Process Simulation Model for Biogas Production

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Introduction

Biogas contains CH_4 and CO_2, where methane can be used as an energy for producing heat, electricity and vehicle fuels.

New substrates (lignocelluloses, textile waste, feathers, etc.,) are now tested in lab-scale, however the behavior of these substrates in industrial process is not the same.

To study the industrial feasibility, intermediary metabolism in biogas production should be studied with industrial perspective.

Some models explained intermediary metabolism includes **BIOTREAT, ADM1**. However, no model covered the thermodynamics and kinetics in one model with industrial parameters like loading rate, retention time, pH, ammonia inhibition.

Model description

Model was designed using **AspenPlus®**.

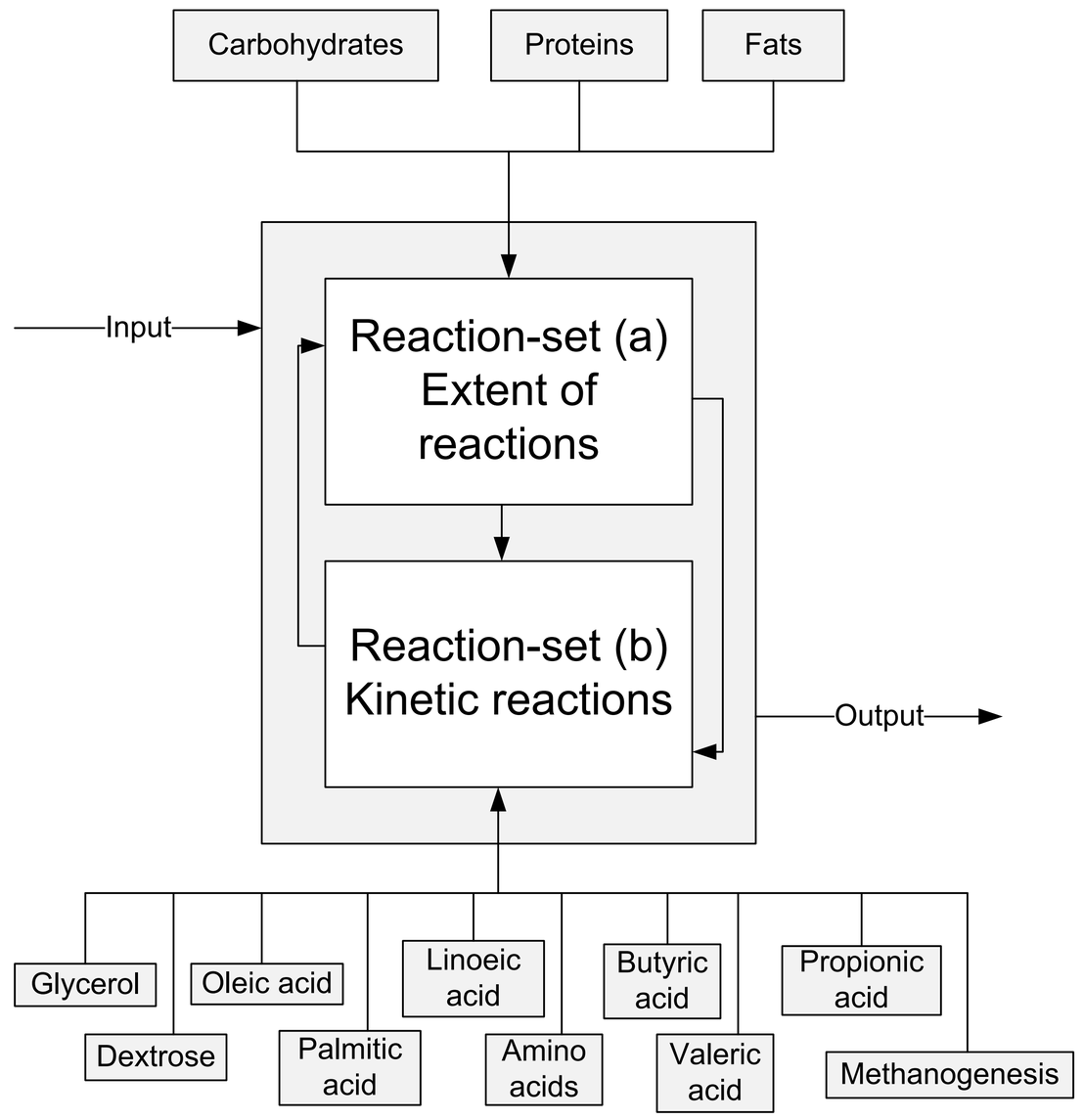
PSM includes intermediary reactions all four stages in biogas production.

Most of the substrates biogas potential can be determined using the proposed model.

It includes two reaction sets: (1) for hydrolysis reactions and (2) for acidogenic, acetogeneic and methanogenic reactions.

Model is validated from previous research and industrial data.

Schematic diagram of the model



Model validation results

	Volume of the reactor	HRT (days)	Loading rate	TS (%)	VS (%)	Substrate	Experimental results	Simulation results	Difference (%)
Case 1	5 L	15	0.33 L/day	6	80	Cow manure	353.5 L/kg_{VS}/day	365.83 L/kg_{VS}/day	3.4
Case 2	5 L	15	3.0 g_{VS}/L/day	15	85	MSW	0.54 m^3CH_4/ kg_{VS}/day	0.473 m^3CH_4/ kg_{VS}/day	-12.4
Case 3	5 L	21	3.0 g_{VS}/L/day	13	87	70% MSW and 30% citrus waste	0.555 m^3CH_4/ kg_{VS}/day	0.537 m^3CH_4/ kg_{VS}/day	-3.2
Case 4	600 L	25	2.0 g_{VS}/L/day	10	90	MSW	401 L/kg_{VS} removed	448.76 L/kg_{VS} removed	11.9
Case 5	3000 m^3	21	150 m^3/day	15	85	MSW	9600 m^3/day	10176 m^3/day	6.0
Case 6	3700 m^3	20	150 m^3/day	12.5	95	75% slaughter house waste, 15% food waste and 10% cow manure	10959 m^3/day	11694.6 m^3/day	6.7
Case 7	30 L	8	230.4 g_{VS}/day	6.4	72	Pig manure	0.269 m^3/kg_{VS}	0.268 m^3/kg_{VS}	0.3

Conclusion

The difference between the model and the experimental data varied between **±12%**.

Process simulation model is a good predictor tool for biogas production from any substrates.

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