

Low-temperature drying and conditioning for asphalt production

How controlled fluid bed processing can support virgin aggregates, reclaimed asphalt pavement and hybrid energy concepts

1. Introduction: asphalt production is changing

Asphalt producers are being asked to combine reliable production with lower energy use, reduced emissions and greater use of recycled asphalt pavement (RAP). At the same time, raw-material moisture, changing recipes and variable production rates continue to affect plant efficiency and final mix consistency.

Drying and heating are central to this challenge. Water must be removed before mixing, while mineral fractions and RAP must reach suitable process conditions without unnecessary thermal load. A single process route is therefore not always the best answer for every material stream.

Ventilex approaches the asphalt market from the drying process itself. Instead of treating the dryer as an isolated machine, the process is assessed around material properties, required outlet conditions, available heat sources, plant integration and cost per tonne.

Core principle

Virgin aggregates, fine fractions and RAP should be assessed as distinct material streams. Particle size, moisture, final temperature and binder behaviour determine the appropriate process route.

2. The raw materials behind asphalt production

Material stream	Role in asphalt	Drying and heating consideration
Sand and fine aggregates	Fine mineral fraction in the mixture	Often carries a relatively high moisture load and can benefit from controlled, efficient drying.
Coarse aggregates	Structural mineral skeleton	Commonly heated in an existing drum; integration depends on plant design and temperature demand.
Mineral filler	Fills voids and influences mix properties	Can be heated separately where this reduces unnecessary heating of the full mineral blend.
Reclaimed asphalt pavement (RAP)	Recycled aggregate plus existing bitumen	Needs moisture removal and temperature control while managing ageing, sticking and emissions.

3. Why moisture and temperature control matter

Moisture directly affects the thermal duty of an asphalt plant. Energy is first required to heat the water and then to evaporate it. Variations in inlet moisture can therefore change fuel demand, throughput and process stability. The effect is especially relevant for fine materials and RAP, which can retain moisture and show variable flow behaviour.

Temperature is equally important. Virgin mineral fractions may require substantial heating before mixing, while RAP already contains aged bitumen. RAP should therefore not automatically be treated in the same way as clean aggregate. Excessive temperature or uncontrolled residence time can increase the risk of binder ageing, sticking and emissions.

A controlled drying process should balance four objectives:

- Remove the required amount of moisture.
- Deliver the material at a defined and repeatable temperature.
- Avoid unnecessary thermal load and heat losses.
- Maintain stable flow and predictable residence time.

4. Fluid bed drying as a separate process step

In a shaking fluid bed, process air passes upward through the product layer while the machine transports the material forward with a controlled shaking motion. The air surrounds the particles and supports uniform heat transfer. The conveying principle creates controlled plug flow, helping to achieve a predictable residence time.

Process characteristic	Potential relevance for asphalt raw materials
Uniform air-to-particle contact	Supports even moisture removal and temperature distribution.
Controlled plug flow	Reduces broad residence-time variation and supports repeatable outlet conditions.
Low-frequency shaking motion	Helps transport material with limited mechanical stress.
Zoned process design	Allows drying, heating, cooling or heat recovery functions to be combined where suitable.
Recipe-based operation	Enables airflow and temperature settings to be adapted to selected material fractions.

Important limitation

A fluid bed is not automatically suitable for every RAP fraction or every aggregate grading. Material testing is required to confirm fluidization, conveying, emissions behaviour, sticking risk and achievable final conditions.

5. Three practical integration routes

The most suitable concept depends on the existing asphalt plant, the target material streams and the available energy infrastructure. Ventilex typically evaluates three routes.

5.1 Sand and selected aggregate fractions

A separate fluid bed can dry and heat natural or crushed sand and selected stone fractions before storage or mixing. The concept may operate as a stand-alone line, as a pre-dryer upstream of an existing drum, or as part of a new production line.

5.2 Controlled conditioning of RAP

RAP can be considered as a separate low-temperature process route. The objective is to remove moisture and add controlled heat while limiting binder activation, sticking and ageing. The required air temperature, residence time and final product temperature must be established through tests and process calculations.

5.3 Hybrid integration with the existing plant

A new dryer does not necessarily replace the existing drum. A hybrid concept can keep the drum for coarse virgin aggregates while a separate Ventilex process handles high-moisture fines, selected sand fractions or RAP. This allows the existing asset to remain in service while targeting the material streams where separate control can add the most value.

Integration route	Typical use	Main design questions
Stand-alone mineral dryer	Selected sand or aggregate fraction	Throughput, moisture range, outlet temperature, hot storage and dust handling.
RAP conditioning module	Dedicated RAP fraction	Binder behaviour, emissions, sticking, target inclusion rate and final temperature.
Hybrid retrofit	Ventilex unit alongside existing drum	Material split, heat integration, controls, interfaces and available space.
New-build integrated line	New asphalt production concept	Overall flowsheet, energy strategy, redundancy and future product mix.

A simplified decision logic

Question	If yes, investigate
Is one material stream responsible for a disproportionate moisture load?	Separate pre-drying or dedicated fluid bed processing.
Is more RAP desired but temperature control is limiting?	Low-temperature RAP testing and a dedicated conditioning route.
Is usable waste heat available?	Heat recovery, heat pump or hybrid air-heating concepts.
Is gas reduction a strategic objective?	Electric heating, recovered heat or a staged hybrid solution.

6. Energy routes: combustion, electricity and recovered heat

The dryer should be configured around the heat sources that are technically available and commercially sensible at the site. The best solution can differ significantly between plants because electricity prices, fuel prices, operating hours, grid capacity and waste-heat availability are site specific.

Heating route	Potential role	Key checks
Combustion	Direct and responsive heat input for high thermal duties.	Fuel availability, emissions, burner control and local requirements.
Electric air heating	Route to full electrification where sufficient power is available.	Grid connection, transformer capacity, peak demand and electricity price.
Waste heat	Use available energy from the asphalt plant or another site process.	Temperature level, flow stability, contamination, operating overlap and duct routing.
Heat pump	Upgrade lower-temperature recovered heat for suitable drying duties.	Source temperature, required sink temperature, COP, condensate and annual hours.
Hybrid system	Combine recovered heat with electric or combustion backup.	Control philosophy, redundancy and seasonal operation.

6.1 Heat recovery inside the drying system

Depending on the selected process, heat can potentially be recovered from cooling air or recirculated within the air system. Ventilex can also evaluate combinations such as recirculation, twin-coil recovery and heat-pump integration. The final selection must be based on the actual air conditions, dust load, corrosion risk and required product temperature.

6.2 Illustrative energy comparison for sand

The example below is an internal benchmark for sand drying at equal product conditions. It is included to show how process design and heat recovery can influence thermal demand. It is not an energy guarantee for hot aggregates or RAP.

Concept	Illustrative thermal demand	Relative to baseline
Conventional drum dryer	325 MJ/t	100% baseline
Modernized drum dryer	240 MJ/t	Approximately 26% lower
Ventilex fluid bed with recirculation	210 MJ/t	Approximately 35% lower

Basis: sand at 5% inlet moisture and 15°C, dried to 0.2% moisture and below 45°C. Project values depend on moisture, ambient conditions, heat losses, capacity and outlet requirements.

Commercial focus

The correct comparison is not only equipment price. It is the cost per dried tonne, including energy, maintenance, availability, product losses and the value of increased RAP use or improved plant flexibility.

7. RAP requires a separate validation approach

RAP contains mineral aggregate and aged binder. Its behaviour changes with source, fraction, moisture content, binder condition and storage history. For that reason, design assumptions taken from clean sand or virgin aggregate cannot simply be transferred to RAP.

A responsible RAP assessment should confirm:

- Particle-size distribution and fines content.
- Bulk density, flow behaviour and tendency to agglomerate.
- Inlet moisture range and expected seasonal variation.
- Required moisture and temperature at the outlet.
- Binder softening, sticking and deposit formation across the proposed temperature range.
- Dust, vapour, odour and emissions behaviour.
- Required RAP inclusion rate in the final asphalt recipe.

7.1 Testing before performance commitments

Material testing provides the basis for selecting air temperature, airflow, bed loading, residence time and mechanical settings. Testing can also identify operating limits and cleaning requirements. Only after these results and the site data are available should throughput, energy use and final product conditions be translated into a project-specific performance basis.

7.2 What Ventilex can and cannot claim at this stage

Established capability	Requires project-specific proof
Fluid bed drying of sand and mineral fractions.	RAP fluidization and conveying behaviour.
Controlled plug flow and recipe-based operation.	Acceptable binder temperature window.
Multiple heating and heat-recovery options.	Achievable RAP throughput and final moisture.
Mineral filler heating reference.	Long-term fouling, emissions and cleaning interval for the selected RAP.

Risk control

No universal RAP guarantee should be issued without representative samples, agreed test methods, a defined moisture basis and clear final-product criteria.

8. Digital performance monitoring with Ventilex MAPS®

Dryer performance changes with weather, raw-material moisture, production rate and recipe. Ventilex MAPS® is intended to make this performance visible by combining process values, energy data and alarms in a structured monitoring environment.

Step	Purpose	Examples
Measure	Collect relevant operating information.	Temperatures, airflow, energy, moisture signals, running hours and alarms.
Understand	Recognize trends and deviations.	Recipe comparison, energy per tonne, recurring alarms and unstable operating windows.
Improve	Support targeted optimization and maintenance.	Set-point review, energy reduction, maintenance planning and performance follow-up.

9. Building the business case

A technically workable process is not automatically a good investment. The business case should compare the proposed concept against the real baseline of the existing plant. The following inputs are normally required:

Input	Why it matters
Annual tonnes by material stream	Determines utilization and annual benefit.
Moisture range and seasonal profile	Defines evaporation duty and peak design conditions.
Current energy use and energy prices	Creates the baseline for savings.
Current maintenance and downtime	Allows lifecycle cost comparison.
Target RAP percentage	Quantifies the potential value of higher recycled content.
Available waste heat and electrical capacity	Determines realistic energy routes.
Required product temperature at the mixer	Avoids an unrealistic low-temperature comparison.
Expected project life and financing assumptions	Supports payback and total-cost analysis.

A complete business case should show both annual savings and operational impact. Depending on the application, value may come from lower primary energy use, higher RAP content, improved throughput stability, reduced maintenance, electrification, heat recovery or a combination of these factors.

The strongest first project is usually not the broadest concept. It is the material stream with a clear moisture or temperature bottleneck, enough annual operating hours and a measurable cost per tonne.

10. Project development with Ventilex

Ventilex develops an asphalt drying concept step by step. The objective is to reduce technical risk before fixing the final equipment scope and performance commitments.

Phase	Main activity	Output
1. Data and samples	Collect material, capacity, moisture, temperature and utility information.	Agreed design basis and test plan.
2. Material testing	Evaluate drying, conveying, temperature and product behaviour.	Operating window and technical risks.
3. Process calculations	Calculate air, heat and moisture balances.	Preliminary equipment sizing and energy demand.
4. Initial flowsheet	Define product route, air system, filtration and heat source.	Concept process-flow diagram and interfaces.
5. Budget and return	Estimate investment and compare operating costs.	Budget proposal and business-case framework.
6. Pilot or reference step	Validate remaining technical or commercial uncertainties.	Decision basis for project continuation.

Phase	Main activity	Output
7. Detailed engineering	Finalize scope, layout, controls, guarantees and responsibilities.	Execution-ready project definition.

11. Information required for an application review

- Priority sand and aggregate fractions.
- RAP fractions, binder information and target inclusion rate.
- Throughput by material and annual operating hours.
- Inlet moisture range and required outlet moisture.
- Required material temperature at the mixer.
- Available electricity, transformer and grid capacity.
- Available waste heat from an existing drum or other process.
- Dust, emissions, condensate and local permitting requirements.

12. Conclusion

Fluid bed drying can offer asphalt producers a flexible route to control moisture and temperature in selected mineral fractions and potentially in RAP. The most promising concepts separate material streams according to their real process needs, integrate available heat sources and keep the existing asphalt plant where that remains the most effective option.

For virgin aggregates and sand, Ventilex brings established mineral drying experience. For RAP, the opportunity is technically interesting but must be developed through representative testing and a clearly defined performance basis. This disciplined approach allows the customer and Ventilex to build a solution around technical suitability, energy use and cost per tonne rather than around a one-size-fits-all machine.

Next step

Select one priority material stream, provide representative samples and operating data, and develop a project-specific test plan, process concept and business case.

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