MARTCP

Training/
Qualification
Program

Hot Mix Asphalt
Plant Technician
Level I

Asphalt Supply Systems

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Objectives

- Identify requirements for all systems
- Describe different asphalt storage supply systems
- Identify different types of equipment used in hot-mix asphalt production
- Describe distribution pumps for plants

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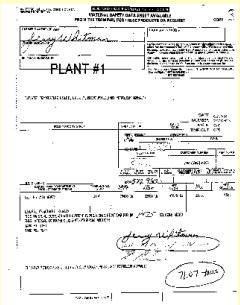
Delivery Ticket & Certification

- Supplier
- Grade of Asphalt
- Silicone Added
- % Antistrip Added
- Net Tons/Gallons



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Requirements for AC Storage Tanks

- Must be capable of heating liquid asphalt to the required temperature
- No flame must come in contact with tank
- Maintain circulation of binder during HMA production
- Use heated jacketed lines to prevent heat loss

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Why Maintain AC Temperature?

- Critical to proper coating of the aggregate
- Critical for proper placement and compaction
- Critical for a quality paving product

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Sampling AC Storage Tanks

- Samples for AC testing are taken from the transport tanker, the plant storage tank, or the last practical point before introduction into the mixture.
- Sampling valves typically installed on tankers, plant storage tank, or inline after storage tank.

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Asphalt Cement Sampling Guidelines

- Waste first portion from sample valve
- Use clean unused containers
- Seal container tightly to avoid contamination
- Label container

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Asphalt Storage Tanks

- Tanks can be horizontal or vertical.
- Tanks typically have hot oil heating coils, but some heated electrically or with burner.

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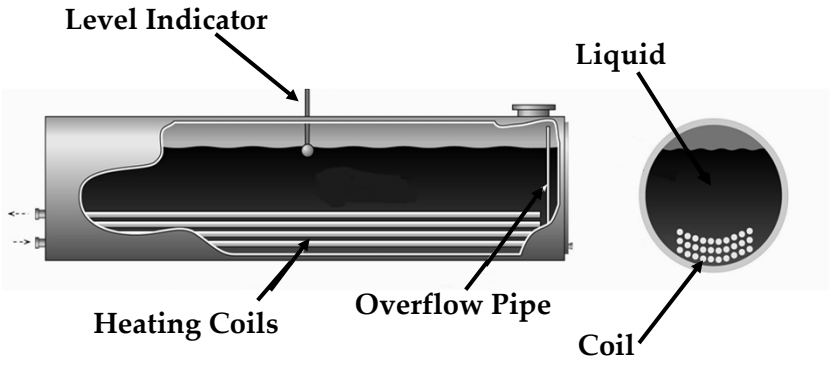
Typical Horizontal Asphalt Tank



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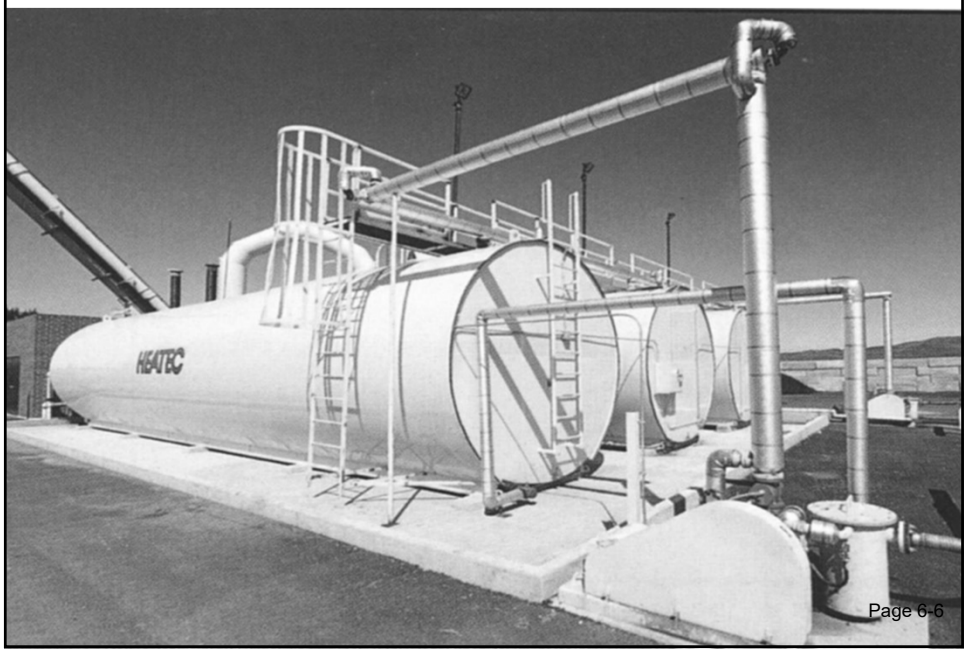
Multiple Horizontal Tanks



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Portable Asphalt Tank

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Hot Oil Pipes for Asphalt Tanks

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Hot Oil Heater

Two kinds typically found:

- Fossil fuel fired
- Electric

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Hot Oil Heat for Plant Components

- AC pumps
- AC lines
- AC Valves
- Hot Mix Silos
- Pugmills
- AC Weigh Hopper
- etc

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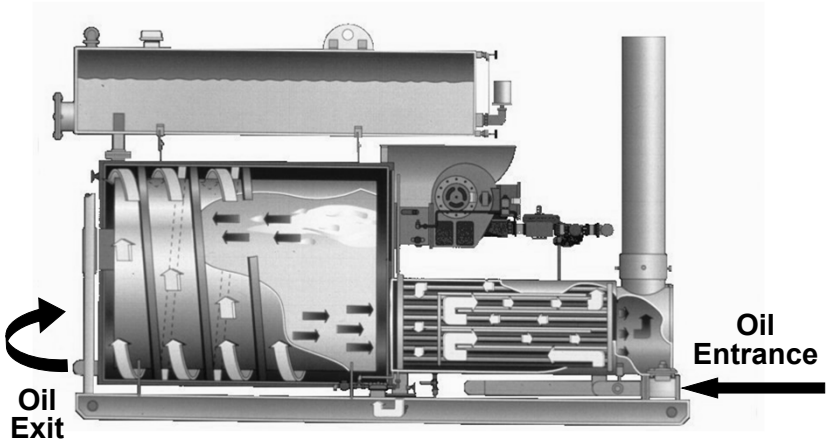
Cutaway Illustration of CEI Hot Oil Heater



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Hot Oil Heater to Heat Asphalt Tanks

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Scavenger Pipes

Used to heat plant components by taking heat from asphalt to heat the hot oil used to heat plant components.

Sound confusing?

(It is!)

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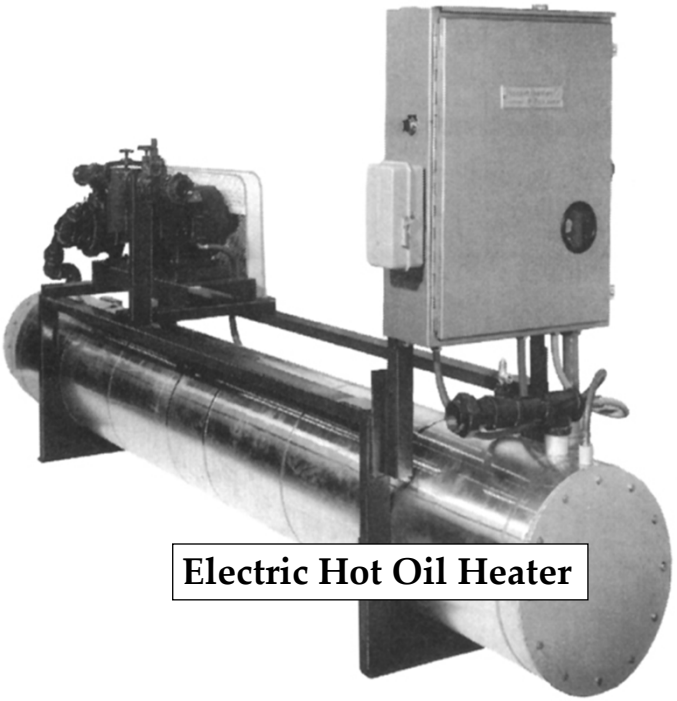

Electric Hot Oil Heater

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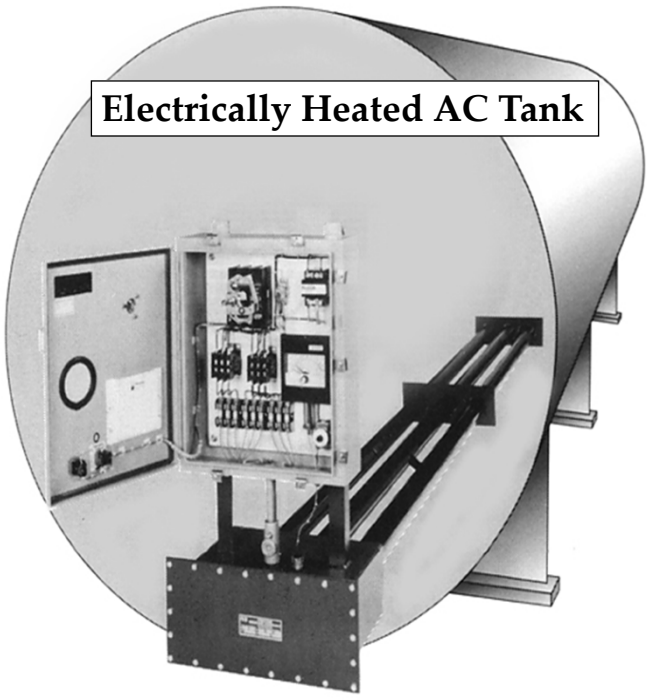

Electrically Heated AC Tank

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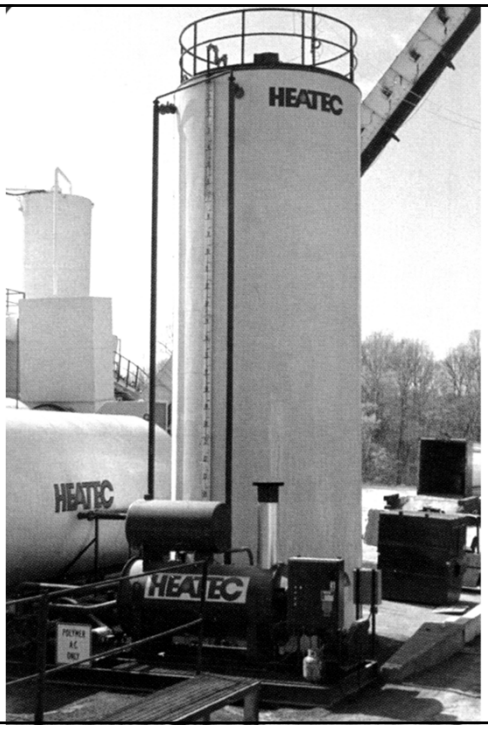

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Direct Fired Tank - Fossil Fuel Burner

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Natural Convective Currents in Asphalt Storage Tanks

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Storing & Using Modified Asphalts

- Can be blended at terminal
- Need to be kept in circulation
- Can be blended at the asphalt plant
- Several equipment options exist

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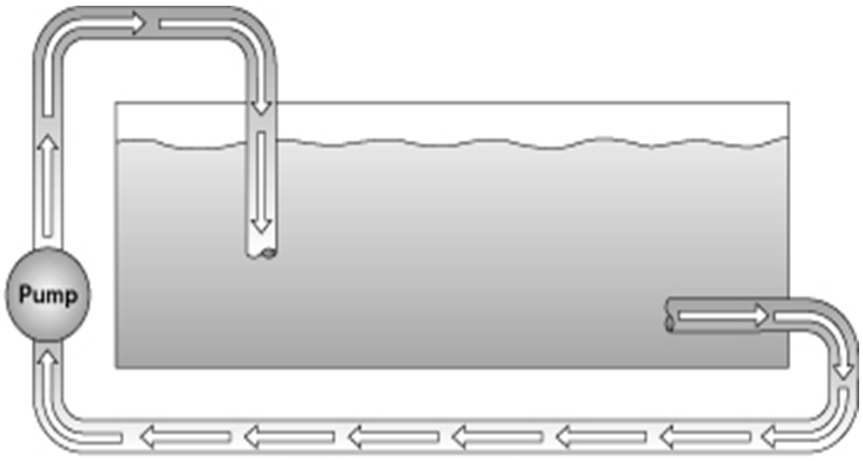

Recirculating with a pump is suggested for some modified asphalts

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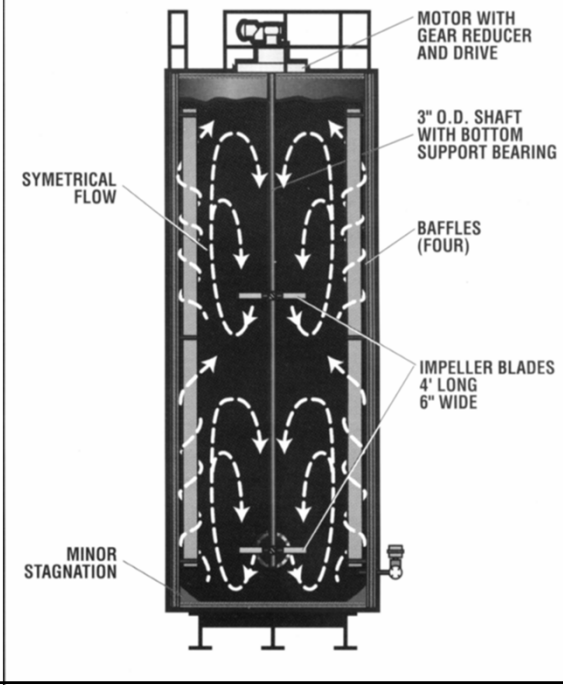

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Asphalt Rubber

- Used as modifier for some mixes.
- Can be terminal blended or blended at plant.

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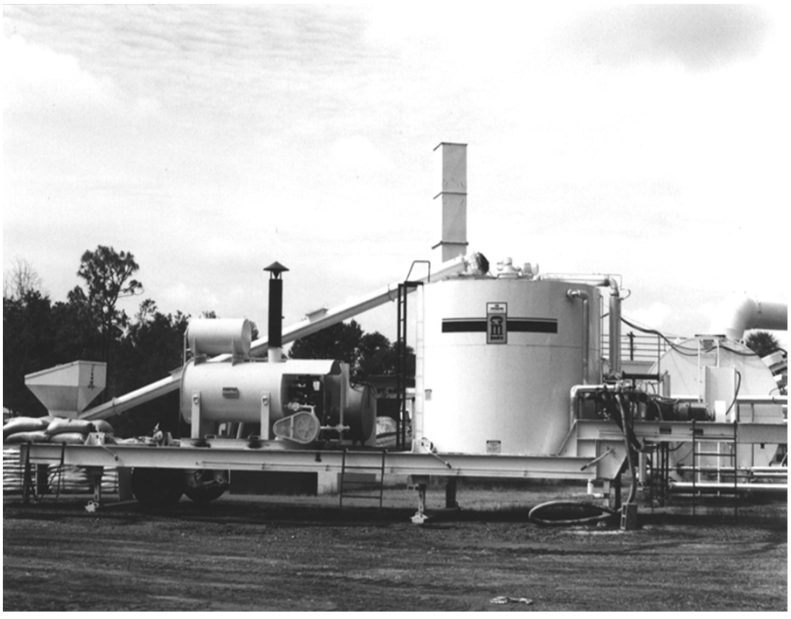
Asphalt Rubber Blended at Plant Page 6-13



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Fiber Injection Systems

Used for some special mixes.

Fibers and Cellulose both used.

Typically plant blended.

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Fiber Injection System on Drum Plant

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Multiple Tank Installations

- Don't mix asphalt types (affects asphalt binder properties)
- Care should be exercised when switching valves to direct asphalt storage (can contaminate asphalt)
- Tanks should be "pulled down" or emptied before a new type binder is stored

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Multiple Tank Installations (cont.)

When putting another grade on that "last little amount" in the tank…..(the real world)

- Use discretion, it could affect the next binder if a significant quantity exists

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Safety Issues

- **CAUTION** when loading, unloading, sampling. Asphalt is HOT. Special first aid cards available.
- Never look inside a tank being charged with asphalt.

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Safety Issues

Condensation in empty tanks **very** dangerous. Moisture turns to steam when charging tank with hot asphalt.

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Heat Jacketed Valve with Hot Oil Lines Attached

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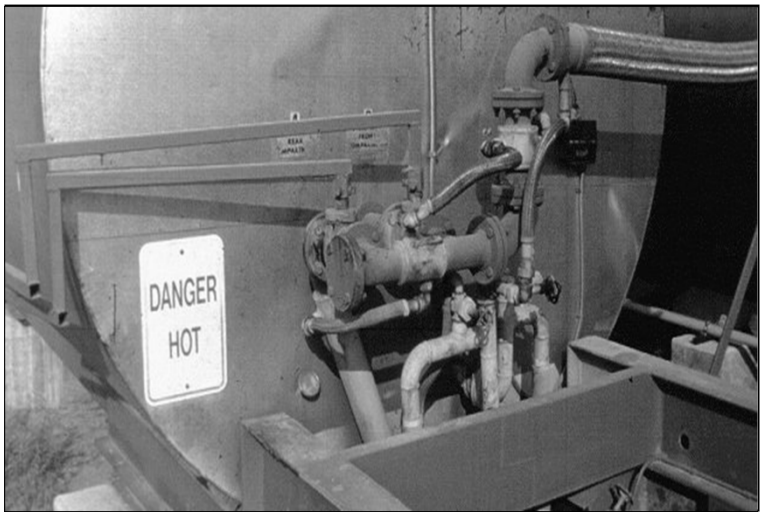

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Batch Plant Asphalt Metering

- Asphalt is in constant circulation.
- Valve opens to allow asphalt to enter weight bucket.
- When valve closes, asphalt continues to circulate

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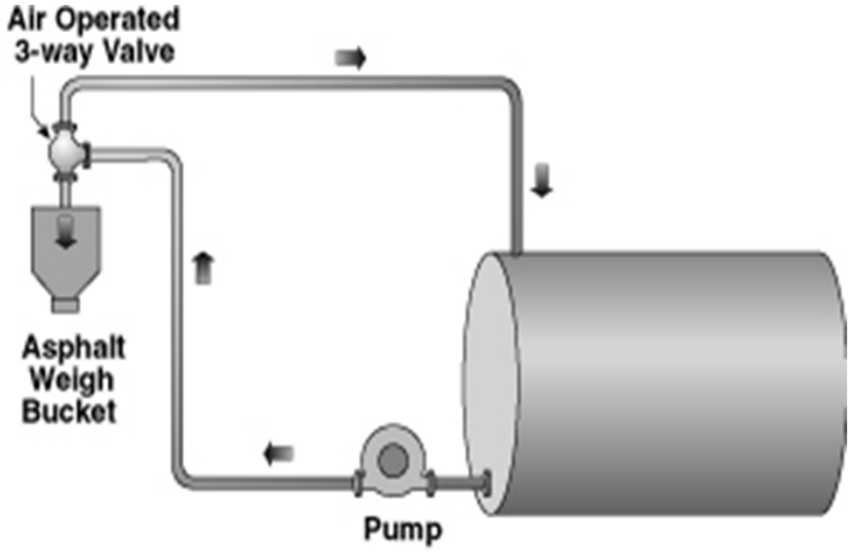

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Asphalt Metering Systems for Drum-Mix Plants

3 Basic Types

- Volumetric/mechanical
- Volumetric/electronic
- Mass Flow

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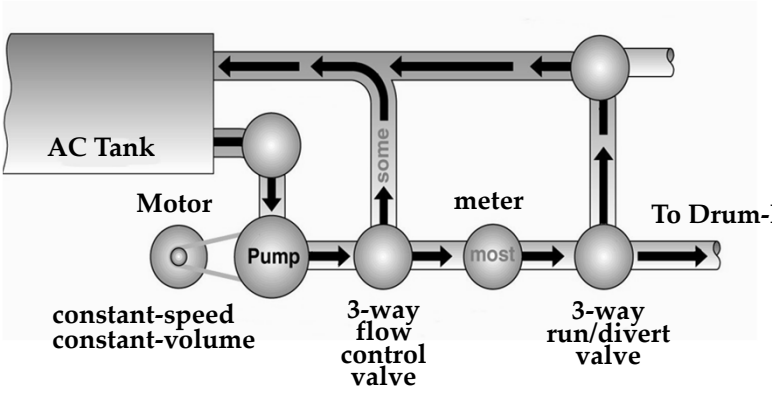
Asphalt Metering System



Asphalt Metering System for drum-mixer plants with constant speed constant volume pump and flow control valve

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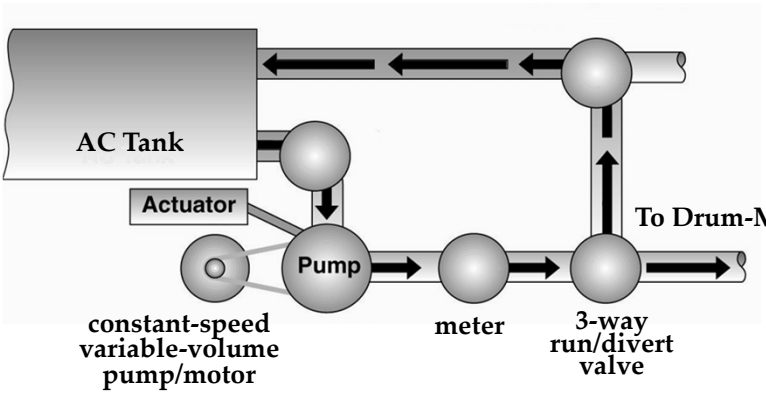
Asphalt Metering System



Asphalt Metering System for drum-mixer plants with constant speed, variable volume pump

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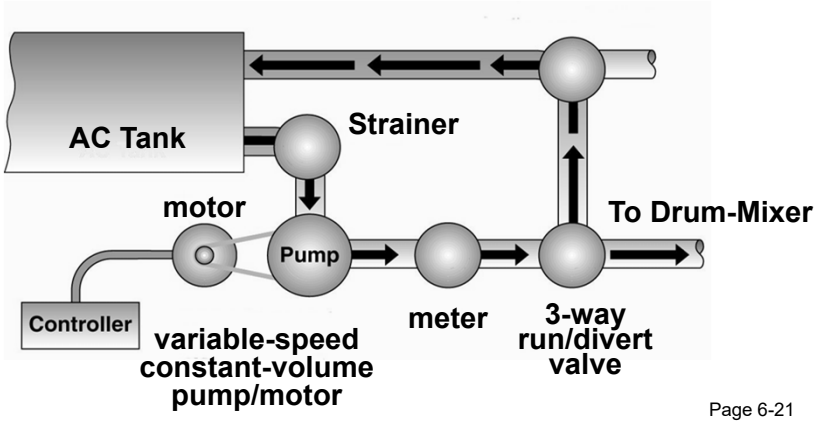
Asphalt Metering System



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Asphalt Metering System for drum-mixer plants with variable speed, constant volume pump

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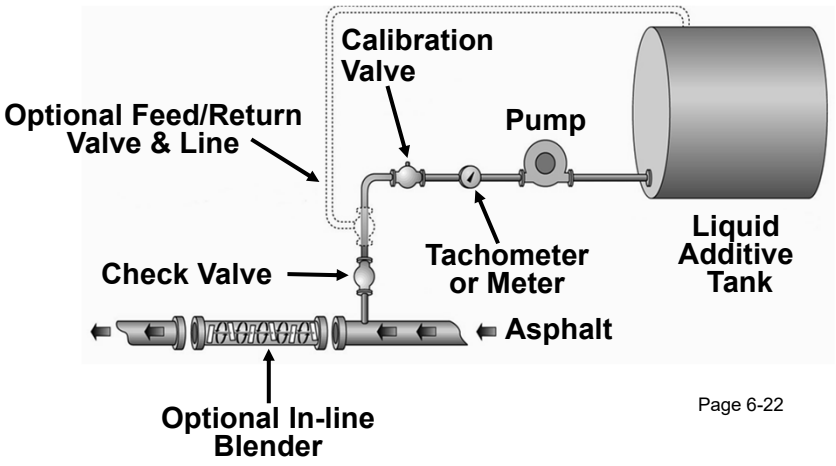
Typical Asphalt Additive Tank System



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Liquid AC Additive Tank System

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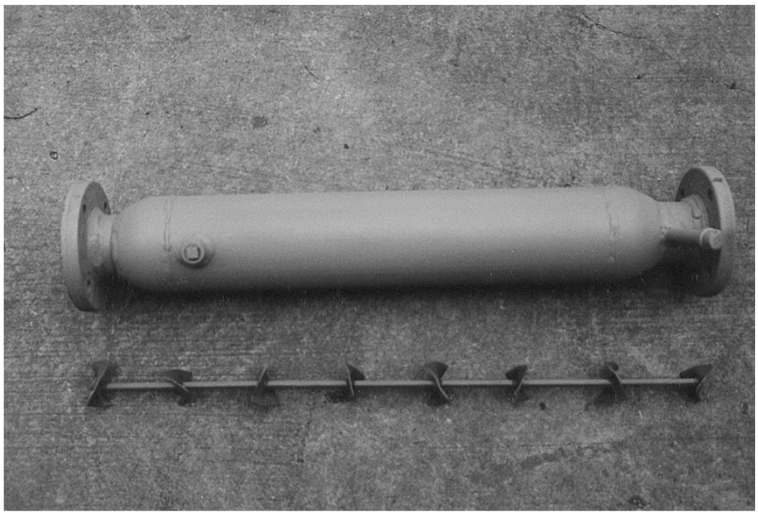
Liquid Additive Static In-Line Blender



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QUESTIONS ?

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MODULE 4

ASPHALT CEMENT SUPPLY SYSTEMS

Glossary of Keywords

Hot Oil The heat-transfer oil used in hot-mix plants to heat asphalt tanks, additive tanks, and many of the hot-mix plant components themselves.

Meter A device used to measure flow. Typical applications for hot-mix production are measuring asphalt flow and additive flow on a continuous basis in drum-mixer plants.

Viscosity A common measurement for the different types or grades of asphalt cement. It relates to the flow characteristics a particular asphalt binder at different temperatures.

4.1 ASPHALT STORAGE TANKS

Asphalt storage tanks typically come in capacities from 38,000 liters to 150,000 liters. Most are 2.7 m to 3.4 m in diameter. Figure 4.1 is a typical horizontal asphalt tank. Tanks can be horizontal or vertical in configuration, with the vast majority being horizontal. Figure 4.2 shows multiple horizontal tanks.

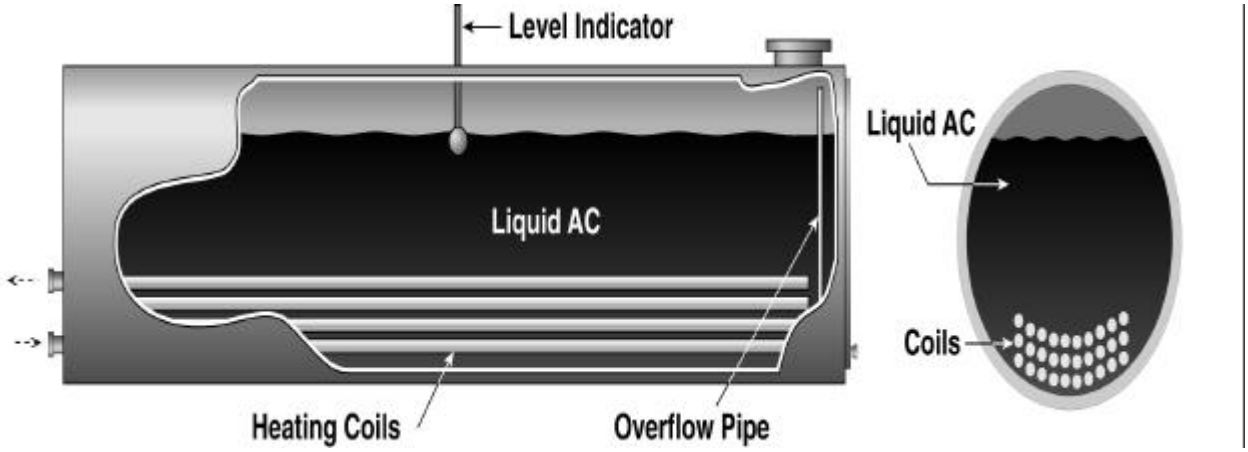

Figure 4.1 Typical horizontal asphalt tank.

They can be portable, as shown in figure 4.3, or stationary, and several tanks can be valved together so that different viscosity's of asphalt can be stored at the plant.

All tanks are insulated and heated with some method. The purpose of asphalt storage tanks is to keep the liquid asphalt hot, not to heat the asphalt. The liquid asphalt must be kept at an elevated temperature so that the viscosity of the asphalt is low enough to pump, meter, and mix with aggregates to produce hot-mix. Typical storage temperatures are 138-160 °C.

Tanks are typically fitted with 76-150 mm of insulation to minimize heat loss. Plant asphalt supply and return lines are likewise insulated and frequently heated.

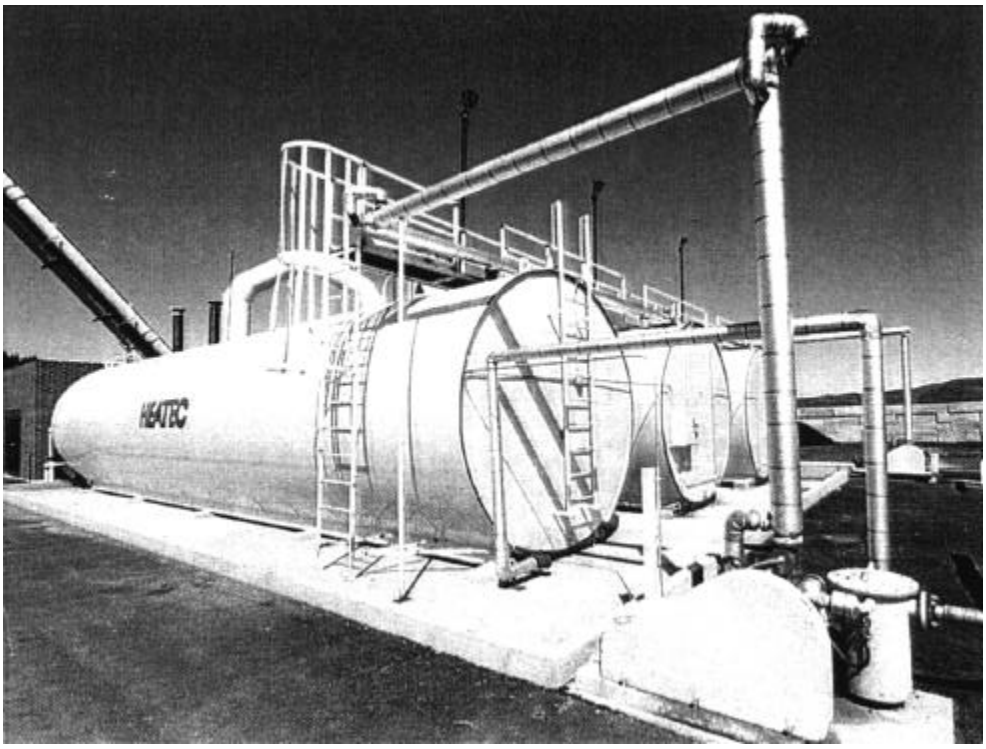

Figure 4.2 Multiple horizontal tanks.

Figure 4.3 Portable asphalt tank.

While electric heat strips can be used, most asphalt lines are heated with hot oil. This is done by "jacketing" the line. A jacketed line is a larger pipe placed over the asphalt pipe. Hot oil flows in the cavity between the larger pipe and the inner pipe. Fittings are welded at pipe junctions, and small "jumpers" are installed to allow the hot oil to flow from one pipe to another. A supply jumper and return jumper must be used. Figure 4.4 displays hot oil pipes for asphalt trucks.

The hot oil itself, and the asphalt tanks, can be heated with either hot oil or electrically. However, it is common for most asphalt tanks to be heated by hot oil.

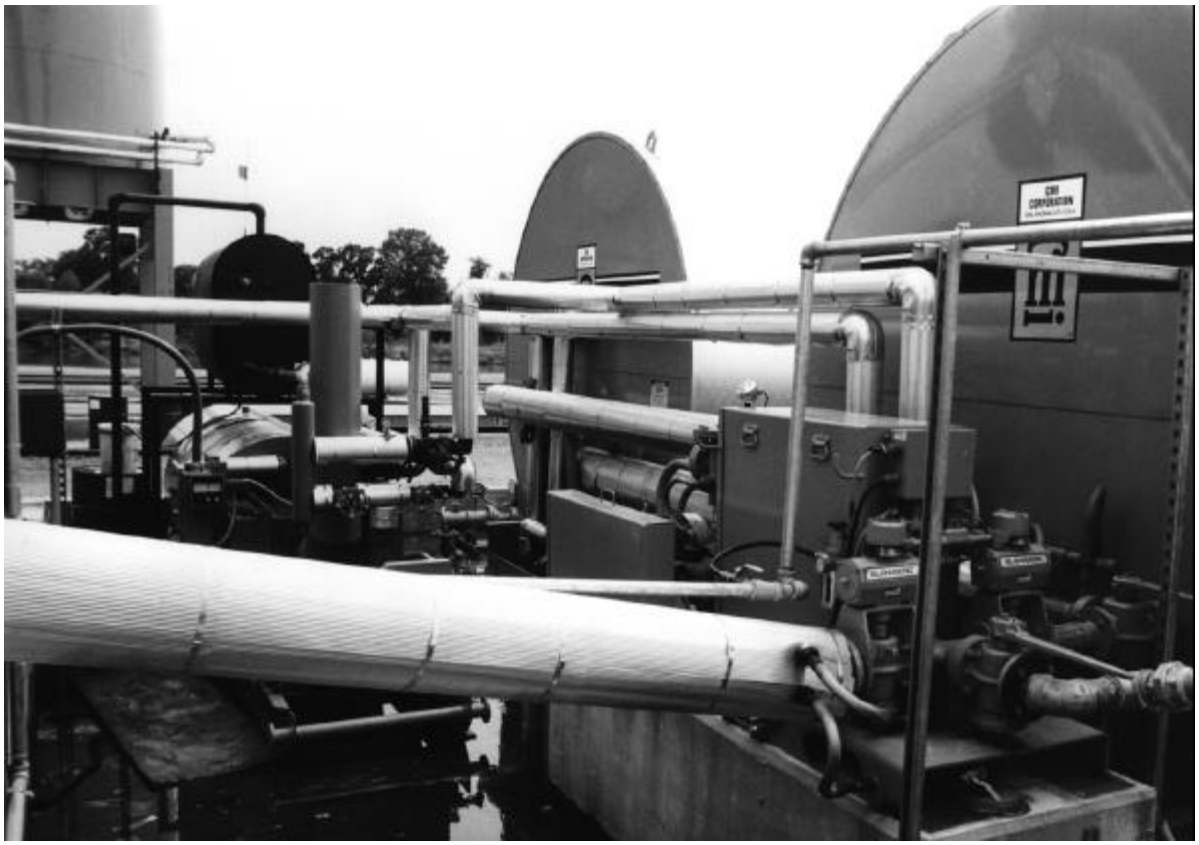

Figure 4.4 Hot oil pipes for asphalt tanks.

4.2 HOT OIL HEATING TECHNIQUES

Direct Combustion Heaters

A fuel oil, propane or gas-fired heater uses the fire box and combustion area, and exhaust stack to heat the heat-transfer oil. Figure 4.5 shows a fossil fuel style hot oil heater. A series of tubes are installed in close proximity to the combustion area, and the flue gases are forced to travel around and/or through these tubes in which the heat-transfer oil is circulated. This heat-transfer oil is then pumped through the asphalt tank and asphalt supply lines to keep the asphalt at the desired temperature. Figure 4.6 shows the hot oil heater to heat asphalt tanks.

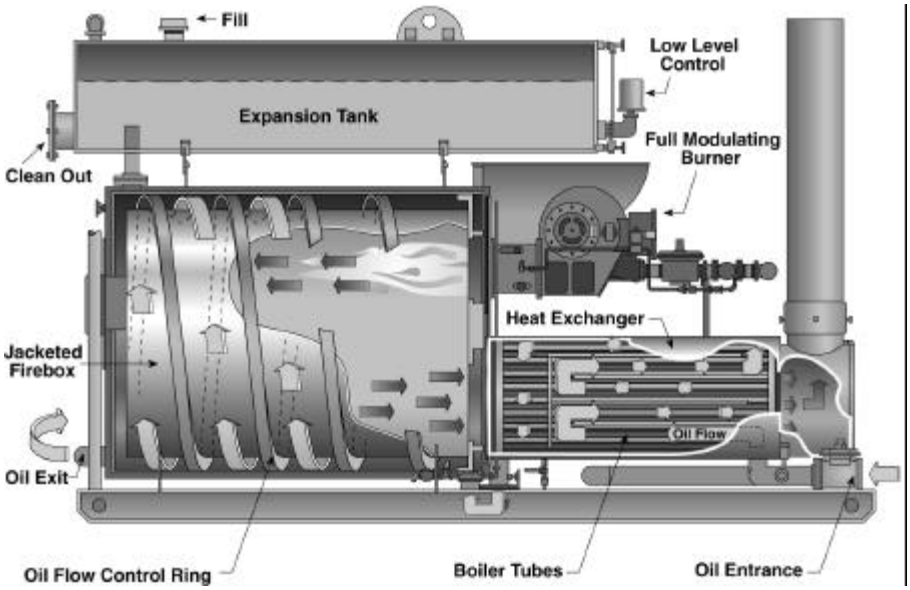

Figure 4.5 Fossil fuel style hot oil heater.

Figure 4.6 Hot oil heater to heat asphalt tanks.

It should be noted that the purpose of the hot-oil heater is to maintain temperature and not to heat asphalt. This distinction is important because if a tank cools to ambient temperature, it can take several days to bring it back to the desired storage temperature.

The hot oil is not only used to maintain the temperature of the asphalt, but it is also used to heat other plant components such as the pugmill, the asphalt weigh bucket, the asphalt pump, the hot-mix storage silos, etc. It is not unusual for a plant to have two heaters; one dedicated to the asphalt storage tanks and asphalt lines, and another for the various plant components that require heat. If a plant has multiple hot-mix storage silos, it frequently has a hot-oil heater dedicated to the silos as shown in figure 4.7.

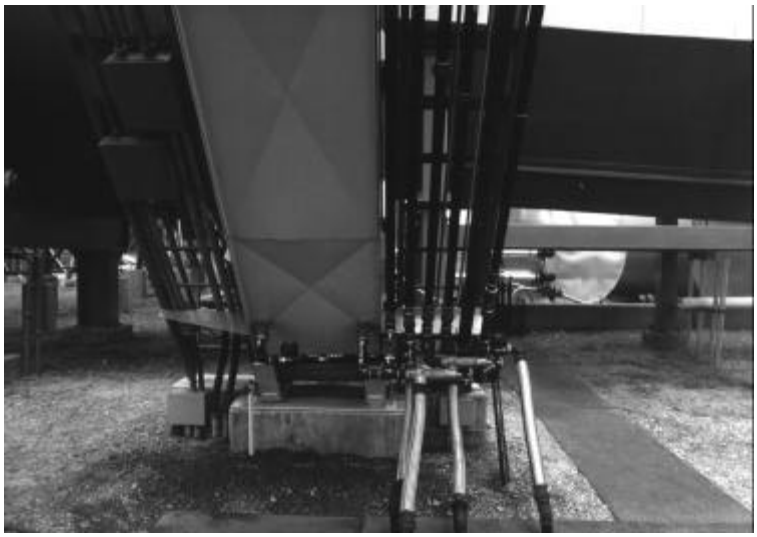

Figure 4.7 Hot oil piping to heat hot mix storage silos.

Electric Heaters

Electric hot-oil heaters work slightly differently. Figure 4.8 shows a hot oil heater. Heating elements reside inside heat tubes, and the oil circulates over and around the tubes to bring it to the proper temperature. The hot oil is then pumped to the asphalt tank and the asphalt supply lines.

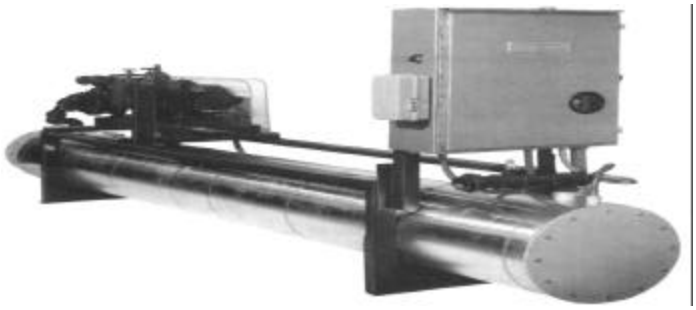

Figure 4.8 Electric hot oil heater.

4.3 DIRECTLY HEATED TANKS

Electrically Heated Tanks

It is a common approach to use electric heating elements to heat the asphalt tanks directly. Heating elements that can be removed for servicing are submerged directly into the tank. Figures 4.9 and 4.10 display horizontal and vertical electrically heated tanks.

Figure 4.9 Electrically heated horizontal tanks.

Figure 4.10 Electrically heated vertical tanks.

This approach is especially common with submerged tanks, as it makes servicing the heating system rather simple. If a separate electric heater is not desired for heating the hot oil going to the asphalt lines and other parts of the plant that require heat, a series of "scavenger coils" can be used to take heat from the liquid asphalt and transfer it to the hot oil.

Direct-Fired Tanks

Some asphalt tanks have a fuel oil or propane-fired heater mounted directly in the tank. The tank is heated from the combustion chamber and the flue gases as they exit through pipes installed in the tank. This is referred to as a direct-fired tank as shown in figure 4.11.

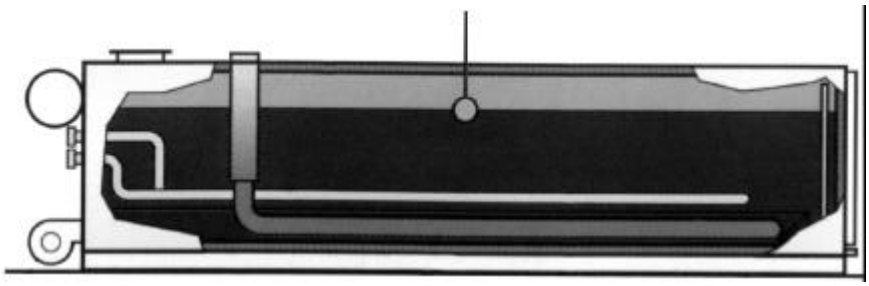

Figure 4.11 Typical direct fired asphalt tank.

Special liners are fitted around the combustion chamber so that the hot metal does not come in direct contact with the asphalt. Liners and exhaust stacks should be inspected periodically for wear and deterioration. These direct fired tanks are primarily used for portable applications. Figure 4.12 shows a portable, direct fired, asphalt tank.

They typically have hot-oil scavenger coils installed for heating asphalt lines and other parts of the hot plant.

Figure 4.12 Portable, direct fired, asphalt tank.

4.4 AGITATION OF STORED LIQUID IN TANKS

Heated tanks have a natural convection current as the asphalt cement heats and cools. As the asphalt is heated, it flows upward and circulates, causing the cooler asphalt to flow downward toward the heating elements as shown in figure 4.13. This keeps the product homogenous and reduces the tendency of cooking around heating elements. Typically, no form of mechanical agitation is used.

Figure 4.13 Natural convective currents in an asphalt storage tank.

With asphalt requiring agitation, such as cements with pre-blended additives, pumps can be used to keep the material recirculated by drawing from the bottom of the tank and pumping to the top of the tank. This may keep the product from separating and eliminates the need for any additional specialized equipment to keep the additives in suspension. Without circulation, however, precipitation usually occurs, and the additives settle to the bottom of the tank or otherwise separate or react with the heating elements.

4.5 SPECIALTY TANKS AND EQUIPMENT FOR MODIFIED ASPHALT'S

Some asphalts that are mixed with other materials or chemicals require specialty tanks, either for mixing the materials with the asphalt or for keeping the materials blended with the asphalt. If the asphalt is mixed with these additive materials at the plant site, then special mixing and storage equipment is sometimes required. Figure 4.14 shows that recirculating with a pump is suggested for some modified asphalts.

Figure 4.15 shows one type of batch processing equipment for making rubber-modified asphalt at the plant site. The rubber is blended and heated with the asphalt on a batch basis, then pumped to a special holding tank where it is stored and heated for a prescribed period of time before the modified asphalt is used at the plant.

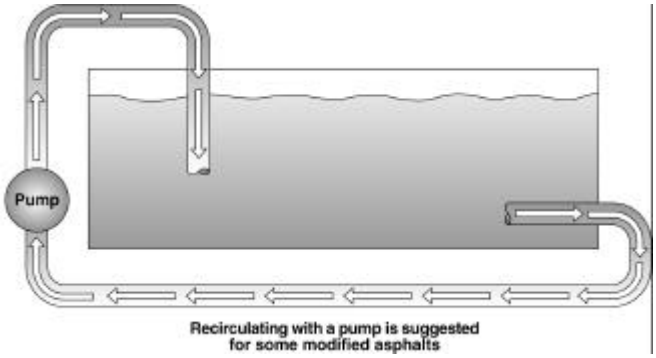

Figure 4.14 Recirculating with a pump is suggested for some modified asphalts.

Figure 4.15 Crumb rubber modified asphalt processing system and tanks.

Figure 4.16 shows an additive system in which fibers are introduced to the asphalt as it is pumped from the tank. These fibers are used in making Stone Matrix Asphalt (SMA) and Open-Graded Friction Courses (OGFC), which contain a high percentage of large stones. The fibers help reduce drain-down of the asphalt binder in the HMA during storage and transportation.

Figure 4.16 Fiber adding system with tank.

Pumping and blending systems, used to measure and inject latex in-line with the asphalt as it flows from the tank to the hot-mix plant, are available. Pre-blended latex-modified asphalt can also be purchased from the asphalt supplier for storage in a conventional tank. If the asphalt is purchased preblended, it is kept in suspension by pumping and circulating through the tank.

As use of additives and modifiers in the asphalt binder increases, more specialized equipment will be required for blending and storing asphalts at the plant site.

4.6 ASPHALT PUMPS AND PUMPING SYSTEMS

Loading Pumps and Transfer Pumps

Loading pumps are required to fill asphalt tanks. Many asphalt tankers have their own off-loading pumps, but it is common for the plant to have a large-capacity, high-speed pump for this purpose. Figure 4.17 displays an asphalt tank off-loading pump.

Figure 4.17 Asphalt tank off-loading pump.

By using a large pump, tanks can be emptied quickly and reduces the time spent in the plant yard. The charging line for most tanks is located low on the outside of the tank, but the piping travels up and deposits the liquid at the top of the tank on the inside. This reduces the possibility of accidentally emptying the tank.

Many tanks are also equipped with special overflow pipes, as shown in figure 4.18, so that if a tank is accidentally overfilled, the asphalt will leave through a controlled drain line rather than flow out the inspection manhole and run down the side of the tank.

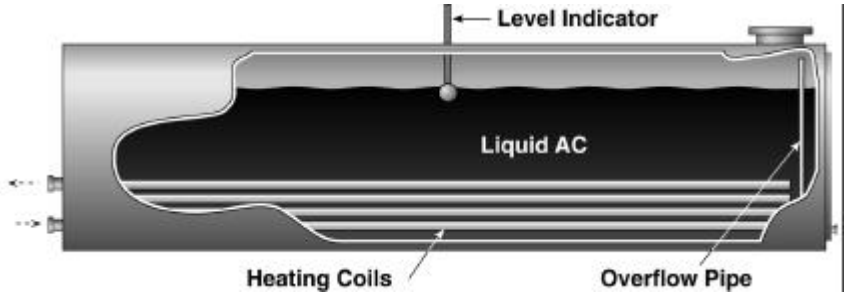

Figure 4.18 Safety overflow pipe in AC tank.

Pumps can be installed for transferring asphalt between tanks as shown in figure 4.19. These pumps require special valving in the suction and return lines. Any such directional valves for asphalt lines should be "heat jacketed," meaning that the valve body has a cavity built into the valve where hot oil may be circulated. Figure 4.20 shows heat jacketed valve with hot oil lines attached. This feature keeps the asphalt from setting up in the valve. Asphalt pumps are similarly equipped as shown in figure 4.21.

Figure 4.19 Multiple tank installation with transfer lines and heat jacketed valves.

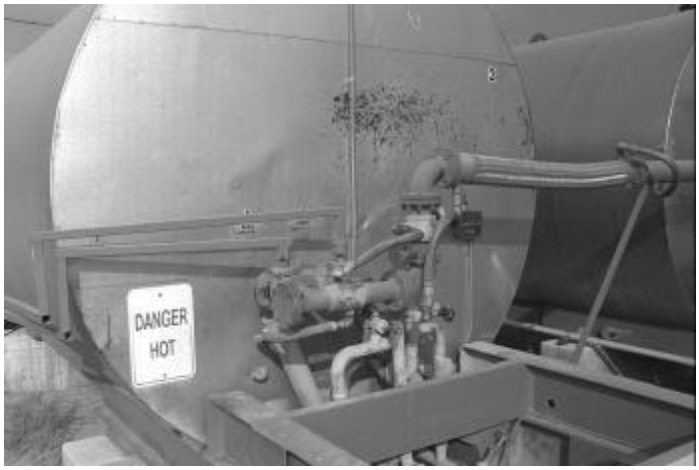

Figure 4.20 Heat jacketed valve with hot oil lines attached.

Figure 4.21 Asphalt pump with hot oil lines attached.

Batch plants require that asphalt be transferred from the storage tank(s) to the batch tower, where it can be introduced into the weigh bucket at the proper time. To do this, a constant-speed, constant-volume pump is typically positioned on the ground near the asphalt tank system. The fixed speed of the pump is adjusted by changing the drive sheaves so that a full bucket of asphalt can be "drawn up" within the time it takes for the aggregate to be weighed in the weigh hopper. Valving, on the ground or at the tower, allows asphalt to be charged to the weigh bucket when the operator or control system calls for flow. Shutting the valve causes asphalt to be re-circulated back to the tank. Figure 4.22 shows an asphalt fill valve on a batch tower.

Two systems

The first system uses two lines from the asphalt tank to the batch tower. The charging line is connected to the asphalt tank. Asphalt is drawn from the tank with the pump and sent to the weigh bucket. There is an air-operated, heat-jacketed, three-way valve positioned at the weigh bucket. Asphalt is allowed to divert back to the tank from the weigh bucket through the return line until asphalt is needed in the weigh bucket. When it is needed, the valve opens, and asphalt flows to the weigh bucket. When the target value is reached, the valve closes, and asphalt flows back to the tank. Figure 4.23 shows a two-line asphalt system for a batch tower.

The second system uses two lines from the storage tank to the pump, but only one line from the pump to the weigh bucket. Asphalt is always being pulled from the storage tank through the pump and being circulated back to the tank. When asphalt is needed in the weigh bucket, a heat-jacketed, two-way valve opens on the end of the line at the weigh bucket, and material is discharged into the bucket. When the proper amount of asphalt has been weighed up, the valve closes, and a pressure relief valve at the pump is opened, re-circulating asphalt cement back to the storage tank in the return line from the pump instead of to the plant. Figure 4.24 shows a single-line asphalt system for a batch tower.

Figure 4.22 Asphalt fill valve on batch tower.

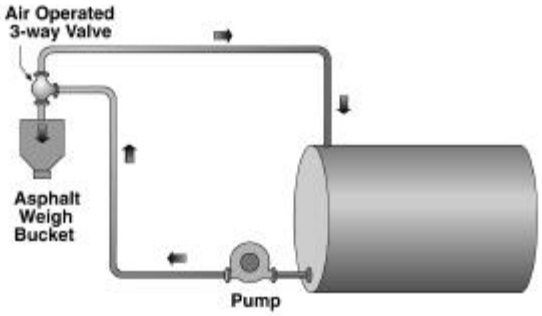

Figure 4.23 Two line asphalt system for batch tower.

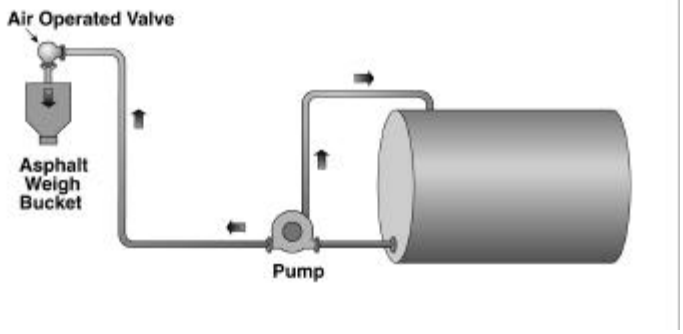

Figure 4.24 Asphalt fill valve on batch tower.

Some manufacturers use an "injection" pump to drain the asphalt weigh bucket and spray liquid into the pugmill. Proponents of this system say that it decreases the length of time in the batch cycle and causes an even distribution of asphalt throughout the pugmill. This pump should not be confused with the pump used to transfer liquid from the asphalt tank and charge the weigh bucket.

Distribution Pump for Drum-Mix Plants

Unlike batch plants, which have an on/off-style constant flow associated with the asphalt pump, drum-mix plants require an asphalt pumping system that allows the flow of the liquid to be regulated to match the flow of the aggregate. Three elements to a drum-mix pumping and metering system are the pump, the flow control mechanism, and the meter.

There are several different ways to vary asphalt flow in a drum-mixer. The following are the most common:

- A constant-volume, constant-speed pump with a separate flow control valve. The asphalt flow control is accomplished by varying the flow control valve as shown in figure 4.25.

- A variable-volume, constant-speed pump. The asphalt flow control is accomplished by varying the volume of asphalt pumped with each revolution of the pump as shown in figure 4.26.

- A constant-volume, variable-speed pump. The asphalt flow control is accomplished by varying the speed of the pump as shown in figure 4.27.

Each of these pumping systems has a variable flow characteristic associated with it. Appendix B describes the different types of pumps and flow control mechanisms in more detail.

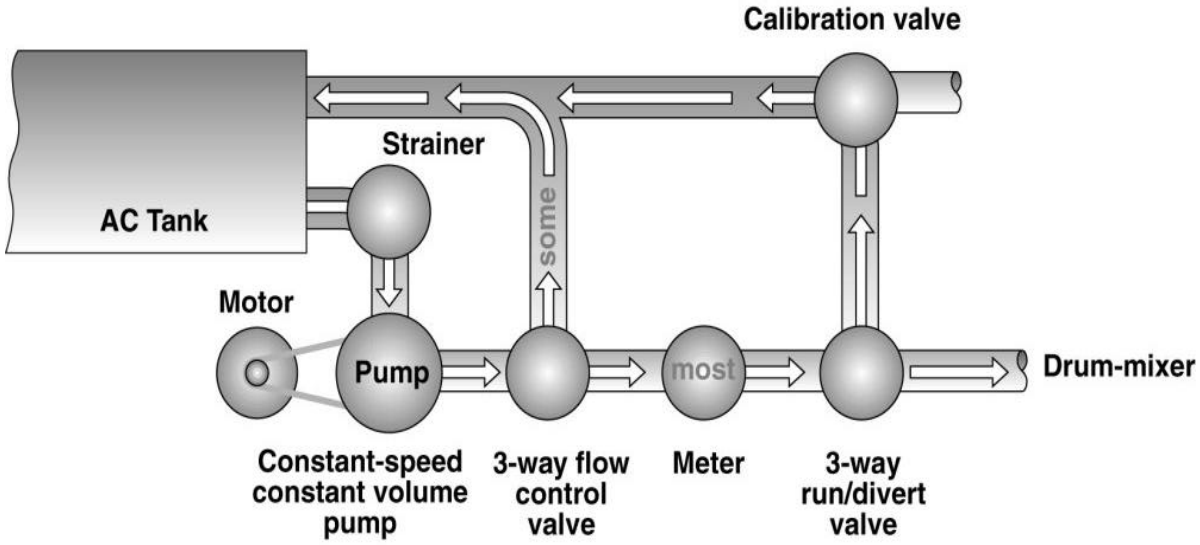

Figure 4.25 Asphalt metering system for drum-mixer plants with constant speed constant volume pump and flow control valve.

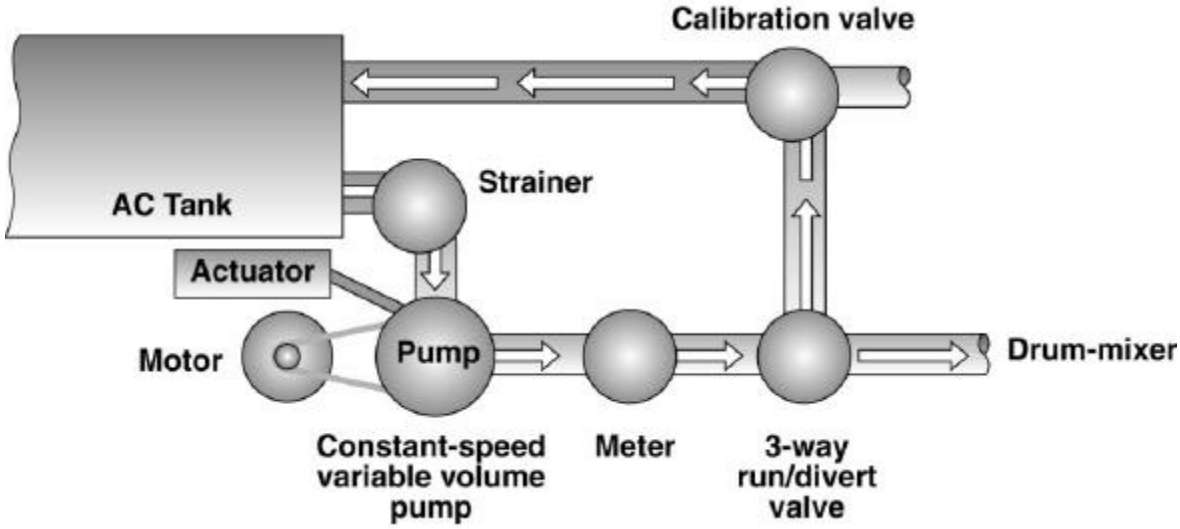

Figure 4.26 Asphalt metering system for drum-mixer plants with constant speed variable volume pump.

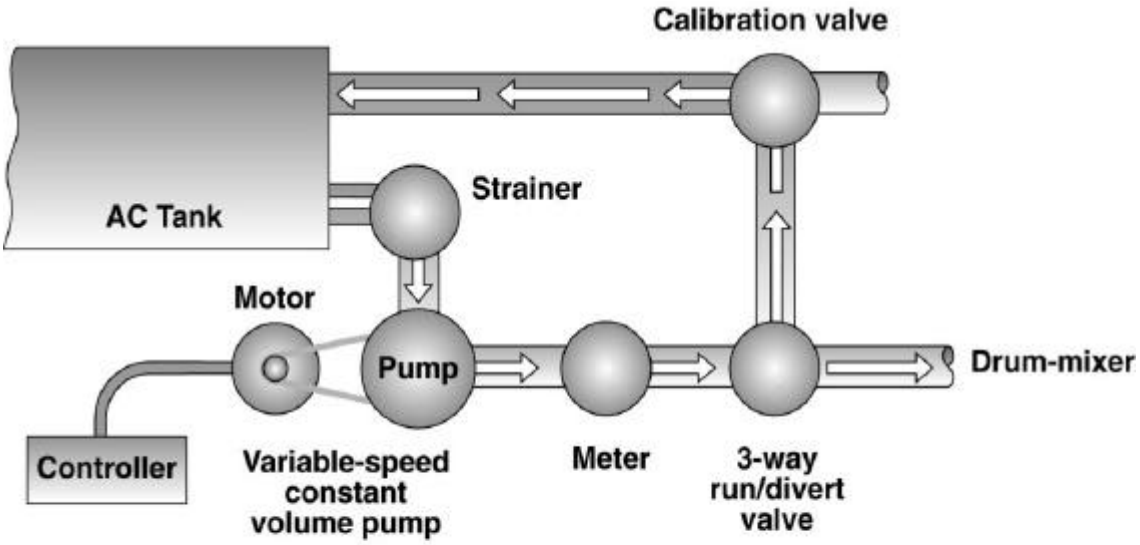

Figure 4.27 Asphalt metering system for drum-mixer plants with variable speed, constant volume pump.

The asphalt meters that are used in drum-mixer plants to measure the flow also come in a variety of styles. The following are the most popular:

- Volumetric meter with mechanical totalizer and temperature compensator
- Volumetric meter with electronic totalizer and temperature compensator
- Mass-flow meter that measures mass (not volume) with electronic totalizer

Appendix B also describes the different types of asphalt meters in more detail.

Appendix C describes the calibration steps required for an asphalt meter on a drum-mixer plant.

4.7 ASPHALT ADDITIVE SYSTEMS

Liquid modifier ingredients can be added to asphalt cement in a variety of ways.

The simplest method to purchase asphalt cement with the additive already blended at the refinery or by the wholesaler. If separation during storage is a concern, constant re-circulation may be required. Re-circulating the asphalt by pumping it from the bottom to the top of the tank may be sufficient to prevent separation.

Liquid modifiers can be added in bulk directly in the storage tanks as shown in figure 4.28. Usually, if this approach is taken, the asphalt must be re-circulated for a minimum period of time to assure thorough mixing of the two materials. Again, if separation during storage is a concern, then constant re-circulation may be required.

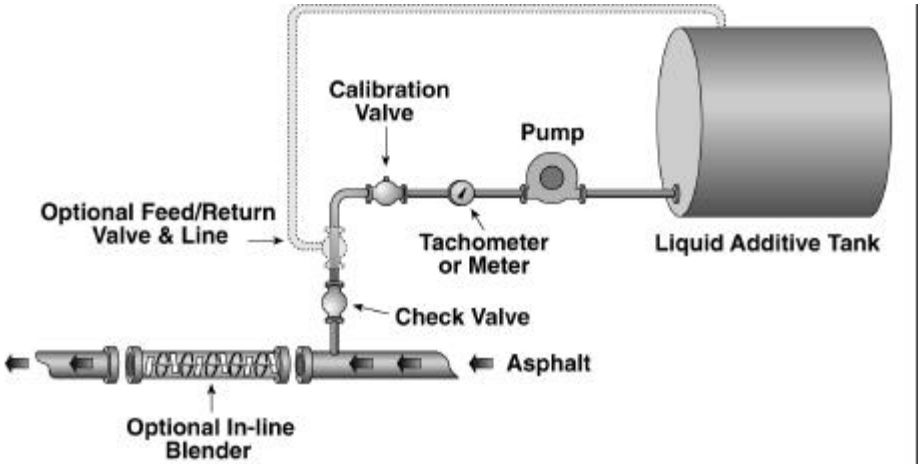

Figure 4.28 Typical asphalt additive tank system.

If liquid modifiers need to be added at the plant, the most common method is to inject them directly in the asphalt line as the asphalt is introduced into the plant. In a drum-mix plant, a separate additive tank, pump, motor, and additive lines are installed on the asphalt binder line. Figure 4.29 shows a typical liquid additive pumping skid including pump/motor and tachometer.

Figure 4.29 Typical liquid additive pumping skid including pump/motor and tachometer.

It is recommended that a static in-line blender be installed in the asphalt binder line. This is a piece of asphalt binder line, 0.9 - 1.2 m long with an insert that causes the asphalt to move back and forth as it travels through the line. This facilitates mixing of the additive with the asphalt. Figure 4.30 shows a liquid asphalt binder tank system.

Figure 4.30 Liquid asphalt binder additive tank system.

Optional components for the additive pumping and metering unit include:

- A tachometer with digital readout for the pump so that the additive can be easily calibrated volumetrically.
- A meter to measure the additive instead of calibrating the pump volumetrically. The meter can have a digital readout to aid the operator in controlling flow.
- A flow/divert valve that can direct additive back to the additive tank when it is not needed.
- A reversible pump so that additive can be drawn back to the additive tank, and the lines cleaned out when additive is not needed.

Controls for the additive can be simple or sophisticated. Simple systems involve a manual control for the operator with a digital position meter; the flow is controlled manually like that of a cold feed bin.

Sophisticated systems use a feedback signal to a control system, with the additive as part of the mix formula and/or tied to the asphalt flow signal. Figure 4.31 shows batch plant liquid additive control panel.

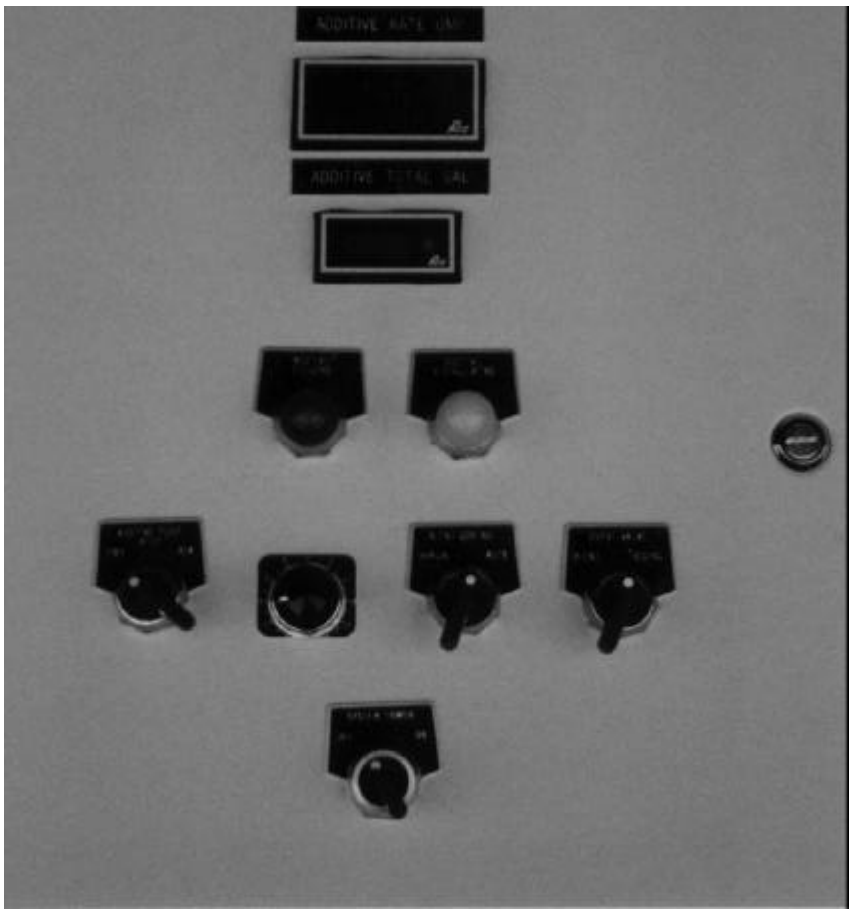

Figure 4.31 Batch plant liquid additive control panel.

It is important to install a check valve at the point of injection in the additive line. This is done to prevent the liquid asphalt from being pushed up the additive line if the pressure of the additive line ever falls below the pressure in the asphalt binder line.

In a batch plant, liquid additive injection is simpler. Because the asphalt in the line feeding a batch plant flows at a constant rate, the additive injection can be set to one speed and does not have to increase or decrease.

Typically a flow/divert valve or a start/stop solenoid valve is installed in an additive skid for a batch plant. When asphalt is sent to the weigh bucket, the additive is injected into the asphalt binder line just prior to the weigh bucket.

When the asphalt flow is diverted from the weigh bucket back to the asphalt binder tank, the additive flow is diverted back to the additive tank, or stopped.

It is recommended that a static in-line blender, as shown in figures 4.32 and 4.33, is installed in the asphalt binder line just prior to the asphalt weigh bucket to insure that the additive is thoroughly mixed with the asphalt before it is dispensed into the pugmill.

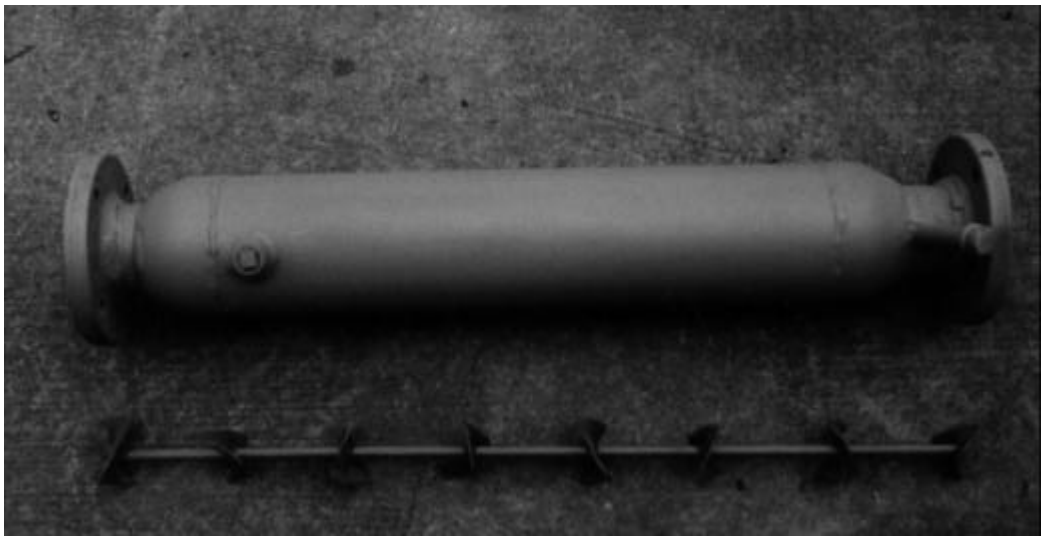

Figure 4.32 Liquid additive static in-line blender.

Controls can be simple or sophisticated. Simple systems include an additive flow rate readout and flow/divert light to assure the operator that the flow rate is correct, and signal whether additive is being pumped into the line. Sophisticated systems include a flow meter and counter to count the additive as it is being added. The system can be tied to the plant automation through the metered signal, or a separate count-down batch controller can be added just for the additive.

Figure 4.33 Liquid additive static in-line blender.

4.8 REFERENCES

1. FAA Circular AC 150/5370-14, *The Hot Mix Asphalt Paving Handbook*, pp. 24-28.

2. Technical Paper T-133, “Heating, Mixing, and Storing Modified Asphalt," Heatec Inc..

QUALITY AND EFFICIENCY TIP(s)

Asphalt Transfer

Special care should be taken in moving asphalt from one tank to another. Only asphalts of the same grade and manufacture should be transferred between tanks. Blending asphalts may change the characteristics of the material when the asphalts are different grades or supplied by different manufacturers.

A proper example of transferring asphalt in the field would be the pumping of the balance of one tank to another of the same grade so that a full load of that grade asphalt could be taken from a delivering tanker and stored in the first tank.

Tanks that have been empty for a long period of time should also be inspected prior to adding hot liquid asphalt. Any moisture that may have accumulated in the bottom of the tank from condensation can cause violent foaming of the asphalt when the hot liquid is added to the top of the water.

If different asphalt with different viscosity are stored on site in a multiple-tank configuration, it is very important that the same type of asphalt is always stored in a given tank and that the asphalt type is not allowed to be switched.

Asphalt Content Errors

If extractions suggest an asphalt pumping or metering malfunction in a drum-mixer plant, keep the following rules of thumb in mind:

If the extraction is consistently either high or low compared to the asphalt meter readings, the meter typically is in need of adjustment. Re-calibrate.

If the extraction is sometimes high, sometimes low, and sometimes fine, and the asphalt meter passes calibration tests, the asphalt flow-control mechanism is probably worn and needs tightening or readjustment. Look for sloppy linkage, a worn gear, or a worn valve in the flow-control system. Repair or replace.