SECTION 9.20
PORTABLE TRANSFER OF HAZARDOUS LIQUIDS

P. A. NOLTE

Transfer systems for hazardous chemicals must not only take into account the best means to transport the chemical based on the chemicals fluid characteristics, but must also pay particular attention to both safety and environmental issues. The chemical can be something as common as gasoline, or a very poisonous restricted-use pesticide such as Paraquat. When the requirement of portability is added to the chemical handling system, design parameters must now take into account variables such as power source, environmental conditions, and chemical restraints. Several power sources have been incorporated through out the years for the portable transferring of hazardous chemicals. One of the earliest is simple hand power. Others consist of gasoline powered, ground-driven, compressed air, and battery operated pumping systems.

Major markets that require the portable transfer of chemicals include petroleum, agricultural, construction, pest control, and lawn care. Systems must be adaptable to changing environmental regulations, chemical container designs, and application requirements.

AGRICULTURAL REQUIREMENTS

The need for portable chemical transfer systems in the agricultural market arises from farmers working fields with large equipment, usually several miles away from local chemical dealerships and storage facilities. It is usually more economical to bring the chemical to the piece of application equipment while it is in the field, rather than transporting the application equipment back and forth from the field. Chemical is delivered to the field in several different ways, depending on the volume required. Tanks can vary in size from 120 gallon (450 liter) herbicide tanks that can be transported by pickup trucks, to large 1000 gallon (3800 liter) tanks that are delivered by trailers or large custom trucks. With the growth of the custom applicator business, the sophisticated chemical transfer rigs have

focused on speed of transfer, flexibility to supply the chemical required, and the ability to cover large areas. Some large aerial applicator rigs have the ability to allow spray helicopters to land directly on the rig, thus allowing quick, portable, and convenient transfer of spray solution from tanks into the helicopter.

The majority of hazardous chemical transferring in the agricultural market deals with the usage of either fertilizers or pesticides. A pesticide is a group of chemicals that consist of insecticides, herbicides, or fungicides. Insecticides focus on the control of insects, herbicides are chemicals used to control of grasses and weeds, and fungicides are chemicals used to control crop damaging bacteria and/or fungus. During the last 20 years, the usage of chemicals in the agricultural market has been greatly affected by growing environmental concerns and worker safety. Environmental concerns have caused chemical formulations to use less aromatic solvents. As an alternative, many chemicals are now viscous water-based suspensions that generate pumping challenges. Chemical systems have also seen new regulations that control items such as chemical spillage from fittings, tank sizes, and design and testing parameters. This, in turn, has affected the needs and requirements of the chemical handling systems.

Fertilizers present a transferring challenge due to the large volumes that are used, and the corrosive nature of most solutions. Two types of power modes are commonly used in the market for the transferring of fertilizers: gasoline-powered centrifugal pumps and ground-driven positive displacement pumps. Gasoline-powered centrifugal pumps used are usually lightweight aluminum or plastic units with 2 in (50 mm) ports. The pumps are coupled to a 3 to 5 hp (2 to 4 kW) gasoline engine and are capable of transferring rates up to 150 gpm (568 l/min). These high flowrate gasoline powered pumps are used to transfer fertilizer and water from large 1000 to 2000 gallon (3785 to 7570 liter) transport tanks into the application equipment's on-board storage tanks, 300 to 500 gallons (1135 to 1890 liters) in size. Ground driven pumps are mounted on the implement equipment such as planters and cultivators. The pumps are used to transfer and meter the fertilizer through a network of tubing that runs to the backside of cutting blades. This allows the knifing of the fertilizer into the ground. Ground driven pumps are popular for this type of application because the volume dispensed is directly proportional to the ground speed of the implement. Popular pumps that have been adapted for ground driven applications are positive displacement piston, diaphragm or multi-tube peristaltic pumps.

Pesticide transfer is now rigorously regulated because of environmental concerns and an increased emphasis on decreasing worker exposure to the hazardous formulation of a large percentage of these chemicals. The Environmental Protection Agency (EPA) has guided the agricultural chemical industry away from using 2.5 gallon (9.5 liter) throwaway containers to larger, returnable, re-usable, chemical-specific containers. These "Mini Bulk" tanks range in size from 15 to 200 gallons (50 to 750 liters), depending on the chemical usage rate. This change in the way farm chemicals are packaged to the end user has generated new requirements for portable pumps. Current chemical delivery systems have evolved around the usage of 12-volt power systems. Due to regulator restrictions that forbid the cross contamination of agricultural chemicals, the delivery systems are usually designed for a particular chemical or container. An adequate pumping rate for most 12-volt portable system is a rate of 5 to 10 gpm (18 to 38 l/min). Agricultural chemicals come in a wide range of viscosities, varying from 1 to 500 centipoise. Some are true liquids, whereas most are a suspension or mix. Typically, positive displacement pumps of the diaphragm, piston, or gear type are used for portable chemical transferring. Gear pumps are usual limited to the low viscosity chemicals with no suspended solids. Piston and diaphragm pumps are best suited to handle the higher viscous chemicals, many of which have suspended solids. Chemicals with solids usually will require tank circulation, and this must be designed into the transfer system.

Figure 1 shows a pumping system on a 120 gallon (450 liter) tank that consists of a pump, 12-volt motor, a digital meter system, and no-drip hose coupling. The pump is permanently mounted to the shipping container at the time of tank manufacture. The motor, meter, and hose are removable items that are normally supplied by the chemical dealer. This allows the drive unit and metering device to be transferred from tank to tank, after a tank is emptied. The pump is a 6-chambered plastic diaphragm pump and is mounted to the tank by means of a bolting flange. The mounting flange also contains a built-in vent to

FIGURE 1 Portable 12-volt chemical pump (Flowserve Corporation)

allow air in during fluid pumping. An internal bypass valve in the pump is connected to the inside of the chemical tank, allowing chemical circulation within the tank during bypassing. This pump also allows manual opening of the bypass valve to allow drainage of chemical from the meter and hose before removal. When the pump is mounted to the tank during shipping, the complete system must meet and pass specific Department of Transportation (DOT) tests. These tests are specified in the United States by DOT's HM181 specifications. Depending on the size of the container and the hazardousness of the chemical, these tests can require drop tests of several feet at 0°F (minus 17.8°C), vibration, stacking, and pressure tests.

Figure 2 shows a typical 120 gallon (450 liter) chemical "Mini-Bulk" tank with the pump connected to the tank by a coupler (not permanently attached). The coupler system provides a means for attaching and detaching the pump and the tank, a means for venting, and a dip tube assembly allowing suction from the bottom of the tank. The pump assembly is coupled through the tank coupling for chemical dispensing and is then removed for transporting. The pump shown is a stainless steel, 12-volt diaphragm pump, with a stainless steel flow meter. The chemical dealer fills the mini-bulk tank with chemical. The grower purchases the chemical, uses the pump to dispense chemical into an application rig, and then returns the tank empty to the dealer.

PETROLEUM AND CONSTRUCTION REQUIREMENTS

One of the original areas requiring the use of portable pumps is the transfer of gasoline and diesel fuel. The need to refuel and maintain equipment in remote locations has generated a large need for portable transfer equipment. Road and building construction, mining, and farming all involve heavy equipment that must be refueled and maintained on a regular schedule. One of the earliest and simplest methods of portable transferring was with hand pumps. Hand pumps are positive displacement pumps of piston, vane, or diaphragm-type design. Of course, the power supply is very limited with hand pumps, and they are typically used only on thin liquids and small jobs. On large pieces of equipment,

FIGURE 2 120 gallon (454 l) "Mini-Bulk" Container and pump (Flowserve Corporation)

the need is to transfer large volumes of fluids, such as water, antifreeze, diesel, gear lube, grease, and transmission fluid.

Figure 3 shows a portable maintenance vehicle with air powered piston pumps. In the construction industry, compressed air is a common power source for transferring product. A typical truck consists of a gasoline-powered air compressor, several tanks of petroleum products plus water and antifreeze. The size and type of pump will normally depend on the size of the equipment requiring servicing and the fluid being pumped. For thin fluids, such as diesel oil or gasoline, high volume, low pressure ratio pumps (approaching 1:1) will be used. Occasionally, on units that have the option of a power take-off (PTO), a high volume centrifugal-type pump will be used. For the oils and lubricants, higher pressure ratio pumps (3:1 to 5:1) are required because of higher transfer pressure requirements. To transfer grease, high pressure ratio pumps—to 20:1—are required. The pumps are normally coupled with a hose reel, 50ft (15 m) of hose, and a control nozzle.

LAWN AND PEST CONTROL

Lawn and pest control companies require a portable means of transferring chemicals in order to provide treatments. Liquids are used to treat yard infestations; in addition, the majority of homes and buildings are treated for termites during construction. It is common for lawn care companies to use PTO-driven centrifugal pumps capable of delivering 10 to 15 gpm (38 to 56 l/min) through a 100 ft (30 m) hose. Specialty requirements, such as tree spraying, will require a higher pressure system, normally a gasoline-powered piston pump. For insecticide treatment, the power source is commonly either electricity or gasoline. Typical pumps are roller pumps, capable of approximately 4 gpm (15 l/min) at 50 lb/in^2 (3.45 bar).

These industries have taken major steps to limit chemical exposure to the general public and to their operators. Efforts have been made by many to eliminate the need of transporting large 100-plus gallon (378 liter) tanks of mixed chemicals. One method that allows

FIGURE 3 Flatbed service truck (Aro Fluid Products)

the tanks to hold and transport only clean water is to inject the chemical into the discharge only at time of use. The chemical is kept in small, 1 to 5 gallon (3.5 to 20 liter) containers with 12-volt metering pumps attached, which allow direct injection into the clean water line. Other systems use small proportioning pumps. These units are two-stage piston pumps powered by clean water. The smaller piston injects a set volume of chemical into the water supply for each stroke of the larger water piston.