

Vacutug Operation & Basic Maintenance

For MK-II through MK-VII



SNV

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Photos in this manual are for representational purposes. Your Vacutug may not be exactly as shown.

Usage Note: The word 'mobil' as used in this manual is a Bangladeshi colloquialism. It is used as a pronoun for 'lubricating oil.' It should not be misinterpreted as Mobil™, a registered trademark of Exxon Mobil Corporation.

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Chapter 1: Scope of This Manual

Purpose

The purpose of this manual is to help you operate, maintain and troubleshoot the Vacutug.

Basic maintenance and troubleshooting procedures are covered. For complex maintenance procedures or repairs, operators are advised to call an experienced technician or mechanic for service.

How to Use This Manual

This manual is written in a simple style and uses a step-by-step approach. Refer to the colour photos and tables to aid your learning. Read from cover-to-cover or just turn to the chapters and sections that you need.

Models Covered

The information in this manual applies to the following Vacutug models:

- MK-II
- MK-III
- MK-IV and MK-V
- MK-VI
- MK-VII

Note

Operation is similar across all models; however, the MK-II has a unique driving mechanism. See **Chapter 4: Using the Vacutug > Operation Procedures > How to Drive the MK-II.**

For detailed information on Vacutug models see **Chapter 2: Introduction to the Vacutug > Model Gallery & Description.**

Warnings, Cautions & Notes

Pay attention to warnings, cautions and notes.



Warnings give you vital information that could help prevent serious injury or death to you or others.



Cautions give you vital information that could help prevent injury to you or damage to the Vacutug.



Notes give you non-vital, helpful information.

Chapter 2: Introduction to the Vacutug

What is It?

The Vacutug is a simple portable machine that is used to extract human excreta from septic tanks and pit latrines for safe transport to a sewage disposal site where wastes can be discharged safely.

The machine automates the unpleasant but necessary job of emptying septic tanks and pit latrines – a job traditionally performed manually by ‘sweepers’, workers who remove excreta (also known as sludge) by hand.

Some Vacutug models are highly manoeuvrable and can navigate narrow streets to access hard to reach extraction points that may be inaccessible to larger, more cumbersome machines.

Advantages

The Vacutug can be an effective tool in sludge management.

- Many Vacutug models have a small footprint and can access sites that are hard to reach.
- The Vacutug works efficiently and hygienically.
- The Vacutug is relatively inexpensive to operate.
- The Vacutug needs minimal maintenance. Spare parts are inexpensive and readily available at many local markets.
- Offering a Vacutug service is a potentially viable micro-enterprise.
- Vacutug operators wearing protective clothing throughout the process will not come into direct contact with sludge.

Functionality

One driver and one or two ‘emptiers’ are needed to operate the Vacutug.

The machine uses a diesel engine-powered vacuum pump to extract sludge via the flexible hose into an on-board collection tank. Tank capacity ranges from 500 litres to 2000 litres and larger depending on the model. When extraction is complete, the sludge is transported to a disposal site where it can be discharged by gravity feed or pump pressure via the flexible hose.

Model Gallery & Description

MK-II 		First built in 2002 by Mirpur Agricultural Workshop and Training School (MAWTS) in Dhaka Self-driving 4-wheeler Engine powers both the pump and drivetrain Tight turning radius, easy to manoeuvre Vertically mounted sludge collection tank Suitable for use on narrow streets, hard to reach extraction sites, flat ground, sites within walking distance	
Tank Capacity	Pump	Engine	Max Speed
700 L	MEC 2000/P	10.5 hp diesel	5 km/h
MK-III 		Second-generation Vacutug built by MAWTS 2-wheeler trailer unit Towed by tractor or large pick-up truck Horizontally mounted sludge collection tank Suitable for use on wide streets and highways	
Photo	courtesy MAWTS		
Tank Capacity	Pump	Engine	Max Speed
2000 L	MEC 2000/P	12 hp diesel	45 km/h

MK-IV and V



Photo courtesy MAWTS

Second-generation Vacutug built by MAWTS

The MK-IV and V are identical in design except for the size of the sludge collection tank

3-wheeler BRV (Bangladesh Rural Vehicle)

Engine powers both the pump and drivetrain

Tight turning radius, easy to manoeuvre

Horizontally mounted sludge collection tank

Suitable for use on narrow streets and highways

Tank Capacity	Pump	Engine	Max Speed
700 L (MK-IV)	MEC 2000/P	12 hp diesel	30 km/h
1000 L (MK-V)			

MK-VI

4-wheeler mini truck

Horizontally mounted sludge collection tank

Top cover conceals engine and pump

Cargo deck sides fold down

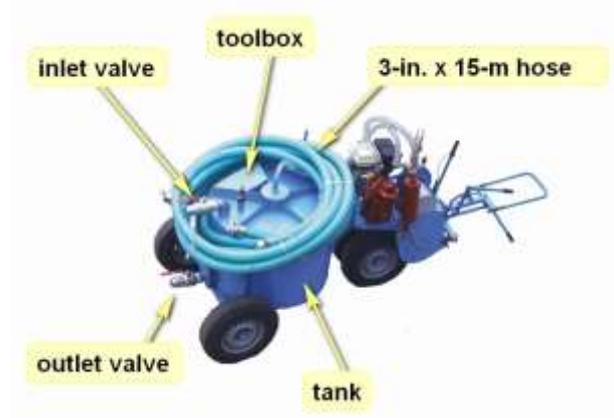
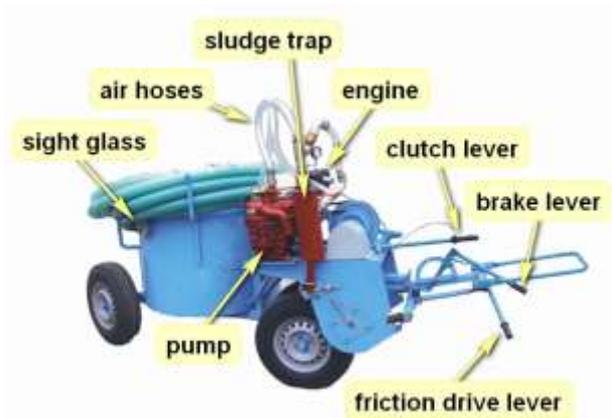
Suitable for use on narrow streets, highways and long distances

Tank Capacity	Pump	Engine	Max Speed
1000 L	MEC 2000/P	12 hp diesel	70 km/h

MK-VII		4-wheeler large truck	
		Horizontally mounted sludge collection tank	
		Suitable for use on wide streets, highways and long distances	
Tank Capacity	Pump	Engine	Max Speed
2000 L	MEC 2000/P	12 hp diesel	100 km/h

Location of Main Components

MK-II (photos courtesy MAWTS)



MK-III (photo courtesy MAWTS)



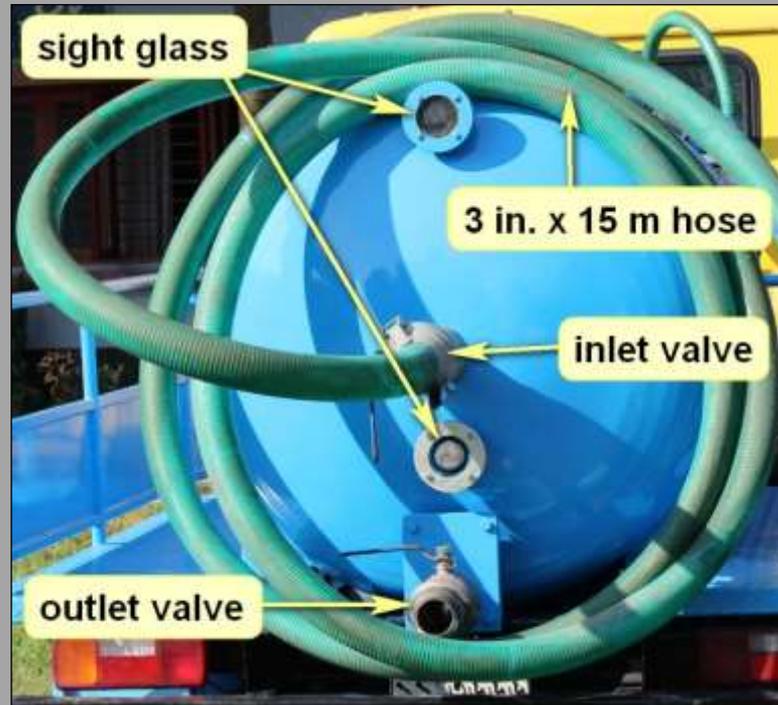
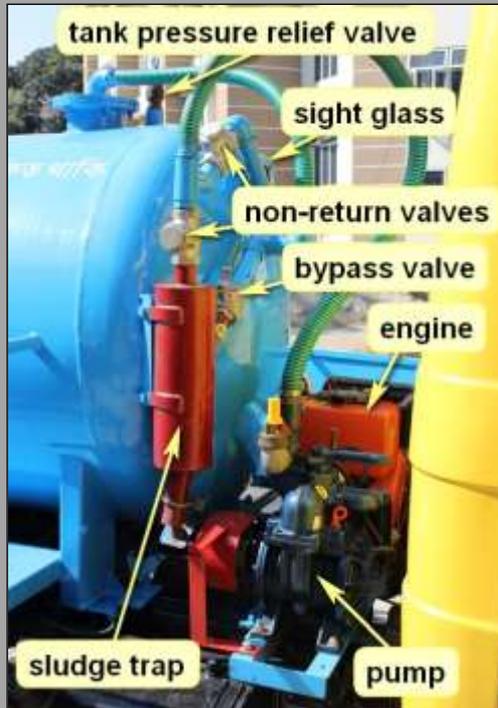
MK-IV and V (photo courtesy MAWTS)

MK-VI



MK-VII





Chapter 3: Operator's Health & Safety

Your own health and safety should be your first priority when operating the Vacutug.

When you ignore your health and safety you risk:

- Sickness, injury or death
- Damaging the machine

The Vacutug vs. Manual Emptying

Manual emptying is a health hazard.

Exposure to sludge without the shield of protective clothing may cause illnesses such as cholera, typhoid and diarrhoea as well as respiratory and skin infections.

Vacutug operators are advised to wear protective clothing throughout the sludge collection and extraction process so as to not come into direct contact with the sludge.

Although the Vacutug eliminates many of the health risks associated with manual emptying, you must still take precautions when operating the machine. (See **this chapter and Chapter 4: Using the Vacutug.**)

Protective Clothing

It is recommended that you wear protective clothing when:

- Operating the Vacutug
- Handling hazardous chemicals such as kerosene and bleaching powder
- Using tools

Your municipality may be able to provide you with protective clothing. Otherwise you can buy it at most local markets. The following protective clothing is recommended:

Helmet

Renew if shell is cracked.



Soft Hat

Renew if damaged.



Safety Glasses

Renew if damaged.



Filter Mask

Renew if damaged.



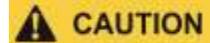
Apron

Renew if damaged



Gloves

Renew if damaged.



It is highly recommended that you wear heavy duty rubber gloves as shown in the picture. This kind of glove is reusable and can be washed easily. Hospital-style surgical gloves are made of thin latex and are not recommended as they are expensive, break easily and cannot be reused.

Gumboots

Renew if damaged or the treads are worn out



Equipment & Supplies

The following equipment and supplies are useful when operating the Vacutug.

Your municipality may be able to provide you with these items. Otherwise you can buy them at most local markets and steel forgers.



Wear gloves when handling kerosene and bleaching powder.

Shovel

Can be used to open a manhole cover.



Kerosene

Can be used to decrease odours in septic tanks and pit latrines.

Note

Kerosene may degrade the quality of the sludge if it will be used as fertilizer.





Bleaching Powder

Use to disinfect gumboots, gloves, hoses and the area around the manhole.

Note

Keep bleaching powder in a covered plastic container that has a tight, waterproof seal. The container should be fixed securely to the chassis of the Vacutug or inside the cabin floor of the MK-VI and MK-VII.



Bucket

Use to:

- Carry fresh water
- Collect sludge spill over from inlet and outlet valves on tank

Detergent & Soap

Use to clean gumboots, gloves and hands.



Health & Safety Precautions

Observe health and safety precautions while operating and maintaining the Vacutug.

WARNING

Do not operate the Vacutug if you have been drinking alcohol or taking medicines that can make you drowsy. Operating the Vacutug while impaired may cause personal injury and damage to the machine.

Some common medicines that could make you drowsy include:

- Cough syrup
- Cold and flu remedies
- Antihistamines (taken to relieve allergies)
- Painkillers and tranquilizers (for example: codeine, Valium)

WARNING

Do not smoke cigarettes while operating, maintaining or troubleshooting the Vacutug. Sparks from the fire box or lit cigarette could ignite fumes or chemicals.

CAUTION

Never use the same gamcha to wipe down equipment and yourself. Use one gamcha to wipe down equipment and tools and a different gamcha to clean and dry your body, hands, feet and face. Keep gamcha separated. Gamcha that has been used to wipe down equipment and tools should never be used to clean and dry your body.

CAUTION

To avoid being splashed accidentally with sludge, stand clear of the inlet and outlet valves and flexible hose when the collection tank is full. Do not point the flexible hose at anyone.

Activity	Precaution
Before operating	<ul style="list-style-type: none"> • Check that your protective clothing and equipment, if available, is in good condition. • Check that equipment and supplies are loaded and secured on the vehicle before driving to the extraction site.
Extracting sludge	<ul style="list-style-type: none"> • Park the Vacutug on solid level ground if possible and set the safety brake. • Wear protective clothing if available. • Stand clear of the exhaust port when the pump engine is starting. Diesel fumes exhaust via this port. <p>After extracting:</p> <ul style="list-style-type: none"> • Wash down any sludge that has spilled around the top of the manhole. • Clean the exterior of the 3-in. x 15-m flexible hose and the pointed aluminium pipe at its inlet end. • Clean your gumboots, gloves and any other protective clothing that may have touched the sludge. • Wash your hands with soap and fresh water. Frequent hand washing may reduce the risk of illness.
Transporting sludge and driving	<ul style="list-style-type: none"> • Stand clear of the inlet and outlet valves on the tank when you are closing them. • Check that the inlet and outlet valves on the tank are in fact closed. • Check that equipment and supplies are loaded and secured on the vehicle before transporting the sludge to the disposal site. • Be careful when driving on sandy or muddy roads. The Vacutug is heavier and less manoeuvrable with a full tank of sludge. It could get stuck easily on soft roads.

Discharging sludge	<ul style="list-style-type: none"> • Park the Vacutug on solid level ground if possible and set the safety brake. • Wear protective clothing if available. • Stand clear of the exhaust port when the pump engine is starting. Diesel fumes exhaust via this port. • Do not point the flexible hose at anyone. • Stand clear of the area where the sludge is being discharged. <p>After discharging:</p> <ul style="list-style-type: none"> • Wash down any sludge that has spilled around the top of the manhole. • Clean the exterior of the 3-in. x 15-m flexible hose and the pointed aluminium pipe at its inlet end. • Clean your gumboots, gloves and any other protective clothing that may have touched the sludge. • Wash your hands with soap and fresh water afterwards. Frequent hand washing may reduce the risk of illness.
Cleaning, maintaining & troubleshooting	<ul style="list-style-type: none"> • Work during daylight hours or under bright lights. Do not work in the dark. • Wear gloves and a filter mask if using bleach or other chemicals. • Wipe down your tools after you have finished working with them. • Turn off the engine and disconnect the battery when troubleshooting either of these components. • Wash your hands with soap and fresh water afterwards. Frequent hand washing may reduce the risk of illness.

Washing Your Hands: Best Practices

When you wash your hands with soap and fresh water, you help to reduce the chance that you and those around you will get sick. Human excreta can contain millions of viruses and bacteria. Germs that cause diseases are transmitted chiefly by the hands. In addition to wearing protective clothing, frequent hand washing with soap and fresh water is an inexpensive and effective way to help prevent illness.

Get into the habit of washing your hands frequently with soap and fresh water after:

- Operating the Vacutug
- Cleaning, maintaining and troubleshooting the Vacutug

You can maximise the benefits of hand washing when you do it properly.

To wash your hands properly:

1. Wet your hands with fresh water.
2. Rub soap between the palms of your hands and work into a foamy lather.
3. Scrub, for a total of at least 20 seconds:
 - Your palms
 - The backs of your hands
 - Between your fingers
 - Underneath your fingernails
4. Rinse your hands with fresh water.
5. Dry your hands with a clean gamcha or towel.

Chapter 4: Using the Vacutug

Always follow pre-operation checks and operation procedures to use the Vacutug safely.

Pre-Operation Checklist



Do not smoke cigarettes while performing pre-operation checks. Sparks from the fire box or lit cigarette could ignite fumes or chemicals.

Vehicle (MK-IV and V, VI, VII)	
Item	Task
Fuel	<ul style="list-style-type: none">• Check that there is fuel in the vehicle.
Mobil	<ul style="list-style-type: none">• Check that the mobil level is sufficient.• Check that the mobil is not gritty, thin or excessively black.
Battery	<ul style="list-style-type: none">• Check that the water level is between the MAX and MIN marks on the battery case.
Tires and wheels	<ul style="list-style-type: none">• Check that the air pressure is within the range indicated on the tire sidewall.• Check that the treads are not worn out.• Check for punctures and other signs of damage.• Check that the spare wheel is in good condition and that the air pressure is within the range indicated on the tire sidewall.
Lights and indicators	<ul style="list-style-type: none">• Check that the lights and indicators work.• Check that the horn sounds.

Engine (all models – see photos below)	
Item	Task
Fuel	<ul style="list-style-type: none"> • Check that there is diesel fuel in the engine.
Mobil	<ul style="list-style-type: none"> • Check that the mobil level is between the low and high marks on the level indicator stick.
Pump (all models – see photos below)	
Item	Task
Mobil	<ul style="list-style-type: none"> • Check that the mobil level is between the low and high marks on the level indicator stick.
Air Hoses (all models – see photos below)	
<ul style="list-style-type: none"> • Check for damage. • Check that the air hoses are securely fastened to the steel pipes. 	
Tires and Wheels (MK-II, III)	
Item	Task
Tires and wheels	<ul style="list-style-type: none"> • Check that the air pressure is within the range indicated on the tire sidewall. • Check that the treads are not worn out. • Check for punctures and other signs of damage. • Check that the spare wheel is in good condition and that the air pressure is within the range indicated on the tire sidewall.

3-in. x 15-m Flexible Hoses (all models – see photos below)	
Item	Task
Hose body	<ul style="list-style-type: none"> • Check for damage and cracks where air could leak. • Check that the O-ring is seated properly and not damaged.
Aluminium pipes	<ul style="list-style-type: none"> • Check that the aluminium pipes are securely fastened at both ends of the hose.
Valve Levers (all models – see photos below)	
Item	Task
Levers	<ul style="list-style-type: none"> • Check that the levers are not broken. • Check that the steel tangs are not bent, cracked or missing.
Flap Valve (all models – see photos below)	
Item	Task
Flap height	<ul style="list-style-type: none"> • Check that when lifted up, the flap valve is flush against the bottom of the trap pipe.

Engine

Driver's side view

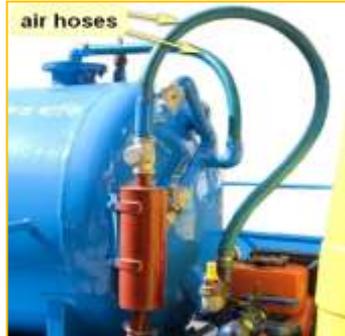


Passenger's side view

Pump



Air Hoses



3-in. x 15-m Flexible Hoses



Valve (Levers and Flap)



Operation Procedures

The following operation procedures apply to all Vacutug models unless otherwise noted.

WARNING

Do not smoke cigarettes while operating the Vacutug. Sparks from the fire box or lit cigarette could ignite fumes or chemicals.

WARNING

Be mindful of lit cooking stoves near the pit latrine or septic tank. Do not open the manhole when a lit cooking stove is nearby. Sparks from the stove could ignite fumes in the tank.

How to Drive the MK-II

The MK-II is a self-propelled machine. It has a unique driving mechanism unlike the other models covered in this manual. Its engine powers both the drivetrain and the pump, but not at the same time. You must change the belt position for either driving or pumping operation. To change the belt position the engine must be turned off and the belt slack.

The engine drives the front wheels via belt and pulley, transmission shaft, chain and friction rollers. The friction rollers engage with the tires via the friction drive lever. Maximum speed of the MK-II is approximately 5 km/h.

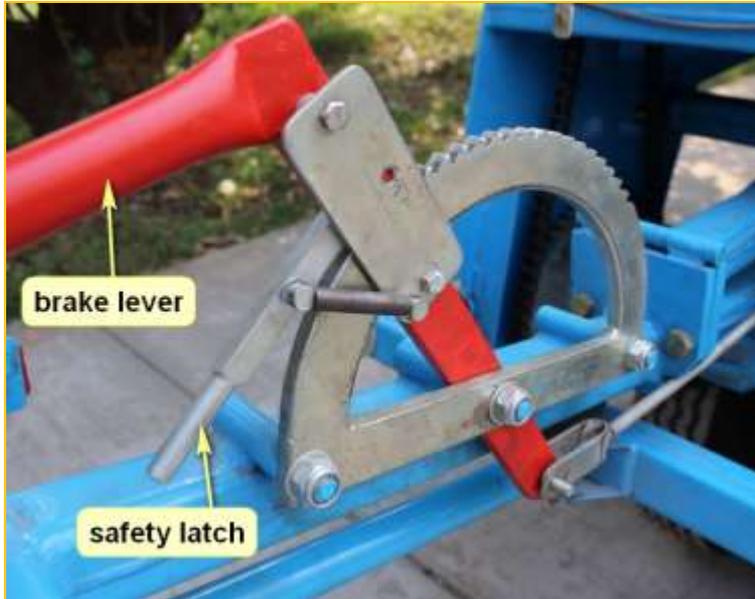
The engine drives the pump via belt and countershaft pulley.



1. Prepare to start the engine

a) Engage the parking brake:

Lift the brake lever towards the engine. The safety latch will mesh with the gear teeth.



b) Check that the belt is slack. To slacken the belt:

Lift the clutch lever towards the engine.



c) Check that the belt is in the outside grooves on the pulleys.

Engine belt



Pump belt on countershaft pulley



2. Start the engine

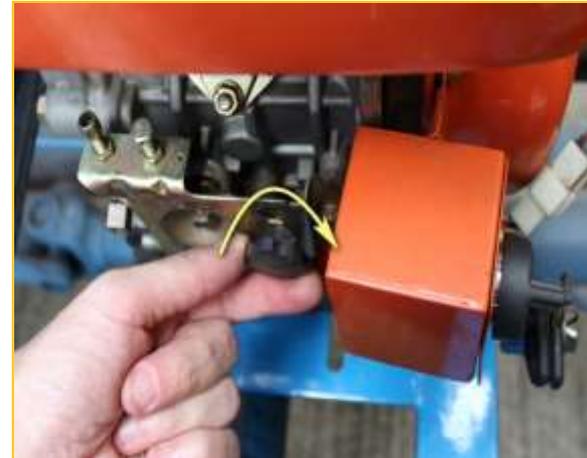
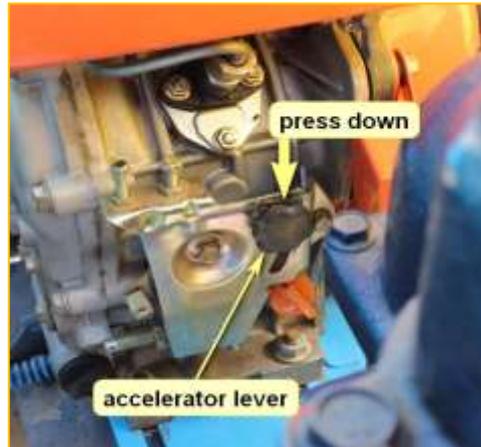


Check that no one is standing in the direct path of the engine exhaust port when starting the engine. Diesel fumes exhaust via this port.

a) Insert the key into the ignition switch.



b) Press down the accelerator lever to the START position and twist the button clockwise to lock in place.



c) Press down the decompression lever.



d) Turn the key.



Note

You can also start the engine by pulling the starter rope.

3. Engage the wheel drive

- a) Lift the safety latch to disengage the parking brake.
- b) Pull down the clutch lever to tighten the belt.
- c) Move the friction drive lever 180 degrees toward the engine to engage the drive rollers with the tires. The MK-II moves forward at a brisk walking pace.



Note

To increase or decrease the speed, twist the throttle grip.

4. Disengage the wheel drive

- Release the throttle grip.
- Lift the clutch lever to slacken the belt.
- Return the friction drive lever to its disengaged position to disengage the drive rollers from the tires.
- Engage the parking brake.

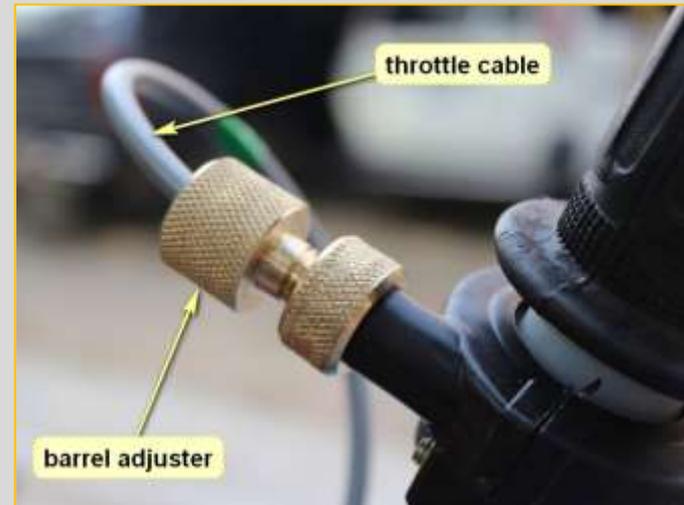


Note

The drive rollers continue to rotate even with a slack belt. This is normal.

5. Stop the engine

Pull out the throttle cable *slightly* from the barrel adjuster on the throttle grip housing.



How to Extract Sludge (Vacuum Mode)

All Vacutug models use a pump vacuum and a 3-in. x 15-m flexible hose with a pointed aluminium pipe at the inlet end to extract sludge from septic tanks and pit latrines. All Vacutug models are equipped with two of these hoses, which can be joined together if the manhole is a very long way from the Vacutug.

Note

If two flexible hoses are joined together, the efficiency of the pump's vacuum will be reduced. It will take more time to extract sludge.

1. Prepare the site



Be mindful of lit cooking stoves near the pit latrine or septic tank. Do not open the manhole when a lit cooking stove is nearby. Sparks from the stove could ignite fumes in the tank.



Open the manhole carefully and from a distance – especially if you are not wearing protective clothing. Do not inhale the hazardous fumes that will disperse from inside the septic tank. Allow at least two minutes for the fumes to disperse before beginning work.

- a) Park the Vacutug on solid level ground as close to the manhole as possible. Engage the safety brake if your vehicle has one.
- b) Locate the manhole. The homeowner may be able to tell you where the manhole is located.
- c) Open the manhole carefully and from a distance – especially if you are not wearing protective clothing. Do not inhale the hazardous fumes that will disperse from inside the septic tank. Allow at least two minutes for the fumes to disperse before beginning work.
- d) Test the thickness of the sludge:
 - Insert a strong piece of bamboo into the septic tank. If the sludge is hard and thick, add water and mix to thin.

2. Insert and attach the 3-in. × 15-m flexible hose

a) Insert the pointed aluminium pipe end of the hose into the manhole.



b) Attach the opposite end of the hose to the inlet valve (top valve) of the collection tank. Make sure that the quick release coupling is securely fastened to the metal ring on the inlet pipe.



Note

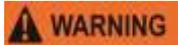
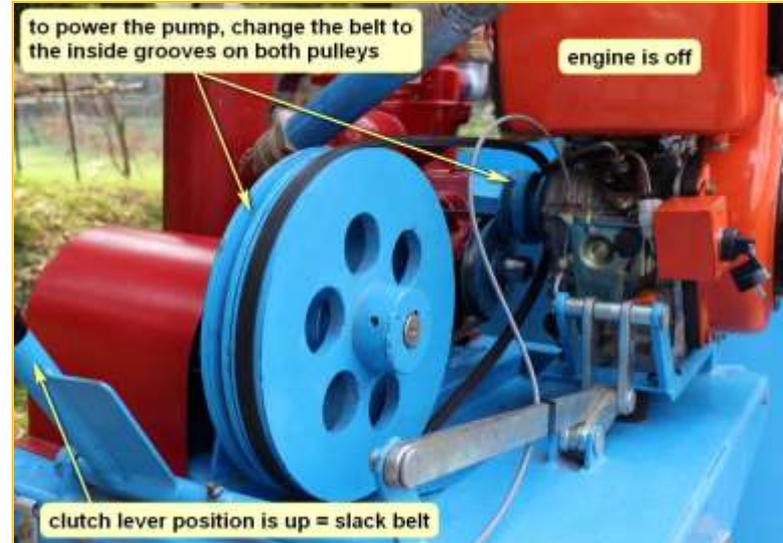
If the manhole is located further than 15 m from the Vacutug, join two flexible hoses together. Keep in mind that if two flexible hoses are joined together, the efficiency of the pump's vacuum will be reduced. It will take more time to extract sludge.

3. Check the pump control lever position

Check that the pump control lever is set to the centre (neutral) position.



MK-II only: Change the belt position to power the pump



Do not change the belt position when the engine is running.

- To power the pump, move the belt from the outside groove to the inside groove on both pulleys.

4. Start the engine

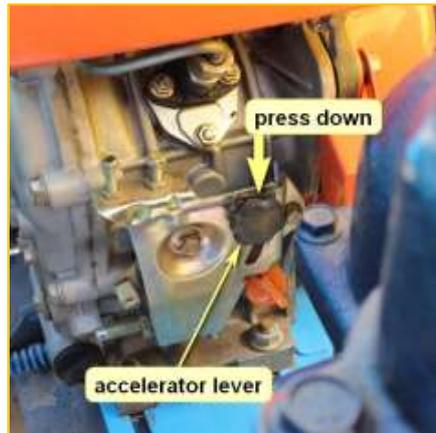


Check that no one is standing in the direct path of the engine exhaust port when starting the engine. Diesel fumes exhaust via this port.

a) Insert the key into the ignition switch.



b) Press down the accelerator lever to the START position and twist the button clockwise to lock in place.



c) Press down the decompression lever.



d) Turn the key

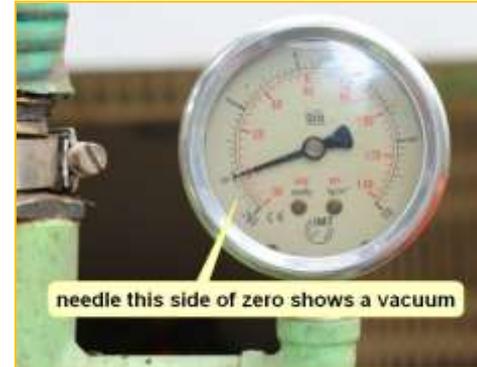
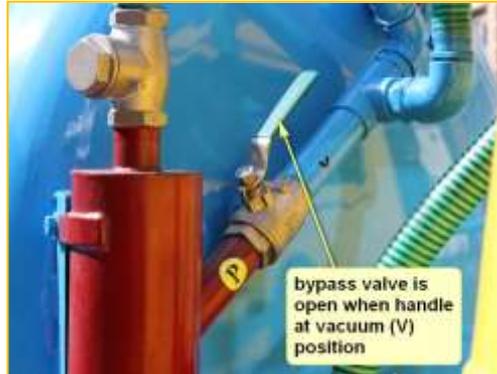


Note

You can also start the engine by pulling the starter rope

5. Set the pump control lever / bypass valve lever / throttle valve

a) Set the pump control and bypass valve levers to the vacuum (V) position. Check that the pump pressure dial shows a vacuum.



b) Lift the throttle valve to the bottom of the sludge trap pipe until vacuum force holds it in place.



c) Watch the drops of mobil through the window of the flow indicator on the top of the pump. There should be 25-30 drops per minute.



6. Open the inlet valve

Slowly open the inlet valve on the tank.



7. Watch the sludge level / close the inlet valve / set the pump control lever to neutral:

a) Close the inlet valve.



Watch the sludge level through the sight glass. When you see sludge at the top sight glass

b) Set the pump control lever to the centre (neutral) position. The flap valve at the bottom of the trap pipe will fall open.



Stand clear of the bottom of the trap pipe. Sludge may drip out.

8. Stop the engine

- **MK-II only:**
 - Pull out the throttle cable *slightly* from the barrel adjuster on the throttle grip housing.
- All other models:
 - Turn the key to the OFF position.
 - Twist the accelerator lever button anti-clockwise to unlock the lever. The lever springs back to the STOP position.

9. Detach the hose



A small amount of sludge may drip out from the inlet valve when you detach the hose.

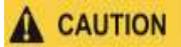
- Remove the hose from the septic tank and detach from the inlet valve.

10. Collect spill over sludge

- To collect any spill over sludge, hang a bucket from the inlet valve pipe.
- Dispose any sludge into the manhole.
- Rinse the bucket with fresh water.



11. Clean up



Never use the same gamcha to wipe down equipment and yourself. Use one gamcha to wipe down equipment and tools and different gamcha to clean and dry your face, feet, hands and body. Keep gamcha separated. Gamcha that has been used to wipe down equipment and tools should never be used to clean and dry your body.

Clean up:

- Any sludge that has spilled around the top of the manhole and the inlet valve.
- The exterior of the 3-in. x 15-m flexible hose.
- Gumboots, gloves and any other protective clothing that may have touched the sludge.
- Your face, feet and hands with soap and fresh water.

Prepare to Drive to the Disposal Site

When the collection tank is full you must drive to the disposal site to discharge the sludge from the tank.



Be careful when driving on sandy or muddy roads. The Vacutug is heavier and less manoeuvrable with a full tank of sludge. It could get stuck easily on soft roads.

Make sure to:

- Load and secure all equipment and supplies onto the vehicle.
- Check that the inlet and outlet valves on the tank are closed.
- **MK-II only:** Change the belt to the driving position. (See **How to Drive the MK-II** in this chapter.)

How to Discharge Sludge (Pressure Mode)



Discharge sludge at a disposal site only. Never discharge sludge into a ditch, pond, river, lake or other body of water used by fish, animals or people.

1. Attach the 3-in. x 15-m flexible hose
2. Check the pump control lever position

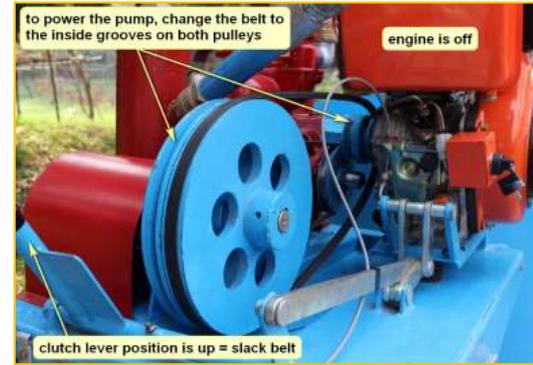


a) Attach the 3-in. x 15-m flexible hose to the outlet valve (bottom valve) of the collection tank. Make sure the quick release coupling is securely fastened.

b) Hold the hose firmly and prepare to start the engine.



Check that the pump control lever is set to the centre (neutral) position.



MK-II only: Change the belt position to power the pump

Move the belt from the outside groove to the inside groove on both pulleys to power the pump.



Do not change the belt position when the engine is running.

3. Start the engine

- See **How to Extract Sludge (Vacuum Mode)** > 4. Start the engine earlier in this chapter.

4. Close the bypass valve / set the pump control lever

a) Close the bypass valve and set the pump control lever to the pressure (P) position. Check that the pump pressure dial shows pressure.



b) Watch the drops of mobil through the window of the flow indicator on the top of the pump. There should be 25-30 drops per minute.



Note

The flap valve at the bottom of the sludge trap will be open during pressure mode.

5. Open the outlet valve



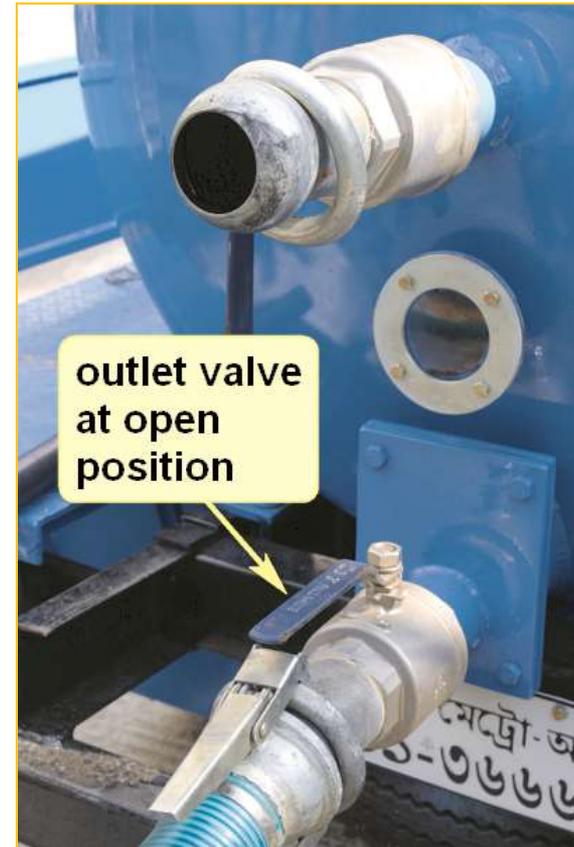
Do not point the hose at anything except the discharge point.

Check that no one is standing in the direct path of the sludge spray.

- Slowly open the outlet valve on the tank to discharge sludge under pressure.

6. Watch the sludge level / open the bypass valve / set the pump control lever to neutral / close the outlet valve:

Watch the sludge level through the sight glass. When the tank is empty:



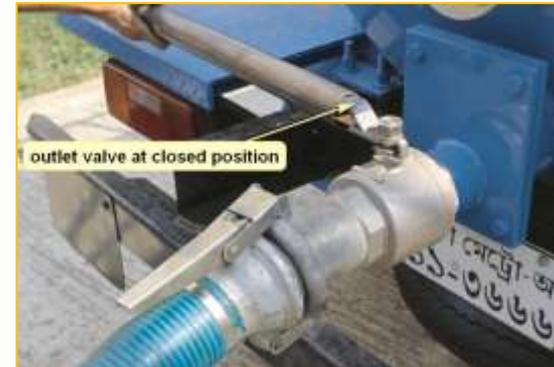
a) Open the bypass valve by setting the lever to the vacuum (V) position.



b) Set the pump lever to the centre (neutral) position.



c) Close the outlet valve.



7. Stop the engine

- See **How to Extract Sludge (Vacuum Mode) > 8. Stop the engine** earlier in this chapter.

8. Detach the hose



A small amount of sludge may drip out from the outlet valve when you detach the hose.

- Detach the hose from the outlet valve.

9. Collect spill over sludge

a) To collect any spill over sludge, hang a bucket from the outlet valve pipe.



Dispose of sludge appropriately.

c) Rinse the bucket with fresh water.

10. Clean up



Never use the same gamcha to wipe down equipment and yourself. Use one gamcha to wipe down equipment and tools and different gamcha to clean and dry your face, feet, hands and body. Keep gamcha separated. Gamcha that has been used to wipe down equipment and tools should never be used to clean and dry your body.

b)

Clean up:

- Any sludge that has spilled around the outlet valve.
- The exterior of the 3-in. x 15-m flexible hose.
- Gumboots, gloves and any other protective clothing that may have touched the sludge.
- Your face, feet and hands with soap and fresh water.

Chapter 5: Maintenance

Maintenance is action that you take at regular intervals to keep the Vacutug in optimum working condition.

Note

The following task frequencies assume that the Vacutug is operating at full capacity most days of the week. You might perform maintenance tasks more or less frequently depending on how often your Vacutug is used.

WARNING

Do not smoke cigarettes while performing maintenance. Sparks from the fire box or lit cigarette could ignite fumes or chemicals.

Schedule

Component	Task	Frequency	Person Responsible	Budget
Vehicle (MK-IV and V, VI, VII)	Check the fuel level	Daily	Operator	-
	Check the mobil level	Daily or Weekly	Operator	-
	Check the mobil colour	Monthly	Operator	-
	Renew the mobil  WARNING This task is highly technical. Do not renew the mobil unless you have sound technical skills and experience.	Monthly or when mobil is gritty or excessively black	Technician	Minimal
	Check the water level in the battery (See	Weekly	Operator/Technicia	-

Component	Task	Frequency	Person Responsible	Budget
	photo below)		n	
	Check the tires and wheels including the spare	Daily	Operator	-
	Check the lights and indicators	Daily	Operator	-
MK-II	Grease the fittings (See photos below)	Once every two weeks	Operator	Minimal
Engine (all models)	Check the fuel level	Daily	Operator	-
	Check the mobil level and colour	Daily	Operator	-
	Check the air filter (See photo below)  WARNING This task is highly technical. Do not check the air filter unless you have sound technical skills and experience.	Weekly	Technician	Minimal
	Check the fuel filter (See photo below)  WARNING This task is highly technical. Do not check the fuel filter unless you have sound technical skills and experience.	Weekly	Technician	Minimal
Check the mobil filter (See photo below)  WARNING This task is highly technical. Do not check the mobil filter unless you have sound technical	Monthly	Technician	Minimal	

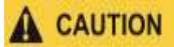
Component	Task	Frequency	Person Responsible	Budget
	skills and experience.			
Pump (all models)	Check the mobil level and colour	Daily	Operator	-
	Check the mounting bolts (See photo below)	Daily	Operator	-
	Grease the fitting (See photo below)	Once every two weeks	Operator	Minimal
Tank (all models)	Flush the tank	Daily	Operator	-
	Clean the inside (See photo below)	Every 100 discharges	Operator	-
	Clean the outside (See photo below)	Daily	Operator	-
3-in. x 15-m flexible hose (all models)	Clean the outside	Daily	Operator	-
	Check for damage and renew if necessary (See photos below)  WARNING This task is highly technical. Do not renew the flexible hose unless you have sound technical skills and experience.	Daily	Operator/Technician	-
Paperwork	Check that the vehicle's tax and fitness certificates are valid	Periodic	Operator	-
	Check that your driving license is valid	Periodic	Operator	-

Tasks



Some of the following maintenance tasks are highly technical and should be performed by an experienced technician or mechanic only.

Vehicle (MK-IV and V, VI, VII)



MK-VI only: Remove the top cover to perform many of the following tasks.

Battery

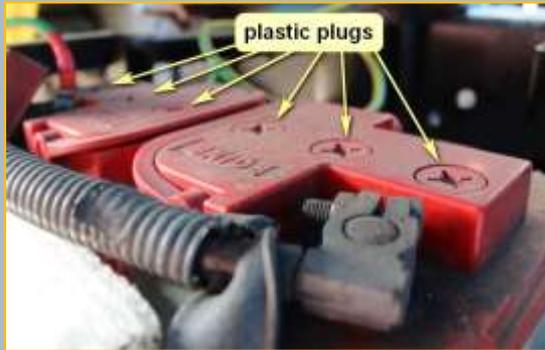
The water in the battery needs to be maintained at a sufficient level. Check that the water level is between the MAX and MIN marks on the battery case.



Use distilled water only, as recommended by the battery manufacturer. Never use tap water, bottled water or any other type of water.

To add water

1. Remove the plastic plugs from the top of the battery.



2. Add distilled water until the level is sufficient.

3. Re-install the plastic plugs.

Note

Battery power may decrease if the Vacutug is not used for long periods of time.

MK-II

Grease fittings

There are a number of grease fittings on the MK-II, at contact points between metal parts where lubrication is necessary. Use a grease gun to inject grease into the fittings.

MK-II grease fittings



Engine

Fuel level

The engine needs diesel fuel to power the pump. Check that the fuel level is sufficient and add as needed.



Do not add fuel while the engine is running.

Mobil level

The engine needs a sufficient level of mobil to keep internal parts lubricated. Check that the mobil level is between the low and high marks on the level indicator stick.

Filters

The engine has three filters:

- Air
- Fuel
- Mobil

You can service the air filter if you have compressed air.

Use compressed air to:

- Blow out the paper filter
- Dry the sponge sleeve after washing it



This task is highly technical. Do not service the air filter unless you have sound technical skills and experience.



Do not clean the paper filter with water. Do not install the sponge sleeve if it is wet.

To service the air filter

1. Unscrew the wing nut on the side of the plastic filter housing.



2. Remove the air filter.

3. Remove the sponge sleeve.

4. Blow out the paper filter with compressed air.



5. Clean the sponge sleeve with fresh water and detergent.



6. Dry the sponge sleeve using compressed air.



To service the fuel and mobil filters: Call an experienced technician or mechanic.

Pump

Mobil level

The pump needs a sufficient level of mobil to keep internal parts lubricated. Check that the mobil level is between the low and high marks on the level indicator stick.

Mounting bolts

The mounting bolts keep the pump securely fastened to the Vacutug chassis. Check that the mounting bolts are tight.

Grease fitting

The pump has one grease fitting located near the pulley. Use a grease gun to inject grease into the fitting.

Pump mounting bolts



Pump grease fitting



Tank

Flushing

Flush the tank daily with fresh water to keep it clean and to prevent corrosive salt in the sludge from damaging the inside of the tank.

Note

You do not need to fill the tank completely with fresh water to flush it. Use only a minimal amount of fresh water to flush the tank.

WARNING

Flush the tank into a pit latrine or septic tank only. Never flush the tank into a ditch, pond, river, lake or other body of water used by fish, animals or people.

To flush the tank:

1. Locate a source of fresh water.
2. Extract a minimal amount of fresh water into the collection tank. To do this, the Vacutug must be set to vacuum mode. See **Chapter 4: Using the Vacutug > Operation Procedures > How to Extract Sludge (Vacuum Mode)**.
3. Discharge the water in the collection tank into a pit latrine or septic tank. To do this, the Vacutug must be set to pressure mode. See **Chapter 4: Using the Vacutug > Operation Procedures > How to Discharge Sludge (Pressure Mode)**.

Cleaning the inside

The inside of the tank must be cleaned after every 100 discharges to break up any hard sludge that has built up on the bottom.

CAUTION

Do not insert a shovel or any other piece of metal into the outlet valve; otherwise the inside of the tank might get damaged.

To clean the inside of the tank:

- Thrust a wooden rod or bamboo stick in and out of the tank through the outlet valve to break up any hard sludge on the tank bottom.

Note

To easily access the inside of the tank to clean more thoroughly, remove the four bolts at the outlet valve plate. Remember to re-install the gasket when assembling.

Tank outlet valve plate



Cleaning the outside

Clean the outside of the tank, especially around the inlet and outlet valves, with fresh water.



Belt

The belt transfers power between the engine and the pump.

If you hear a cracking sound or unusual noise coming from the belt area, then the belt may be damaged and should be renewed.

WARNING

This task is highly technical. Only an experienced technician or mechanic should renew the belt.

WARNING

Never touch the belt while the engine is running.

To renew the belt:

- Call an experienced technician or mechanic.



3-in. x 15-m Flexible Hose

The 3-in. x 15-m flexible hose may crack and develop leaks along its plastic body. Leaks are a possible cause of a weak vacuum.

There is no set time to renew the flexible hose. However, if it is cracked or otherwise damaged it should be renewed. A leaky hose will cause the vacuum to be weak.

Tips to keep the flexible hose in good condition:

- When not in use, keep the hose out of direct sunlight. Sunlight accelerates the breakdown of the plastic in the hose. When the plastic breaks down, the hose develops cracks more easily.
- Avoid coiling (wrapping) the hose into a small radius. This could induce the plastic to crack. Wrap the hose only three or four times before putting it away.
- Avoid placing sharp, heavy or hot objects on or near the hose.

To renew the 3-in. x 15-m flexible hose:

1. Detach the hose from the collection tank and unscrew the hose clip.



2. Use an electric heat gun to heat the length of the hose that joins the quick release coupling pipe. Remove the hose. You may need to saw down through the hose to the pipe to make it easier to remove.



3. Heat the new hose at the length where it will slide over the quick release coupling pipe.



WARNING

This task is highly technical. Do not renew the hose unless you have sound technical skills and experience.

WARNING

Do not use a flame to heat the hose unless you have sound technical skills and experience.

4. Spread a few drops of mobil on the outside of the quick release coupling pipe so that the new hose length slides on easily.



5. Slide the hose onto the quick release coupling pipe.



6. Re-install the hose clip and tighten.



Thread Seal Tape

A poor seal at the threads between the inlet valve (top valve) and the pipe on the sludge collection tank can cause a weak vacuum. A weak vacuum will increase the time it takes to extract sludge.

Thread seal tape is a very thin white tape that helps make a tight seal between the inlet valve and the pipe on the collection tank.

It is recommended to renew the thread seal tape whenever the 3-in. x 15-m flexible hose is renewed.

To renew the thread seal tape:



This task is highly technical. Do not renew the thread seal tape unless you have sound technical skills and experience.

1. Unscrew the valve from the pipe on the collection tank.
2. Wrap the tape two or three times around the pipe threads.
3. Screw the valve onto the pipe and tighten.



Chapter 6: Tools & Spare Parts

Tools

A small number of basic tools are needed to maintain the Vacutug. Your municipality may provide tools. Otherwise you can buy tools at most local markets.

Note

Tools may last longer and be more effective if you clean them regularly.

CAUTION

Never use the same gamcha to wipe down equipment and yourself. Use one gamcha to wipe down equipment and tools and different gamcha to clean and dry your face, feet, hands and body. Keep gamcha separated. Gamcha that has been used to wipe down equipment and tools should never be used to clean and dry your body.

It is recommended that you carry the following tools:

Wrenches

17 mm/19 mm combination wrench



12 mm/13 mm combination wrench



250 mm adjustable wrench



Screwdrivers

Phillips screwdriver, long handle



Slot screwdriver, long handle



Pliers and Push-Type Grease Gun

8 in. combination pliers



Push-Type Grease Gun



Extra Tools

In case you need to change a wheel you should also carry the following:

- Lug nut wrench
- Pry bar
- Jack

Toolbox

Keep tools in a toolbox.

The MK-II Vacutug has a built-in, lockable toolbox on top of its collection tank. For all other Vacutug models, a separate toolbox is needed.

Recommended toolbox size: 14 in. (36 cm) x 6 in. (15 cm) x 3 in. (7 cm)



All of the basic tools described earlier will fit inside a toolbox of this size. However, extra tools, such as those used to change a wheel, may not fit.



The toolbox and other tools should be fixed securely to the chassis of the Vacutug or inside the cabin floor of the MK-VI and MK-VII.



Always fix the toolbox and other tools securely before driving. Sudden stops and bumpy roads could cause these items to come loose and cause injury.

Spare Parts

If you perform regular maintenance on the Vacutug, you will use spares rarely.

You may find it handy to keep small-size spares inside the toolbox.

Note

The following spares may not be available at all local markets. Some spares may need to be sourced through MAWTS (Mirpur Agricultural Workshop and Training School) in Dhaka.

O-Ring

The O-ring is seated inside the quick release coupling at one end of the 3-in. × 15-m flexible hose. Renew if missing or damaged.



Hose Clips

Hose clips are fastened at connection points between the air hoses and the steel pipes. Renew if missing or damaged.



1½-in. Ball Valve

The 1½-in. ball valve is located between the sludge trap and the pump. Renew only the lever if it is broken or the tangs are bent or cracked. The ball valve itself fails rarely.



3-in. Ball Valve

The 3-in. ball valve is located at the inlet and outlet valves on the collection tank. Renew only the lever if it is broken or if the tangs are bent or cracked. The ball valve itself fails rarely.



3-in. x 15-m Flexible Hose

Renew if the hose is cracked or damaged. Leaks in the hose may cause a weak vacuum. (See **Chapter 5: Maintenance > Tasks > 3-in. x 15-m Flexible Hose.**)



Note

In Bangladesh flexible hose is usually sold in lengths of 40 to 50 feet. (1 foot = 0.305 metres.)

Air Hoses

Renew if the hoses leak.



Pump Rebuild Kit

A pump rebuild kit contains seals, vanes, gaskets and bearings to rebuild the pump.



Chapter 7: Troubleshooting

When the Vacutug fails to operate as intended, you have to troubleshoot the problem to find a solution. Use the chart below.



Some of the following problems require action that is of a highly technical nature and should be performed by an experienced technician or mechanic only.



Do not smoke cigarettes while troubleshooting. Sparks from the fire box or lit cigarette could ignite fumes or chemicals.

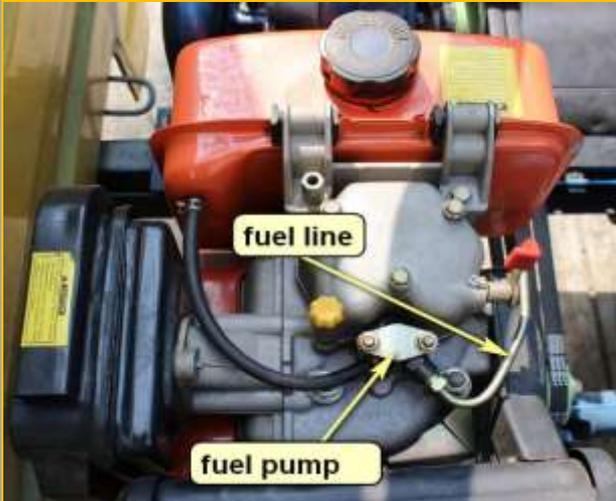
Troubleshooting Chart

Engine			
Problem	Possible Cause	Action	Items Needed
Engine will not start	Fuel tank is empty	Add fuel	Fuel
	Battery is disconnected	Connect battery	Wrench
	Battery is too weak	Charge battery	Battery charger
	Battery is defective	Renew battery	-
	Air in fuel line between fuel pump and injector (See photo below)	Call an experienced technician or mechanic for service	-
	Fuel injector is dirty (See photo below)	Call an experienced technician or mechanic for service	-
Engine makes bad or unusual noise and exhausts excessively black fumes	Engine is beginning to seize	Stop engine immediately and call an experienced technician or mechanic for service	-

High fuel consumption	Air filter is dirty	<p>Check and clean (See Chapter 5: Maintenance > Tasks > Engine > Filters)</p> <p> WARNING</p> <p>This task is highly technical. Do not check the air filter unless you have sound technical skills and experience.</p>	Fresh water, detergent, compressed air
Exhaust fumes are excessively black	Air filter is dirty	<p>Check and clean (See Chapter 5: Maintenance > Tasks > Engine > Filters)</p> <p> WARNING</p> <p>This task is highly technical. Do not check the air filter unless you have sound technical skills and experience.</p>	Fresh water, detergent, compressed air
Pump			
Problem	Possible Cause	Action	Items Needed
No pressure or vacuum	Non-return valves are dirty and not making a tight seal (See photo below)	Remove the caps to check and clean the valves	Combination wrench
Weak vacuum	Leak in the 3-in. x 15-m flexible hose	<p>Check the hose for leaks and renew as needed (See Chapter 5: Maintenance > Tasks > 3-in. x 15-m Flexible Hose)</p> <p> WARNING</p> <p>This task is highly technical. Do not renew the hose unless you have sound technical skills and experience.</p>	<ul style="list-style-type: none"> Hacksaw, slot screwdriver, heat gun, mobil, new hose
	Leak at the tank inlet valve	Renew the thread seal tape on the tank pipe	<ul style="list-style-type: none"> Pipe wrench,

	connection	threads (See Chapter 5: Maintenance > Tasks > Thread Seal Tape)  WARNING This task is highly technical. Do not renew the thread seal tape unless you have sound technical skills and experience.	thread seal tape
Pump will not run	Pump is seized	Stop the engine immediately and call an experienced technician or mechanic for service	-
Belt			
Problem	Possible Cause	Action	Items Needed
Cracking sound or noise coming from the belt area	Belt is loose or damaged	Call an experienced technician or mechanic for service (See Chapter 5: Maintenance > Tasks > Belt)  WARNING This task is highly technical. Do not adjust or renew the belt unless you have sound technical skills and experience.	-
Tires and Wheels			
Problem	Possible Cause	Action	Items Needed
Tire is leaking air	Puncture in the tube and/or tire	Remove the defective wheel and replace with spare Take the defective wheel to an experienced technician or mechanic for service	Jack, lug nut wrench, pry bar, spare wheel

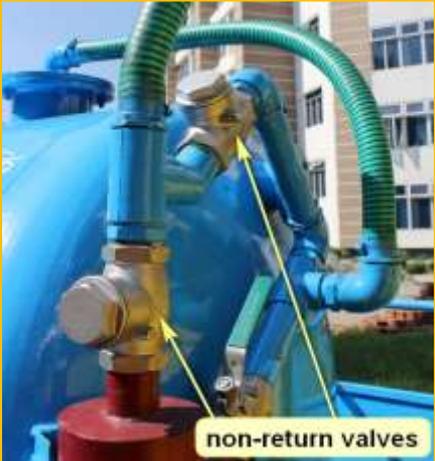
Fuel pump location



Fuel injector location



Non-return valves location



Index

I would recommend making an index. It would be helpful to users.

Some layout software (Adobe InDesign) can create an index automatically.

An index can also be created manually after formatting and before printing, when page numbering is finalised.

I can't include an index here because a separate computer / software will format this manual (page nos. will be wrong).

Example:

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3-in. ball valve	
<i>spare parts</i>	64
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Demonstration of pro-poor market based solutions for faecal Sludge management in urban centres of Southern Bangladesh

