

Animal Waste Anaerobic Digester Basics

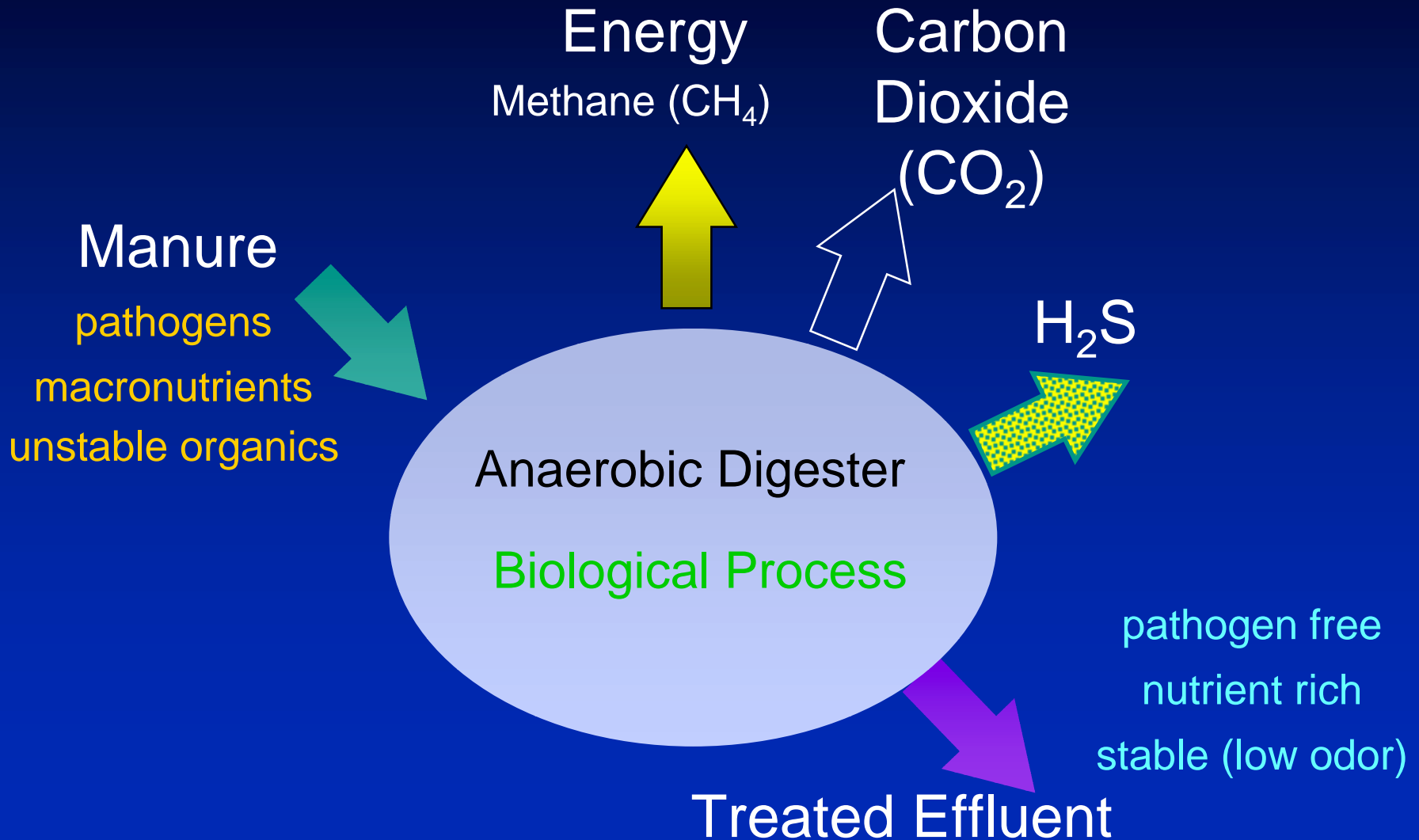
R. T. Burns, Ph.D., P.E.

**Agricultural & Biosystems Engineering Department
Iowa State University**

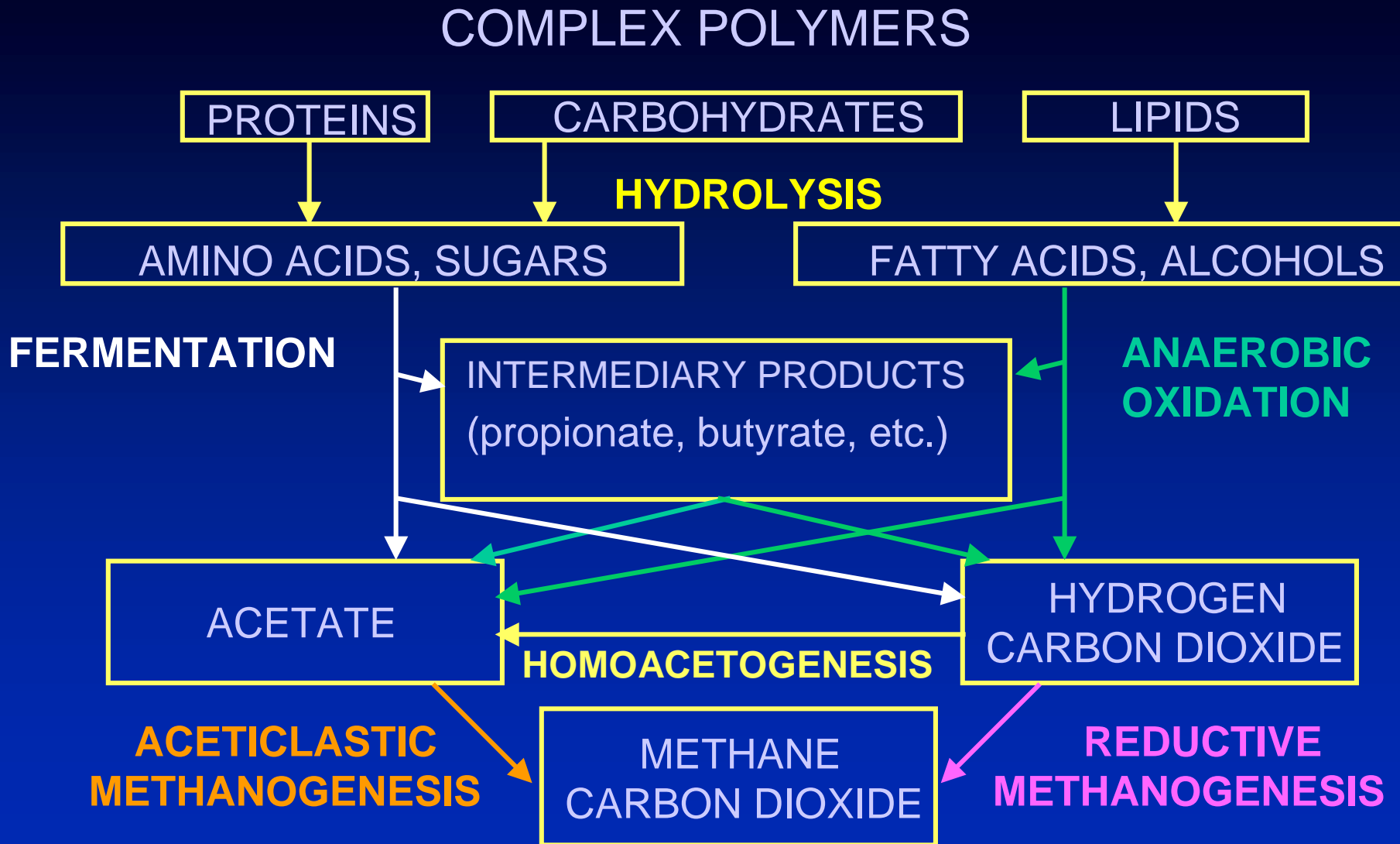
Outline

- ✓ Biological Processes
- ✓ Digester Types
- ✓ Management Requirements
- ✓ Challenges to success

Anaerobic Digestion Process Overview

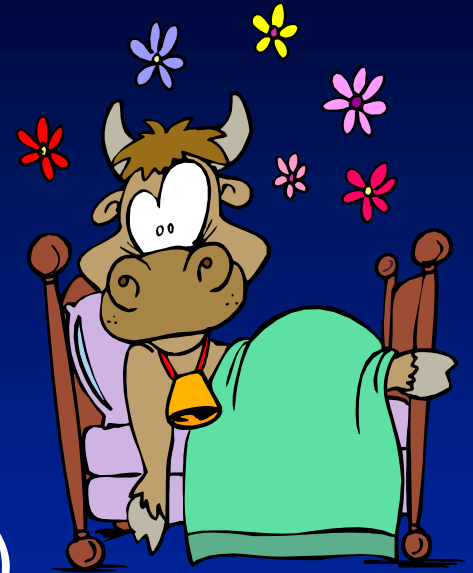


Microbiology of Anaerobic Digestion



The anaerobic digestion process is sensitive to changes in:

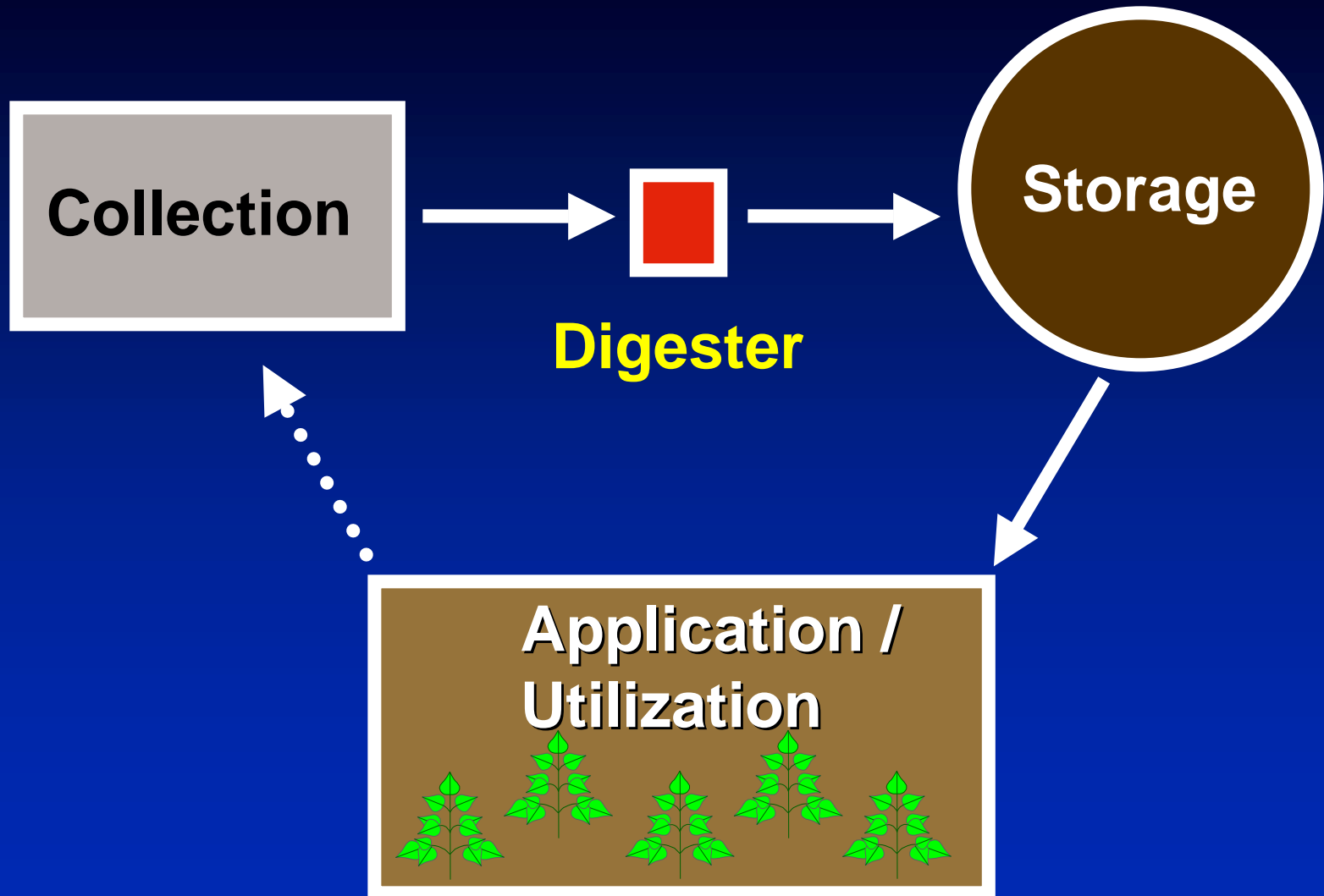
- ✓ Temperature
- ✓ Alkalinity
- ✓ Waste Strength (loading rate)
- ✓ Flow (hydraulic retention time)



System Management

Successful manure digesters
have committed managers on-site

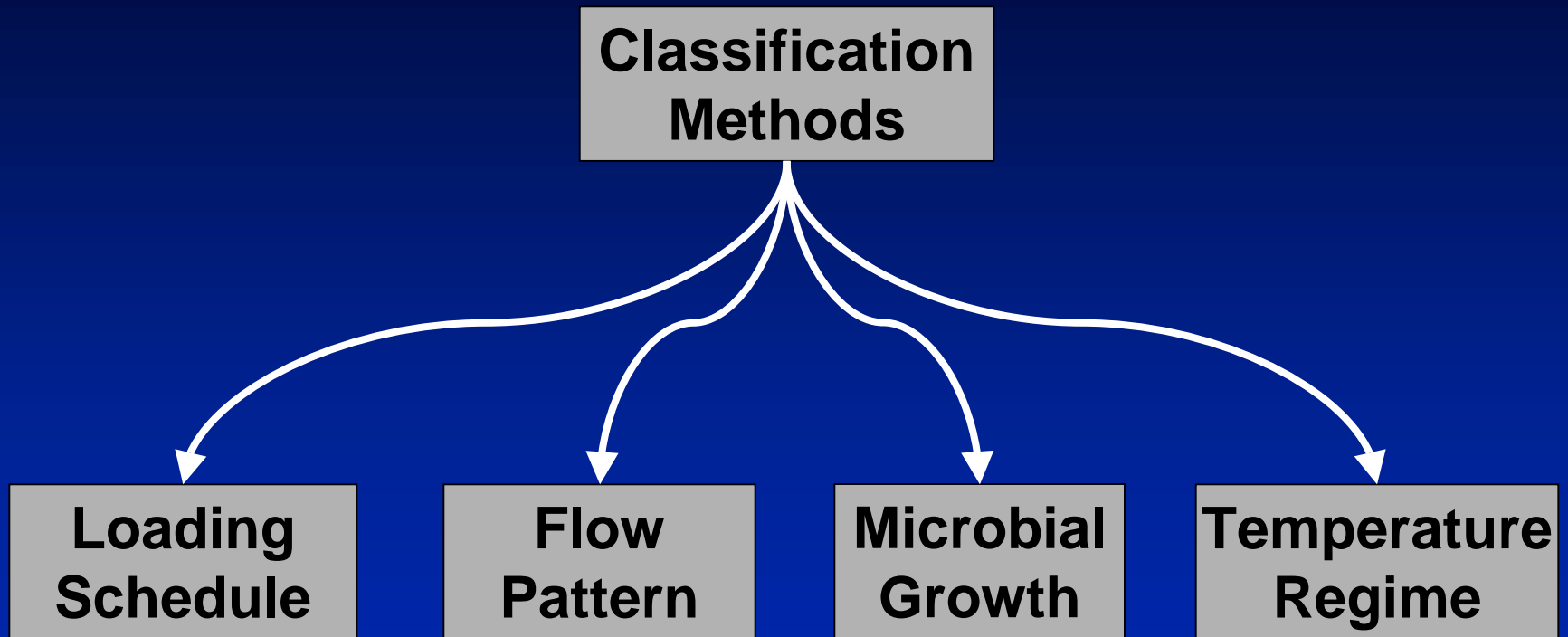
Animal Waste Management System



AD Treatment Goals

- ✓ Odor Control
- ✓ Electricity generation
- ✓ Heat recovery

Many Types of Anaerobic Digesters



Anaerobic Digester Configurations

- Covered lagoons (ambient and heated)
- Complete mix digesters (CSTR)
- Plug flow digesters
- Anaerobic sequencing batch reactors (ASBR)
- Fixed film digesters (anaerobic filters)



Covered Lagoons

NRCS Code 365 AD Ambient Temperature

Covered Lagoons

Advantages

- Low cost (relative)
- Low tech / easy to construct

Disadvantages

- Cover maintenance / life
- Large footprint
- solids / nutrient accumulation

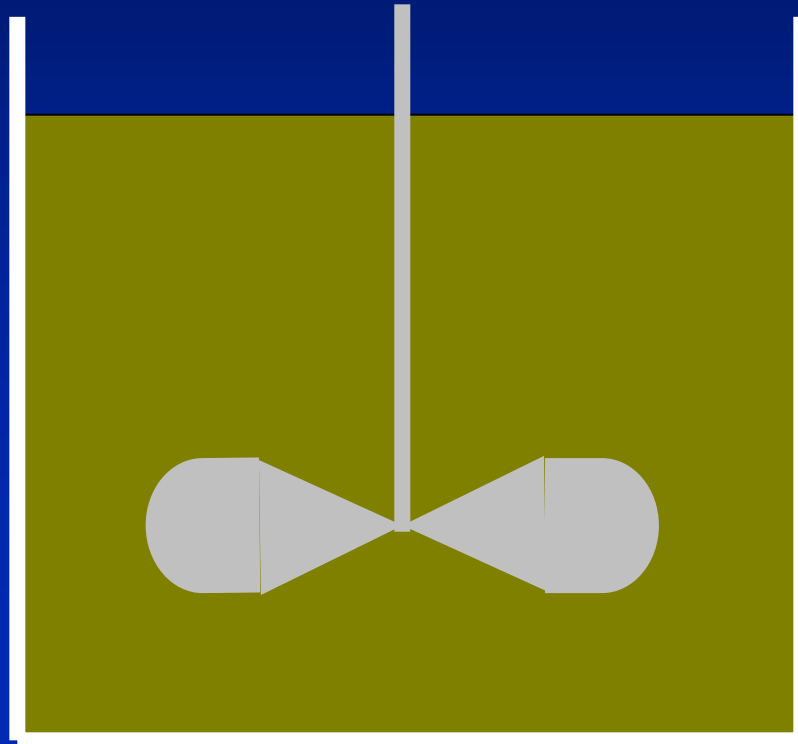


Complete Mix Digesters
NRCS Code 366 AD Controlled Temperature

Complete Mix Digesters

Complete Stirred Tank Reactors (CSTR)
Completely Mixed Flow Reactors (CMF)
Continuous Flow Stirred Tank (CFST)

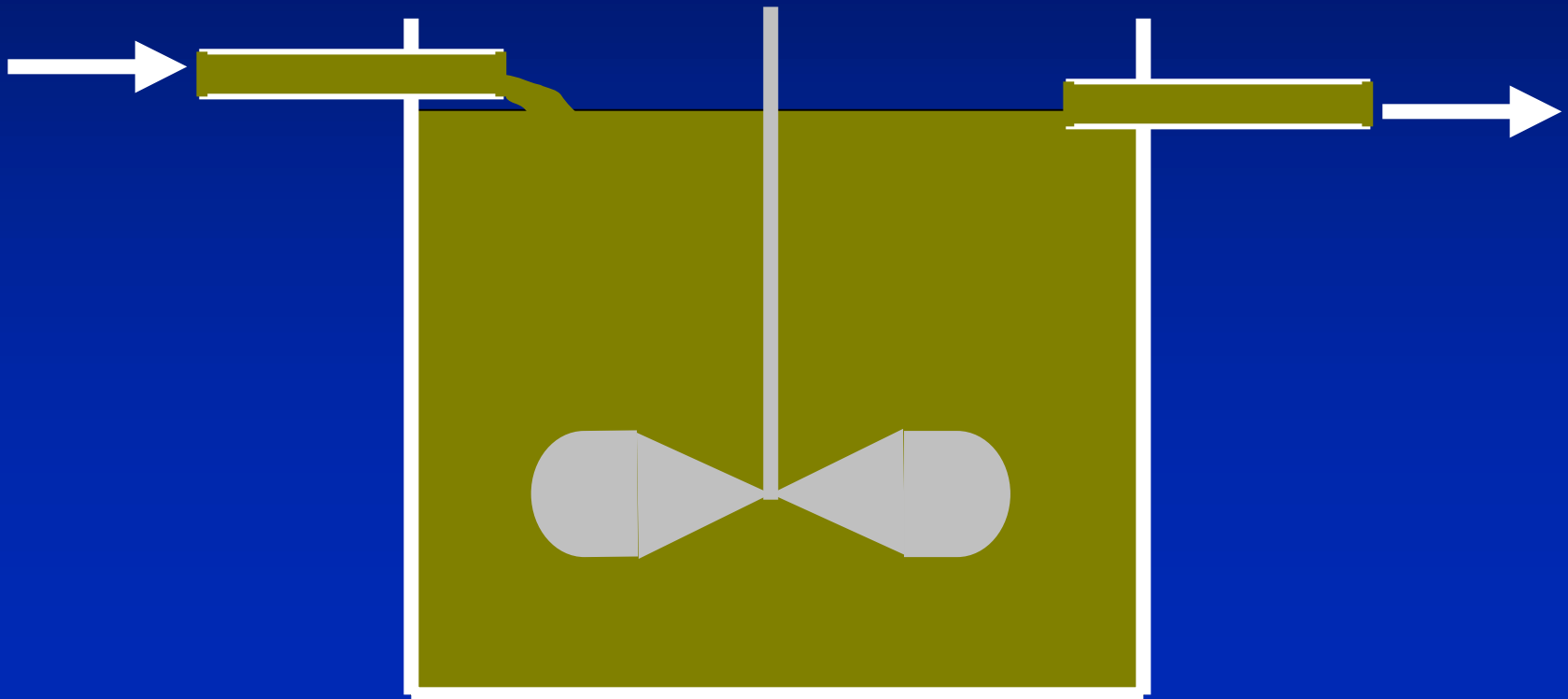
Contact Processes



Complete Mix Digesters

Complete Stirred Tank Reactors (CSTR)
Completely Mixed Flow Reactors (CMF)
Continuous Flow Stirred Tank (CFST)

Contact Processes



Complete Mix Digesters

Advantages

- High level of experience
- Works over wide range of influent Total Solids (TS)
 - + Can be used with scrape or flush systems
 - + Can be used with swine or dairy systems

Disadvantages

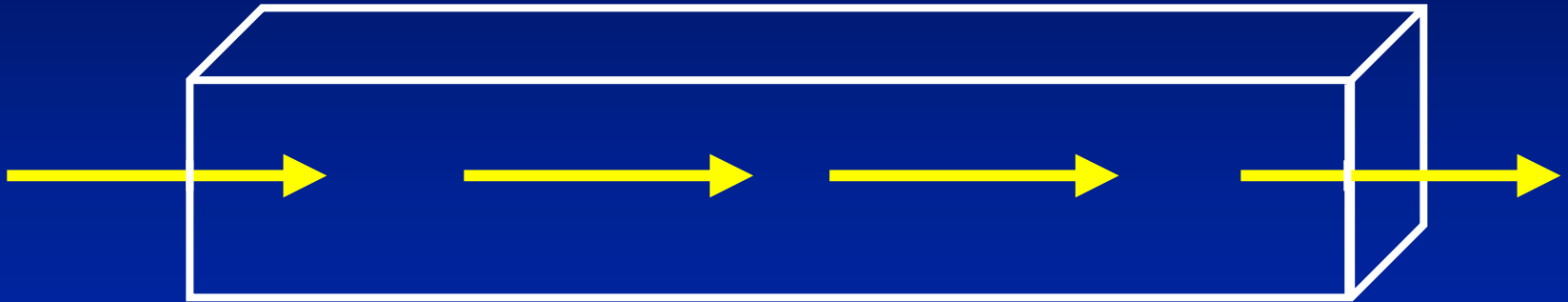
- Poor biomass immobilization ($HRT=SRT$)
- Mechanical mixing requirement

A large, white, dome-shaped anaerobic digester tank is the central focus, situated in a field of dark, tilled soil. Behind the tank is a small, light-colored building with a gabled roof. The background shows a clear blue sky with some light clouds and distant hills. The overall scene is an industrial or agricultural facility.

Plug Flow Digesters

NRCS Code 366 AD Controlled Temperature

Plug Flow Digesters No Mixing



Plug Flow Digesters

Advantages

- Good track record with Dairy manure
- Works well with scrape systems

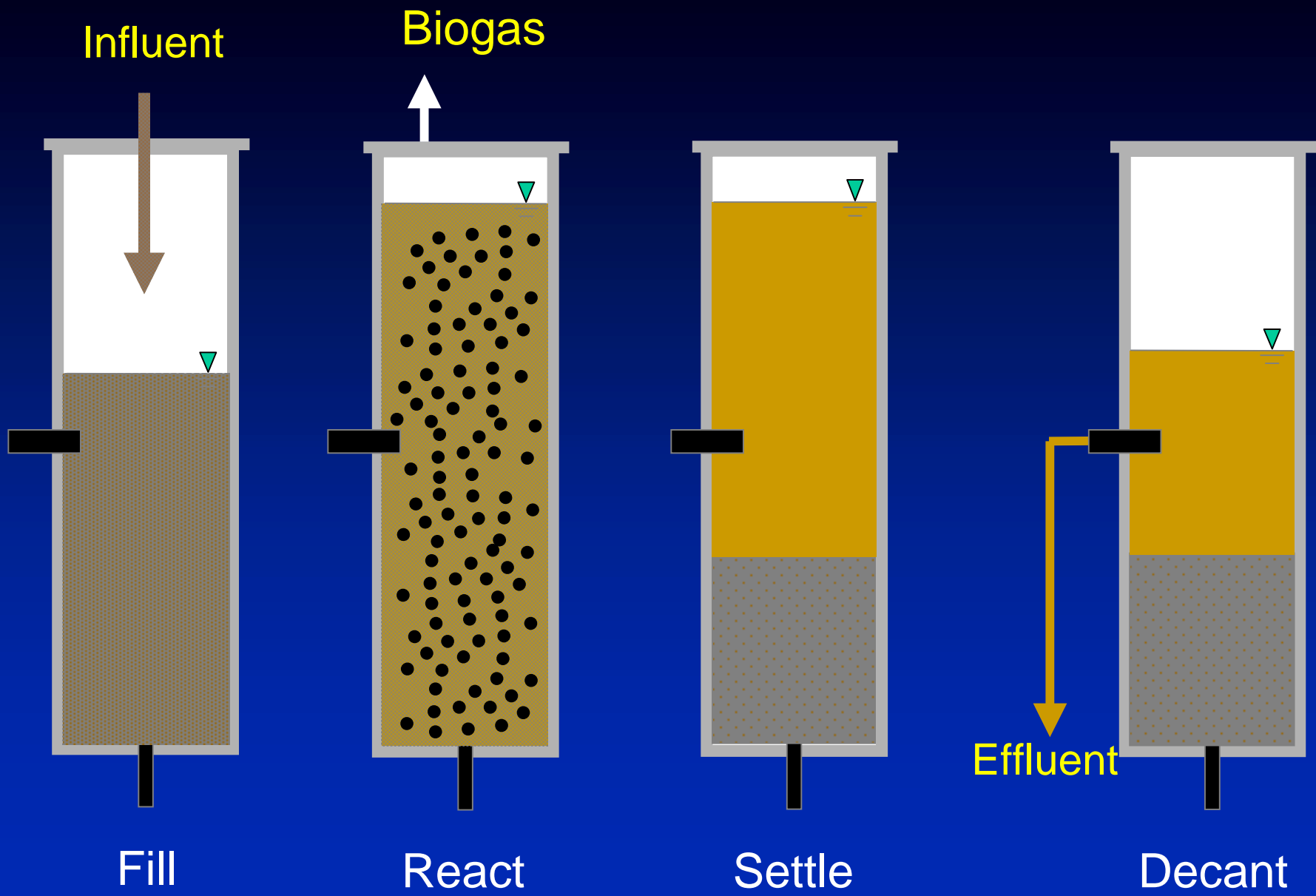
Disadvantages

- Requires high solids manure (11 - 14 %)
- not compatible with sand bedding

Anaerobic Sequencing Batch Reactor

NRCS Code 366 AD Controlled Temperature
Alternative Digester Design Criteria





ASBR

Advantages

- Can work over wide range of influent TS
- SRT partially decoupled from HRT

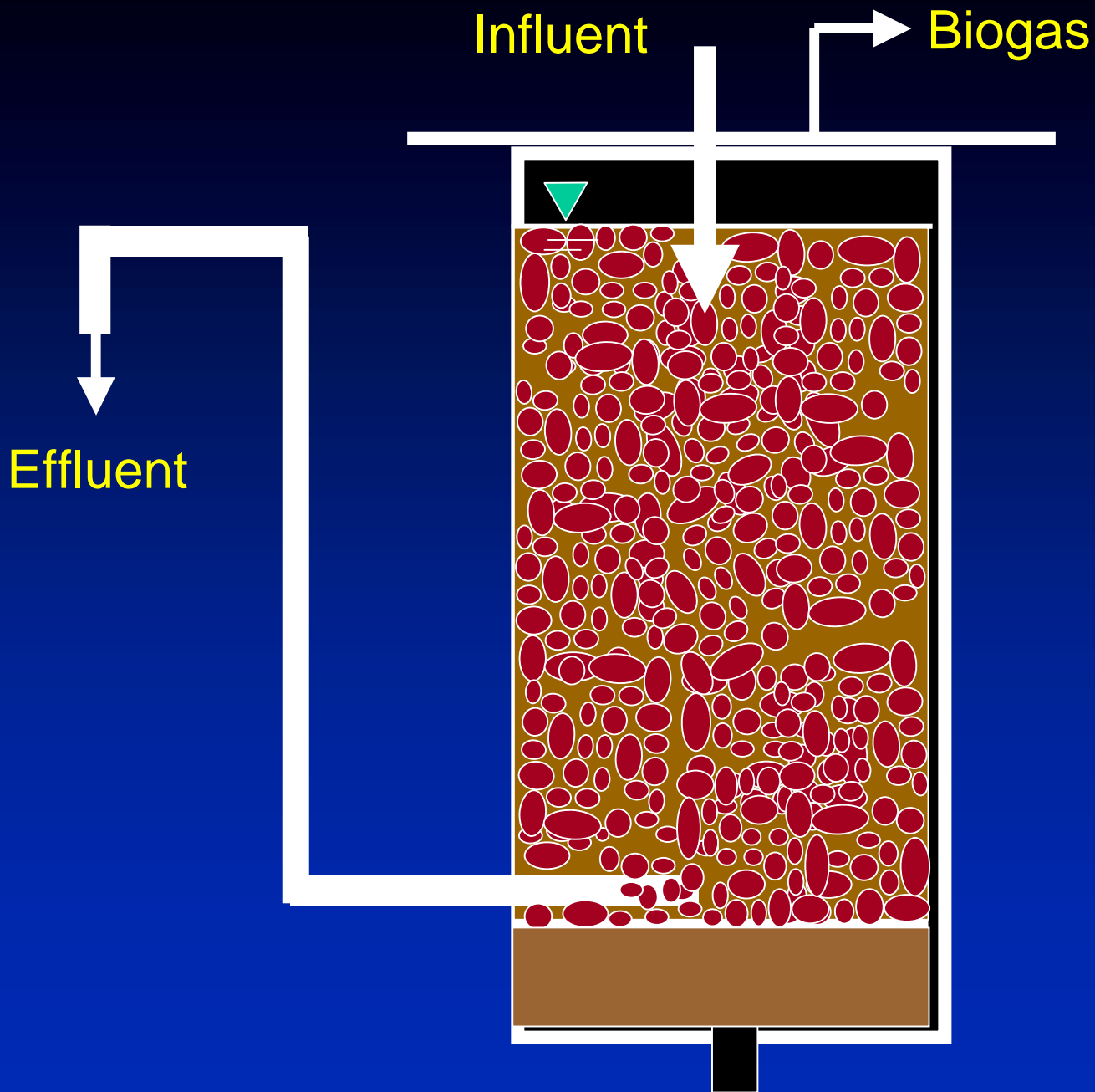
Disadvantages

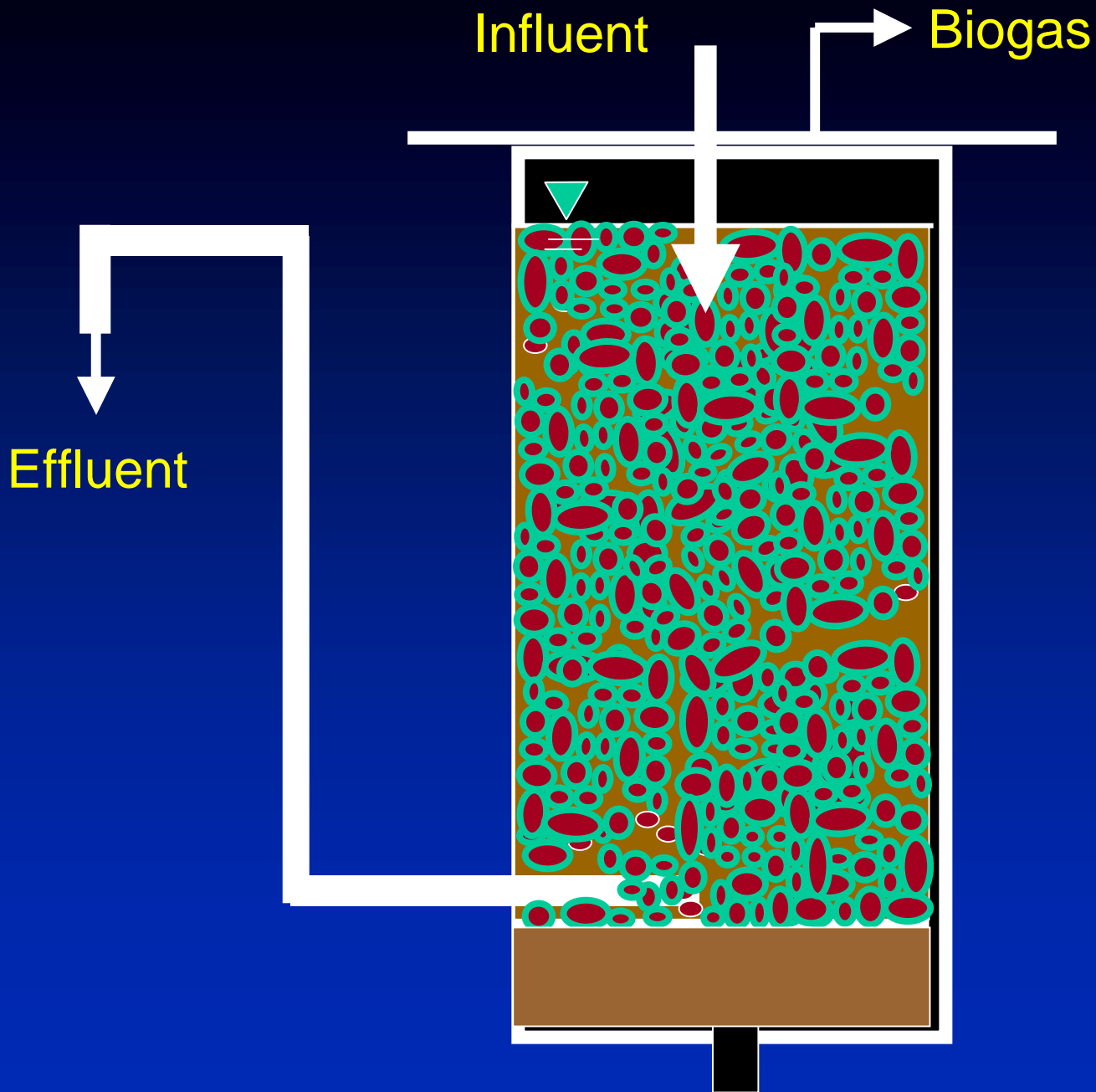
- Limited full-scale experience
- Potential for solids build-up in reactor

Fixed Film Digesters

NRCS Code 366 AD Controlled Temperature







Fixed Film Digesters

Advantages

- Short HRTs
- Excellent biomass immobilization
- Works with flush waste systems

Disadvantages

- Cannot handle medium / high TS manures
- Solids separation required
- Potential for plugging problems

Potential Challenges to Success:

- High capital costs
- Low wholesale electricity prices
- Commitment to system management
- Lack of a well developed support industry

Take Home Message - Anaerobic Digesters:

- Are a proven technology
- Provide excellent odor control
- Do not replace manure management systems
- Can require significant system management
- Are currently not cash cows

Questions ?

A long, narrow aisle in a large industrial pig farm. On both sides of the aisle are rows of metal cages. Each cage is filled with several pink pigs. The pigs are mostly lying down, but some are standing or moving. The floor is made of concrete slats. The ceiling is high and has a grid of metal beams with some lights hanging from it. The walls are white and have many windows, letting in bright light. The overall atmosphere is one of a large-scale, industrialized animal production facility.

Comments