For Questions Call: 1 800.000.0000

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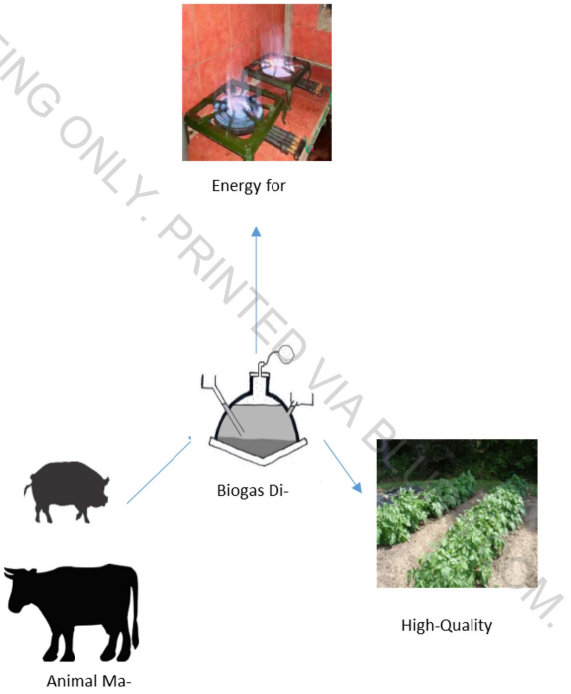
A main contact at Purdue will be established and available at all times for any questions and/or problems that might arise especially while the biogas system is still in the cycle of setting itself up and producing gas for the first time. This contact information will be displayed in this section of the manual as well as in the front of the manual.

The Biogas System



When manure is collected, mixed with water and digested in a warm environment like the biogas digester tank it produced what is known as a biogas. Biogas is a mixture of mainly methane and carbon dioxide. This biogas is ideal for fuel and can be used to energize cooking burners. The waste produced by the biogas is also useful, it can be dried and used as a high-quality fertilizer.

General Operation and Maintenance

· It is very important that the inlet feed is mixed at a 1:1 ratio of water and manure. This insures that no substances settles in the inlet flow line.

· Smaller inlet particles allow more bacteria to grow which leads to more gas produced.

· The inlet should not contain absolutely no antiseptics, pesticides, and detergents or non-digestible materials.

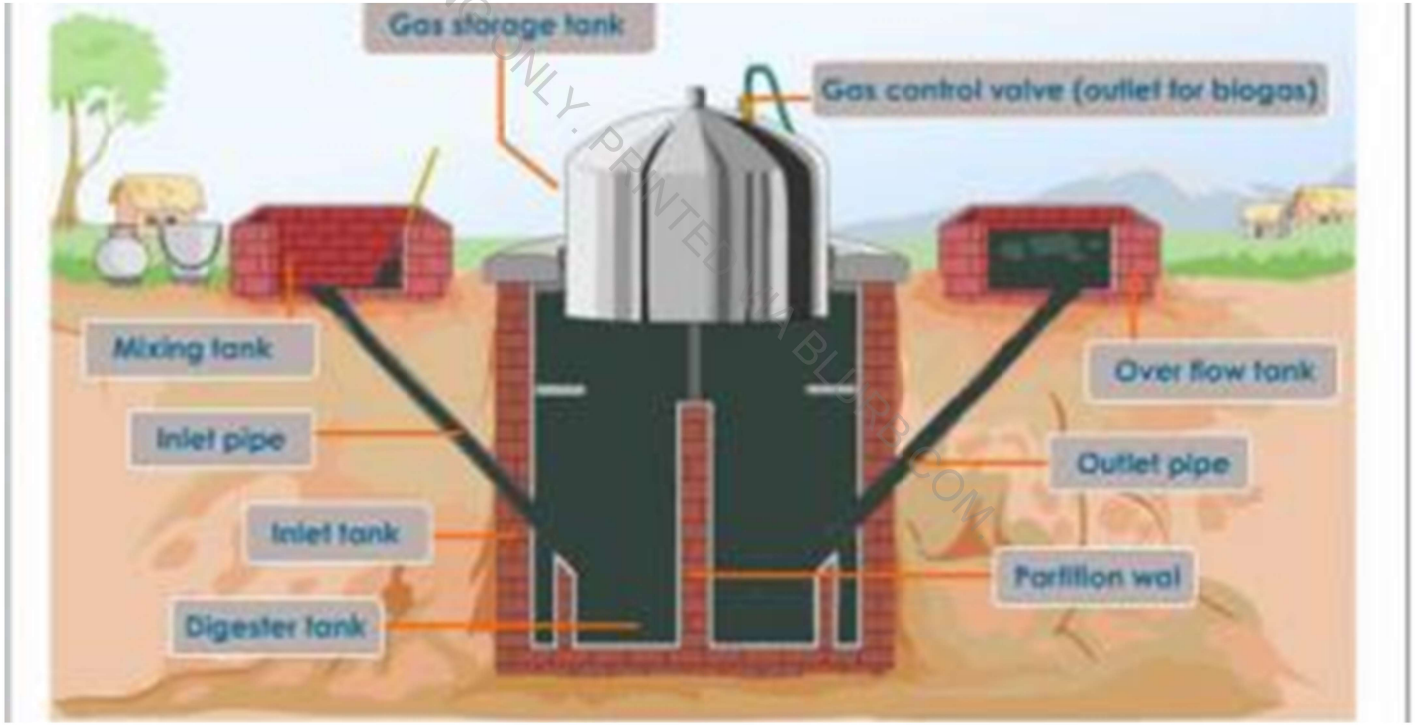
· Before using gas, check manometer pressure. Pressure should be around 15-20 cm

· Do not use igniter or lighter to light the burner

· After burner is used, its valve must be completely turned off. Leaking glass when valve is open is very dangerous and can cause severe asphyxiation.

Parts of the Biogas Digester System

Example only: Pictures will be taken at site



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Feeding the Digester System

Materials Needed:

Equal, 1:1 ratio, parts of:

Animal Manure

Water

Mixing:

Manure and water must be mixed in the mixing chamber before being poured in to the inlet pipe leading into the slurry tank.

Temperature:

In the event of extreme temperature, caused extreme weather, the biogas may stop being producing gas.

pH level:

The pH level must remain acidic. If the biogas digester stops working, low pH level can be the cause. To be certain, check the pH level of the tank. To do this, take a sample of the slurry, and add baking soda. If the sample bubbles, the slurry has become basic. Refer to the failure scenarios section of manual to see what needs to be done to fix this problem.

Maintenance of the Digester System

System Part	Needed Maintenance
Mixing Chamber	Daily Cleaning
Floating Drum Tank	Weekly leakage check Daily drum level check
Slurry Tank	Cleaning if clogged (2-3 years)
Compost Pit	Empty compost daily
Water Trap	Draining water down to marked line (every 2 weeks)
Manometer	Checking pressure before each use (15—20 cm)
Pipes	In case of major leak, seal drum and excavate piping to locate and repair pipe

Maintenance Diagrams will go here

Health Hazards and Precautions

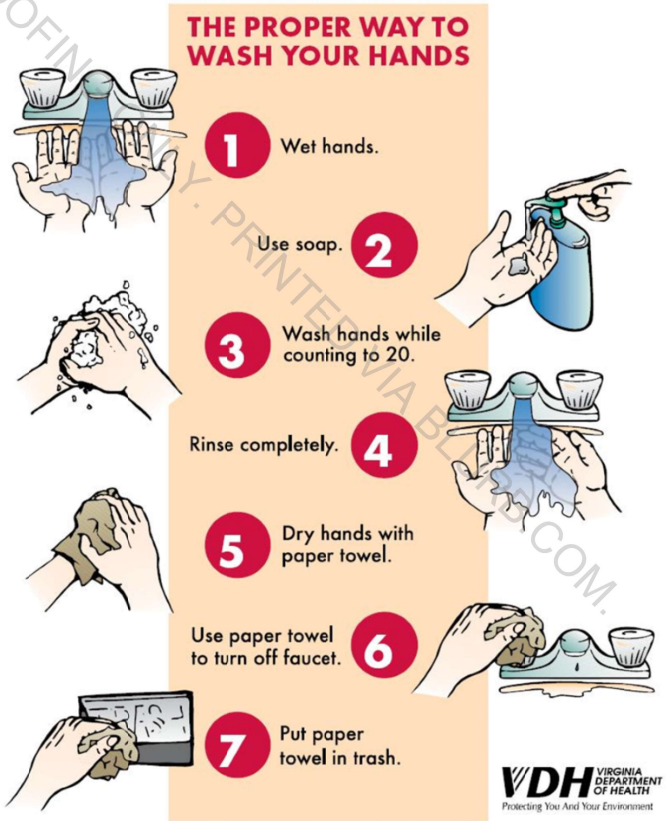
The use of manure and animal waste without proper hygiene can lead to the spread and infection of several diseases that are transmitted through pathogens. There are over 150 pathogens in manure that could impact human health.

Signs and Symptoms of Pathogen Infection [1]

Pathogen	Disease	Symptoms
Bacillus anthracis	Anthrax	Skin sores, headache, fever, chills, nausea, vomiting
Escherichia coli	Colibacilosis, Coliform mastitis-metris	Diarrhea, abdominal gas
Leptospira pomona	Leptospirosis	Abdominal pain, muscle pain, vomiting, fever
Listeria monocytogenes	Listerosis	Fever, fatigue, nausea, vomiting, diarrhea
Salmonella species	Salmonellosis	Abdominal pain, diarrhea, nausea, chills, fever, headache
Clostirdum tetani	Tetanus	Violent muscle spasms, lockjaw, difficulty breathing
Histoplasma capsulatum	Histoplasmosis	Fever, chills, muscle ache, cough rash, joint pain and stiffness
Microsporum and *Trichophyton*	Ringworm	Itching, rash
Giardia lamblia	Giardiasis	Diarrhea, abdominal pain, abdominal gas, nausea, vomiting, fever
Cryptosporidium species	Cryptosporidosis	Diarrhea, dehydration, weakness, abdominal cramping

Pathogen Infection Prevention

Pathogen infection occurs as a result of fecal-oral transmission through inhalation [1]. This happens when hands are not properly washed after contact with manure and the nose or mouth is touched. Hand washing after contact with the biogas digester system is then essential and the main method of preventing pathogen infections [2].



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Digester System Potential Problems and Solutions

Legend:

Category	Explanation
Failure	Any situation that can compromise the digester's ability to fulfill its function and/or be a hazard to the people around it
Indicators of Failure	Any abnormal physical sings of failure that can be seen, heard, or smelled
Methods of Testing for Failure (if applicable)	A physical test that can be performed to make a conclusion on whether a specific failure is pending
Causes	Steps that cause the failure to happen
Effects to Biogas Digester	Steps to the biogas digester that will take place as a result of failure
Effects to Humans	Hazards that can happen to humans as a result of failure
Solution	Steps that can be taken to resolve the failure and reestablish biogas digester function
Prevention	Ways to keep failures from happening

Failure	Indicators of Failure	Methods of Testing Failure	Causes	Effects to Biogas	Effects to humans	Solution	Prevention
gas tank flips upside down	Physical gas tank is seen upside down	Not applicable	Improper installation causes gas tank to come lose	gas tank will fill with slurry and travel to the bottom of digester slurry tank making reaction unable to happen (no gas production)	none	gas tank needs to be fished out of slurry tank and place back into proper location	Proper installation of slurry tank/gas tank
too much solid in the inlet	Biogas production is lower than usual and mixture is not flowing down inlet properly	Not applicable	improper mixing	slurry will not travel into digester slurry tank	none	adding water to mixture	Make sure to mix correct amounts of manure and water (1:1 ratio)
too much liquid in the inlet	Biogas production is lower than usual and inlet is flowing more rapidly than usual	Not applicable	improper mixing	slurry will be too weak enabling reaction (no gas production)	none	adding solid into digester slurry tank (note: solid will not travel by itself through the inlet, might need to be added directly into digester slurry tank)	Make sure to mix correct amounts of manure and water (1:1 ratio)
digester reaction pH drops too low	Biogas production is low	Mix slurry with baking soda to test for acidity. If a reaction takes place (bubbles appear) the digester reaction has dropped too low	Animal waste being used is too acidic. Acid-forming bacteria grew faster than methane-forming bacteria (souring). Ideal pH is between 6.8 and 8.5	Reaction will not occur (no gas production)	none	The digester needs to be loaded more slowly. Try feeding the digester every other day and see if gas production improves	Feeding animals properly
explosion	gas tank has not moved upward for several days and digester is still being fed and biogas production is still normal or high; Manometer is displaying a high pressure and gas tank is not moving upward	Not applicable	biogas is diluted with 10-30% air. Causes of this include having open flames never the digester, having large engines or electric generators close by, or smoking near the digester	Explosion will destroy biogas structure and other structures around it	Effects related to explosion such as injury from falling debris, and burns. Also, asphyxiation caused by released gases	New biogas digester will need to be build	Keep open flames, large engines, and/or electric generators away from biogas digester. Never smoke near the biogas digester

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disease	Humans working around biogas digester system are showing signs and symptoms of pathogen infections as described in the Health Hazards and Precautions section of the Operation and Maintenance Manual	Medical Diagnosis	bacteria, viruses, and parasites found in the manure can cause diseases. Direct contact with manure exposes stakeholders to obtain disease	none	infection, diseases	Trip to the hospital/doctor where antibiotics can be prescripted	use personal protective equipment to avoid contact with manure. Washing after working around digester specially of the hands before eating and drinking and before touching the eyes or other mucous membranes
Biogas gas line pipe rupture	Slurry input has not changed but biogas production is low and burner is not working properly	Not applicable	high pressure inside pipe, high force acting on top of pipe, tree roots growing around/close to pipe, water build-up around water trap area	gas will not travel	leaking gas can cause poisoning or asphyxiation	Locate ruptured zone and seal or replace ruptured pipe	Keep from putting pressure in the areas where pipes are running through. Monitoring car traffic through pipe zones
Inlet / Outlet pipe rupture	Less effluent is coming out of biogas digester system and slurry input has not changed	Not applicable	high pressure inside pipe, high force acting on top of pipe, tree roots growing around/close to pipe	slurry or effluent will not travel	none	Locate ruptured zone and seal or replace ruptured pipe	Keep from putting pressure in the areas where pipes are running through. Monitoring car traffic through pipe zones
digester slurry tank hole, leaking slurry or gas	Input has not changed, no waste is being products and gas tank is at resting position	Insert a rod (long pvc pipe) into inlet or outlet pipe to feel for a resisting buoyancy force	improper construction of digester, improper maintenance, digester aging	Gas will leak and accumulate around the digester area	leaking gas can cause poisoning or asphyxiation	Remove all slurry, locate ruptured zone, and seal or rebuild slurry tank	proper construction of digester slurry tank, proper maintenance
gas tank hole, leaking gas	Unsual noise or smell coming out of digester slurry tank or gas tank and biogas production decreases	Not applicable	improper construction of digester, improper maintenance, digester aging, weights on top gas tank	gas will not travel to pipes	leaking gas can cause poisoning or asphyxiation	replacement of gas slurry tank	proper construction of digester slurry tank, proper maintenance

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asphyxiation from cleaning slurry tank yearly	User passes out, has difficult breathing, or feels light headed	Not applicable	improper precautions taken when cleaning	none	asphyxiation can cause poisoning or death	trip to hospital	open slurry tank and allowing it to air out before entering it to clean
no input slurry	No slurry is physically being placed in inlet slurry tank	Not applicable	lack of water, lack of animal waste	will not produce gas, process will restart	none	digester will need to be emptied and process will need to restart when slurry is available	conserving water as much as possible, taking good care of animals
pressure release valve opens	Gas gas tank height is decreasing rapidly ; hissing sound	Not applicable	Foreign object collision with slurry tank or gas tank	Gas will leak and accumulate around the digester area	leaking gas can cause poisoning or asphyxiation	Remove foreign object, and add water back to the pressure release valve	Monitoring of animals around biogas digester area. Making sure no trees have loose branches
Water build-up in biogas pipeline	Biogas production is normal (input has not changed) but biogas is not traveling to burner	Open valve to check for water build-up	Water trap was not properly emptied	Biogas will not travel to burner. Digester gas tank will continue to increase until gas starts leaking	leaking gas can cause poisoning or asphyxiation	Open water trap and release water build-up	Empty water trap everyday
Burner stops functioning	Biogas productions is normal (input has not changed) but burner will not turn on	Connect burner to propane to check if it works	Broken hose, water leaked in burner	Biogas production is wasted	leaking gas can cause poisoning or asphyxiation	Replace burner	Having a back-up burner, turn off burner after each use
Cage breaks	Visual signs	Not applicable	Foreign object collisicn with cage	Biogas digester gas tank or slurry tank could flip and cause other failures	if slurry tank or gas tank flips, leaking gas can cause poisoning or asphyxiation	Replace cage	Having available back-up pvc pipes that can used to make a new cage. Having a safe method to release gas until cage can be replaced