Chapter 8

Asphalt Plant Supervisor and Operations

Topics

To hear audio, click on the box.

Overview

The Naval Construction Force (NCF) uses various makes and models of asphalt plants in both the Atlantic and Pacific Fleet deployment sites. As the plant supervisor, you should understand the asphalt process from stockpiling of ***aggregates*** to project completion. It is important to stress to all crewmembers the importance of keeping aggregates separated to maintain the quality of the finished surface. It is also the supervisor's responsibility to ensure maintenance is scheduled and performed regularly. The lack of proper lubrication, adjustments, and other maintenance procedures results in lost time, costly repairs, and premature replacement of parts. In addition, improper maintenance can adversely affect mission accomplishment.

As the plant supervisor you should be aware of all federal, state, and local regulations and ordinances relating to the operation of the plant. Before deployment or starting a project locally, contact the COMSECOND/COMTHIRDNCB equipment offices for Environmental Protection Agency (EPA) directives and operator's manuals that relate to the area you will be working in and the asphalt plant you will be using.

This chapter gives you an overview of asphalt plant operations; however, you should refer to all manufacturers' manuals and instructions for the most current procedures when operating an asphalt plant.

Objectives

When you have completed this chapter, you will be able to do the following:

1. Understand the responsibilities of the Asphalt Plant Supervisor.
2. Identify the major components of asphalt plants.
3. Understand types of asphalt plants, operations, and safety.
4. Identify types and grades of bituminous surfacing materials.
5. Understand types of tests used to identify bituminous materials.

6. Understand how to estimate the amount of materials needed for projects.

Prerequisites

None

This course map shows all of the chapters in Equipment Operator (EO) Advanced. The suggested training order begins at the bottom and proceeds up. Skill levels increase as you advance on the course map.

Well Drilling Supervisor and Operations	↑	E
Asphalt Plant Supervisor and Operations		O
Concrete Batch Plant Supervisor and Operations		
Crusher Supervisor and Operations		A
Quarry Supervisor and Operations		D
Project Supervisor		V
Crane Crew Supervisor		A
Air Detachment Equipment Supervisor		N
Transportation Supervisor		C E D

Features of this Manual

This manual has several features which make it easy to use online.

- Figure and table numbers in the text are italicized. The figure or table is either next to or below the text that refers to it.
- The first time a glossary term appears in the text, it is bold and italicized. When your cursor crosses over that word or phrase, a popup box displays with the appropriate definition.
- Audio and video clips are included in the text, with italicized instructions telling you where to click to activate it.
- Review questions that apply to a section are listed under the Test Your Knowledge banner at the end of the section. Select the answer you choose. If the answer is correct, you will be taken to the next section heading. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.
- Review questions are included at the end of this chapter. Select the answer you choose. If the answer is correct, you will be taken to the next question. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.

1.0.0 ASPHALT SUPERVISOR RESPONSIBILITIES

Asphalt Plant Supervisor responsibilities involve much more than asphalt mix production. You should know how to operate either a batch asphalt plant, continuous-flow asphalt plant, or drum-mix asphalt plant used by the NCF. You will also need to know how to identify the different types and grades of ***bitumen*** and their grading criteria. As the supervisor you will need to have a working knowledge of federal and local policies regarding plant operations and asphalt cement production. You will also be responsible for the training of crewmembers assigned to plant operations. A training plan should be developed to ensure all personnel attain the proper qualifications. Most training is received through on-the-job training; therefore, OJT should be thorough and emphasize the use of the manufacturers' operator and maintenance manuals.

1.1.0 Resources/Instructions

1.1.1 Flexible Pavement Structures US Army Engineer, Subcourse EN5458

The Flexible Pavement Structures subcourse is designed to teach you design considerations of subgrade, base, and surface for road, airfield, and heliports in the theater of operation, and the design of flexible pavements for frost conditions. The subcourse is presented in three lessons, each corresponding to a terminal learning objective as indicated below.

1.1.2 Paving and Surfacing Operations FM 5-436

Field Manual (FM) 5-436 provides essential information to military personnel who are engaged in or responsible for bituminous and concrete operations for roads and airfields. It contains information on construction materials and equipment and the mix design, production, placement, and repair of concrete and bituminous pavements. Emphasis is primarily placed on the duties and responsibilities of engineer platoon sergeants, platoon leaders, company commanders, and staff personnel during bituminous and concrete operations. In addition, technical engineering specialists (military occupational specialty [MOS] 51T) are involved in quality control of bituminous and concrete operations.

1.1.3 Pavement Maintenance Management, TM 5-623

The purpose of this manual is to describe a pavement maintenance management system (PAVER) for use at military installations. This system is available in either a manual or computerized mode. The maintenance standards prescribed should protect Government property with an economical and effective expenditure of maintenance funds commensurate with the functional requirements and the planned future use of the facilities. The majority of pavements on Army installations were built many years ago, and thus many have reached their economic design life. Because of limited maintenance funds, timely and rational determination of maintenance and repair (M&R) needs and priorities are very important factors. These factors can be determined by using PAVER as described in this manual. The use of PAVER by personnel who have the responsibility for pavement maintenance should assure uniform, economical, and satisfactory surfaced area maintenance and repair. When information in this publication varies from that contained in the latest issue of Federal or Military specifications, the specifications shall apply. Reference to Federal, Military or other specifications is to the current issues of these specifications as identified by their basic number(s).

1.1.4 Soil Stabilization for Pavements, TM 5-822-14/AFMAN 32-8010

This manual establishes criteria for improving the engineering properties of soils used for pavement base courses, subbase courses, and subgrades by the use of additives which are mixed into the soil to effect the desired improvement. These criteria are also applicable to roads and airfields having a stabilized surface layer.

1.1.5 Asphalt Institute

This website, www.asphaltinstitute.org, provides information on aspects of asphalt production and operations.

2.0.0 ASPHALT PLANT MAJOR COMPONENTS

Basic components of an asphalt plant are shown in *Figure 8-1*.

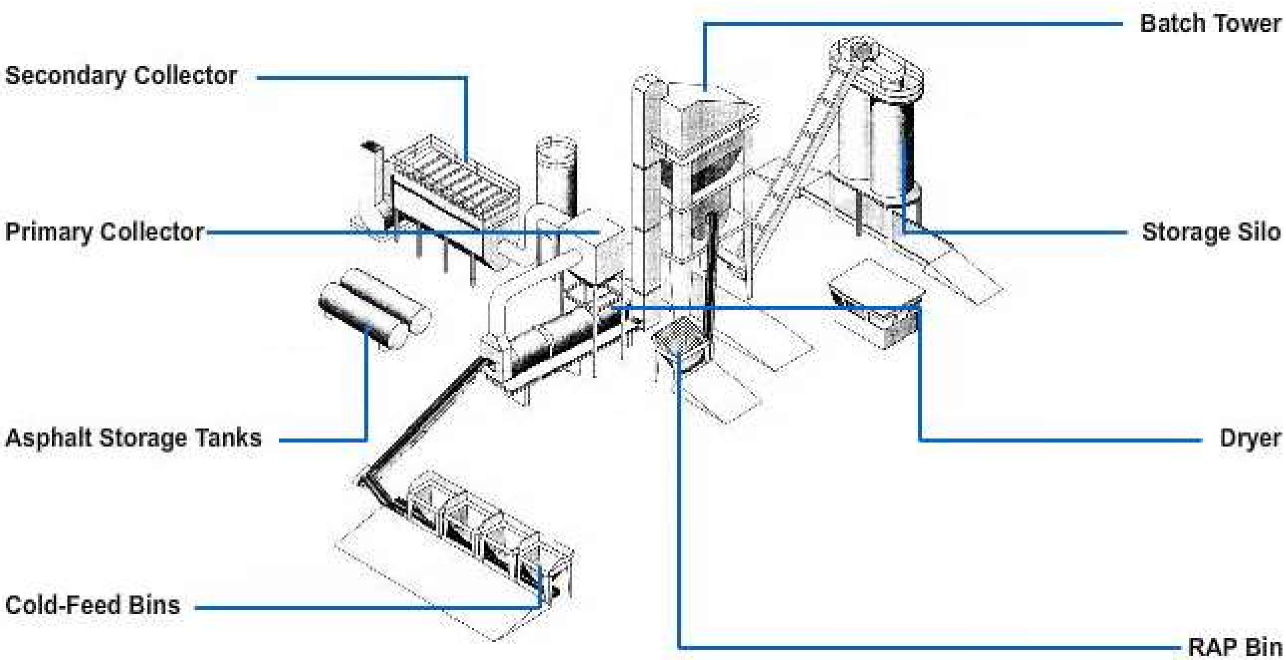

Figure 8-1 — Asphalt major components.

2.1.0 Aggregate Cold-Feed System

The aggregate storage and cold-feeder system moves aggregate from storage into the plant (*Figure 8-2*). The feeder may be charged by a clamshell or front-end loader. Aggregate feeder units should have controls that can be set and secured to produce a uniform flow of aggregate to the cold elevator.

For a uniform output from the asphalt plant, input must be accurately measured. The importance of feeding the exact amounts of each size aggregate into the dryer at the correct rate of flow cannot be overemphasized.

Several conditions must be met to ensure the correct size and amounts are fed to the dryer.

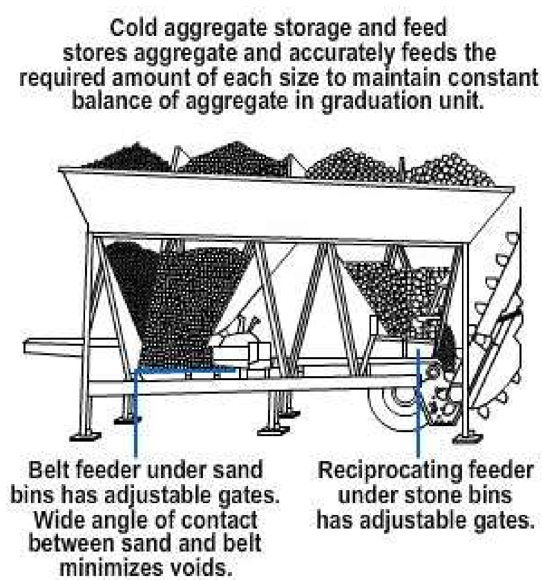

Figure 8-2 — Aggregate cold-feed system.

The first step is to ensure that there is no mixing or segregation of the aggregates in their respective stockpiles. The second step is to properly calibrate the feeder gates and ensure the gates remain free flowing. The last step is to ensure the fines are properly discharged into the dryer. Fines have more of a tendency to compact in the bin on the way to the gate. To stop the compaction of the fines, vibrators are placed on the outside of the fines storage bins. Vibrators should be wired to cut off automatically when the feeder stops. This eliminates excessive packing in the bin.

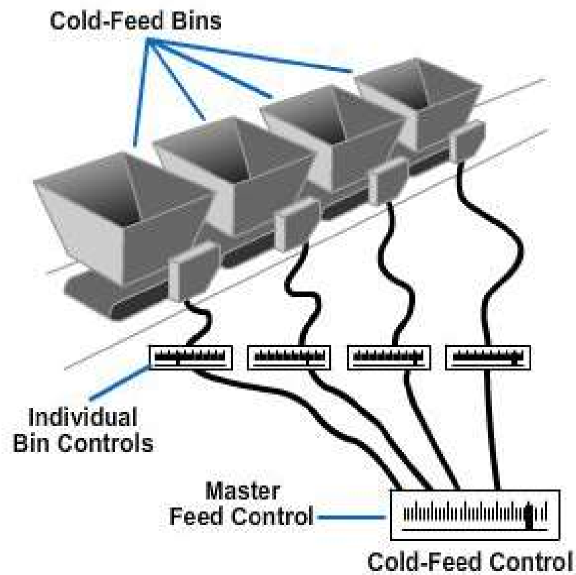

Figure 8-3 — Cold-feed calibration.

Proper cold-feeding mitigates wide variations in the moisture content in the quantity of a specific aggregate. If not given the proper attention, the cold-feed may cause a considerable change in the temperature of the aggregate leaving the dryer, leading to a high viscosity mix clogging the storage silo feed chute.

Improper cold feeding can also lead to a sudden increase in the cold-feed aggregate that can overload the screens, creating a carry-over of the fine aggregate into the coarse aggregate hot bins and resulting in the wrong consistency needed for proper compaction of the asphalt pavement.

Erratic feeding may cause some bins to overfill while starving others. This can result in layers of variable grading in the hot bin gradation unit storage, especially in the fine bin, resulting in alternating rich and lean batches, an overloaded dust collection system, or reduced efficiency in the aggregate dryer due to over filling.

The cold aggregate feeder gates should be calibrated *(Figure 8-3).* Most manufacturers furnish calibrations for the gate openings of their equipment. When these are available, they are helpful in making the initial gate setting. The only accurate way to calibrate the feeder gate is to use the actual aggregates that are to be used in the pavement.

To calibrate the gates, you must first plot the amount of mixture flowing through each gate. Plot the gate opening (in inches or square inches) on the chart as the horizontal coordinate, and make the pounds of material per revolution of the feeding mechanism (or pounds per minute) the vertical coordinate. When you are preparing the calibration chart, set the gate, usually at 25 percent or less of the total opening, and start the feeder. When the feeder is running normally, measure the material into a tare container and weigh it at known time intervals (or number of revolutions). This gives one point on the calibration chart. Repeat the operation for three or more gate openings and connect the points on the chart. After the gates have been calibrated and locked, you may need to make minor adjustments to assure uniform production.

When the gates discharge onto the belt conveyer, you can check their output by closing all of the gates except one, which is set at one of the calibration points. When the gates cannot be closed completely, you may have to stop the feeder or disconnect it if it is mechanically driven.

Start the plant and bring it to normal operating speed. Then stop the plant and remove the material from a measured section of the belt and weigh it, ensuring all fines are removed.

The weight of the material, divided by the length (in feet) of the belt section, multiplied by the belt speed (in feet per minute) will give the amount of material delivered per minute from the gate opening. Determine the material from other gate openings in the same manner and plot the gate calibration chart as described above.

When variable speed drives are used to control belt feeders, calibration is simplified. The gate opening can be estimated, and the speed of the belt can be increased or decreased to deliver the required percentage and tonnage of aggregate.

In calculating the output of a gate for a given opening, deduct the weight of the surface moisture on the aggregate being weighed. This is very important when calibrating gates through which fine aggregates are flowing.

For uniform flow, gates that feed coarse aggregate should not be set at a height less than 2 1/2 to 3 times the largest aggregate size; for example, if a gate is feeding aggregate that has a maximum size of 1 inch, the gate should not be set at less than 2 1/2 or 3 inches. Sometimes it may be necessary to restrict the opening width to provide the necessary opening height.

Before you set the cold-feed gates, you must determine the production volume of the plant in normal operation. You can estimate this from the plant size (dryer, screening, and mixing capacities) and mixing cycle time. Then, using the gate calibration charts, set each gate to deliver its share of the desired volume of aggregate.

Grading of the individual cold aggregate is determined by sieve analysis. The percentage of each size of aggregate to be used is calculated by trial and error.

The proportions required on the basis of these percentages will determine the gate settings. These settings should be checked by the same method used in calibrating the gate originally.

The setting should be considered tentative because the cold aggregate may vary in grading and moisture with the weather and other conditions that will affect its bulking and flow.

The hot bins should be watched carefully and the cold aggregate feeders regulated to see that they do not run out of material or overflow.

2.2.0 Dryer

From the aggregate cold-feed system, aggregates are delivered to the dryer. The dryer is a revolving cylinder in which the aggregate is dried and heated by an oil or gas burner (*Figure 8-4*). The cylinders used range from 3 to 10 feet in diameter and from 15 to 40 feet in length. A cylinder is usually equipped with longitudinal cups or channels (called lifting flights) that lift the aggregate and drop it in veils through the burner flame and hot gases. The slope of the cylinder, its speed, diameter, length, and the arrangement and number of flights control the length of time required for the aggregate to pass through the dryer. The dryer performs two functions: (1) it removes

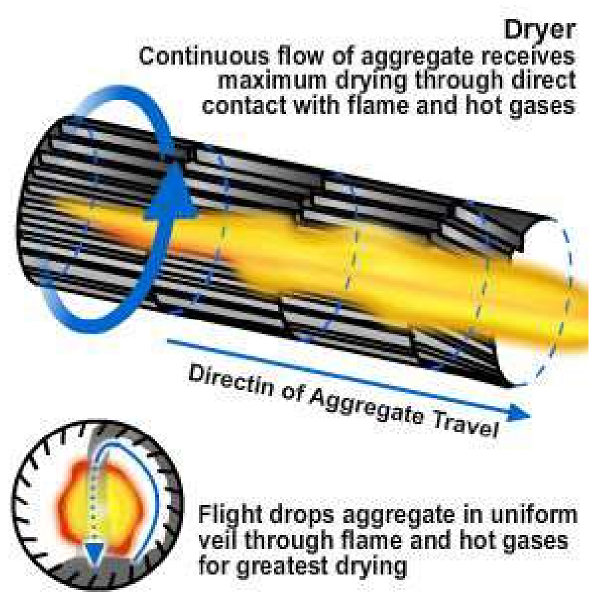

Figure 8-4 — Dryer.

moisture from the aggregate and (2) it heats the aggregate to mixing temperature.

The dryer includes an oil or gas burner with a blower fan to provide the primary air for combustion of the fuel and an exhaust fan to create a draft through the dryer. For efficient dryer operation, the air that is combined with the fuel for combustion must be in balance with the amount of fuel oil being fed into the burner. The exhaust fan creates the draft of air that carries the heat through the dryer and removes the moisture. Imbalance among these three elements causes serious problems. With fuel oil, lack of sufficient air or excess flow of fuel oil can lead to incomplete combustion of fuel. The unburned fuel leaves an oily coating on the aggregate particles–a coating that can adversely affect the finished mixture.

A quick procedure to check if oil is coating the aggregate is to place a shovel full of aggregate being discharged from the dryer in a bucket of water. A film of oil floats to the surface if there is oil on the aggregate. A slight film is not of concern; however, a heavy film on the surface of the water requires immediate attention.

Lack of balance between the blower air and draft air velocities can create hack pressure within the dryer drum, causing puff back at the burner end. Puff back indicates that the draft is not sufficient to accommodate the air pressure being introduced by the burner blower. The solution is to increase the draft or to reduce the pressure of the blower air.

Dryer burners using natural gas or liquid petroleum gas rarely develop combustion problems; however, an imbalance between gas pressure, combustion air, and draft can occur. Make sure the gas burner you use is the correct type for the pressure of the gas available.

The temperature of the aggregate, not the asphalt, controls the temperature of the mix. Overheating the aggregate can harden the asphalt during mixing. Underheating the aggregate makes it difficult to coat with asphalt and the resulting mix is difficult to place; therefore, a pyrometer, which is a reliable and accurate temperature-measuring device, should be installed in the dryer discharge in full view of your burner operator.

The pyrometers are sensitive instruments, designed to measure the very small electrical current induced by the heat of the aggregate passing over the sensing element. The pyrometer must be completely shielded from the heat and plant vibrations. The head of the device is usually located several feet away from the dryer and is connected to its sensing elements by wires. Any change in the connecting wire length, size, splice, or coupling will affect the calibration of the device and it must be recalibrated.

Two types of pyrometers are used: (1) the indicating pyrometer, which is usually located at the discharge chute of the dryer, and (2) the recording pyrometer. The recording head of this instrument is usually located in the plant control room.

The major difference between the indicating pyrometer and the recording pyrometer is that the indicating pyrometer gives a dial or digital reading, and the recording pyrometer records aggregate temperatures on paper in graph form, providing a permanent record. Both types of pyrometers are quite similar in operation. Both pyrometers have a sensing element, that is, a shielded thermocouple that protrudes into the main hot-aggregate stream in the discharge chute of the dryer.

Pyrometers should be cleaned periodically. Dust accumulating on them may cause a time lag in temperature measurement. They should also be checked frequently for accuracy. A simple way to do this is to put the sensing element of the pyrometer, together with an accurate thermometer, in an oil or asphalt bath. Being cautious of the flash point for the bath, slowly heat the oil or asphalt and compare readings from the pyrometer and thermometer. These readings should be taken at temperatures below, through, and above the expected operating temperature range.

Another means to check the accuracy of a temperature-indicating device is to take two shovel loads of hot aggregate from the dryer discharge chute and dump them in a pile on top of each other. The top shovel load of hot aggregate keeps the bottom shovel load of aggregate hot while the temperature is taken. Inserting the entire stem of an armored thermometer into the hot aggregate pile will give a temperature reading that can be compared to the reading on the pyrometer. Several thermometer readings may be necessary to get accurate temperature data.

A moisture check of the hot aggregate can be performed at the same time a temperature indicator check is performed. From the two shovel loads of aggregate, observe the aggregate for escaping steam or damp spots. These are signs of incomplete drying or porous aggregate releasing internal moisture, which may or may not be a problem. Another procedure used to check the moisture content is to take a dry, clean mirror, shiny spatula, or other reflective item and pass it over the aggregate slowly and at a steady height. Observe the amount of moisture that condenses on the reflective surface. With experience, you will be able to detect excessive moisture consistently. These quick-moisture checks are useful in determining whether you should perform a more precise laboratory moisture test.

2.3.0 Dust Collector

Manufacturers have designed asphalt plants to have equipment that restricts the escape of pollutants from the plant. Even so, during the operation of an asphalt plant, some gaseous and particulate pollutants may escape into the air. These pollutants must be controlled and limited to meet established clean air regulations. As the supervisor, you must be fully aware and familiar with the local laws concerning air pollution.

A major air pollution concern at an asphalt plant centers on the combustion unit. Dirty, clogged burners and improper air-fuel mixtures result in excessive smoke and other undesirable combustion products; therefore, close attention to the cleanliness and adjustment of the burners and accessory equipment is very important.

Another source of air pollution is aggregate dust. The greatest dust emissions from the plant come from the rotary dryer. Dust collectors are installed at this location to reduce dust emissions to a level that meets anti-air-pollution requirements (*Figure 8-5*).

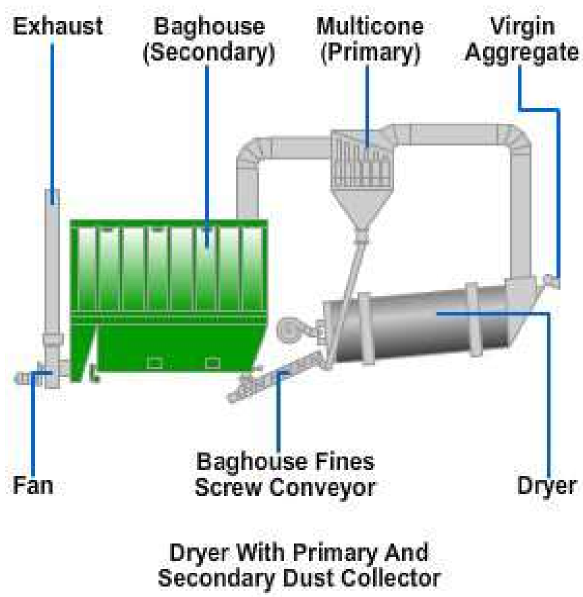

Figure 8-5 — Dryer with dust collector.

Most dust collectors are centrifugal (cyclone) units, either horizontal or vertical with single or multiple shells. Dust particles enter the top of the dust collector in the current of draft air from the dryer, drawn by the fan(s) that pull(s) the flame and the hot gases through the dryer. In the collector, the dust-laden air is forced into a whirling motion.

Heavier dust particles in the exhaust gas stream are separated by centrifugal force against the collector shell and are carried to the lower outlet. If the collector works efficiently, the finer dust that remains in suspension is carried out the exhaust stack with the air. The fines collected at the bottom of the cyclone are normally picked up by a dust-return auger and returned to the plant or wasted.

When required by specifications, a baghouse or wet wash system is added to the dust-collecting system. Several types of wet systems are used. They usually consist of a short tower, with or without baffles, or multiple horizontal tubes with spirals. The washer swirls the high-velocity exhaust coming from the dust collector through a fog and a fine spray to wash the gas. The dampened fines are thrown to the sides by centrifugal force. The material washes down the sides and discharges, with the water, out the bottom of the washer. The wastewater containing the dust must be properly handled to prevent it from becoming another source of pollution. Use of a wet wash system requires a large source of water. Also, the output of the fan in the dust collector must be increased by 10 to 20 percent because of pressure loss in the tower.

The baghouse is a large metal housing containing hundreds of synthetic, heat-resistant fabric bags. The bags are usually silicone-treated to increase their ability to collect and retain very fine particles of dust. The function of the baghouse is similar to the function of a vacuum cleaner. A large vacuum fan creates suction within the housing that draws in dirty air and filters it through the fabric of the bags. A typical unit may contain as many as 800 bags to handle the huge volume of exhaust gases from the aggregate dryer. Eventually, they accumulate into what is called a “dust cake” that must be removed before it reduces or stops the flow of dirty air through the filter. Several methods for cleaning the bags in the baghouse are used; however, the most commonly used methods are as follows: flex the bags, back flush the bags with clean air, or flex and back flush the bags. The Jet-Pulse system is another method, and it is similar to the back flush in that it produces a pulse of positive pressure within the bag to dislodge the “dust cake.” Dust removed from the bags drops into an auger at the bottom of the baghouse and is normally transferred to a storage silo. This material is often used in the hot mix.

When the material removed from the dust collector can be recombined satisfactorily with the aggregates in the mix, some or all of it may be returned to the plant. The amount returned depends upon the combined grading of the finished mix. When the collected dust is unsatisfactory or is prohibited by the mix specifications, it is removed from the bottom of the collector and wasted.

2.4.0 Hot Screens

After the aggregates have been heated and dried, they are carried by a hot elevator to the gradation unit; in the gradation unit, the hot aggregate passes over a series of screens (*Figure 8-6*). The function of the screens is to separate the hot aggregate into the specified sizes accurately and deposit those sizes in hot bins.

The gradation control unit or screening unit includes a set of several different-sized vibrating screens. The top screen is a scalping screen that rejects and carries off oversized aggregates. This is followed by one or two intermediate-sized screens, decreasing in size from the top to bottom.

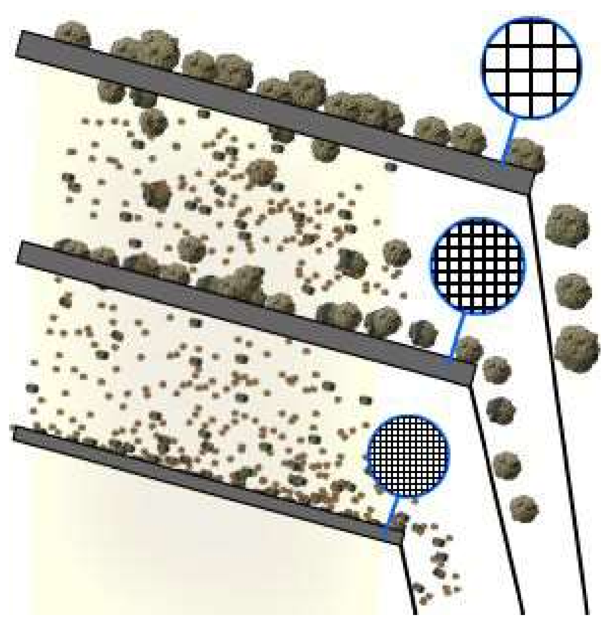

Figure 8-6 — Gradation unit.

The very bottom screen is normally a sand screen. The effective screening area must be large enough to handle the maximum amount of feed delivered to separate the hot aggregates properly; therefore, the capacity of the screens should be checked against the capacity of the dryer and the capacity of the pugmill.

When too much material is fed to the screens or the screen openings are plugged, many particles that should pass through ride over the screen and drop into a bin designated for larger sized aggregate. When screens are worn or torn, resulting in enlarged openings and holes, oversized material will go into bins intended for smaller sized aggregate. Fine aggregate misdirected into bins intended for larger aggregate is known as “carry-over.”

Carry-over can cause a lack of uniformity in the aggregate gradation and in the mixture. Additionally, excessive carry-over adds to the amount of fine aggregate in the total mix, thus increasing the surface area to be coated with asphalt. Excessive carry-over, or its fluctuations, can be detected by a sieve analysis made from the contents of the individual hot bins, and must be corrected immediately. Corrective measures include the cleaning of screens, the regulation of the quantity of material coming from the cold-feed, or a combination of both. Some carry-over is permitted in normal screening; however, the permissible amount in each bin is usually specified.

Daily visual inspection of the screens for cleanliness is recommended, preferably before the start of operation. When conditions warrant, the screens should be cleaned.

NOTE

Always make sure the bolts securing the screens are tight.

2.5.0 Hot-Bins

Hot bins are used to store the heated and screened aggregates temporarily in the various sizes required. Each bin is an individual compartment or a segment of a large compartment divided by partitions (*Figure 8-7*). A properly sized hot-bin installation should be large enough to prevent running out of material when the mixer is operating at full capacity. Bin partitions should be tight, free from holes, and of sufficient height to prevent intermingling of the different size aggregates.

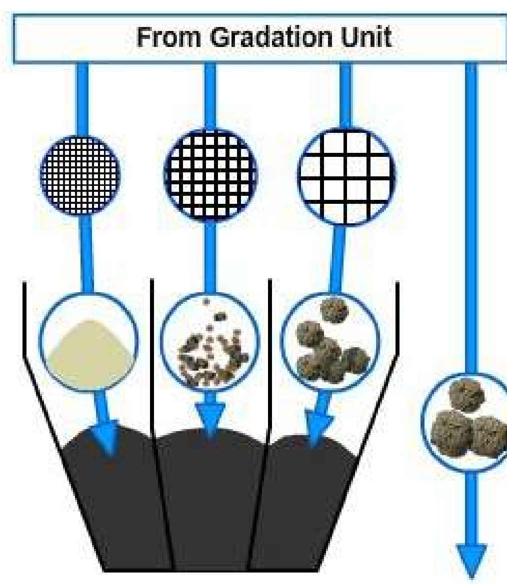

Figure 8-7 — Hot bins.

Hot bins usually have indicators that tell when the aggregates fall below a certain level. These indicators may be either electronic or mechanical. Each hot bin should be equipped with an overflow pipe to prevent excess amounts of aggregate from backing up into the other bins. The overfill pipes should be set up to stop overfilling of the bins. When a bin overfills, the screen above the bin rides on the aggregate, resulting in heavy carry-over and possible damage to the screen. Check overflow vents frequently to ensure they are free flowing.

Sometimes, very fine aggregate particles build up in the bin corners; when this buildup of aggregate collapses, it can result in an excessive amount of fines in the mix. This rush of fine materials normally occurs when the aggregate in the bin is drawn down too low. This condition can be controlled by having fillet plates welded in the bin corners to eliminate the 90-degree angles and by maintaining the proper aggregate level in the bin.

Other potential obstacles to obtaining a good mix includes a shortage of aggregate in one bin or excess in another bin, worn gates (at the bottom of the bins) that allow leakage of aggregate, and sweating of the bin walls. These obstacles must be overcome. Bin shortages or excesses can be corrected by adjusting the cold-feed. Sweating occurs when moisture vapor in the aggregate and in the air condenses on the bin walls. This usually happens only at the beginning of the day's operation or when the coarse aggregate is not thoroughly dried. Sweating may accumulate dust that, when released suddenly, will add unwanted fines in the mix.

Hot-Bin Sampling

Most modern hot-mix asphalt plants are equipped with devices for sampling hot aggregate from the bins. These devices vary in design but usually serve to divert the flow of aggregate from the feeders, or gates, under the bins into sample containers. On continuous-flow plants, the best place to obtain a sample is from the feeder gate as the material is deposited onto the elevator leading to the pugmill. Sampling facilities must be constructed and located so that the samples obtained will be representative of the material in the bins.

From the flow of aggregate over the screens, the finer aggregates fall to the near side of the bins and coarser aggregates fall to the far side. When the aggregate is drawn from a bin by opening a gate at the bottom, the flow of aggregate consists predominantly of fine aggregate at one edge and coarse aggregate at the other; therefore, the position of the sampling device in the flow of aggregate determines whether the sample will be composed of the fine portion, the coarse portion, or will be an accurate representation of all the aggregate in the bin. This condition is critical in the bin that contains the fine aggregate since the asphalt required in the mix is influenced heavily by the aggregate from this bin.

Stratification (layering) of sizes in the fine bin may be caused by variation of grading in the stockpiles or by erratic feeding of the cold aggregate. When this form of segregation exists, representative samples cannot be obtained even when the sampling device is used correctly.

2.6.0 Asphalt Heating and Circulation

Provisions should be made for the circulation of the asphalt through the feeding and storage system. All storage tanks, transfer lines, and pumps should have heating coils and/or jackets to maintain the asphalt at the required temperature.

Return lines discharging into the storage tanks should be submerged below the asphalt level in the tank to prevent oxidation of the asphalt. When the pump is reversed, two or three vertical slots should be cut in the return line within the tank to break the vacuum in the lines. The slots should be cut above the high level mark of the stored asphalt.

To assure temperature control of the asphalt, you should place an armored thermometer or a pyrometer with a recorder in the asphalt feed line at a location near the discharge valve at the mixer unit. Also, the asphalt storage tank should be equipped with a recording thermometer having a minimum time range of 24 hours.

An approved valve or spigot should be installed in the tank or in the circulating system to provide a means for sampling the asphalt. Sufficient material must be drawn and wasted before the sample is taken to ensure the material obtained is truly representative of the storage supply.

When the temperature of the asphalt is maintained by circulating heating oil, you should inspect the level of the hot oil in the reservoir of the heating unit frequently. If the hot-oil level falls, check for leakage of the hot oil into the stored asphalt.

2.7.0 Temperature of Mixture

Both asphalt and aggregate must be heated before they are combined in the pugmill. The asphalt is heated to make it fluid enough to coat the aggregate particles. The aggregate is heated to make it dry and hot enough to keep the asphalt in a fluid state while it is coating the particles.

Asphalt is a thermoplastic material that decreases in viscosity with increasing temperature; however, the relationship between temperature and viscosity may not be the same for different sources or types and grades of asphalt material.

The temperature of the aggregate controls the temperature of the mixture, and a mixing temperature normally is specified based on factors relating to placement and compacting conditions. Another consideration is the temperature required to dry the aggregate sufficiently to obtain a satisfactory mix.

Mixing should be accomplished at the lowest temperature that provides complete coating of the aggregate particles and a mixture of satisfactory workability. *Table 8-1* provides a guide for suggested asphalt temperatures ranges.

Table 8-1 — Suggested asphalt temperature ranges.

Type and Grade of Asphalt	Pugmill Mixing Temperature of Aggregates*	Distributor Spraying Temperature
Asphalt Cements (For open-graded mixes, types I & II)**		
40-50	225° F – 310° F	
60-70	225° F – 305° F	
85-100	225° F – 300° F	
120-150	225° F – 300° F	
200-300	225° F – 300° F	
(For dense-graded mixes, types III-VIII)**		
40-50	275° F – 350° F	
60-70	265° F – 330° F	
85-100	255° F – 325° F	
120-150	245° F – 325° F	
200-300	225° F – 300° F	
(For distributor spray applications)		
40-50***		300° F – 410° F
60-70***		295° F – 405° F
85-100		290° F – 400° F
120-150		285° F – 395° F
200-300		275° F – 385° F
Liquid Asphalts (RC, MC, and SC grades)		
30	60° F – 105° F	
70	95° F – 140° F	
250	135° F – 175° F	
800	165° F – 205° F	
3000	200° F – 240° F	

Type and Grade of Asphalt	Pugmill Mixing Temperature of Aggregates*	Distributor Spraying Temperature
Asphalt Emulsions		
RS-1	****	75° F – 130° F
RS-2	****	110° F – 160° F
MS-2	50° F – 140° F	100° F – 160° F
SS-1	50° F – 140° F	75° F – 130° F
SS-1h	50° F – 140° F	75° F – 130° F
RS-2K	****	75° F – 130° F
RS-3K	****	110° F – 160° F
CM-K	50° F – 140° F	100° F – 160° F
SM-K	50° F – 140° F	100° F – 160° F
SS-K	50° F – 140° F	75° F – 130° F
SS-Kh	50° F – 140° F	75° F – 130° F
*The temperature of the aggregates and asphalt immediately before mixing should be approximately that of the completed mix.		
**Mix type III is intermediate between dense- and open-graded mixes. As the gradation of the mix changes from dense-graded to open-graded, the mixing temperature should be lowered accordingly.		
*** Not normally used for spray applications in pavement construction.		
****Not used for mixing.		

2.8.0 Mineral Filler

Mineral filler is a fine material (dust) that passes through the No. 200 sieve during a sieve analysis. Mineral filler is normally part of the asphalt mix design used to fill in the voids of the aggregates. Mineral fillers commonly used are Portland cement, pulverized limestone (limestone dust), silica, and hydrated lime.

High production plants often have a separate feeding system for introducing mineral filler into the asphalt mix. Part of this system is a storage silo that maintains several days' supply of mineral filler. A receiving hopper, screw conveyer, and dust elevator are used to charge the storage silo, and a vane feeder meters the filler introduced into the mix. The ultimate choice of this system is usually dependent on the availability of bulk filler and their price in relation to bagged fines.

In plant operations where the volume of filler required does not justify a bulk silo, a bag feeding system is used. This system consists of a ground-mounted feeder, dust-tight elevator, surge hopper, vane feeder or screw conveyer, and an overflow chute.

Bulk or bag filler systems are equally adaptable for continuous-flow asphalt plants. Final metering of the filler to the mix is accomplished through a variable speed vane, a screw feeder, or a belt feeder, depending on the material to be handled and the capacity required. In each case, the mineral filler feed is interlocked with the aggregate and asphalt feed to ensure constant accuracy.

When an excess of filler is encountered in the raw aggregate feed, a bypass system can be used to receive the fines collected by the dust collector. The required amount of fines is then fed back to the mix, and any surplus amounts are diverted to a storage bin for disposal or other use.

Test your Knowledge (Select the Correct Response)

1. For a uniform output from the asphalt plant, what must occur at the input?

   A. Aggregate temperature must be consistent.
   B. Aggregate measurement must be accurate.
   C. Aggregate moisture content should be 2%.
   D. Aggregate texture should be rounded.

2. Fine aggregate misdirected into bins intended for larger aggregate is known by what term?

   A. Bypass
   B. Waste
   C. Carry-over
   D. Arched

3.0.0 TYPES of ASPHALT PLANTS, OPERATIONS, and SAFETY

3.1.0 Batch Asphalt Plant

The batch asphalt plant is shown in *Figure 8-8*. The cold aggregate storage and feed system, dryer, and dust collector are similar in operations for both the batch and continuous-flow type of asphalt plant. A distinguishing feature of the batch plant is the batching unit shown in *Figure 8-9*. Here the dried hot aggregate is screened into different sizes and stored by size in separate bins.

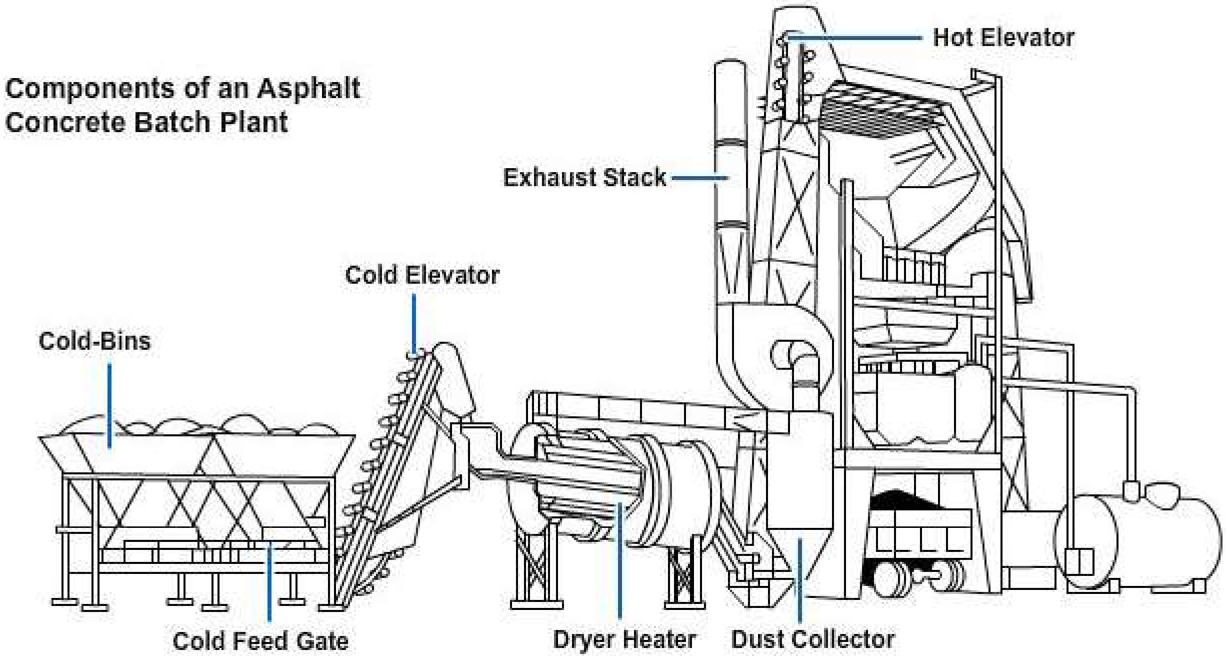

Figure 8-8 — Batch plant.

From the hot bins the aggregates are deposited into a weigh-hopper. Coarse aggregates are usually the first to be deposited, the intermediate-size aggregates next, and the fine aggregates last. This sequence is designed to place the fines at the top of the aggregates deposited in the weigh-hopper to mitigate segregation and loss through the gate at the bottom of the weigh-hopper. This system also allows the most efficient utilization of the available volume in the weigh-hopper. The weigh-hopper is suspended from scale beams, and the scales indicate the weight of the full amount of aggregate entering the hopper.

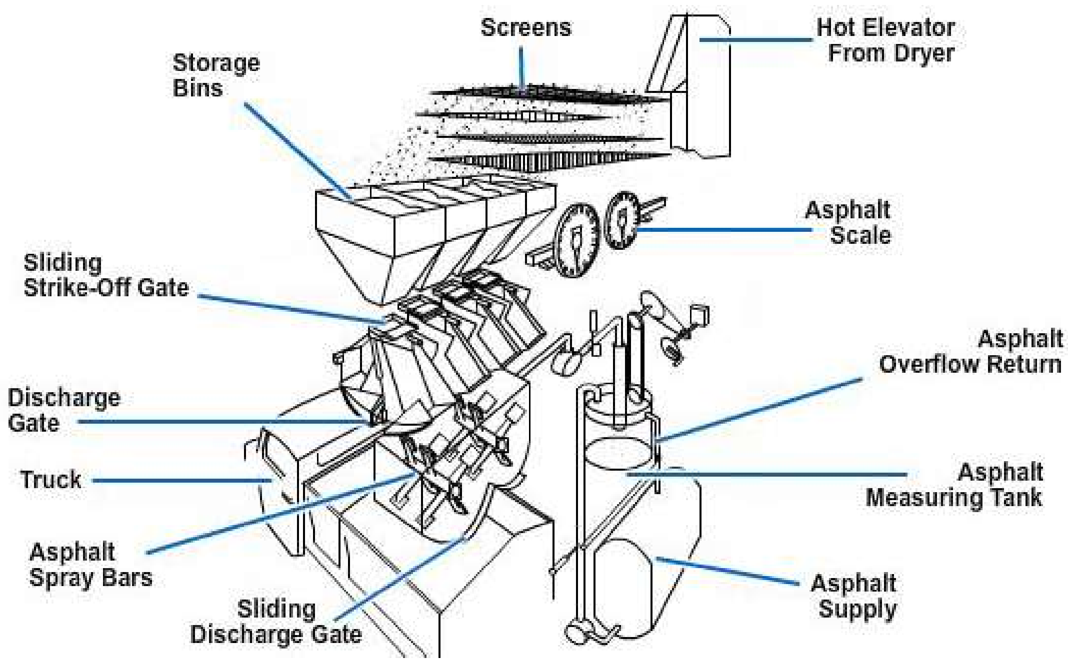

Figure 8-9 — Batch unit.

When each size of aggregate is deposited into the weigh-hopper, the weights to be drawn from the hot bins are marked on the scale dial. Because the scales indicate the weights cumulatively, the dial must be marked accordingly, the size of a batch depends on the capacity of the pugmill.

3.1.1 Asphalt Introduction

From the weigh-hopper, the aggregates are deposited into the plant pugmill (mixing chamber) and are blended with the proper proportion of asphalt. In a typical plant system, asphalt is weighed separately in a weigh bucket before being introduced into the pugmill. When the asphalt reaches a predetermined level in the weigh bucket, a valve in the delivery line closes to prevent excess asphalt from being discharged into the bucket. The asphalt is then pumped through spray bars into the pugmill. Asphalt buckets should be checked for accuracy in the mornings. New asphalt loosens some of the old asphalt that accumulated the previous day on the sides and bottom of the bucket. Loss of this accumulated asphalt changes the tare weight of the bucket.

3.1.2 Pugmill Mixing

Asphalt and aggregates are blended in a chamber called the pugmill (*Figure 8-10*). The pugmill consists of a lined mixing chamber with two horizontal shafts on which several paddle shanks, each with two paddle tips, are mounted. The paddle tips are adjustable and fairly easily replaced.

Adjust the paddle areas to ensure there are no “dead areas” in the pugmill. A “dead area” is a location where aggregates can accumulate out of reach of the paddles and not be thoroughly mixed. You can avoid dead areas by making sure the clearance between the paddle tips and the liner is less than one half of the maximum aggregate size.

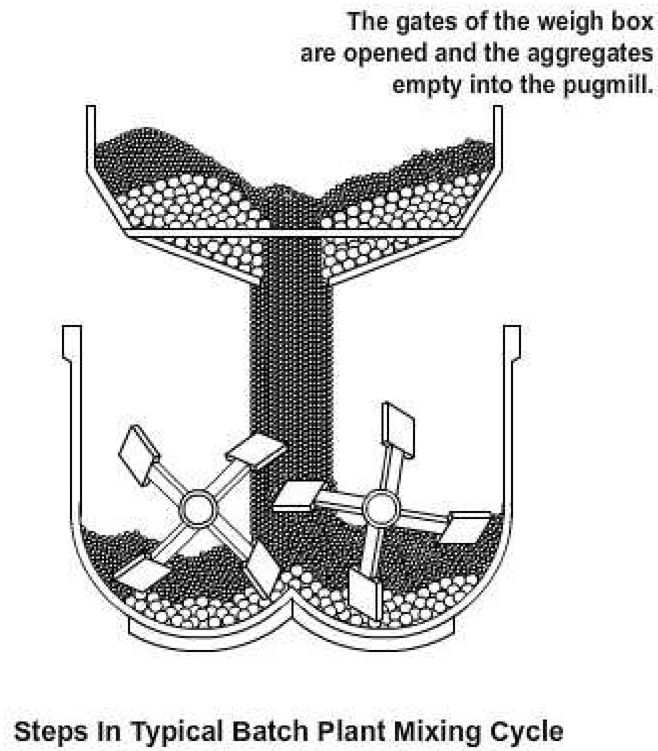

Figure 8-10 — Pugmill mixing.

Nonuniform mixing can occur if the pugmill is overfilled. When the plant is operating at full production, the paddle tips should be barely visible at the surface of the material during mixing. If the material is too high, the surface aggregates will tend to “float” above the paddles and will not thoroughly mix. Conversely, in a pugmill containing too little aggregate, the tips of the paddles rake through the material without mixing it. These problems can be avoided by following the manufacturer’s pugmill batch rating recommendation. Normally, the rating is based on a percentage of the capacity of the pugmills “live zone.” This live zone is the net volume in cubic feet below a line extending across the top area of the inside body shell radius with shafts, liners, paddles, and tips deducted.

The batch mixing time must be long enough to produce a homogeneous mixture of evenly distributed and uniformly coated aggregate particles. If the mixing time is too long, the lengthy exposure of the thin asphalt film to the high-aggregate temperature in the presence of air can affect the asphalt and reduce the durability of the mix. The speed of the mixer shafts and the arrangement and pitch of the paddles are factors governing the efficiency of the mixing. Most job specifications require the use of a timing device to monitor batch mixing time.

3.1.3 Discharge Gate

Little time is lost in discharging a completed batch through the hydraulically actuated discharge gate because there is no segregation of materials. The gate opens across the entire length of the paddle shafts and across the width (distance between the paddle shaft centers) of the pugmill. The large gate opening permits access from the bottom for maintenance and replacement of parts.

3.1.4 Plant Automation

The batch asphalt plant is almost completely automated. After mix proportions and timers are set and the plant is started, the plant repeats the weighing and mixing cycles until stopped by the operator or until a shortage of material or some unexpected malfunction causes the plant to shut down itself.

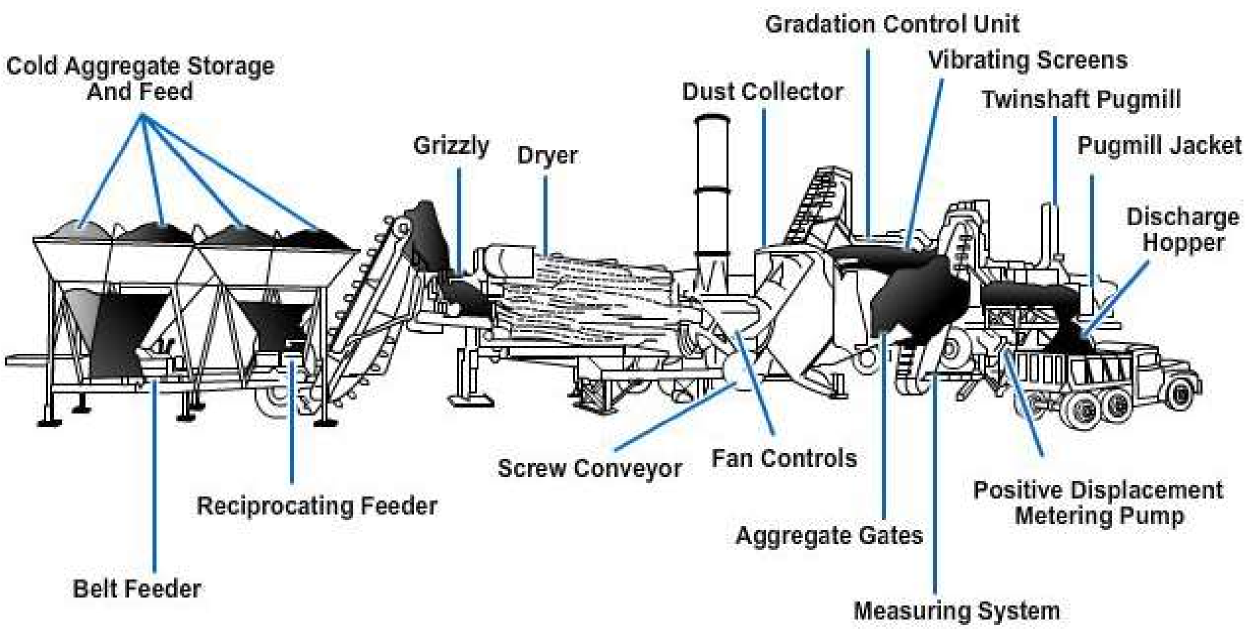

Figure 8-11 — Continuous flow asphalt plant.

The plant operator's manual provided by the manufacturer provides details on the setup and adjustment of the automatic equipment. You must check the accuracy and adjustment of this equipment, particularly the aggregate scales, asphalt scales or meters, batching controls, and recording equipment (if used). This should result in trouble-free production; moreover, you should check the entire plant periodically to ensure the finished product meets specifications.

3.2.0 Continuous-Flow Asphalt Plant

The continuous flow asphalt plant makes up less than 5% of all asphalt plants due mainly to its non-environmentally friendly operations. It produces massive amounts of hydrocarbons because of the high temperatures needed to quickly heat the asphalt mix. Continuous-flow asphalt plants are equipped with positive displacement asphalt pumps (*Figure 8-11*). One type is regulated by changing the drive sprockets or gears that are mechanically interlocked with the aggregate feeders. The other is controlled by a calibrated remote control handwheel on the mixer operator platform. When using the former type, you must use the manufacturer's tables as a basis for determining the proper pump and sprocket combinations to fix the amount of asphalt discharge. By doing so, you can control the feeder gates and asphalt pump while ensuring no change in setting can be made unless you, the asphalt plant supervisor, know about it.

The temperature of the asphalt going through the positive displacement asphalt pump must be known at all times to maintain constant asphalt proportioning. You should take frequent readings of the thermometer installed in the circulating line just ahead of the pump. This allows you to make any necessary adjustments to compensate for volume changes in the asphalt when substantial temperature changes occur.

3.2.1 Pugmill Mixer

The function of a continuous-flow plant pugmill is almost identical to the pugmill in the batch mix plant. The primary difference is that the mixing principle is different. In a batch mixer, the materials are confined in the mixing chamber. In a continuous-flow plant pugmill mixer, the materials are propelled toward the discharge. The mixing pressure varies with the height or weight of material in the pugmill that can be controlled by adjusting the dam gate at the discharge. The height of material in the pugmill mixer should not be allowed to rise above the paddle tips, with the exception of the last set of paddles.

3.2.2 Mixing Time

Total mixing time begins when all the combined mineral aggregates are in the mixer, and ends when the mixer discharge gate is opened. Dry mixing time begins when all the combined mineral aggregates are in the mixer, and ends with the introduction of the asphalt. Wet mixing time begins with the start of the asphalt application, and ends with the opening of the mixer discharge gate.

The asphalt film on aggregate is hardened by exposure to air and heat; therefore, mixing time should be the shortest time required to obtain a uniform distribution of aggregate sizes and a uniform coating of asphalt on all aggregate particles. The speed of the mixer shafts and the arrangement and pitch of the paddles are factors governing the efficiency of the mixing.

To further aid the operation of a continuous mix plant, you can add or extend several automatic controls. The operator's manual for the particular plant being used gives details on the setup and adjustments of the automatic equipment included with the plant.

NOTE

Normally all automatic systems have manual override. You should know where it is located and how to use it. See the manufacturer's manual for specific details.

3.3.0 Drum Mix Asphalt Plant

The drum-mix plant is shown in *Figure 8-12*. The mixing drum for which the plant is named is very similar in appearance to the batch plant dryer drum. The difference between the two is that in a drum-mix plant the aggregate is not only dried and heated within the drum, but it is also mixed with the asphalt cement. In a drum-mix plant, there are no gradation screens, hot bins, weigh-hoppers, or pugmills. Aggregate gradation is controlled at the cold-feed.

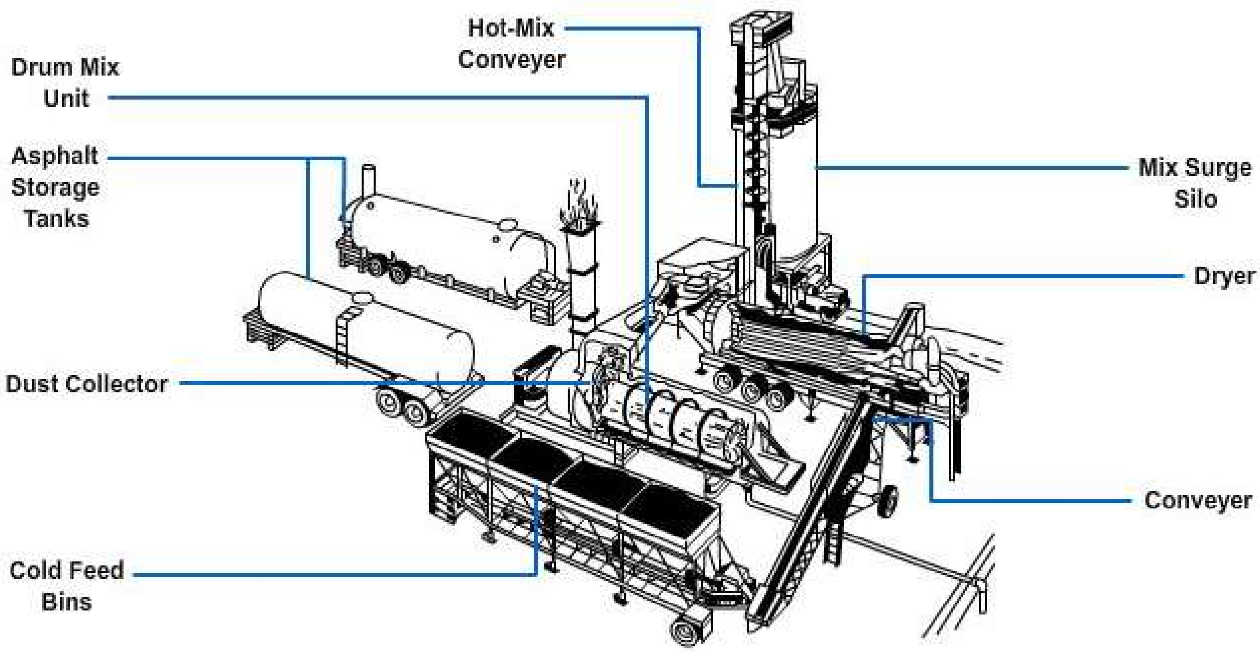

Figure 8-12 — Drum mix asphalt plant.

The basic plant consists of a coldfeed system, a rotating drum dryer, an asphalt proportioning and dispensing system, and a surge silo. The ease of setup and operation of the drum mix plant makes it the ideal machine for operations.

3.3.1 Aggregate Storage and Feed

Aggregate gradation and uniformity are entirely dependent on the cold-feed system. Proper care must be exercised not only in producing the aggregate but also in storage. Aggregates used for drum-mix plants must be received, handled, and stored to ensure there is no danger of contamination or intermingling.

Stockpiles must be properly graded and split into different sized fractions to control the gradation of the mix properly. Uncorrected segregated stockpiles will result in mix gradation difficulties. The plant supervisor should establish and maintain stockpiles in the most economical manner and correct any deficiencies in uniformity before the aggregate is fed into the mixing plant.

Since the typical drum-mix plant does not have a gradation unit, the aggregate must be proportioned before entering the mixing drum. This is accomplished with a multiple-bin cold-feed system equipped with precision belt feeders for control of each aggregate. Under each bin is a belt feeder upon which the aggregate is proportioned.

The plant should be equipped with a means to obtain samples of the full flow of aggregates from each cold-feed and the total cold-feed. These samples are required to perform a sieve analysis of the dried aggregate. Cold-feed controls consist of the following:

1. Sieve analysis of aggregate in each bin.
2. Calibrate feeders–both belt speed and gate opening.
3. Established bin proportions.
4. Set belt drive speeds and gate openings.

Once the gates are calibrated, you should check them regularly to ensure they remain properly set. All settings should be considered tentative because the cold aggregate used in the mix normally varies in grading and moisture content; therefore, adjustment of the gates is required to maintain a uniform flow.

Drum-mix plants require the use of a continuous weighing system on the cold-feed conveyer belts. In-line belt scale, known as weigh bridges, are belt-weighing devices used to weigh the combined aggregate passing over the conveyer belt, and a readout indicates the weight of the flow over the scales at any given instant. No material should ever be diverted from the conveyer belt after it passes the belt scale.

The in-line belt scale is usually located between the head and tail pulley of the cold-feed belt conveyer; this location tends to lessen variations in readings caused by impact loading, rollback of aggregate, or changes in belt tension.

In drum-mix plants the aggregate is weighed before drying. Damp aggregates may contain a substantial amount of moisture that can influence the total weight; therefore, an accurate measurement of the moisture content is important. From the weight measurement, adjustments can be made to the automatic asphalt metering system to ensure that the amount of asphalt delivered to the drum is correct for the amount of aggregate minus its moisture content.

Monitor the moisture content of the cold-feed aggregates at the beginning and middle of each day. Where conditions make the moisture content vary, you should check it more frequently.

3.3.2 Asphalt Metering

The drum-mixer is normally equipped with a system to add asphalt to the aggregate inside the drum mixer. Called the asphalt metering and delivery system, it is a continuous mechanical proportioning system interlocking with the aggregate weigh system to ensure the exact asphalt content of the mix. The weight of the aggregate delivered into the mixer, as measured by the weigh belt, is the basis for determining the quantity of asphalt delivered into the drum.

Asphalt proportioning is accomplished by establishing the necessary rate of asphalt delivery in gallons per minute to match the aggregate delivery in tons of dry aggregate per hour. The asphalt delivery rate is adjusted to correspond to the weight measurement of the aggregate crossing over the belt scale.

3.3.3 Drum-Mix Operation

The mixer is the heart of a drum-mix plant. Compared to a conventional batch plant rotary dryer, the mixer is similar in design and construction except that the drum-mixer can be divided into two sections: (1) a primary or radiation zone and (2) a secondary or convention/coating zone.

Aggregates enter the primary zone where heat from the burner dries and heats them. Then the aggregate moves to the secondary zone where asphalt is added, and aggregates and asphalt are thoroughly blended. Continued drying also occurs in the secondary zone. The mixture of hot asphalt and moisture released from the aggregate produces a foaming mass that traps the fine material (dust) and aids in the coating of the larger particles.

Drum-mixers are equipped with flights to direct the aggregate flow and spread the aggregates into a veil across the cross section of the drum. The aggregates must not only rotate with the revolving motion of the drum but must also spread out sufficiently to make heating and drying of all particles quick and efficient.

The spiral flights are located at the charging (burner) end of the drum-mixer and direct wet aggregates into the drum in such a manner as to attain uniform drum loading. Tapered lifting flights pick up the aggregates and drop them in an even veil through the burner flame.

3.3.4 Burner Operation

The burner inside the drum-mixer provides the heat necessary to heat and dry the aggregates used in the final mixture (*Figure 8-13*). The burner provides this heat by burning fuel oil, gas, or both.

When oil is burned, a low-pressure air draft is used to atomize the fuel oil for burning. Depending on the type of fuel used for the burners, the fuel feed and air blower must be balanced to ensure that the proper proportions of fuel and air are being introduced into the burner to ensure efficient combustion. Lack of balance can lead to incomplete burning of the fuel. Especially, when fuel oil or diesel fuel is used, this can leave an oily coating on the aggregate particles. You can adjust an imbalance between the fuel feed and air flow by either decreasing the fuel rate or increasing the blower or draft air.

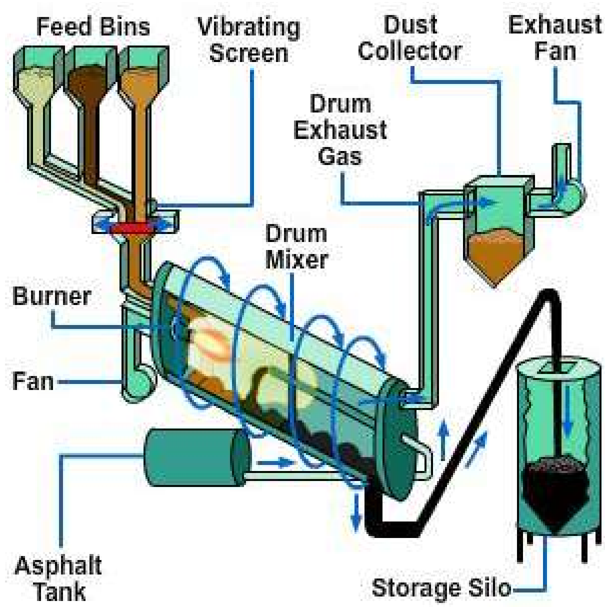

Figure 8-13 — Burner operation.

3.3.5 Surge Silo

A storage silo is often used to store a bituminous mixture before it is loaded onto trucks. Thus, plants can run continuously even when there is a temporary shortage of trucks. Material can be stored in silos for short periods of time, but if it is stored too long, the material may oxidize excessively and cause the bituminous binder to become hard and brittle. There are many types of storage silos, with some doing less damage than others to the asphalt concrete. As a general rule, bituminous concrete mixtures should be stored no more than 4 hours regardless of the type of storage silo used. If segregation of aggregate or drainage of bitumen occurs in the silo, use of the silo should be disallowed or changes should be made to prevent segregation and drainage. A weight system is normally connected to the holding bin of the silo to monitor the amount of hot mix loaded into each truck. Weight measurements are normally recorded by the weight system control panel.

Test your Knowledge (Select the Correct Response)

3. What is the name of the chamber where asphalt and aggregates are mixed in a batch plant?

   A. Surge silo
   B. Hot bin
   C. Drum
   D. Pugmill

4. Aggregate gradation and uniformity are entirely dependent on what system?

   A. The surge silo
   B. Gradation
   C. the cold-feed
   D. The drum mix

4.0.0 BITUMINOUS SURFACING MATERIALS

Bituminous materials are tremendously important in the construction of roads and airfields for both military and civilian use. A basic knowledge of these bituminous materials, their origin, composition, types, and grades are essential for an understanding of their use in construction.

Bituminous surfaces are composed of compacted aggregate and bitumen (binder). The aggregate transmits the load from the surface to the subgrade, takes the abrasive wear of the traffic, and provides a nonskid surface. The binder binds the aggregate together, thus preventing the displacement and loss of the aggregate. The binder also provides a waterproof cover for the base that keeps surface water from seeping into and weakening the material.

Bituminous surfaces are particularly adaptable to stage construction. Additional courses can be added to existing pavements to provide further reinforcement when loads or traffic density increases. The flexibility of bituminous surfaces permits slight adjustment caused by settlement of the subgrade without detrimental effect. Properly designed bituminous wearing surfaces, when compared with concrete, are less affected by temperature strains. The surfaces resist wear, weathering, and deterioration from aging with only minimal maintenance.

Bituminous materials are highly versatile and serve admirably in temporary, expedient, and light traffic situations where concrete is not justifiable. It is equally true that thicker bituminous pavement designed for heavy and continuing duty is fully comparable to concrete designed for heavy volumes of traffic or heavy wheel loads; however, bituminous wearing surfaces lack appreciable bearing action to carry wheel loads over weak spots in the subbase. For this reason, the subgrade must have an adequate, uniform bearing strength, and the base course must have adequate thickness, bearing capacity, and cohesion.

4.1.0 Types and Grades of Asphalt

Asphalt is a natural or man-made by-product of petroleum distillation (*Figure 8-14*). Natural asphalt is found in nature as either lake (pit) asphalt or rock asphalt. The common bituminous surfacing materials are asphalt cements, asphalt cutbacks, asphalt emulsions, road tars, and road tar cutbacks. For identification purposes, these materials are divided into three classes: asphalt bitumens, emulsions, and tars. The classification of these materials is based on the extent to which they dissolve in a distillate of petroleum or coal. Asphalt cements and asphalt cutbacks are asphalt bitumens (or asphalts). Road tars and road tar cutbacks are tars.

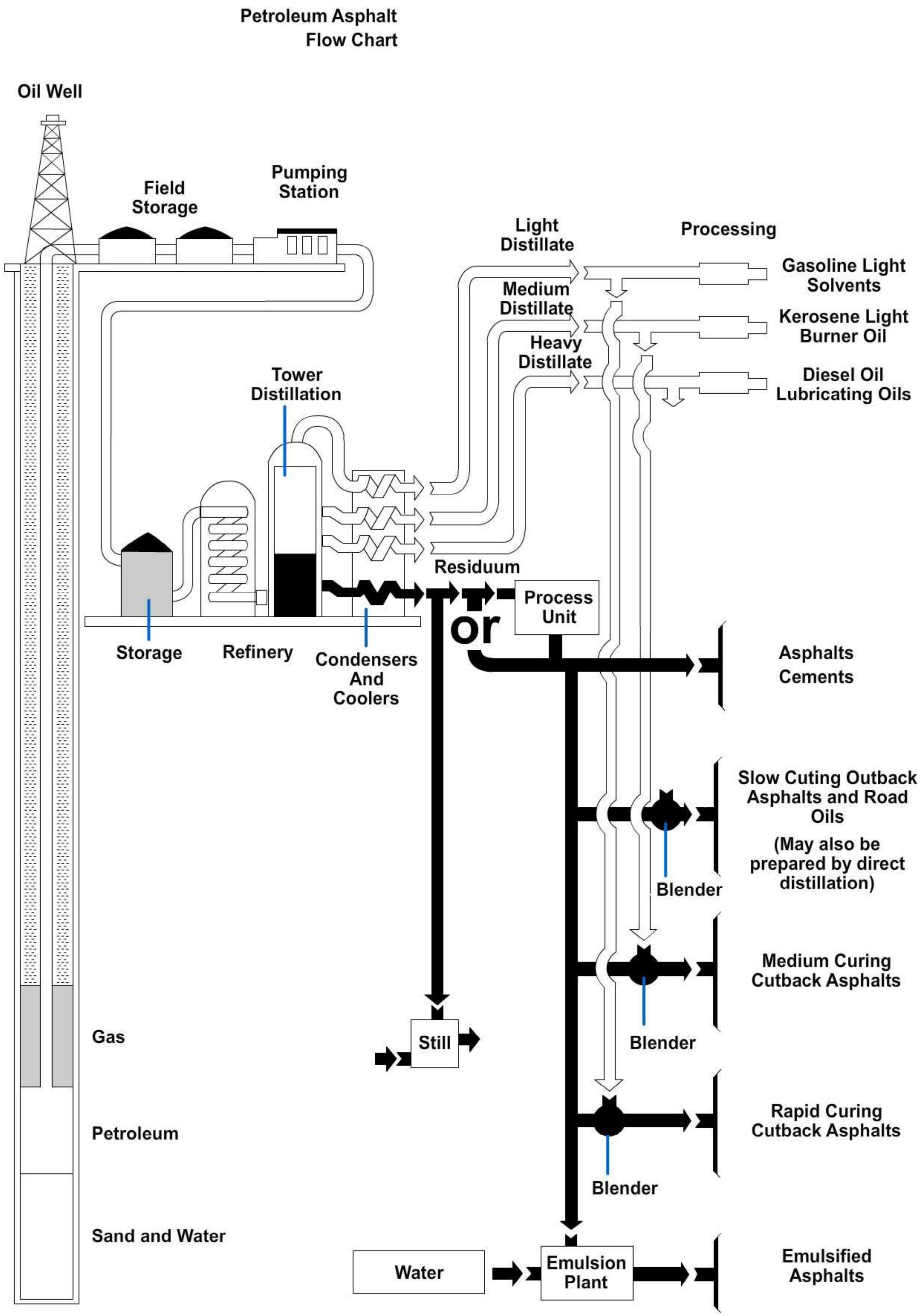

Figure 8-14 — Asphalt flow chart.

4.1.1 Asphalt (Bitumen)

Bitumen may refer to either a naturally occurring mixture of various organic liquids, also called crude bitumen, or a residue yielded in the distillation process of coal or petroleum, called refined bitumen. It is a brown-black, extremely viscous, tar-like material that was the first oil product utilized by humans because of its adhesive and cohesive properties. Its principle contemporary usage is in the paving of roads. In North America, bitumen is referred to as asphalt.

4.1.1.1 Asphalt Cements

Asphalt cements are solid products of petroleum refining. Asphalt cement is designated by the letter symbol AC, followed by the penetration grade that represents its relative hardness, ranging from 40 (hard) to 300 (soft). The number is derived from a penetration test that is the distance that a standard needle penetrates the asphalt cement under a standard loading weight, in a given time, under known temperature conditions.

All asphalt cements are solid or semisolid at room temperature (77°F) and must be converted to a fluid for mixing with aggregate or for spraying. Asphalt cement must be heated to a temperature ranging from 250°F to 350F, depending upon the grade of the asphalt cement.

The various penetration grades of asphalt cement are suitable for different uses, such as plant mixes, penetration macadam, and surface treatment. Soft penetration grades of asphalt cement are preferred for use in cold climates, medium grades in moderate climates, and hard grades in warm climates.

4.1.1.2 Asphalt Cutbacks

The use of cutback asphalts is decreasing because they contain volatile chemicals that evaporate into the atmosphere, increasing greenhouse gases; additionally, the petroleum solvents used to cut back the asphalt require higher amounts of energy to manufacture and are expensive compared to the water and emulsifying agents used in emulsified asphalts.

In many places, the EPA has restricted cutback asphalt to patching materials for use in cold weather. The special equipment needed to heat asphalt cements is not always available; since asphalt must be in a fluid condition to spray or to mix with an aggregate, the solid asphalt cement would not be suitable. Asphalt cement (AC) can be made fluid by adding solvents called cutter stock or flux oil. Cutter stock may be any one of the more volatile petroleum distillate products. The resulting combination is called asphalt cutback. Exposure to air causes the petroleum distillate to evaporate and leaves the asphalt cement to perform its function.

The rate of evaporation determines the type of asphalt cutback that is in the mixture. Gasoline or naphtha (highly volatile) will produce a rapid-cure cutback (RC) with a curing time of 4 to 8 hours; kerosene (medium volatility) will produce a medium-curing cutback (MC) with a curing time of 12 to 24 hours; and a fuel oil (low volatility) will produce a slow-curing cutback (SC) with a curing time of 48 to 60 hours.

4.1.1.2.1 Grades of Asphalt Cutbacks

Viscosity grade is the measure of the relative consistency of a fixed amount of asphalt bitumen after cutter stock is added. A very thin liquid results when a great amount of cutter stock is added to a given amount of asphalt cement. The grade is designated by a number that corresponds to the lower limit of the viscosity of asphalt cutback as determined by a standard test. The upper limit of viscosity is defined as twice the lower limit (*Figure 8-15*).

The viscosity grades of RC, MC, and SC are 70 (70-140), 250 (250-500), 800 (800-1,600), and 3,000 (3,000-6,000). The numbers in parentheses are the lower and upper limits of viscosity. In addition, MC has a grade 30 (30-60). The grade ranges are 30 (most fluid) to 3,000 (least fluid).

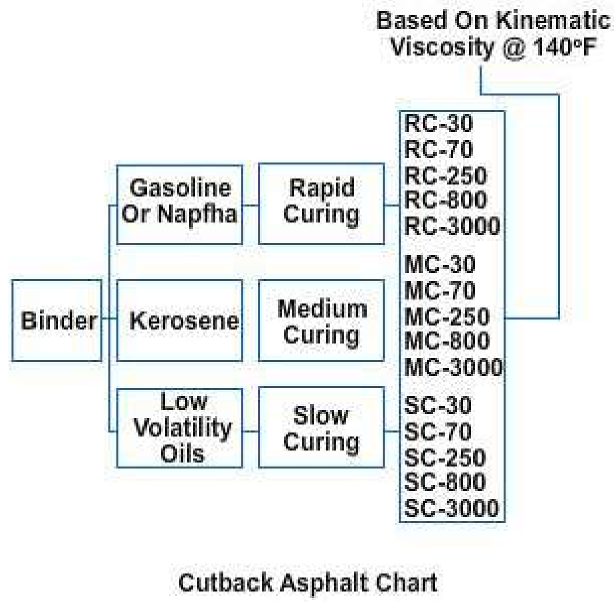

Figure 8-15 — Asphalt cutback grades.

4.1.1.2.2 Uses of Asphalt Cutbacks

Different types and grades of asphalt cutbacks are used to meet various climate conditions for different types of pavement. Asphalt cutbacks are usually used for prime/tack coats and for bituminous surface treatments. The prevailing atmospheric temperatures existing during construction projects are a major factor in selecting the grade of asphalt cutback. The heavier grades are preferred for use in warm weather; the lighter grades in cool weather. When the preferred grade of a given type of asphalt cutback is not available, a comparable grade of another type may be substituted; for example, RC-800 maybe used instead of MC-800, or RC-70 instead of MC-70, without seriously affecting the finished pavement.

4.1.2 Emulsions

An asphalt emulsion is a nonflammable liquid substance composed of asphalt cement, water, and an emulsifier mixed together to produce a liquid material. Emulsions are environmentally friendly, have the same basic uses as cutbacks, and are more commonly used in the field. Asphalt and water will not mix; therefore, a chemical agent called an "emulsifying agent" must be added. The chemical used as an emulsifier greatly influences the properties of an asphalt emulsion. The emulsifier keeps the asphalt particles in suspension and controls the breaking time. It also determines whether the emulsion is ***cationic*** or ***anionic*** (or non-ionic). Chemical compatibility of the emulsifying agent with the asphalt cement is essential for producing a stable emulsion.

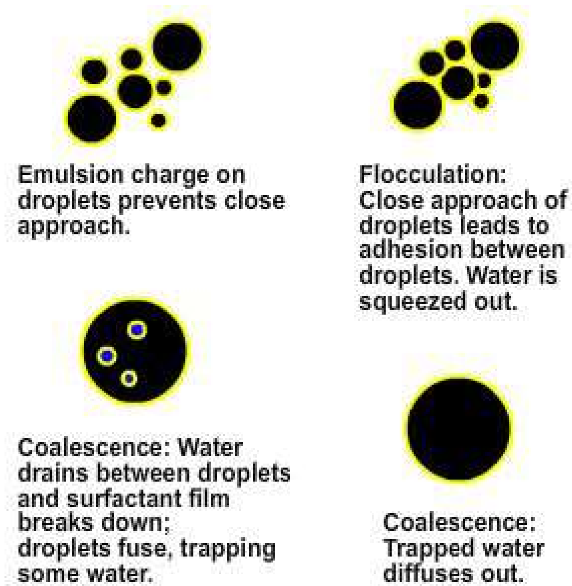

Figure 8-16 — Stages of emulsion breakdown.

Common emulsifying agents are soaps, animal blood chemicals, and certain specified colloidal clays in dust. When emulsion is applied to a surface, the water and asphalt cement break (separate), leaving a thin film of asphalt cement (*Figure 8-16*).

4.1.2.1 Classification of Emulsions

Emulsions are classified by their ionic charge. Cationic emulsions begin with a "C." If there is no C, the emulsion is usually an anionic. The charge is important when designing an emulsion for compatibility with certain aggregates.

After the charge designation, the next set of letters describes how quickly an emulsion will set or coalesce to continuous asphalt mass. The standard terms are RS (Rapid Set), MS (Medium Set), SS (Slow Set), and QS (Quick Set).

RS emulsions break rapidly and have little or no ability to mix with an aggregate. MS emulsions are designed to mix with aggregates, and are often called mixing grade emulsions. MS emulsions are used in cold recycling, cold and warm dense-graded aggregate mixes, patch mixes, and other mixes.

SS emulsions are designed to work with fine aggregates to allow for maximum mixing time and extended workability. They are the most stable emulsions and can be used in dense-graded aggregate bases, slurry seals, soil stabilization, asphalt surface courses, and some recycling. SS emulsions can be diluted with water to reduce their viscosity so they can be used for tack coats, fog seals, and dust palliatives. SS emulsions are also used as driveway sealers.

QS emulsions work well with fine aggregates but are designed to break faster than SS emulsions. QS emulsions are used in micro-resurfacing and slurry seal designs. The quick break allows for faster opening to traffic.

4.1.3 Tars

Tars are obtained from the distillation of bituminous coal and are seldom used in the NCF. A road tar is designated by the symbol RT and is manufactured in 12 grades of viscosity. RT-1, RT-2, and RT-3 are priming oils. RT-4 through RT-7 are called cold tars because they are fluid enough to be mixed and applied at relatively low temperatures. RT-8 through RT-12 are called hot tars because they are solids and require high temperatures for mixing and applying.

The symbol RTCB refers to road tar cutback. RTCBs are manufactured only in viscosity grades 5 and 6. Coal distillate, such as benzene or a solution of naphthalene in benzol, may be used to cut back the heaviest grades of road tar to produce both grades of road tar cutbacks.

4.1.3.1 Use of Tars

Tars are suitable for use on areas where asphalt is unsuitable. A good example is an airfield where petroleum distillates are likely to be spilled. Tars do not strip easily from aggregate in the presence of water and are preferred as a prime coat. Tars penetrate more deeply into the base course than will asphalt of the same viscosity and curing rate.

Cold-tar mixes are used for road mix and patching. Hot-tar mixes are used for plant mix, surface treatment, crack fillers, and similar uses. Since tars become soft at high temperatures and brittle at low temperatures, the heavier grades are preferred for use in warm weather and the lighter grades in cool weather.

Road tar cutbacks are used for patching mixes; however, an open flame must NOT be used near storage tanks and drums of road tar cutbacks because they are flammable.

Test your Knowledge (Select the Correct Response)

5. Asphalt cutbacks are classified as what type of material?

   A. Asphalt cement
   B. Asphalt bitumen
   C. Asphalt emulsion
   D. Asphalt tar

6. Which is NOT a standard term for an emulsion?

   A. Rapid Set
   B. Normal Set
   C. Slow Set
   D. Quick Set

5.0.0 FIELD IDENTIFICATION of BITUMINOUS MATERIALS

Engineering Aids normally perform field tests on bitumens; however, as a plant supervisor you should be aware of the types of tests available. Identifying bituminous materials is difficult at best. Stockpiled bituminous materials that are unmarked or improperly marked can cause unnecessary delays in construction operations. Fairly accurate identification is necessary to decide on the type of construction that the materials can be used for, the method of construction to be used, the type and quantity of equipment needed, and the applicable safety regulations to be observed. Some of the tests used in the field to identify bituminous materials as asphalt cement, asphalt cutback, asphalt emulsion, road tar, or road tar cutback will be discussed.

5.1.0 Solubility Test

The most common method of testing unknown materials is the solubility test. The solubility test consists of taking a small amount of the unknown bituminous material, enough to cover the head of a nail if a solid, or a few drops of a liquid material, and attempting to dissolve the material by stirring it in a petroleum distillate--gasoline, kerosene, diesel fuel, and so forth. If the material is asphalt, it will mix uniformly with the distillate. Tars, however, will form a stringy undissolved mass. Emulsions, in addition to other distinguishing tests, may also be identified in the solubility test since they will form undissolved balls or beads of the emulsion at the bottom of the container of petroleum distillate. The solubility test provides a positive method of identification.

5.2.0 Pour Test

When you perform the volubility test and the bituminous material dissolves, an asphalt product–asphalt cement or asphalt cutback–is present. At room temperature (77°F) asphalt cements are solids, and asphalt cutbacks are fluids. With these facts in mind, you may run a second test, a pour test, to determine whether a sample is asphalt cement or an asphalt cutback.

In the pour test, an attempt is made to pour the material from a small container. Asphalt cements are solids and will not pour. Asphalt cutbacks are fluids at 77°F and will pour.

The pour test can be used to determine whether the unknown material is an asphalt cutback. The approximate viscosity grade number of the cutback is found by comparing the flow to well known materials such as water, syrup, and others. If this test is made at a temperature below 77°F, the materials will appear more viscous (stiff) than at 77°F and the opposite if tested when warmer than 77°F. The cutbacks of a given viscosity grade will pour in a manner similar to Table 8-2.

Table 8-2 — Cutback viscosity.

30	Water
70	Light syrup
250	Syrup
800	Molasses
3000	Barely deform

After the pour test, the approximate viscosity grade of the cutback is known, but the type (RC, MC, or SC) is not.

5.3.0 Smear Test

The smear test is used to separate an RC from an MC or SC. The test is primarily based on the fact that RCs are cut back with a highly volatile material (naphtha or gasoline). You can determine whether a sample is an RC or not by smearing some of the sample in a thin layer on a nonabsorbent surface, such as a piece of glazed paper. The volatile substance evaporates within a few minutes and the surface becomes so tacky that when touched, the specimen, paper and all, sticks to your fingers and can be lifted into the air

Checking the reverse side of the paper, you will find that the RC did not penetrate through the paper as MCs or SCs do. MCs and SCs on smear tests remain fluid and oily for time periods that vary from hours to days, depending on the type and grade of material. If an 800 or 3,000 grade MC or SC is present, they may become sticky in a few minutes since there is such a small amount of cutter stock in them. When such a viscous grade is present, it is well to confirm the identification of the sample by a prolonged smear test. Generally, the MCs and SCs will penetrate through the paper while the RCs will not. You can determine this by observing the back side of the paper.

In a prolonged smear test, a thin smear is made on nonabsorbent paper and allowed to cure completely. If the viscous cutback is all RC-3000, it will cure completely in about 3 hours. When the spot has cured completely (the cutter stock has almost all evaporated), the smear will be almost pure asphalt cement (AC) and will be hard and no longer sticky. If the viscous sample were an MC or SC-800 or 3,000, the spot would still be uncured and, therefore, very sticky, even after 24 hours, while the RC smear will have become a hard, glazed spot.

5.4.0 Heat-Odor Test

A heat-odor test is used to distinguish between medium-curing and slow-curing asphalt cutback by identifying the cutter stock as kerosene, fuel oil, or diesel oil. A sample of the material is heated in a closed container to retain the vapors.

NOTE

Do not overheat the cutback.

Medium-curing asphalt cutback will have a strong odor of kerosene. Slow-curing asphalt cutback will lack the kerosene odor, but a faint odor of motor oil may be present.

5.5.0 Field Penetration Test

The field penetration test is performed to determine the approximate hardness of the asphalt, not to pinpoint the exact penetration number for it. To determine if the number falls in the hard, medium, or soft group is sufficient. To perform this test, attempt to push a sharpened pencil or nail into the container of asphalt (at about 77°F), using a firm strong pressure of approximately 10 pounds. If only a slight penetration is made with considerable difficulty, hard asphalt cement is present. When the penetration is made slowly but without great difficulty, medium asphalt cement is present. If the penetration is made with ease, soft asphalt cement is present.

5.6.0 Stone-Coating Test

When a material has been tested and found to be an emulsion, the stone-coating test is performed. This test is conducted to determine if the emulsion is a rapid-setting emulsion, termed a non-mixing grade, or a medium- or slow-setting emulsion, termed as mixing grade emulsion. To know which type is present is important because the applications of the mixing and non-mixing types vary greatly. The test performed to distinguish between these two types of emulsions is the stone-coating test. This test consists of taking a handful of damp sand and adding to the sand a small amount of emulsion (estimate about 6 to 8 percent by weight) and attempting to mix the two materials. Be careful not to add so much emulsion that the sand becomes saturated.

A rapid-setting emulsion will “break” so quickly it will not be possible to mix it with sand. It breaks immediately, gumming up the mixing spoon and the aggregate with asphalt cement; otherwise, if the unknown sample is a medium- or slow-setting emulsion when added to the damp sand, it will mix easily and coat all the particles completely, as well as the mixing spoon, with a uniform coating of asphalt. Identification of an emulsion merely as a mixing or non-mixing type is sufficient for field conditions. The difference in viscosity is unimportant because there are so few grades. No distinction is necessary between medium- and slow-setting emulsions since both are mixing types used largely for the same purpose.

Another test for emulsions is done by mixing the emulsion with water. Because emulsions are made with water, more water may be added to emulsions without disturbing the uniformity of the liquid. None of the other bituminous materials will dissolve in water.

Yet another test involves saturating a small piece of cloth with emulsion and lighting it on fire. A cloth saturated with asphalt emulsion will smolder but will not burn or burst into flame. Other bituminous materials are combustible.

5.7.0 Laboratory Test of Bituminous Materials

In addition to the field tests, various tests are performed on bituminous materials in the laboratory. These tests usually are made for the purpose of checking compliance with the established specifications; however, laboratory tests may also be made to identify the material beyond field identification, to furnish information for mix design, or to establish safe handling procedures.

Bituminous materials are produced to meet the specification established by the federal government, the American Association of State Highway Officials (AASHO), and the American Society for Testing Materials (ASTM). These specifications define the extreme limits permitted in the manufacture of the material and assure the user that the material will possess definite characteristics and fulfill the project requirements. Consult with the EAs for the proper specifications required.

Test your Knowledge (Select the Correct Response)

7. What type of cement is present if, in a field penetration test on asphalt cement at 77°, slow penetration takes place using ten pounds of constant pressure?

   A. Soft
   B. Medium
   C. Medium soft
   D. Hard

8. Why is the field penetration test performed?

   A. To pinpoint the exact penetration number of the asphalt
   B. To determine the approximate hardness of the asphalt
   C. To determine the type of asphalt
   D. To find its relative melting point

6.0.0 ESTIMATION of MATERIALS

To obtain a satisfactory surface, combine bituminous materials and aggregate in various proportions. Material estimates must be as accurate as possible to avoid an inadequate supply or an oversupply. Base estimates on the sequence of operations and the materials needed for each construction step. Materials should arrive at the paving site shortly before needed; keep a minimum amount of materials on hand for a full-scale operation. The formulas in this chapter use 40 gallons per barrel as a conversion factor to deal with shrinkage that takes place when the bitumen cools after barreling operations. This does not consider the loss of bitumen in debarreling operations. Many different combinations of materials are used on bituminous surfaces. Before a bituminous surface is placed, the surface to be covered normally requires the placing of a preliminary treatment: a prime or a tack coat.

6.1.0 Prime Coat

Priming consists of the initial treatment on a granular base before surfacing with a bituminous material or pavement. The purpose of a prime coat is to penetrate the base (about 1/4-inch minimum penetration is desired), fill most of the voids, promote adhesion between the base and the bituminous applications placed on top of it, and waterproof the base. Surfaces must be as clean as possible, and where dry conditions exist you should consider a light fog spray with water before priming actually begins.

The priming material may be a low viscosity tar, low-viscosity asphalt, or a diluted asphalt emulsion. The bituminous materials used for the prime coat should be applied in quantities known as rate of application (ROA) of not less than 0.2 gallon or more than 0.5 gallon per square yard. Normally, the construction project specifications denote the ROA for the prime coat application; however, when the ROA is not included in the project specifications, the NCF uses an ROA of .3 for planning purposes. When the base absorbs all of the prime material within 1 to 3 hours or when penetration is too shallow, the base is underprimed. Underpriming may be corrected by applying a second coating of the prime material.

An overprimed base may fail to cure or set and may contribute to failure of the pavement or bleed up through the asphalt mat. A free film of prime material remaining on the base after a 48-hour curing period indicates that the base is overprimed. This condition may be corrected by spreading a light, uniform layer of clean, dry sand over the prime coat to absorb the excess material. Application of the sand is usually followed by light rolling and brooming. Excess prime, held in minor depressions, should be corrected by an application of clean, dry sand. Any loose sand should be lightly broomed from the primed surface before the wearing surface is laid.

The primed base should be adequately cured before the wearing surface is laid. In general, allow a minimum of 48 hours for complete curing. Ordinarily, proper surface condition is indicated by a slight change in the shiny black appearance to a slightly brown color.

When a soil base is to be covered by a bituminous wearing surface, barricade the area to prevent traffic from carrying dust or mud onto the surface both before and after priming. If it is necessary to open the primed base course to traffic before it has completely cured, a fine layer of sand may be used; when you are ready to place the wearing surface, lightly broom the sand from the primed base course.

To estimate the amount of bitumen required for the prime coat, multiply the area to be treated by the rate of application (ROA).

NOTE

Under certain conditions, the estimate should include sufficient bitumen for an additional width of 1 foot on each side of the surface course to be constructed on the primed base.

The formula for a prime coat estimate is as follows:

$$G \text{ or } B = \frac{Lx(W+2)ROAb(1.00+WF)}{Cf}$$

G = amount of bitumen, in gallons

B = amount of bitumen, in barrels

L = length of surface, in feet (convert miles to feet)

W = width of surface, in feet

ROAb = bitumen application rate, in gallons per square yard

WF = Waste factor for bitumen

Cf = conversion factor, in square feet per square yard (use 9 for gallons and

360 [40 x 9] for barrels)

6.2.0 Tack Coat

A tack coat is an application of asphalt to an existing paved surface to provide bond between the existing surface and the asphalt material to be placed on it. Two essential requirements of a tack coat are as follows: (1) it must be thin and (2) it must uniformly cover the entire surface to be treated. A thin tack coat does no harm to the pavement, and it will properly bond the course.

Some of the bituminous materials used for tack coats are rapid-curing cutbacks, road tar cutbacks, rapid-setting emulsions (may be used in warm weather), and medium-asphalt cements. Because rapid-curing cutbacks are highly flammable, safety precautions must be carefully followed.

A tack coat should be applied only when the surface to be tacked is dry and the atmospheric temperature has not been below 35°F for 12 hours immediately before application.

Before applying the tack coat to a surface that is sufficiently bonded, ensure that all loose material, dirt, clay, or other objectionable materials are removed from the surface to be treated. This operation may be accomplished with a power broom or blower, supplemented with hand brooms if necessary.

Immediately following the preparation of the surface, the bituminous material should be uniformly applied by means of a bituminous (asphalt) distributor at the spraying temperature specified. The amount of bitumen application, known as rate of application (ROA), for a tack coat should be applied in quantities not less than 0.05 or more than 0.25 gallon per square yard. The exact quantity varies with the condition of the existing pavement being tack coated. Normally, the construction project specification denotes the ROA for the tack coat application; however, when the ROA is not included in the project specifications, the NCF uses an ROA of .15 for planning and estimating purposes.

Following the application of bituminous material, allow the surface to dry until it is in a proper condition of tackiness to receive the surface course; otherwise, the volatile substances may act as a lubricant and prevent bonding with the wearing surface. Spread clean, dry sand on all areas that show an excess of bitumen to blot up and cure the excess effectively. After excess bitumen is set, lightly broom any loose sand from the primed surface before the wearing surface is laid.

An existing surface that is to be covered by a bituminous wearing surface should be barricaded to prevent traffic from carrying dust or mud onto the surface, either before or after the tack coat is applied. Should it become necessary for traffic to use the surface, one lane may be tack coated and paved, using the other lane as a traffic bypass. The bypass lane should be primed and sanded before it is opened to traffic and it should be swept and reprimed after the adjacent lane is completed

Tack coat materials may be as follows: (1) a road tar, grade RTCB 5-6, RT-6, 7, 8, 9, 10, or 11; (2) an asphalt cutback, such as RC-250 or -803; (3) a diluted emulsion; or (4) an asphalt cement, such as an AP-3 (85-100 penetration) or AP-1 (120-150 penetration).

The procedure for estimating the bitumen required for a tack coat is similar to that described for a prime coat except that the tack coat is applied only over the proposed width of the pavement.

The formula for a tack coat estimates is as follows:

$$\text{G or B} = \frac{L x W x ROAb x (1.00 + WF)}{Cf}$$

G = amount of bitumen, in gallons

B = amount of bitumen, in barrels

L = length of surface, in feet (convert miles to feet)

W = width of surface, in feet

ROAb = bitumen application rate, in gallons per square yard

WF = Waste factor for bitumen

Cf = conversion factor, in square feet per square yard (use 9 for gallons and

360 [40 x 9] for barrels)

6.3.0 Surface Treatment

Bituminous materials and aggregate are combined in various proportions to obtain the most satisfactory surface for a given situation. Accurate estimates are required to avoid production delays because of inadequate supplies. You also want to avoid oversupply and waste of materials.

The formula for estimating supplies for a single surface treatment is as follows:

$$\text{P or T} = \frac{L x W x ROAa x (1.00 + WF)}{Cf}$$

P = aggregate weight, in pounds

T = aggregate weight, in tons

L = length of surface, in feet

W = width of surface, in feet

ROAa = Rate of aggregate application

WF = Waste factor for aggregate

Cf = conversion factor, in square feet per square yard (use 9 for pounds and 18,000 for tons)

The materials for a multiple-surface treatment are determined by the same method as above except the application rate of the binder and the aggregate, and the size of the aggregate for the second lift are one half of that of the first lift.

6.4.0 Compute Bituminous Material

Several methods are used to calculate the amount of hot-mix material required for paving projects; however, when the weight of a hot-mix per square yard or cubic foot is not known, two equations are used in the NCF to compute the number of tons of asphalt required for a project. These equations are as follows:

$$\text{Tons of Asphalt} = \frac{L x W x D x 146}{2000} = \text{Tons x WF}$$

L = length of project in feet

W = width of project in feet

D = depth or thickness of compacted mat. You must change inches into feet by dividing the number of inches by 12 (inches in 1 foot). For paver screed height, add 1/8 inch for each inch of the mat to be paved. (Example: for a 2-inch mat, two blocks of wood 2 1/4 inch thick will be required to set under the screed.) The blocks must be thicker than the finished compacted mat to allow for additional compaction by rollers.

146 = This number represents the approximate weight of 1 cubic foot of compacted hot-mix asphalt. This number can vary from 140 to 160 pounds; however, 146 pounds equals the 110 pounds per square yard per 1-inch depth of asphalt used in the second equation for figuring tons require for asphalt.

WF = Waste factor equals 5% or .05, or 10% or .10, depending on the experience of the screed operators and handwork required on the project.

2,000 = 2,000 pounds is equal to one ton; therefore, you must divide the total weight of material by 2,000, giving tons required.

110 = Pounds per square yard of asphalt per 1 inch depth. (Example: A 2-inch mat will equal 220 pounds per square yard.)

9 = To obtain square yards from square feet, divide by 9.

6.4.1 Estimates for Asphalt Plants

The amount of materials comprising the plant mix can be best determined by a proportionate method. This is demonstrated by the following example:

The required tonnage of plant mix for a project is 800 tons. The aggregate blend is 50/40/10 (percentage coarse aggregate/fine aggregate/mineral filler). The bitumen content is 6 percent. How many tons of each aggregate are required?

The job mix formula is as follows:

$$\frac{100 - OAC}{100} \text{ x Percent AGG}$$

OAC = Optimum Bituminous (Asphalt) Content Solution.

Total aggregate percent by weight= 100 – 6 = 94 percent, or 0.94.

Coarse/aggregate = 0.94 x 50 percent = 47.0 percent by weight of the total mix.

Fine aggregate = .094 x 40 percent = 37.6 percent by weight of the total mix.

Mineral filler = 0.94 x 10 percent = 9.4 by weight of the total mix.

To convert to tons, multiply the required tonnage of plant mix by the percentage of each component of the mix. The results should be adjusted so that the sum of the tonnage of components is equal to the required tonnage of plant mix.

Coarse aggregate = 800 x 0.470 = 376.0 tons

Fine aggregate = 800 x 0.376 = 300.8 tons

Mineral filler = 800 x 0.094 = 75.2 tons

Bitumen = 800 x 0,060 = 48.0 tons

800 tons

(The bitumen weight was calculated as a check.)

6.4.2 Tons per Hour

The equation used to compute the amount of asphalt that can be laid with a paver per hour is as follows:

$$\text{Tons per hour} = \frac{L x W x D x 146}{2000} \text{ x } 60$$

L = Feet per minute. The NCF uses 11 feet per minute for planning purposes.

W = Width of the paver screed

D = Depth or thickness of compacted mat

146 = the approximate weight of 1 cubic foot of compacted hot-mix asphalt

60 = minutes in one hour

2000 = pounds in 1 ton

By planning and estimating the amount of hot-mix asphalt that can be laid per hour, you are able to tell the asphalt plant exactly how much hot-mix asphalt is required to be delivered per hour and/or per day.

6.5.0 Silo and Truck Loading

Estimating the complete cycle time of the haul trucks from loading to delivery and back to loading is a very important step in ensuring there is always enough asphalt mix in the surge silo (*Figure 8-17*). The effective movement of asphalt from the batch or drum plant to the paving site is perhaps the single hardest element in paving operations to keep under control. There are many external factors such as traffic and inexperienced drivers that can slow down or even the stop the flow of asphalt mix to the job site. It is your job as the plant supervisor to ensure the loading of the haul trucks is not one of the factors.

Figure 8-17 — Surge silos.

The objective in truck-cycle management is to supply the paving crews in an even and steady manner that keeps them moving forward at an equally steady rate. In an ideal situation, the paver would never stop, and the truck wait-time on site to discharge would be negligible. As you know, asphalt should not be kept in the surge silo longer than four hours or it will cool down, clogging the silo. Therefore it is very important to know all of the steps involved in a one-haul truck cycle. There are eight elements in a truck cycle: bed washout, loading, weight, ticket and tarp, haul, on-site wait, discharging, and back-haul. Once the cycle is started, all efforts to achieve a smooth and continual rate of delivery should be made.

Once the truck cycle time has been estimated and compared to the capacity of the paving machines, the number of trucks used on a project can be optimized. Once the number of trucks and the cycle time have been determined, you should adjust the plant's production accordingly so as to not overfill the surge silo.

Summary

This chapter discussed the responsibilities an Asphalt Plant Supervisor. It gave an overview of the major components of an asphalt plant as well as the types of plants used in the NCF. The chapter also discussed the types and grades of asphalt and the uses of cutbacks and emulsifiers. Identification of bitumen and their grades were discussed, as well as their testing. Estimation of materials such as prime coats and tack coats were discussed, and the calculations used to determine the amounts of materials needed to complete a project were shown.

This chapter provided general information about all processes needed to supervise an asphalt plant. You should always refer to the manufacturer's manuals and instructions for the most up to date information regarding the equipment you will be operating.

Review Questions (Select the Correct Response)

1. On a batch plant, the size of a batch varies according to the capacity of what component?

   A. Hopper
   B. Dryer
   C. Pugmill
   D. Screens

2. The proper amount of aggregates for asphalt mixes is initially controlled by a uniform flow of the aggregate through what component?

   A. Cold-feed adjustment
   B. Hot-feed adjustment
   C. Cold-bin capacity
   D. Hot-bin capacity

3. The overloading of the screens with aggregate underscores a need for control of what factor?

   A. Proper dryer control
   B. Proper weigh-hopper calibration
   C. Proper cold feeding
   D. Proper gradation control

4. The grading of an individual cold aggregate is determined by taking what action?

   A. Matching a sample of aggregate with a previous marked sample.
   B. Running a sieve analysis.
   C. Measuring the rate of aggregate to the fines.
   D. Noting the progressive thickness of the fines.

5. Which factor(s) control(s) the time required for aggregate to pass through a dryer?

   A. Cylinder speed
   B. Slope of the cylinder
   C. Length, arrangements, and number of flights
   D. All of the above

6. When aggregate particles show signs of an oily coating after leaving the dryer, what adjustment should you make?

   A. Decrease the amount of fuel oil.
   B. Decrease blower or draft air pressure.
   C. Increase the amount of fuel oil.
   D. Increase the amount of natural gas.

7. The temperature of what element controls the temperature of an asphalt mix?

A. Asphalt
B. Dryer
C. Aggregates
D. Pugmill

8. If not kept clean, which component(s) can be a serious cause of air pollution at an asphalt plant?

A. Dust collector
B. Burners
C. Storage silos
D. Batching unit

9. The Jet-Pulse system is used in an asphalt plant as a method to produce what result?

A. Pulses of heat to keep aggregate hot
B. Suction pulses to control dust
C. Pulse of pressure within a filter bag to dislodge “dust cake”
D. Stream of hot asphalt onto aggregates

10. What factor determines the amount of dust from the dust collector that can be returned to the plant?

A. Moisture content
B. Degree of suspension efficiency
C. Mix specification
D. Combined grading of the finish mix

11. Bin partitions should have which property to prevent intermingling of the aggregates within the hot bins?

A. Be tight fitting
B. Be free of holes
C. Be of sufficient height
D. All of the above

12. In a continuous-flow plant, a sample of hot aggregate should be obtained from which location?

A. Scalping screens
B. Overflow vents
C. Feeder gates
D. Dryer

13. What function does the vertical slot in the asphalt return line serve in asphalt heating and circulation?

A. It breaks the vacuum in the line upon reversing the pump.
B. It allows for circulation of asphalt through the feeding and storage system.
C. It prevents oxidation of the asphalt.
D. It provides a means of sampling asphalt.

14. As part of an asphalt mix design, what is the purpose of the mineral filler?

A. To increase the weight of intermediate aggregate.
B. To decrease the curing time of the asphalt mix.
C. To increase the workability of the asphalt mix.
D. To fill in the voids of the aggregates.

15. What is the spraying temperature of emulsion SS-1h?

A. 50°F-140°F
B. 75°F-130°F
C. 110°F-160°F
D. 135°F-175°F

16. Final metering of mineral filler to a mix is accomplished through what device?

A. Constant speed vane
B. Screw feeder
C. Weigh feeder
D. Gate feeder

17. From the hot bins, what size aggregates are deposited into the weigh-hopper first?

A. Coarse
B. Intermediate
C. Fine
D. Mineral filler

18. What factor must be known at all times in order to maintain constant asphalt proportioning?

A. Temperature of the aggregate
B. Output temperature of the dryer
C. Temperature of the hot bins
D. Temperature of the asphalt

19. What period of time begins when all the combined mineral aggregates are in the mixer and ends when the gate is open?

A. Total mixing time
B. Wet mixing time
C. Dry mixing time
D. Shortest mixing time

20. What period of time starts with the asphalt application and ends with the opening of the discharge gates?

A. Total mixing time
B. Wet mixing time
C. Dry mixing time
D. Shortest mixing time

21. Exposure to what environmental condition(s) makes asphalt film harden on the aggregates?

A. Air only
B. Moisture only
C. Heat and air
D. Moisture and air

22. In a drum-mix plant, in what location is aggregate mixed with the asphalt?

A. Mix surge silo
B. Hot-mix conveyer
C. Dust collector
D. Dryer

23. What factor is the basis for determining the quantity of asphalt delivered into the drum?

A. Weight of the aggregate
B. Gradation of the aggregate
C. Drum-mix output requirement
D. Speed of the in-line belt feeder

24. What condition creates an oily coating on the aggregate particles?

A. Unheated aggregate
B. Unbalanced distribution of asphalt
C. Lack of balance in the burner operation
D. Slowness of the drum-mixer speed

25. What is/are the function(s) of the aggregates in an asphalt surface?

A. Transmits the load from the surface to the subgrade.
B. Absorbs the abrasive wear of the traffic.
C. Provides a nonskid surface.
D. All of the above

26. Which factor is required to support the bearing action on a bituminous wearing surface?

A. Larger aggregates are placed in the mix design.
B. Subgrade and base course have adequate thickness, strength, cohesion, and bearing capacity.
C. Amount of asphalt in the mix is upgraded.
D. Mix is given adequate curing time.

27. When used with asphalt cement, which distillate allows for slow curing after application to a roadway?

A. Naphtha
B. Kerosene
C. Fuel oil
D. Gasoline

28. Which viscosity grade of MC asphalt bitumen is considered the most fluid?

A. 30 to 60
B. 200 to 800
C. 800 to 1,000
D. 1,000 to 3,000

29. When added to asphalt cement, which produce(s) an asphalt emulsion?

A. Water only
B. Soap only
C. Water and soap
D. Kerosene

30. What road tar symbol designates a hot tar?

A. RT 1
B. RT 2
C. RT 5
D. RT 9

31. Field identification of bituminous material found stockpiled in unmarked containers is necessary for which reason?

A. To determine the type and method of construction it can be used for.
B. To establish safe handling practices for the material.
C. To determine type and quality of equipment needed.
D. All of the above

32. Normally, what field test is used to differentiate between unknown bituminous materials?

A. Heat-odor
B. Solubility
C. Water-mixing
D. Penetration

33. When you are performing the solubility test, what material will form a stringy undissolved mass?

A. Asphalt
B. Asphalt cement
C. Emulsion
D. Tar

34. What grade of asphalt is indicated by a field test in which the sharp point of a pencil penetrates the asphalt with difficulty?

A. Hard
B. Medium
C. Medium hard
D. Soft

35. What is the purpose of a prime coat?

A. To waterproof the surface.
B. To plug capillary voids.
C. To coat and bond loose particles.
D. All of the above

36. If the ROA is not known, what ROA is used in the NCF for planning purposes?

A. .1
B. .2
C. .3
D. .4

37. What is the NCF ROA for a tack coat?

A. .10
B. .15
C. .20
D. .25

38. How many drums of tack coat material are required for a project 500 feet long and 50 feet wide with a waste factor of 5 percent and an ROA of .15?

A. 8.25
B. 10.94
C. 43.74
D. 82.54

39. What does a bituminous wearing surface Lack?

A. Flexibility
B. Bearing action
C. Versatility
D. Expedience

40. What is one function of a bituminous binder?

A. To hold the aggregate together.
B. To bind the tars to the surface.
C. To bind the asphalt to the road surface.
D. To help the surface water seep into the road base.

41. What type of asphalt cutback is composed of asphalt cement and gasoline?

A. Rapid-curing
B. Medium-curing
C. Slow-curing
D. Road oil

42. When should the aggregate in a drum-mix plant be proportioned?

A. As it enters the pugmill
B. After the cold-feed system
C. Before entering the mixing drum
D. Upon introduction with the bitumen

43. What are the two types of preliminary treatments used before a bituminous surface is placed?

A. Bituminous coat and asphalt coat
B. Prime coat and tack coat
C. Aggregate coat and bituminous coat
D. In-place coat and imported coat

Terms Introduced in this Chapter

Aggregate	Granular material such as sand, gravel, crushed gravel, crushed stone, slag, and cinders. Aggregate is used in construction for the manufacturing of concrete, mortar, grout, asphaltic concrete, and roofing shingles.
Anionic	The term anionic is derived from the migration of particles of asphalt under an electric field. The droplets migrate toward the anode (positive electrode), and hence the emulsion is called anionic.
Bitumen	Any of various flammable mixtures of hydrocarbons and other substances, occurring naturally or obtained by distillation from coal or petroleum, that are a component of asphalt and tar and are used for surfacing roads and for waterproofing.
Cationic	The term cationic is derived from the migration of particles of asphalt under an electric field also. The droplets migrate toward the cathode (negative electrode), and hence the emulsion is called cationic.

Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.

COMFIRSTNCDINST 11200.2 Naval Construction Force Equipment Management Instruction, Commander First Naval Construction Division, Norfolk, VA. 2006

Naval Construction Force Operations, Navy Tactics, Techniques and Procedures (NTTP) 4-04.2. Department of the Navy Office of the Chief of Naval Operations, 2009.

Naval Construction Force Welding Materials Handbook. NAVFAC P-433, Naval Facilities Engineering Command Alexandria, VA, 1991

Pavement Maintenance Management, TM 5-623, Headquarters, Department of the Army, Washington, DC, November 1982.

Paving and Surfacing Operations FM 5-436, Headquarters, Department of the Army Washington, DC, 28 April 2000.

Seabee Crewleader's Handbook: 3rd ed., Seabee Readiness Division of the Naval School, Civil Engineer Corps Officers (CECOS), Port Hueneme, CA, 2003.

Seabee Planner's and Estimator's Handbook, NAVFAC P-405, Naval Facilities Engineering Command, Alexandria, VA, 1996.

Soil Stabilization for Pavements, TM 5-822-14/AFMAN 32-8010, Headquarters, Department of the Army, and the Air Force Washington, DC, 25 October 1994.

State Binder Specifications, Asphalt Institute, Lexington, KY, 2003

Title 40: Protection of Environment, Part 60 Standards of Performance for Nonmetallic Mineral Processing Plants, Subpart 000, Standards of Performance for Nonmetallic Mineral Processing Plants, Section 60.670 Applicability and Designation of Affected Facility, Electronic Code of Federal Regulations, 2009

US Army Engineer, Flexible Pavement Structures Subcourse EN5458

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