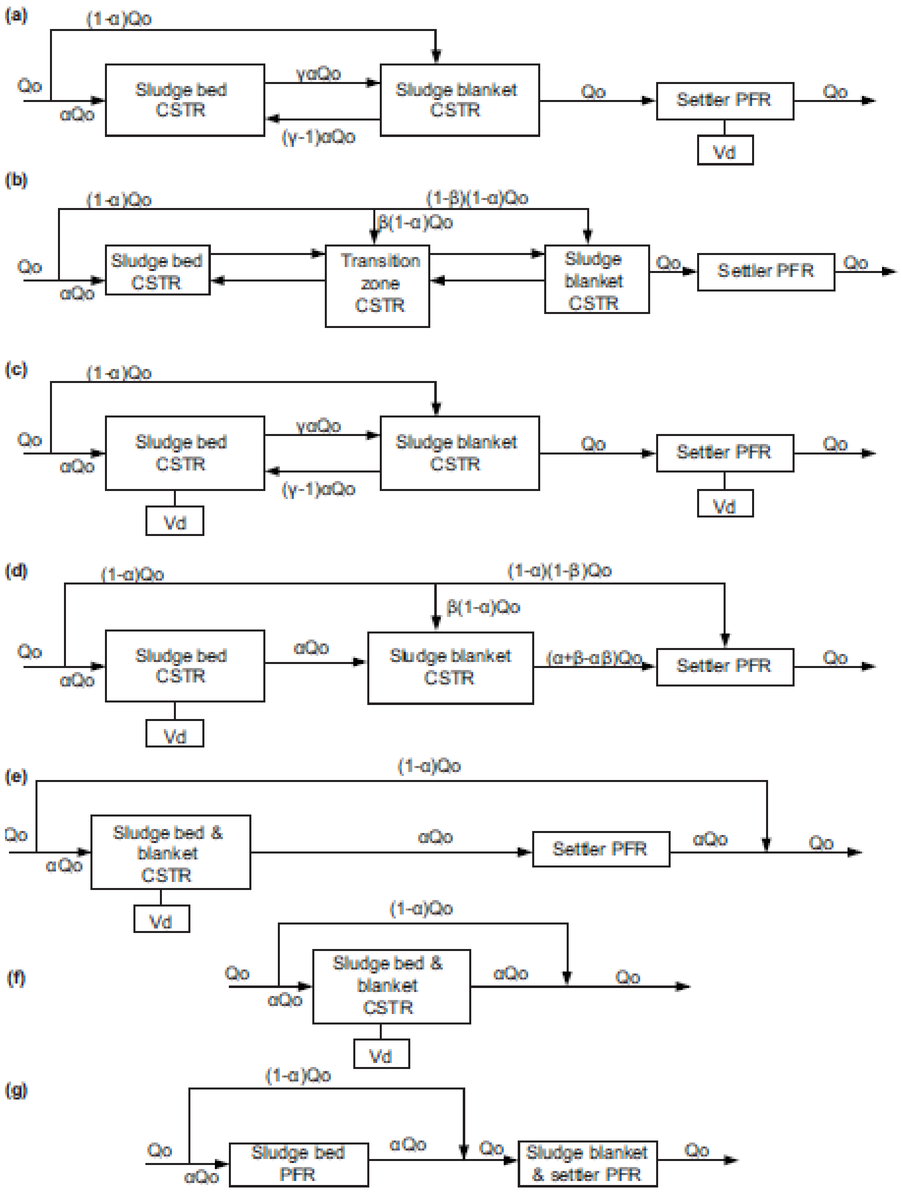
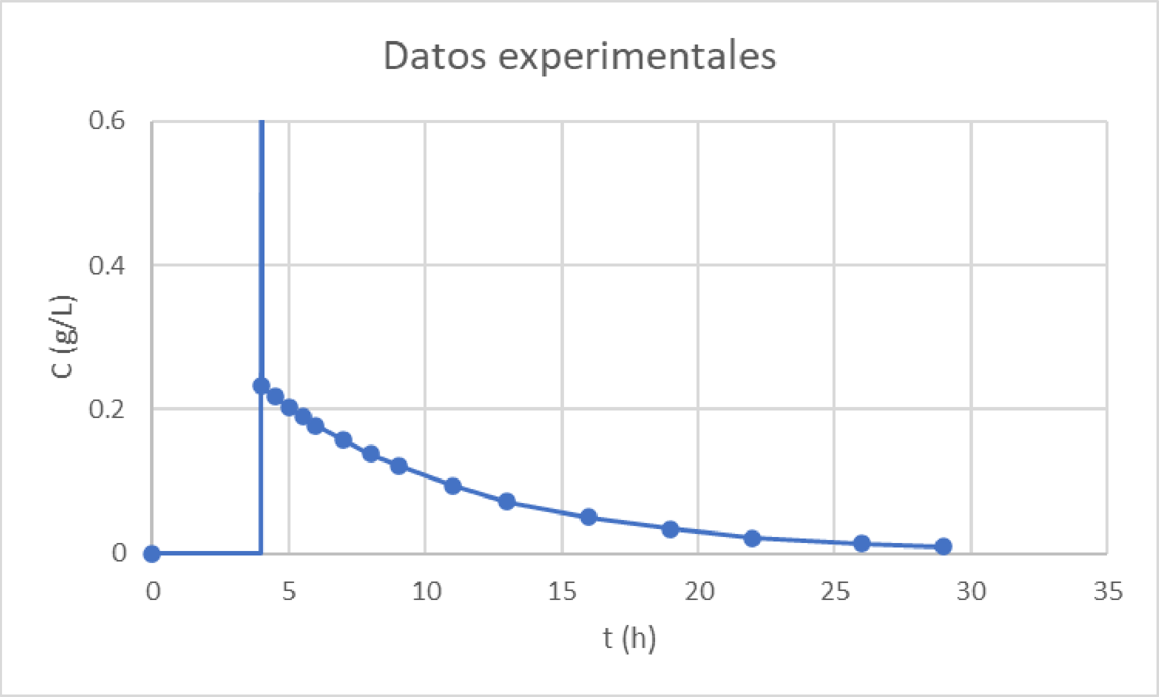
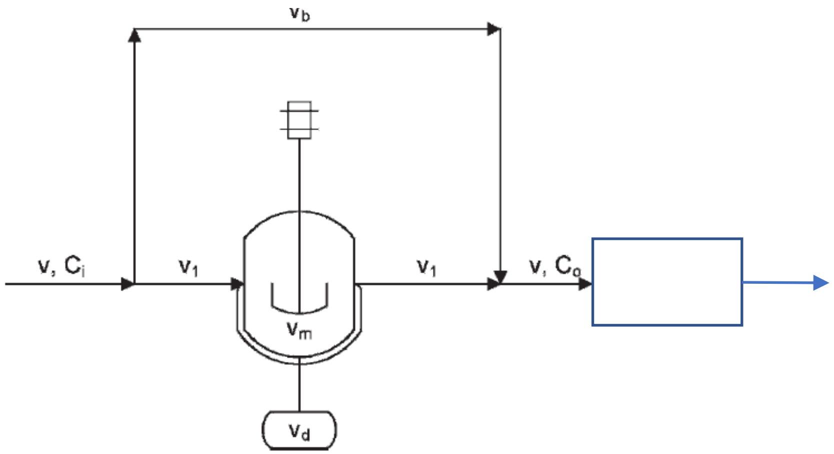


Fig. 1. UASB models, proposed by different researchers: (a) Heertjes and van der Meer (1978); (b) Heertjes et al. (1982); (c) Heertjes et al. (1982); (d) Bolle et al. (1986); (e) Wu and Hickey (1997); (f) Singh et al. (2006); and (g) Singhal et al. (1998)

Ejercicio: En un reactor UASB de 140 m^3, operando con un caudal de 10 m^3/h, se inyectó un pulso de lítio de 20 kg y se obtuvo la siguiente tabla de concentración a la salida:

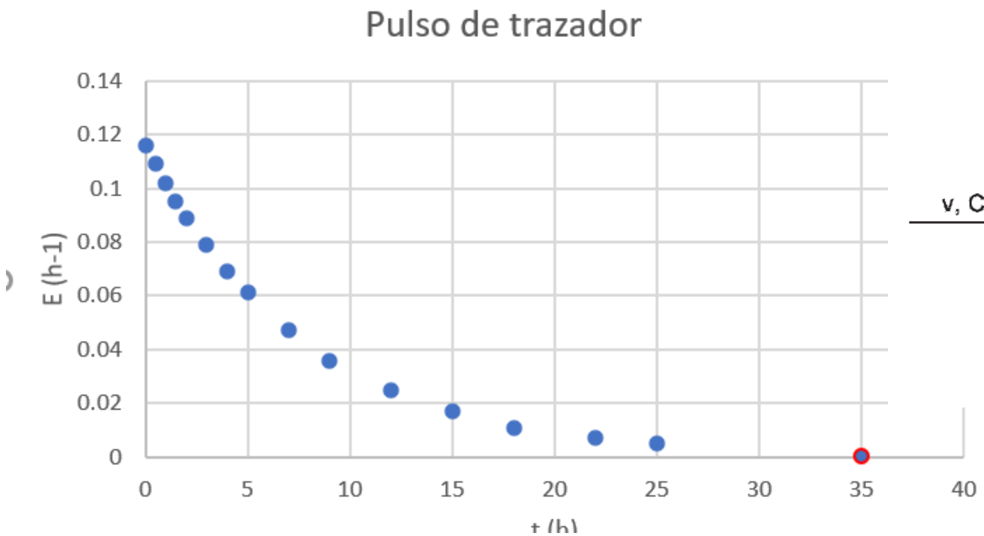
t (h)	0 a 4	4	4	4.5	5	5.5	6	7	8	9	11	13	16	19	22	26	29
C (g/L)	0	salto de escala	0.232	0.218	0.204	0.19	0.178	0.158	0.138	0.122	0.094	0.072	0.05	0.034	0.022	0.014	0.01

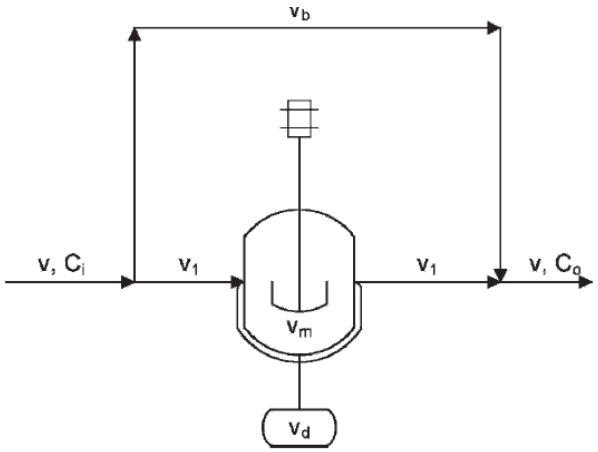




$\tau_P = 4$ h, Vp = 40 m^3

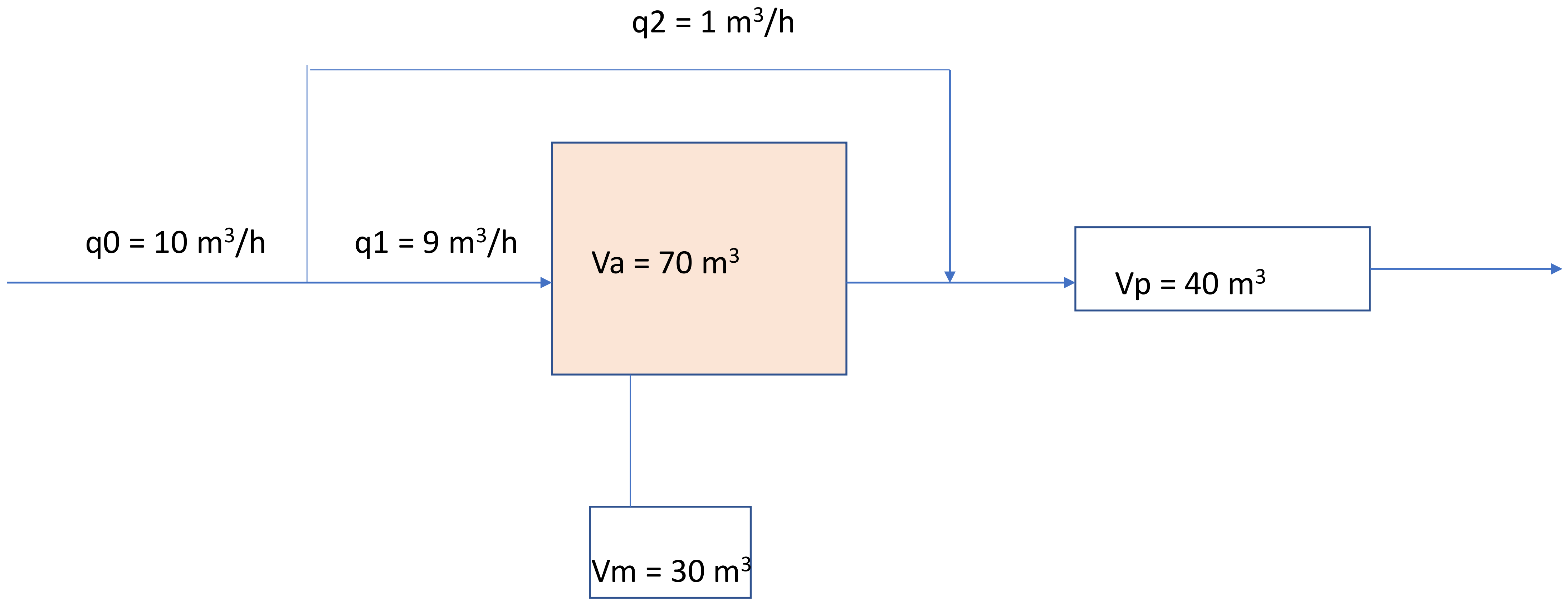
t (h)	t' (h)	C (g/L)	E = C/(M/v)	área
0 a 4		0		
4		salto de escala		
4	0	0.232	0.116	
4.5	0.5	0.218	0.109	0.0563
5	1	0.204	0.102	0.0528
5.5	1.5	0.19	0.095	0.0493
6	2	0.178	0.089	0.0460
7	3	0.158	0.079	0.0840
8	4	0.138	0.069	0.0740
9	5	0.122	0.061	0.0650
11	7	0.094	0.047	0.1080
13	9	0.072	0.036	0.0830
16	12	0.05	0.025	0.0915
19	15	0.034	0.017	0.0630
22	18	0.022	0.011	0.0420
26	22	0.014	0.007	0.0360
29	25	0.01	0.005	0.0180
39	35	0	0	0.0250
				0.89375





entonces by pass = 10%

tau tot =	10 h		
tauA =	7.8 h	Va =	70 m3
		Vm =	30 m3


q2 = 1 m³/h
q0 = 10 m³/h
q1 = 9 m³/h
Va = 70 m³
Vp = 40 m³
Vm = 30 m³

El reactor desde el punto de vista de la reacción…

En rigor el sistema es trifásico:

PSEUDO HOMOGÉNEO

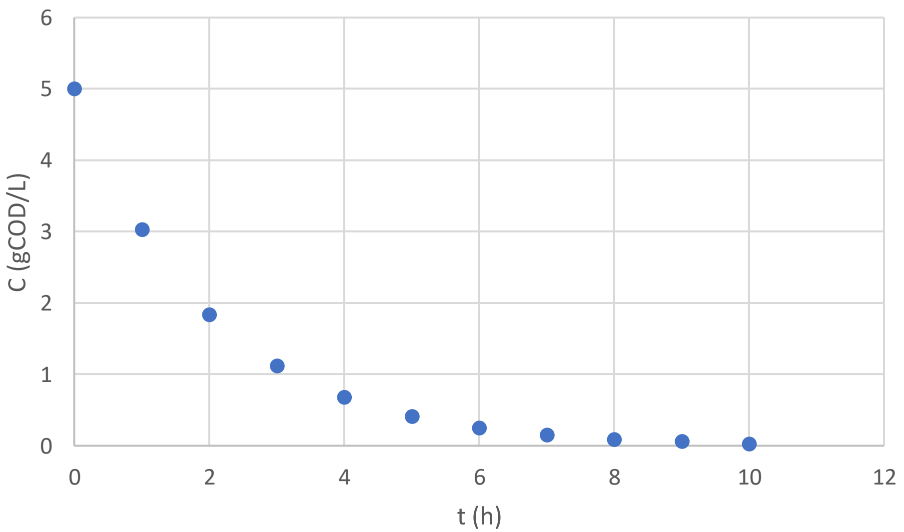
Determinar la CINÉTICA:

Varias alternativas: Batch o Continuo; método integral, método diferencial; velocidades iniciales, etc.

Por ejemplo, puedo realizar ensayos en batch (inóculo más sustrato), y seguir la evolución del sustrato o del producto en el tiempo.

Supongamos que obtenemos estos datos experimentales:

t (h)	C (gCOD/L)
0	5
1	3.03
2	1.84
3	1.12
4	0.68
5	0.41
6	0.25
7	0.15
8	0.09
9	0.06
10	0.03



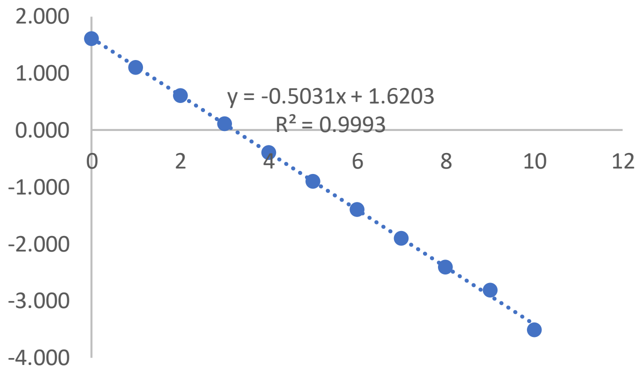
Voy a suponer cinética de primer orden: r = k*C

En batch: $$\frac{dC}{dt} = -k\,C$$

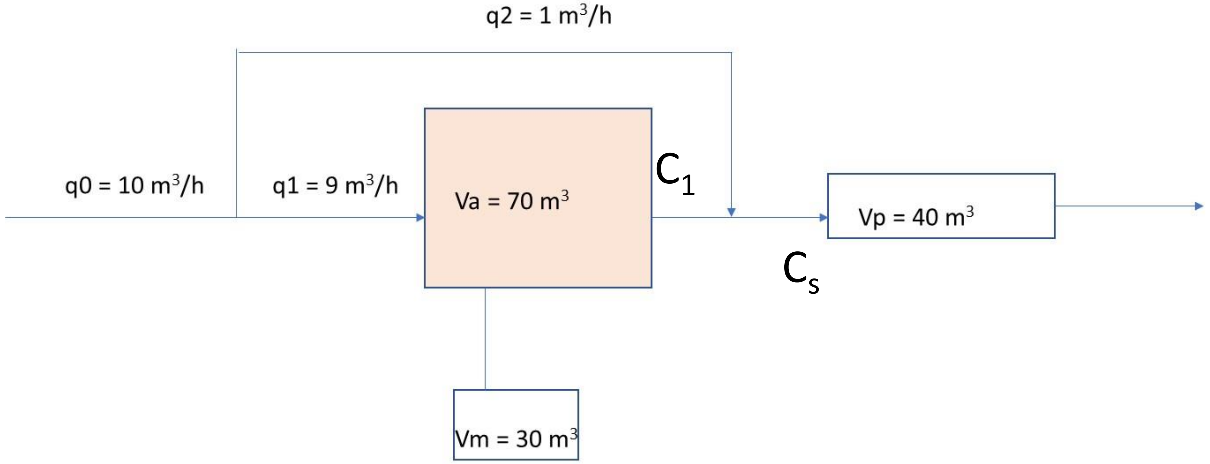
$$C = C(0)\,e^{-kt}$$

$$ln(C) = -k\,t + ln\big(C(0)\big)$$

t (h)	C (gCOD/L)	ln (C)
0	5	1.609
1	3.03	1.109
2	1.84	0.610
3	1.12	0.113
4	0.68	-0.386
5	0.41	-0.892
6	0.25	-1.386
7	0.15	-1.897
8	0.09	-2.408
9	0.06	-2.813
10	0.03	-3.507



$$k = 0.5\,h^{-1}$$



BM (estacionario) en zona agitada (donde se produce la reacción): $$q_1(C_0 - C_1) = V_a\,k\,C_1$$

$$C_1 = C_0\frac{\frac{q_1}{kV_a}}{1+\frac{q_1}{kV_a}} = 5\,\frac{gCOD}{L}\,\frac{\frac{9\,m^3/h}{0.5h^{-1}70m^3}}{1+\frac{9\,m^3/h}{0.5h^{-1}70m^3}} = 1.02gCOD/L$$

BM en la unión con el by pass:

$$C_s = \frac{9\frac{m^3}{h}1.02\frac{gCOD}{L} + 1\frac{m^3}{h}5.0\frac{gCOD}{L}}{10\frac{m^3}{h}} = 1.42\frac{gCOD}{L}$$

$$Ef = conversión = 72\%$$