PART II

Hot-Mix Asphalt Plant Operations

5 Types of Asphalt Plants: Overview

The purpose of an HMA plant is to blend aggregate and asphalt cement together at an elevated temperature to produce a homogeneous asphalt paving mixture. The aggregate used can be a single material, such as a crusher run aggregate or a pit run material, or it can be a combination of coarse and fine aggregates, with or without mineral filler. The binder material used is normally asphalt cement but may be an asphalt emulsion or one of a variety of modified materials. Various additives, including liquid and powdered materials, can also be incorporated into the mixture. Indeed, with Superpave the use of additives is becoming more common. Use of additives can result in a need for more binder storage tanks, as well as silos for adding mineral materials.

There are three basic types of HMA plants currently in use in the United States: batch, parallel-flow drum-mix, and counter-flow drum-mix. All three types serve the same ultimate purpose, and the asphalt mixture should be essentially similar regardless of the type of plant used to manufacture it. The three types of plants differ, however, in operation and flow of materials, as described in the following sections.

BATCH PLANTS

The major components of a batch plant are the cold-feed system, asphalt cement supply system, aggregate dryer, mixing tower, and emission-control system. A typical batch plant is depicted in Figure 5-1; the major plant components are shown in Figure 5-2. The batch plant tower consists of a hot elevator, a screen deck, hot bins, a weigh hopper, an asphalt cement weigh bucket, and a pugmill. The flow of materials in a batch tower is illustrated in Figure 5-3.

The aggregate used in the mix is removed from stockpiles and placed in individual cold-feed bins. Aggregates of different sizes are proportioned out of their bins by a combination of the size of the opening of the gate at the bottom of each bin and the speed of the conveyor belt under the bin. Generally, a feeder belt beneath each bin deposits the aggregate on a gathering conveyor located under all of the cold-feed bins. The aggregate is transported by the gathering conveyor and transferred to a charging conveyor. The material on the charging conveyor is then carried up to the aggregate dryer.

The dryer operates on a counter-flow basis. The aggregate is introduced into the dryer at the upper end and is moved down the drum by both the drum rotation (gravity flow) and the flight configuration inside the rotating dryer. The burner is located at the lower end of the dryer, and the exhaust gases from the combustion and drying process move toward the upper end of the dryer, against (counter to) the flow of the aggregate. As the aggregate is tumbled through the exhaust gases, the material is heated and dried. Moisture is removed and carried out of the dryer as part of the exhaust gas stream. The hot, dry aggregate is then discharged from the dryer at the lower end.

The hot aggregate is usually transported to the top of the plant mixing tower by a bucket elevator. Upon discharge from the elevator, the aggregate normally passes through a set of vibrating screens into, typically, one of four hot storage bins. The finest aggregate material goes directly through all the screens into the No. 1 hot bin; the coarser aggregate particles are separated by the different-sized screens and deposited into one of the other hot bins. The separation of aggregate into the hot bins depends on the size of the openings in the screen that is used in the screen deck and the gradation of the aggregate in the cold-feed bins.

The heated, dried, and resized aggregate is held in the hot bins until being discharged from a gate at the bottom of each bin into a weigh hopper. The correct proportion of each aggregate is determined by weight.

At the same time that the aggregate is being proportioned and weighed, the asphalt cement is being pumped from its storage tank to a separate heated weigh bucket located on the tower just above the pugmill. The proper amount of material is weighed into the bucket and held until being emptied into the pugmill.

The aggregate in the weigh hopper is emptied into a twin-shaft pugmill, and the different aggregate fractions are mixed together for a very short period of time—usually less than 5 seconds. After this brief dry-mix time, the asphalt cement from the weigh bucket is discharged

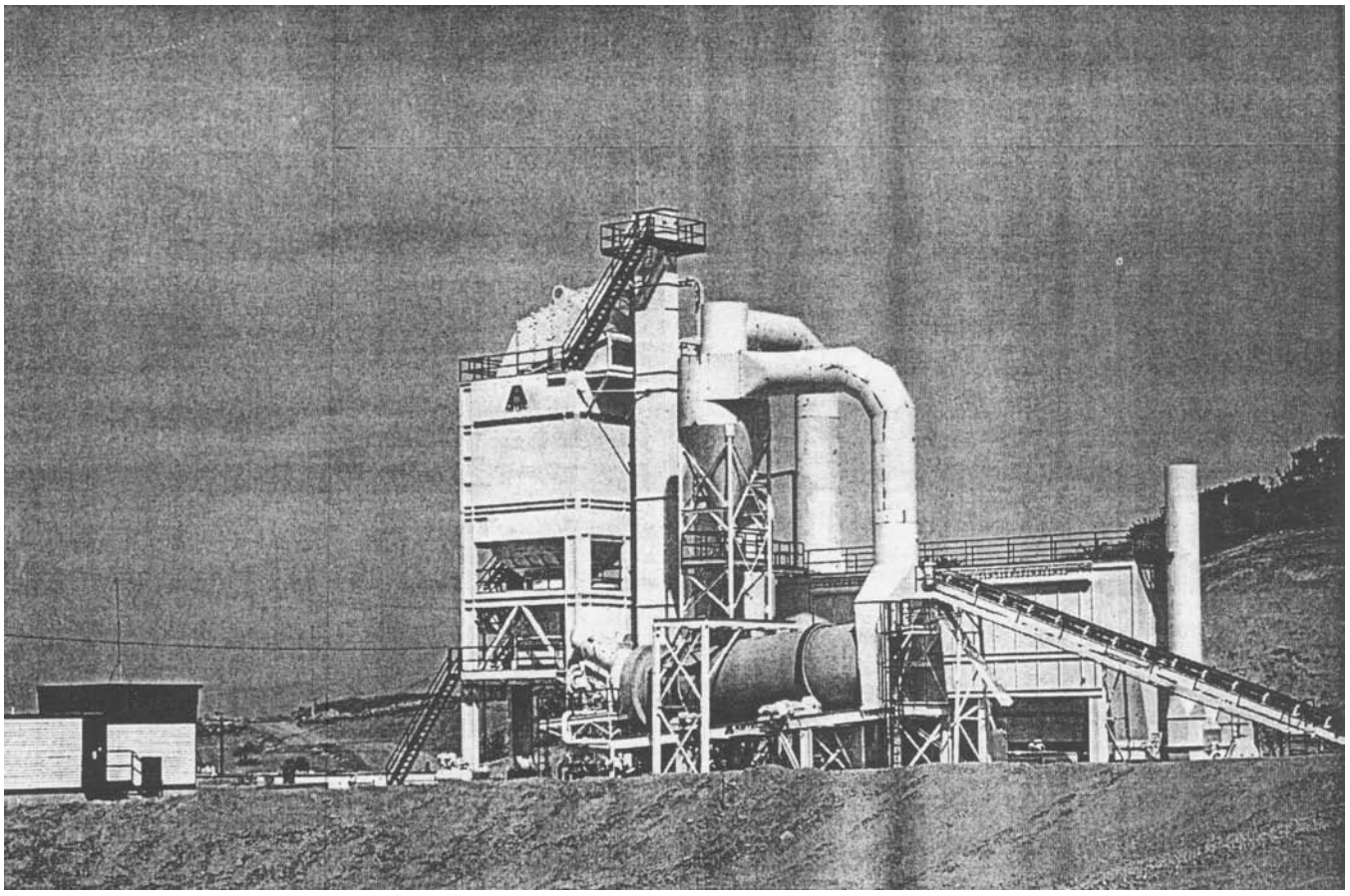

FIGURE 5-1 Typical HMA batch plant.

into the pugmill, and the wet-mix time begins. The mixing time for blending of the asphalt cement with the aggregate should be no more than that needed to completely coat the aggregate particles with a thin film of the asphalt cement material—usually in the range of 25 to 35 seconds, with the lower end of this range being for a pugmill that is in good condition. The size of the batch mixed in the pugmill can be in the range of 1.81 to 5.44 tonnes (2 to 6 tons).

When mixing has been completed, the gates on the bottom of the pugmill are opened, and the mix is discharged into the haul vehicle or into a conveying device that carries the mix to a silo from which trucks will be loaded in batch fashion. For most batch plants, the time needed to open the pugmill gates and discharge the mix is approximately 5 to 7 seconds. The total mixing time (dry-mix time + wet-mix time + mix discharge time) for a batch can be as short as about 30 seconds, but typically, the total mixing time is about 35 seconds.

The plant is equipped with emission-control devices, comprising both primary and secondary collection systems (see Section 12). A dry collector or knockout box is normally used as the primary collector. Either a wet scrubber system or, more often, a dry fabric filter system (baghouse) can be used as the secondary collection system to remove particulate matter from the exhaust gases that flow out of the dryer and send clean air to the atmosphere through the stack.

If RAP is incorporated into the mix, it is placed in a separate cold-feed bin from which it is delivered to the plant. The RAP can be added to the new aggregate in one of three locations: the bottom of the hot elevator; the hot bins; or, most commonly, the weigh hopper. Heat transfer between the superheated new aggregate and the reclaimed material begins as soon as the two materials come in contact and continues during the mixing process in the pugmill.

PARALLEL-FLOW DRUM-MIX PLANTS

The parallel-flow drum-mix plant is a variation of the old-style continuous-mix plant. It consists of five major components: the cold-feed system, asphalt cement sup-

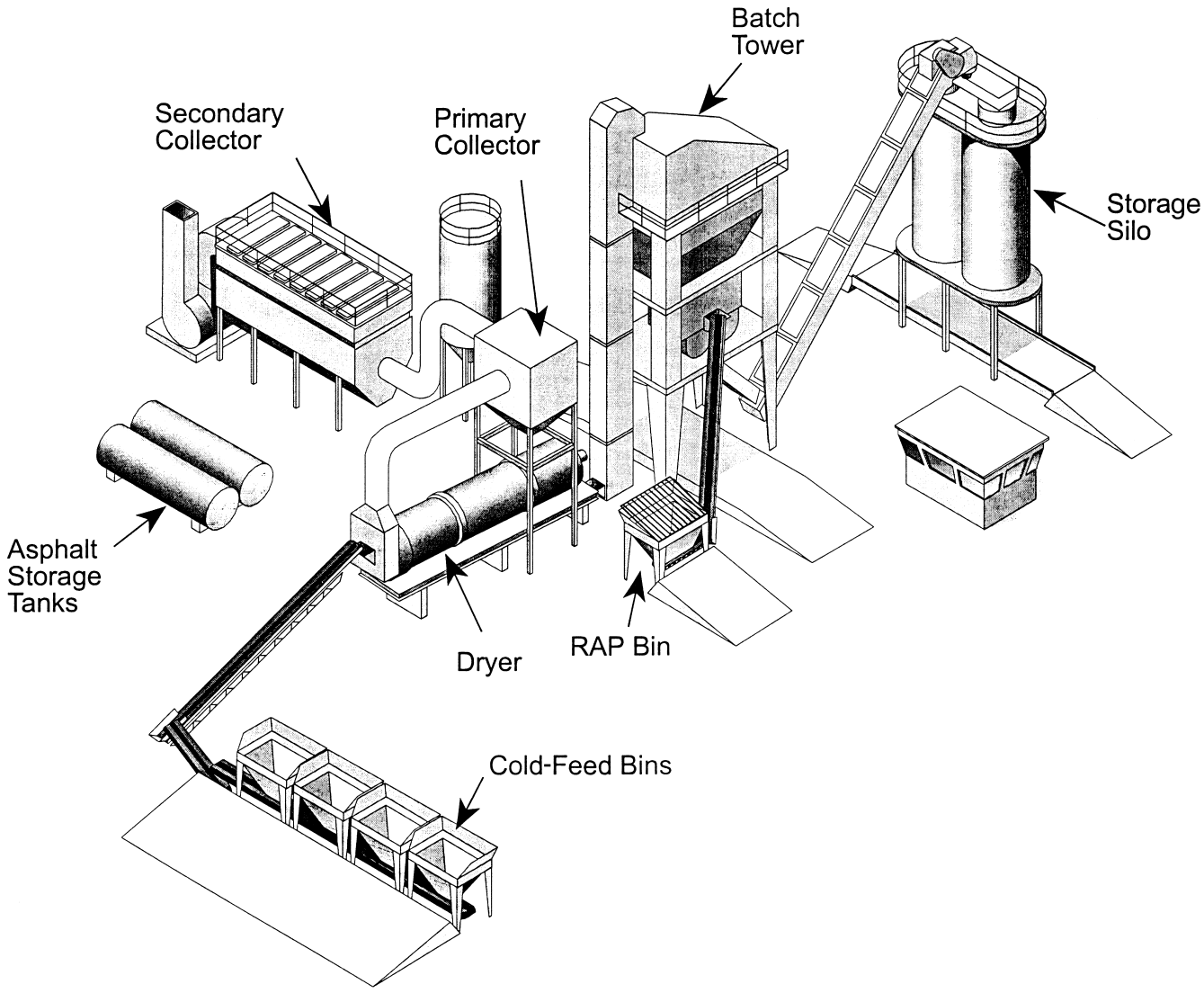

FIGURE 5-2 Major components of a batch plant.

ply system, drum mixer, surge or storage silos (see Section 11 for definitions of these silo types), and emission-control equipment. A typical parallel-flow drum-mix plant is depicted in Figure 5-4; the major plant components are shown in Figure 5-5.

The cold-feed bins are used to proportion the material to the plant. A variable-speed feeder belt is used under each bin. The amount of aggregate drawn from each bin can thus be controlled by both the size of the gate opening and the speed of the feeder belt to provide accurate delivery of the different-sized materials. The aggregate on each feeder belt is deposited onto a gathering conveyor that runs beneath all of the cold-feed bins. The combined material is normally passed through a scalping screen and then transferred to a charging conveyor for transport to the drum mixer.

The charging conveyor is equipped with two devices that are used to determine the amount of aggregate being delivered to the plant: a weigh bridge under the conveyor belt measures the weight of the aggregate passing over it, and a sensor determines the speed of the belt. These two values are used to compute the wet weight of aggregate, in tonnes (tons) per hour, entering the drum mixer. The plant computer, with the amount of moisture in the aggregate provided as an input value, converts the wet weight to dry weight in order to determine the correct amount of asphalt cement needed in the mix.

The conventional drum mixer is a parallel-flow system—the exhaust gases and the aggregate move in the same direction. The burner is located at the upper end (aggregate inlet end) of the drum. The aggregate enters the drum either from an inclined chute above

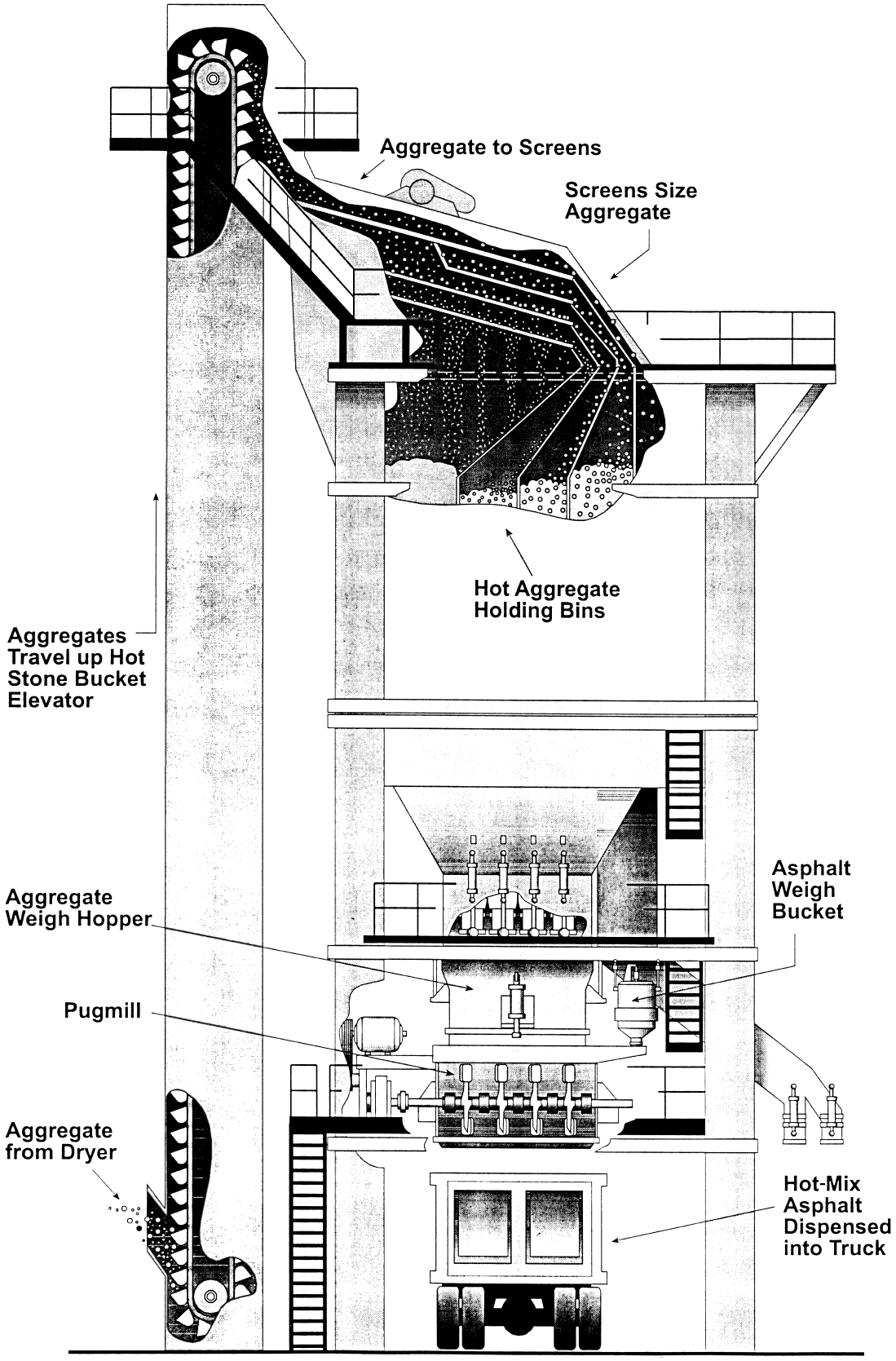

FIGURE 5-3 Flow of materials in batch tower.

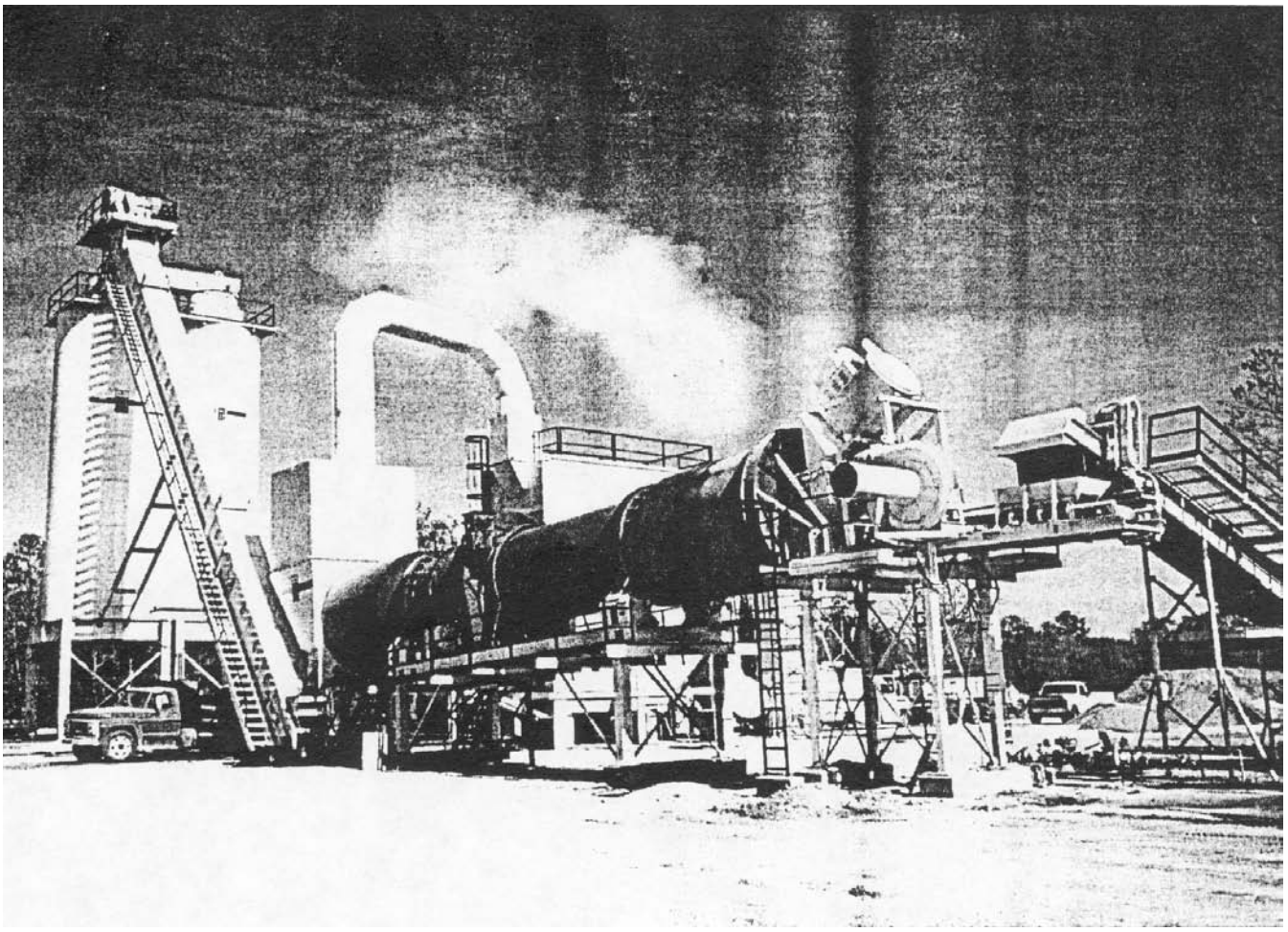

FIGURE 5-4 Typical HMA parallel-flow drum-mix plant.

the burner or on a Slinger conveyor under the burner. The aggregate is moved down the drum by a combination of gravity and the configuration of the flights located inside the drum. As it travels, the aggregate is heated and the moisture removed. A dense veil of aggregate is built up near the midpoint of the drum length to assist in the heat-transfer process.

If RAP is added to the new aggregate, it is deposited from its own cold-feed bin and gathering/charging conveyor system into an inlet located near the center of the drum length (split-feed system). In this process, the reclaimed material is protected from the high-temperature exhaust gases by the veil of new aggregate upstream of the RAP entry point. When mixes with high RAP content are used, it is more likely that the RAP will be overheated in the process. This may result in smoke being emitted from the drum or damage to the RAP.

The new aggregate and reclaimed material, if used, move together into the rear portion of the drum. The asphalt cement is pulled from the storage tank by a pump and fed through a meter, where the proper volume of asphalt cement is determined. The binder material is then delivered through a pipe into the rear of the mixing drum, where the asphalt cement is injected onto the aggregate. Coating of the aggregate occurs as the materials are tumbled together and moved to the discharge end of the drum. Mineral filler or baghouse fines, or both, are also added into the back of the drum, either just before or in conjunction with the addition of the asphalt cement.

The asphalt mix is deposited into a conveying device (a drag slat conveyor, belt conveyor, or bucket elevator) for transport to a storage silo. The silo converts the continuous flow of mix into a batch flow for discharge into the haul vehicle.

In general, the same type of emission-control equipment is used on the drum-mix plant as on the batch plant. A primary dry collector and either a wet scrubber system or a baghouse secondary collector can be used. If a wet scrubber system is used, the collected fines cannot be recycled back into the mix and are wasted; if a baghouse is

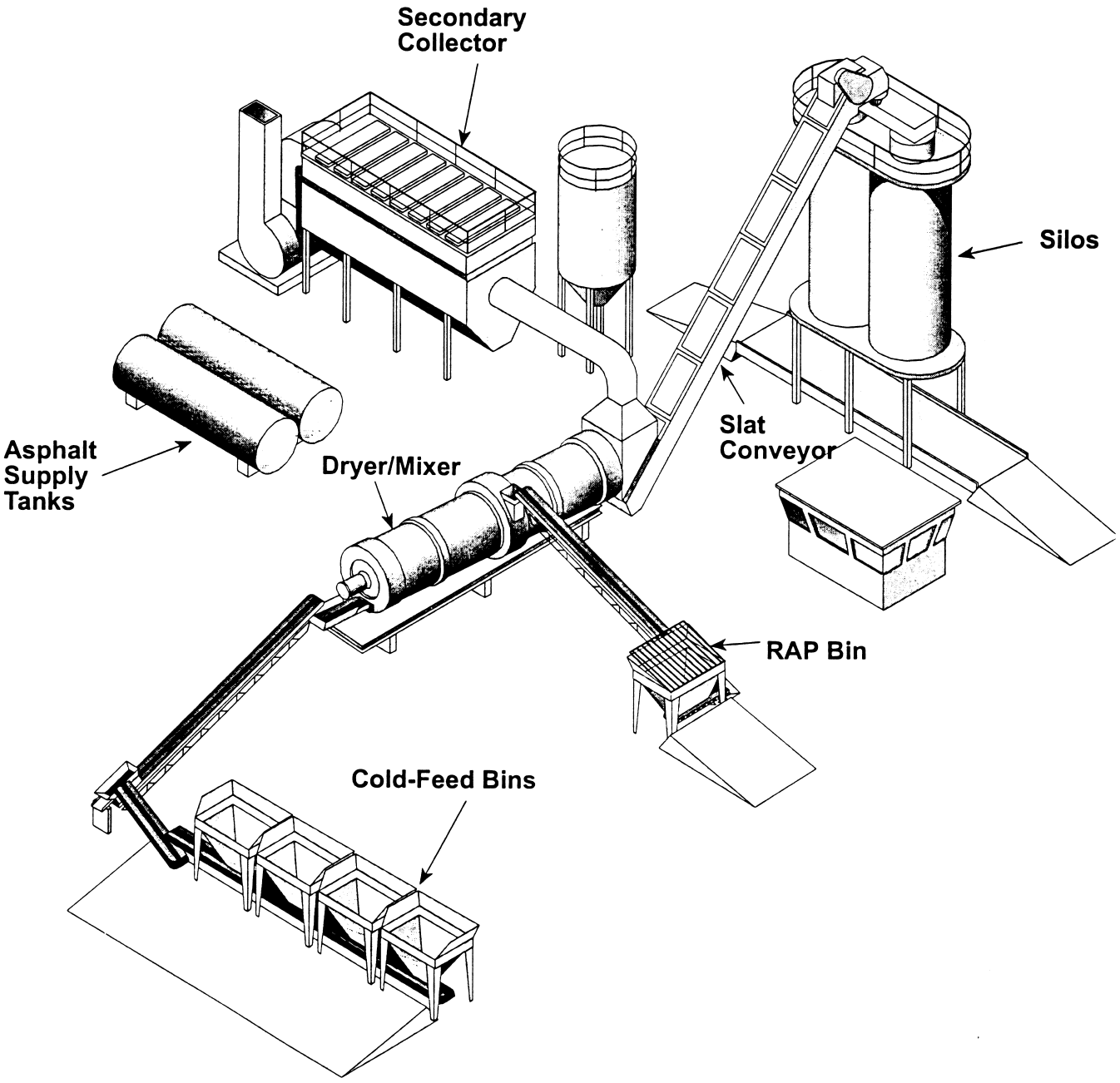

FIGURE 5-5 Major components of a parallel-flow drum-mix plant.

used, the collected fines can be returned in whole or in part to the mixing drum, or they can be wasted.

In the late 1980s, a number of variations on the conventional parallel-flow drum-mix plant were introduced to the HMA industry. One of these is the coater plant. For this type of drum mixer, the asphalt cement injection pipe is removed from the drum. This modification eliminates exposure of the asphalt cement to the high-temperature exhaust gases and reduces both hydrocarbon and visible emissions from the plant. The uncoated aggregate, which is heated and dried inside the parallel-flow drum, is discharged into a single- or dual-shaft mixing chamber, where it is sprayed with asphalt cement. The blending of the asphalt cement and the aggregate takes place as the materials move from one end of the mixing unit to the other. When mixing has been completed, the material is delivered to the conveying device used to transport it to the silo. Figure 5-6 depicts the coater type of drum-mix plant. Because the number of coater parallel-flow drum-mix plants in use is currently limited, this type of plant is not discussed further in this manual.

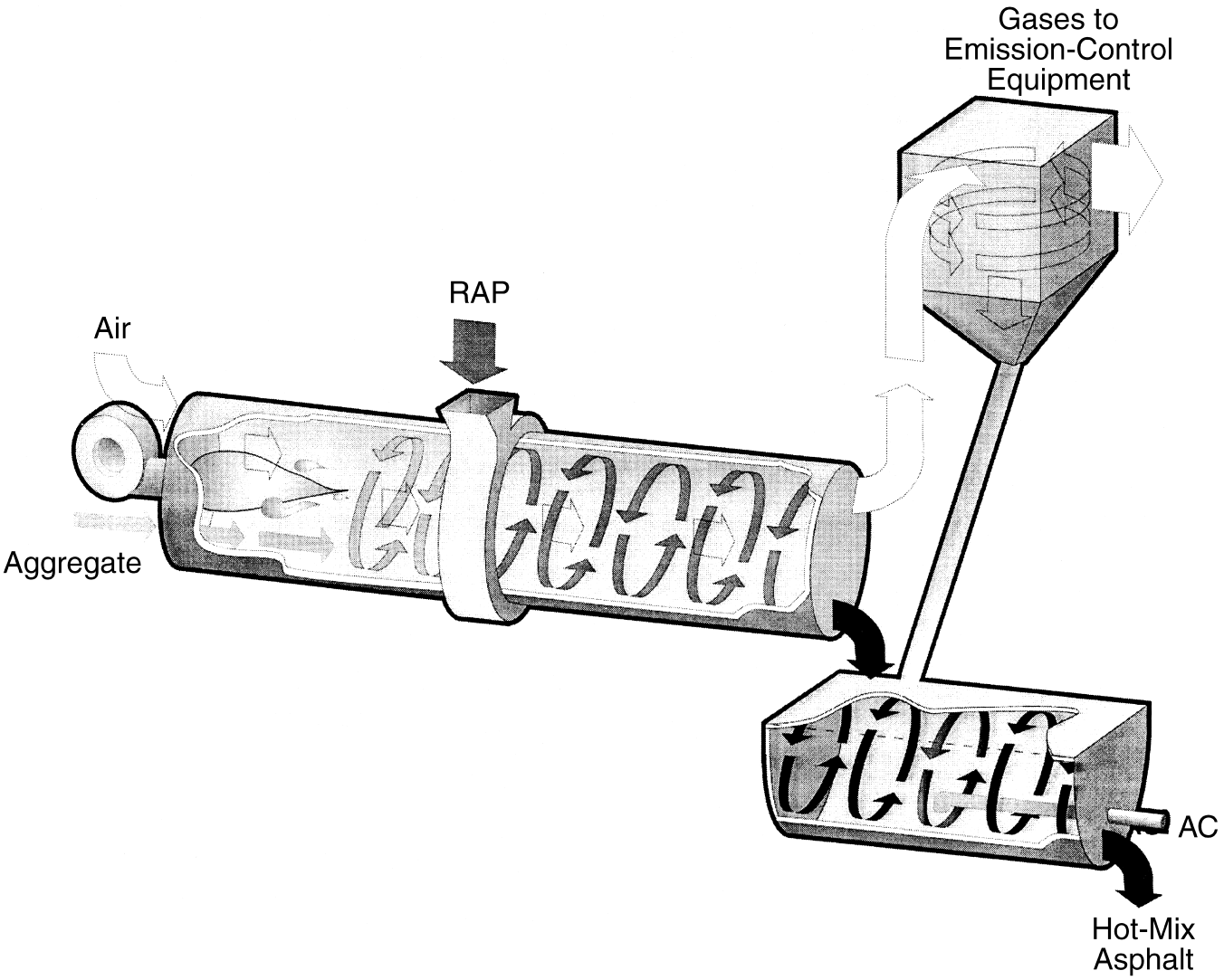

FIGURE 5-6 Drum-mix plant with coater.

COUNTER-FLOW DRUM-MIX PLANTS

A more recent development in drum-mix plant design is the counter-flow drum-mix plant. Its design represents an effort to improve the heat transfer process inside the drum and to reduce plant emissions. In the counter-flow drum-mix plant, the heating and drying of the aggregate are accomplished in a manner similar to that of a conventional batch plant dryer.

Two basic types of counter-flow drum-mix plants are in use. The first, shown in Figure 5-7, has the mixing unit extended on the end of the aggregate dryer portion of the drum. The second, shown in Figure 5-8, has the mixing unit folded back around the aggregate dryer portion of the drum. With both designs, the aggregate enters the drum from the upper end. The burner, however, is located near the lower end of the drum, similar to its position on a batch plant dryer. The aggregate moves down the drum against the flow of the exhaust gases in a counter-flow direction. No asphalt cement is introduced into the aggregate within the main (drying) portion of the drum. The mixing of the binder material with the heated and dried aggregate is accomplished completely outside of the exhaust gas stream—behind or underneath the burner.

In the counter-flow drum-mix plant design shown in Figure 5-7, the hot aggregate passes the burner into a mixing zone. At the upper end of the mixing zone, the baghouse fines or mineral filler (or both) are added to the aggregate. A short distance later, the binder material is introduced into the drum. The mixing of the aggregate and asphalt cement thus takes place behind (downstream of) the dryer in a separate mixing zone, out of contact with the exhaust gases from the burner. If RAP is used in the asphalt mix, it is introduced into the drum

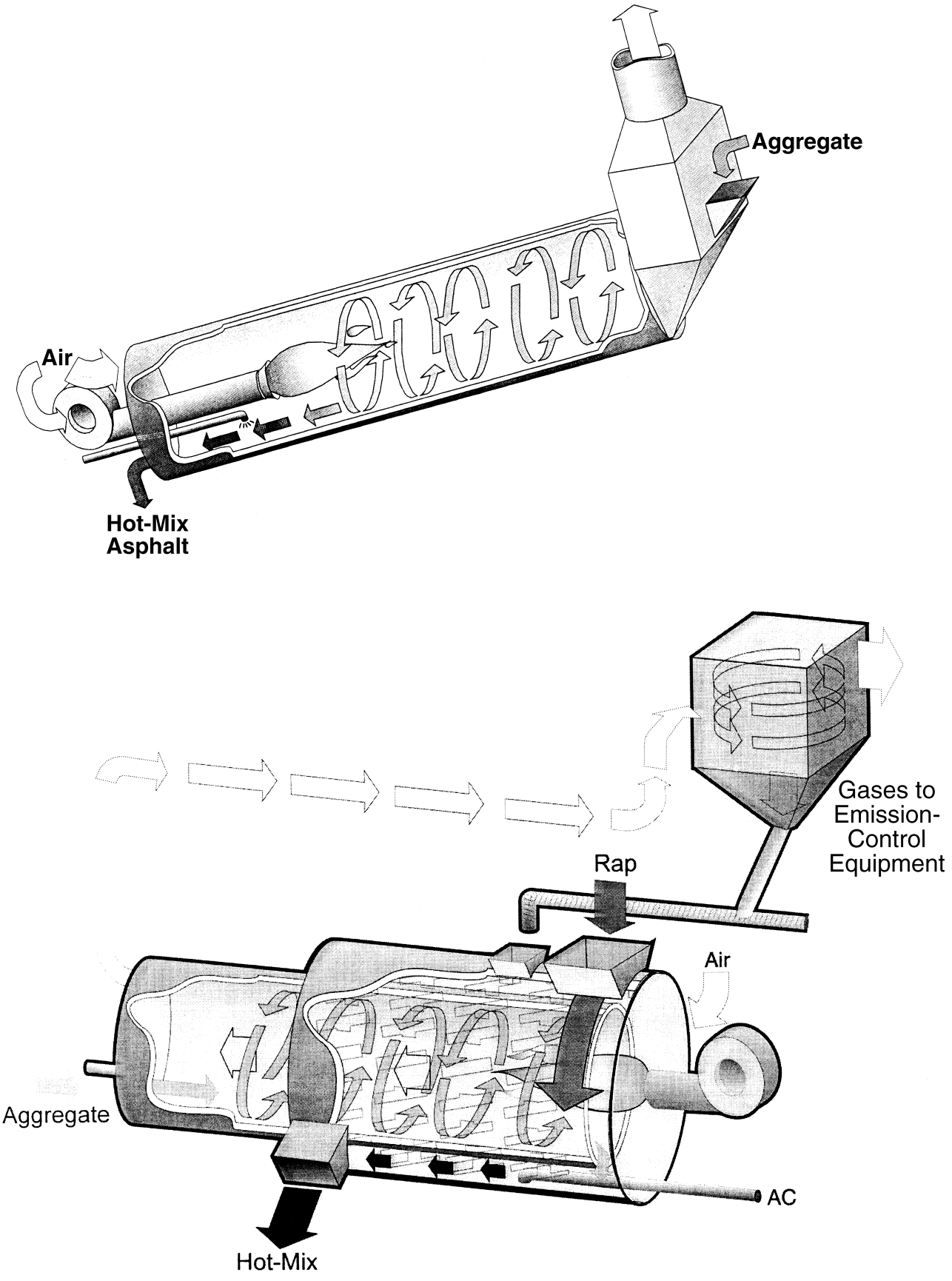

FIGURE 5-8 Counter-flow drum mixer with mixing unit folded around aggregate dryer.

downstream of (behind) the burner. Thus the RAP also does not come in contact with the high-temperature exhaust gases from the burner, and visible hydrocarbon emissions are reduced. The reclaimed material is heated by overheating the new aggregate in the upper end of the counter-flow dryer and blending the two materials together in the lower portion of the drum, between the burner and the discharge end of the mixing unit.

In the counter-flow drum-mix plant design shown Figure 5-8, the inner drum acts as an aggregate dryer, and the outer drum serves as the mixing unit. The asphalt cement is introduced into the aggregate after the aggregate has been discharged from the inner into the outer drum. The blending of the two materials occurs as the aggregate and asphalt cement are conveyed back uphill in the outer drum by a set of mixing paddles attached to the inner drum. The inner drum rotates, whereas the outer drum is stationary. This type of counter-flow drum-mix plant is known commercially as a double-barrel plant because of the double-drum setup. Any mineral filler or baghouse fines, as well as RAP material, enters the drum in the double-barrel process between the inside and outside drums. Thus, as with the design shown in Figure 5-7, the material is kept away from the exhaust gases from the burner. In particular, this protects the RAP from contact with the high-temperature exhaust gases and thus reduces the possibility that visible emissions will be generated during the recycling process.