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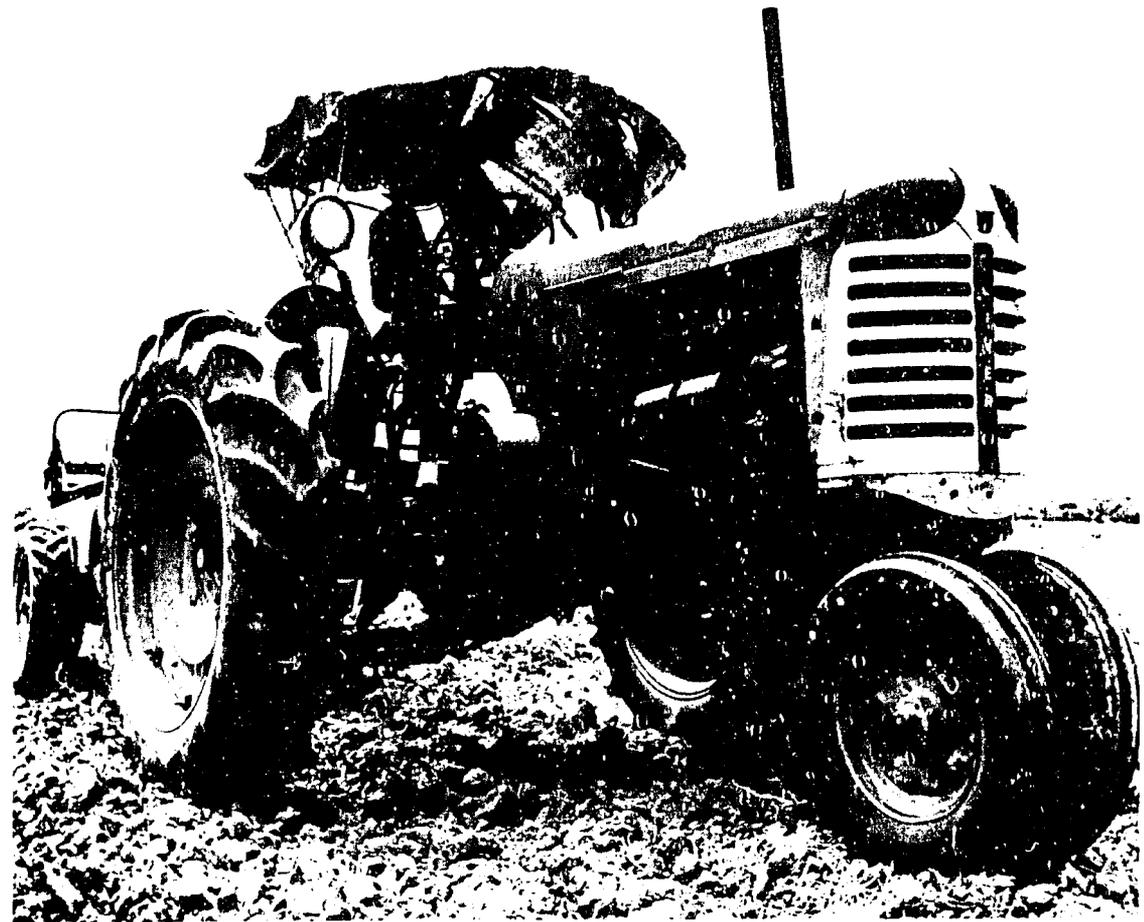
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Manual for Handling FUEL OIL



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P R E F A C E

It has been noted that one of the most pressing problems involving the care and maintenance of farm diesel engines is in connection with repairs that are often the result of faulty practices on the handling of diesel fuel. These repairs run to several thousands of pesos annually. It is estimated that an average of two hundred pesos is spent each time an injection pump is overhauled.

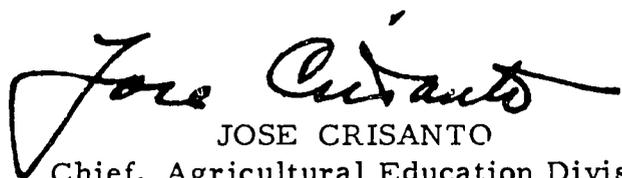
The importance of the proper ways of handling fuel in the maintenance of an engine cannot be over-estimated. Even the most expensive, the cleanest and the highest quality fuel will cause faulty operation if such fuel is improperly handled and stored. It is easy to contaminate clean fuel with water and dust. Contaminated diesel fuel gives disastrous results.

The life as well as the efficiency of a diesel engine depends to a large extent upon the performance of an injection fuel system, and the durability and proper performance of the fuel injection system depend a great deal on the quality and cleanliness of the fuel used. It is imperative, therefore, to observe correct practices in handling and storing diesel fuel.

To bring about a more profitable use of diesel engines for production in the agricultural and rural high schools, this Office is putting out this Manual to serve as a guide. Operators as well as school heads are advised to study this Manual carefully to the end that maximum and

efficient service as well as long life of their machines may be obtained.

It is hoped that the practical information contained herein will result in efficiency which means more profitable use and increased service hours with minimum repairs of the engines.

A handwritten signature in black ink, reading "Jose Crisanto". The signature is written in a cursive style with a large initial "J" and a long horizontal flourish extending to the right.

JOSE CRISANTO
Chief, Agricultural Education Division

INTRODUCTION

Keep Them Moving

Investment in a single piece of diesel equipment, such as a tractor or generator may run into thousands of pesos. The only way to realize a profitable return on this investment is to operate it efficiently over an extended period of time.



Handle fuel properly to prolong life of equipment. Productive work over a period of time enables a tractor to pay for itself. If it is broken down or halted from any cause, it cannot be profitable until repaired. Not only are repairs expensive but depreciation progresses while the machine is idle. The use of clean fuel insures fewer breakdowns and more hours of work.

In other words, if an engine is idle or not in working order from any cause whatsoever, it cannot be doing productive work for the owner. The depreciation due to weathering and aging of the machine progresses even if the machine is idle.

Everyone who has operated such a machine for any length of time realizes the expense involved in repair and maintenance of these expensive units. Practices which will lengthen the life of the machine and give it more hours of productive use before needing repairs must be implemented if the equipment is to be profitable. The following pages deal with one of these phases which, in many cases, has been overlooked by the operator. It is the proper storage and handling of fuel oil.

Oil Additives

Generally speaking, diesel engines are sensitive to variations in the fuel, and the fuel oil specifications are held to very narrow limits. Therefore, it is important that the engine operator strictly adhere to the specifications as set forth by the manufacturer in the operator's manual. It is particularly important that the fuel be free from corrosive agents such as acids and hydrogen sulphide gases. Many operators of diesel powered equipment find it advantageous to use a fuel oil additive. It is claimed that in most cases, the use of the additives affords relief

from annoying gum and wax formations.

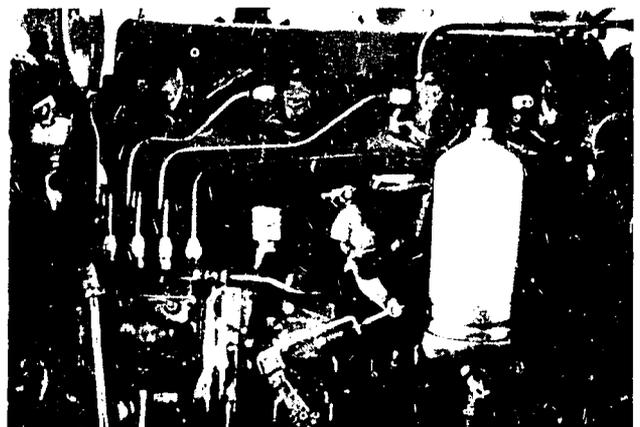
Chemicals in Fuel

An excessive amount of water, sulfur or Conradson carbon is harmful to both engine and injection equipment. Fuels whose specifications are high in respect to asphalt or ash are likely to be troublesome to spray nozzle valve action, especially if the nozzles are not well cooled. When it is known that the fuels to be burned are of chemically injurious character, the injection equipment can be fitted with precision parts made of corrosion-resistant material. This material is slightly less resistant to abrasion.

Dirty Fuel Causes Wear

It is of equal or even greater importance to use fuel oil which is clean. Injection equipment, such as pumps and spray nozzles, can be ruined in a very short time if they are not adequately protected.

Fuel oil must be clean. The fuel injection system is an important part of the diesel engine. A unit of this type will fail if the fuel oil is dirty. The use of clean fuel will prolong the service life and reduce maintenance costs.



Once the close fitting lapped parts and assemblies contained in the injection units have been affected through erosion and corrosion, it is usually impossible to recondition them and it becomes necessary to have them replaced. The wear due to dirty fuel on precision parts, plunger and barrel assemblies, delivery valves and seats, nozzle valve and body of the injection equipment can seriously lower the economy of operation and will soon cause damage calling for expensive replacement of parts.

Breakdowns Are Costly

The repair of equipment which has been damaged by dirt is not only expensive, because of the necessity of replacing the precision parts, but it may cause costly delay by tying up the machinery during repair. However, what is more important is that the expense and delays are unnecessary. The injection units are composed of precision parts which determine the accuracy of metering and timing the fuel, and control the injection and spray pattern. The very accuracy of the manufacture of these parts is the reason why they give long trouble-free operation - if the operator heeds the necessary precautions in selecting and handling the fuel oil.

Manual For Handling Fuel Oil

Fuel Oil Must Be Clean

Since fuel plays such an important role in the efficient operation and length of trouble-free service realized from an engine, it is of utmost importance to make sure that the fuel oil delivered to the nozzles of the diesel is of the best quality. This means the oil must be clean.



It is best to store barrels in the shade protected from the direct rays of the sun.

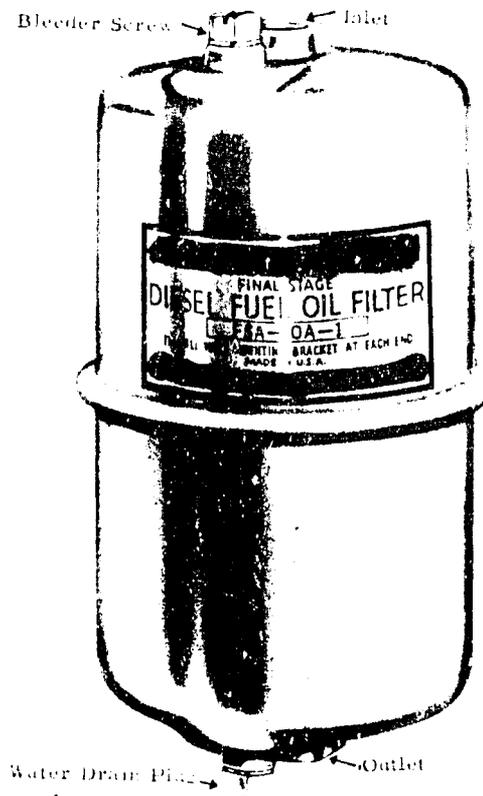
These barrels are subjected to a wide range of temperature variations, causing undue condensation of moisture and scaling of the sides.

Foreign elements frequently found in fuels are:

1. Water
2. Scale
3. Rust
4. Impurities and residue from storage tanks
5. Dust and dirt

Use A Fuel Filter

Most fuel oils hold in suspension a large quantity of sediment composed of fine abrasive particles. These abrasives may gain access to the fuel oil tanks during the periods of idleness or through carelessness in filling the tanks. In some types of service, such as tractors, it is almost impossible to prevent some dirt from getting into the fuel. Adequate filtration of the fuel is particularly important under such conditions.



A filter is necessary for the protection of the injection mechanism. The inlet screw is at the top of the filter-- the outlet at the bottom. The plug at the top is a "bleeder screw" to allow escape of air from the system. The plug at the bottom is removed to drain off water.

Cases have been known where the plunger and barrel assemblies, delivery valves and nozzles were ruined after a few hours of operation because the engine was running in dusty surroundings without the necessary protection for the fuel oil. The abrasive particles which are present in the fuel oil may pass through the average filter. Therefore, it is important that the job of filtering the fuel is not left solely to a metal strainer having openings of .0015" - .003" or larger. The use of filters capable of removing the fine particles which pass through this mesh is imperative. Properly designed filters having felt, cloth or paper disc elements are more effective than the metal edge units. These filters are absolutely necessary for the protection of the injection mechanism and should be changed at regularly prescribed intervals as they are no longer effective once they become clogged or saturated with dust, etc.

Change Filter Regularly

The frequency of the replacement is determined by operating conditions.

Drain Water Which Collects in Filter

The fuel inlet screw is at the top of the filter and the outlet at the bottom. There is a bleeder screw provided in the top for allowing air to escape from the system. Most filters are provided with a water drain plug at the bottom which permits draining of any water which has col-

lected in the bottom of the filter. The frequency of draining depends on operating conditions. When the equipment is subjected to great changes in temperature, water is produced in the fuel by condensation from the air in the tanks. It is important that it be drained off before the filter becomes overloaded and allows it to pass through. If it reaches the lapped parts of the injection equipment, it causes considerable damage.

Keep It Clean When Handling Fuel Oil

The main consideration in handling fuel oil is to keep it clean. The first step is to buy clean oil from a reputable dealer. However, this is not enough. It must be protected from the time it is purchased until it has been burnt.

Each separate step in the handling and storage must be designed to do this as failure in but one respect will defeat the care and expense exercised in all the areas.

Store in Shade Under Shelter

Several satisfactory storage and handling methods are in use. The exact arrangement depends upon the size of engine (if stationary) frequency and methods of fuel delivery, climatic conditions, and local conditions or needs to be met.

Some type of shelter is necessary to protect the storage barrels or tank from the weather. It is particularly important to keep the containers in the shade as barrels exposed to the direct rays of the sun

will tend to condense unusually large quantities of water from the air. This is due to the wide range of temperature variation inside the drums when heated by the sun's rays. Expansion and contraction of the walls of the containers tend to dislodge or loosen any rust or scale particles which may clog the filter or fuel lines on the engine.



Keep barrels out of the weather. Barrels allowed to stand in the rain collect water on their tops. This may seep into the barrel mixing with the contents.

Keep Barrels Out of Rain

Barrels allowed to stand in the rain collect the water on their tops. If a bung is loose, water will seep into the barrel carrying with

it dust or sediment from the atmosphere or top of the barrel. Even if the bungs are kept tightly screwed in, a certain amount of water has a chance of getting inside, when the barrel is opened for use.

Move Drums As Little As Possible

It is recommended that the fuel shed be located where the mobile units can be brought for refueling rather than to move the drums of fuel to the machine in the field. Such handling of the drums agitates and mixes the fuel with any dirt, sediment, scale or water, which might have found its way inside. This material may be held in suspension for several hours and will undoubtedly be poured or pumped into the fuel tank of the engine as it is filled.

Use Care in Locating Shed

The location of a fuel storage shed calls for consideration of the following factors:

Do not place it too close to other buildings. If possible, a minimum of 40 feet of clear space should be between the fuel shed and any other buildings. It is obvious that the storage of highly inflammable liquids presents a fire hazard. Hence, the reason for isolating the building to prevent spread of possible fire. The open space can be utilized for a servicing area and will give ready access to the storage tank for refueling.



Prepare a permanent site for the storage of fuel and oil barrels. Mark the fuel storage shed with signs prohibiting smoking and indicating inflammability of fuel. The barrels of water and sand placed alongside the storage area are effective safety precautions in case of fire.

Beware of Fire

Maintain some type of fire fighting equipment at the fuel shed. If commercial types of equipment are not available, a couple of 50-gallon drums with the tops cut out may be kept filled with water. Another drum cut in half can be filled with sand. Provide buckets or containers to use

in fire fighting. All this equipment should be painted red and clearly marked "For Fire Only." Inspect it at regular intervals. The fuel shed should be well marked with signs indicating the danger of fire and that smoking is prohibited in the area. It is a good idea to have each container labeled, so that easy identification of the contents can be made without having to actually open the barrel.

The shed must be accessible to the mobile units as well as centrally located in relation to the stationary units.

Include Service Area - Grease Pit

It is a good idea to provide a grease pit and slab for washing and servicing the equipment adjacent to the fuel shed. If the tractors and trucks are brought to this area each day for fueling, it will centralize the servicing records and make for more regular and satisfactory service of the units.

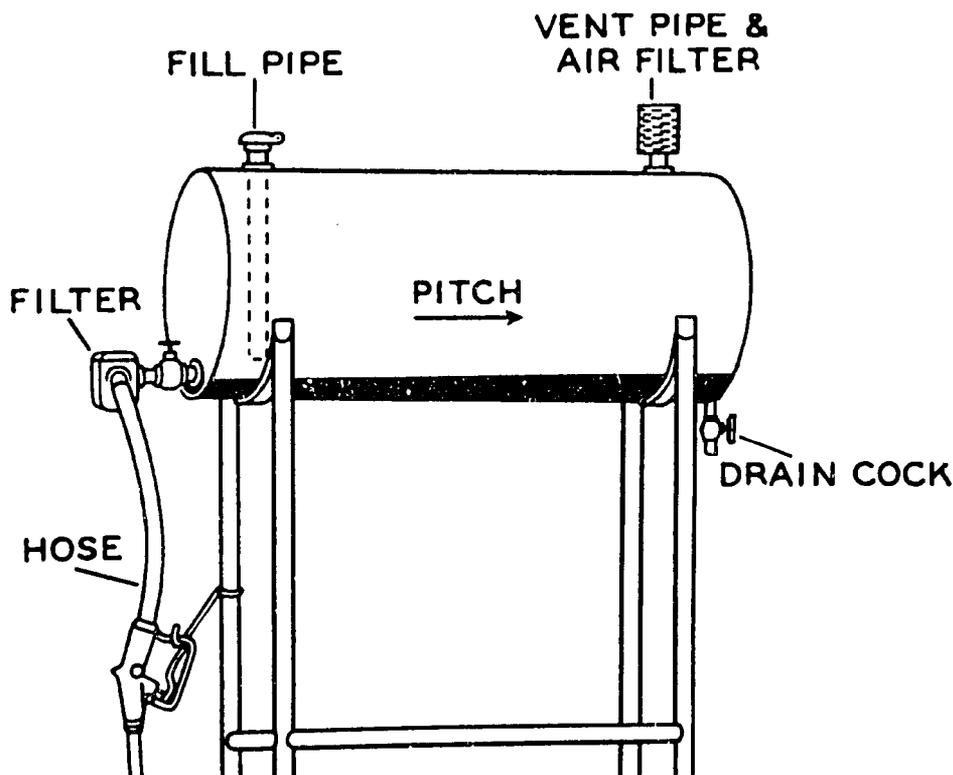
Large Tanks Are Best

For most operations, storage of fuel within the shed should be in large tanks of either the vertical or horizontal type with a capacity of 250 to 500 gallons. Underground storage is safest but often prohibitive in cost. Zinc or galvanized steel tanks should be avoided to prevent possible formation of harmful compounds due to reaction with fuel oil impurities.

Use tanks with adequate capacity to permit the fuel to clarify by

settling of impurities and water and to avoid agitation of the fuel by too frequent refilling. Tanks large enough for 2-4 week's supply are adequate.

Elevate the tank high enough to gravity fill the tank of the highest mobile unit. This means that the bottom of the storage tank must be a few inches higher than the top of the engine fuel tank.



Recommended system for storing and handling fuel oil. Locate in permanent shed. A sump with drain cock located on the bottom at the lower end may be used in place of the drain cock shown on the back end. Lubrication oils may be stored underneath the fuel tank on a rack.

Slope Bottom of Tank

Slope or pitch the tank bottom so that water condensation and solid impurities which precipitate will collect at the low point where they can be drawn off through a drain valve. A sediment sump with a drain valve is often located at this low point.

The bottom of the tank must be higher at the end from which the fuel is drawn for use. If it is raised one inch per foot of tank length, the slope is adequate. That is, a tank 5 feet long is about 5 inches higher at the front end than the back.

The filler pipe should have a fine mesh screen (80 to 100 mesh) to filter the fuel as the tank is filled. This pipe is extended down to within 6 inches of the bottom of the tank. The vent pipe has a cap. It is important that the suction or pipe to dispense fuel for use be located 3 to 4 inches above the bottom of the tank so that only clean oil will be drawn off.

Filling

The storage tank may be filled in several ways -- the best of which is to have delivery made from a truck tank. In filling, the discharge hose from the tank car should be clean as well as the screen on the filler opening of the storage tank.

Another method used to fill the storage tank, if no deliveries from tank cars are available, is to use drums transported to the fuel shed by

truck. Set these upright under the shelter of the fuel shed for at least 48 hours to allow the fuel to clear before being pumped into the main tank. The suction pipe of the pump should not extend nearer than 3 inches or 4 inches to the bottom of the barrel. The fuel left in the drums after pumping may then be poured into one drum for further settling before using the remaining fuel.

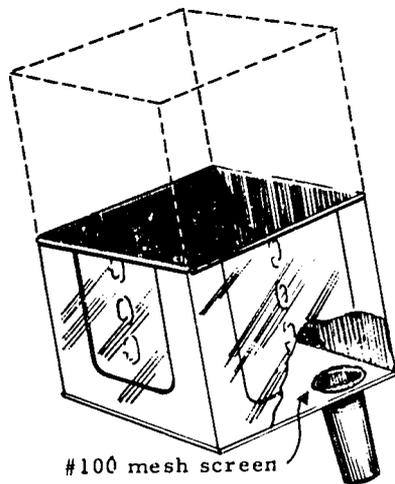
Use Two Tanks

The use of two tanks is recommended so that each tank can be filled and used alternately. This permits the fuel to settle after filling before it is used and allows the tank to be completely drained and cleaned at periodic intervals.

Install a filter in the discharge line near the tank. The tractors or mobile units can be brought near the fuel shed for filling by gravity flow through a plastic hose. Clean the area around the cap on the fuel tank of the engine before the cap is removed.

Fill Tank Immediately After Using

Filling the fuel tank on mobile equipment at the end of each day aids materially in keeping condensation at a minimum. This also allows the dirt or sediment to settle before the machine is put into operation the following day.



Funnel for filling tank can be made from 5-gallon kerosene can. Cut off as indicated by dotted lines and roll sharp edge over #8 galvanized wire. Solder spout in the round reinforced opening found in the corner of each can. Fine mesh screen is soldered across top of spout to strain sediment, water, or other impurities.

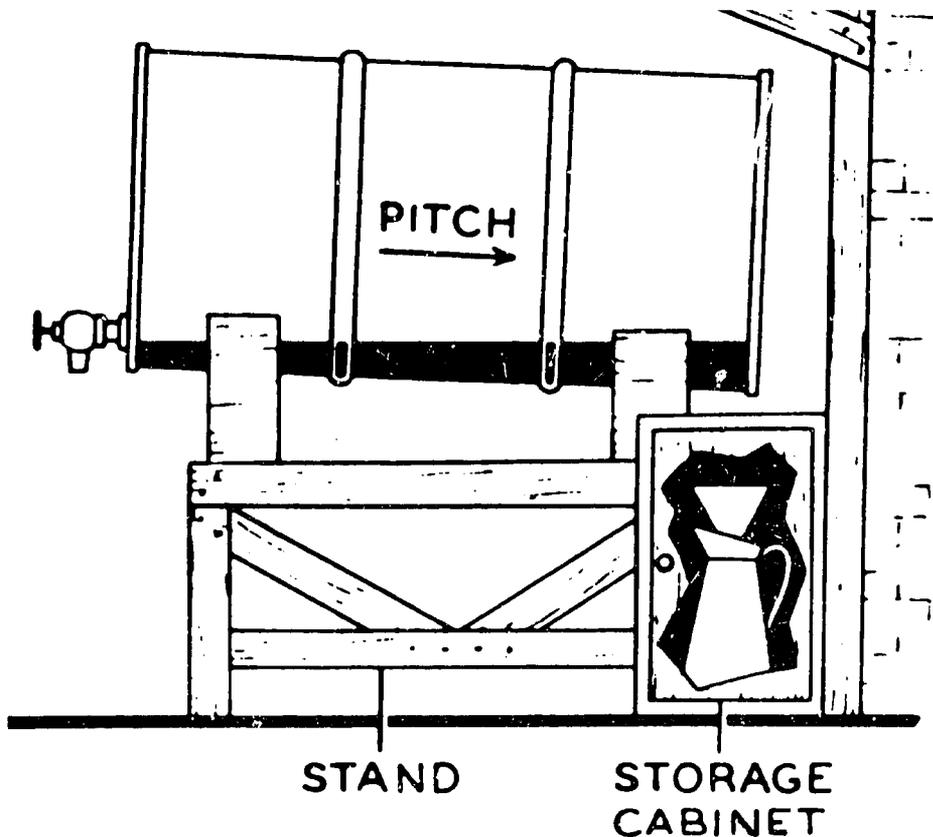
The bottom of the can makes a good pan for washing or holding parts when repairs on equipment are being made.

Use Funnel To Fill

Use a filling funnel which incorporates fine mesh screen, and store this or other receptacles in a close cabinet. Clean before using. Vehicle and tractor tanks should be inspected and flushed out occasionally to prevent an accumulation of road dust or other contamination, which by constant agitation may cause trouble if the filters between the tank and fuel injection pump are inadequate or neglected.

Handling in Drums Is Costly

For small engine and tractor application particularly where the installation is not permanent or where the tractor cannot be brought to the fuel shed, it may not be practical to use the large storage tank. Handling the fuel in drums is the only alternative. This method is less satisfactory than the use of storage tanks because of the more frequent handling of the drums and consequent danger of contamination due to the increased agitation of the fuel oil. In many cases, large losses may result from leaking bungs or spilled or slopped fuel when it is being



If 50-gallon drums must be used for fuel storage, the method illustrated above is recommended. A plastic hose may be attached to the valve to deliver the fuel directly to the motor tank. Be sure to place in the shade and out of the weather. This method is inferior, however, to the larger storage tank with the sump, drain cock and filters.

transferred. These losses may seem small but when added over a period of time mount into a considerable amount.

One method of handling drums is to mount them on their sides in a rack with the back end lower than the front. This will permit relatively clean oil to be drawn off through a faucet at the front without disturbing the dirt and water which has collected at the lower back end of the drum. A faucet must be used rather than opening the bung and turning or rolling the barrel to pour the fuel into containers.

This latter method agitates the fuel and mixes it with the impurities which have settled at the bottom.

Hand Pump Is Good

Another common method is to stand the drums on end and draw the fuel out with a dispensing pump in which the suction pipe reaches within 3 inches to 4 inches of the bottom.

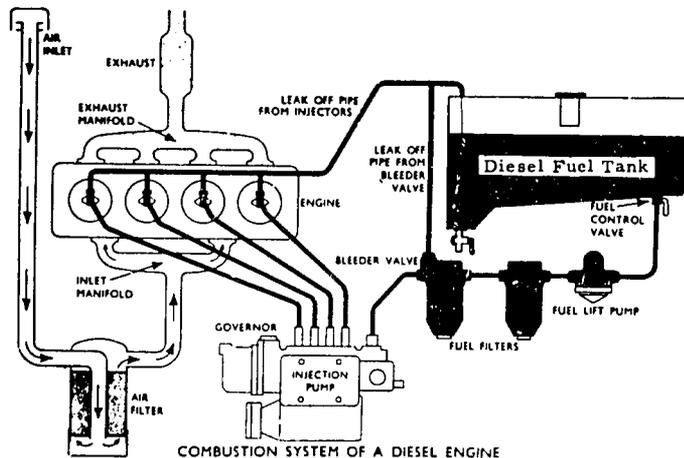


Opening the bung to remove fuel is an improper method of handling fuel. Scales are loosened on the inside of the barrel when it is moved and foreign materials including water may drain into the open fuel can. Dust from the air collects on the exposed surfaces of the can. Fuel spilled on the ground is wasted.

Whichever method is adopted, it is best to have several drums of fuel available so that the fuel oil is allowed to settle for two or three days before use. In each of the methods of handling fuel in drums, some protection from the weather must be provided to minimize contamination of the fuel by condensation of moisture in the air and entrance of dust.

Stationary Engines

For stationary engines, a separate storage tank is usually provided. Select a tank that is large enough so as not to require too frequent filling. Use a funnel with a fine mesh wire strainer to fill and the cover or cap on the filler opening must be tight enough to prevent entry of dust. Locate bottom of this tank just higher than the head of the engine it feeds and for best results keep the tank as full as possible.



Fuel set up for a stationary engine. Note the sloped bottom of the storage tank with the valve at the lower end to drain off collected water and sediment. The bypass or return pipe enters the top of the tank and does not extend to the bottom of it.

It is best to fill immediately after the motor is shut down as this allows maximum time for dust to settle out of the fuel before the motor is started again.

Settle Fuel for 48 Hours

Allow fuel that is moved to the stationary engines in drums, to stand for 48 hours or more before the fuel is pumped into the tank. This allows the sediment and water to settle to the bottom. If the suction pipe of the pump is raised 3 inches to 4 inches from the bottom of the barrel, such foreign material will be left in the drum and can be poured into a settling tank.

Draw Oil Above Tank Bottom - Use a Sump

Place the tank outlet pipe about 2 to 3 inches above the bottom of the tank and provide a faucet or valve to drain the water and dirt which collects on the bottom. This valve is located at the lowest part of the tank preferably in a sump.

If a bypass or return line from the engine is used, install it to enter near the top of the tank and not protrude toward the bottom.

Store Containers in Cabinets

If other containers are used to fill the tank, they must be stored in tight cabinets and be clean when used.

Summary of Points to Remember in Handling Fuel Oil:

1. Buy clean oil -- keep it clean.
2. Store fuel in shade -- out of rain.
3. Allow fuel to settle 48 hours before using.
4. Use adequate filters and change them regularly.
5. Guard against fire.
6. Properly designed large storage tank in good location is best.
7. Have tank bottom sloped -- drain at lower end.
8. Draw fuel a few inches above bottom of tank.
9. Use fine wire mesh funnel to fill.
10. Each step in fuel handling must be designed to keep the fuel clean.