BENNINGHOVEN

THE DEMAND OF THE TIME

RECYCLING

Cold - Warm - Hot Recycling

BENNINGHOVEN

THE DEMAND OF THE TIME

RECYCLING

Cold - Warm - Hot Recycling

Arguments for the use of RAP

Advantages:
- Deduction of Bitumen purchase
- Deduction of Aggregate and Filler purchase
- Deduction of Bitumen storage → deducted heating costs
- Identical quality to standard Asphalt Mixes

Disadvantages:
- More technical components needed
- Higher quality controls of the incomming RAP materials needed
- Bigger storage space and additional logistics needed
- Incomming RAP materials and RAP consumption might not be proportional at all

The process of recycling-material

BENNINGHOVEN

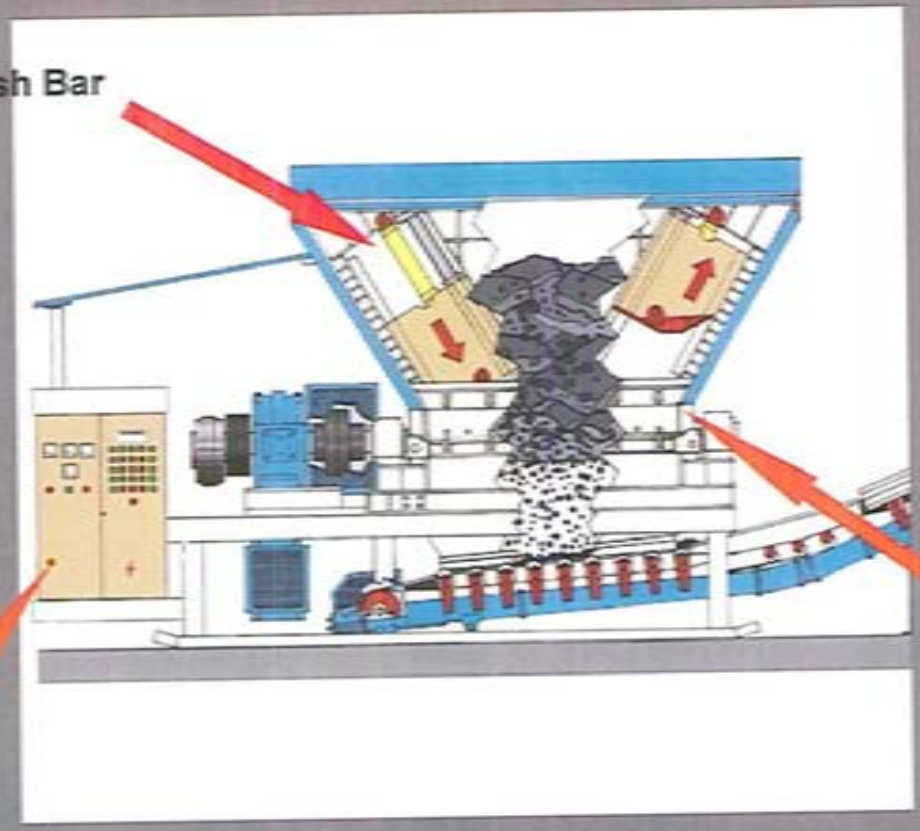
Location:

Czech Republic

Prag

Recycling Granulator

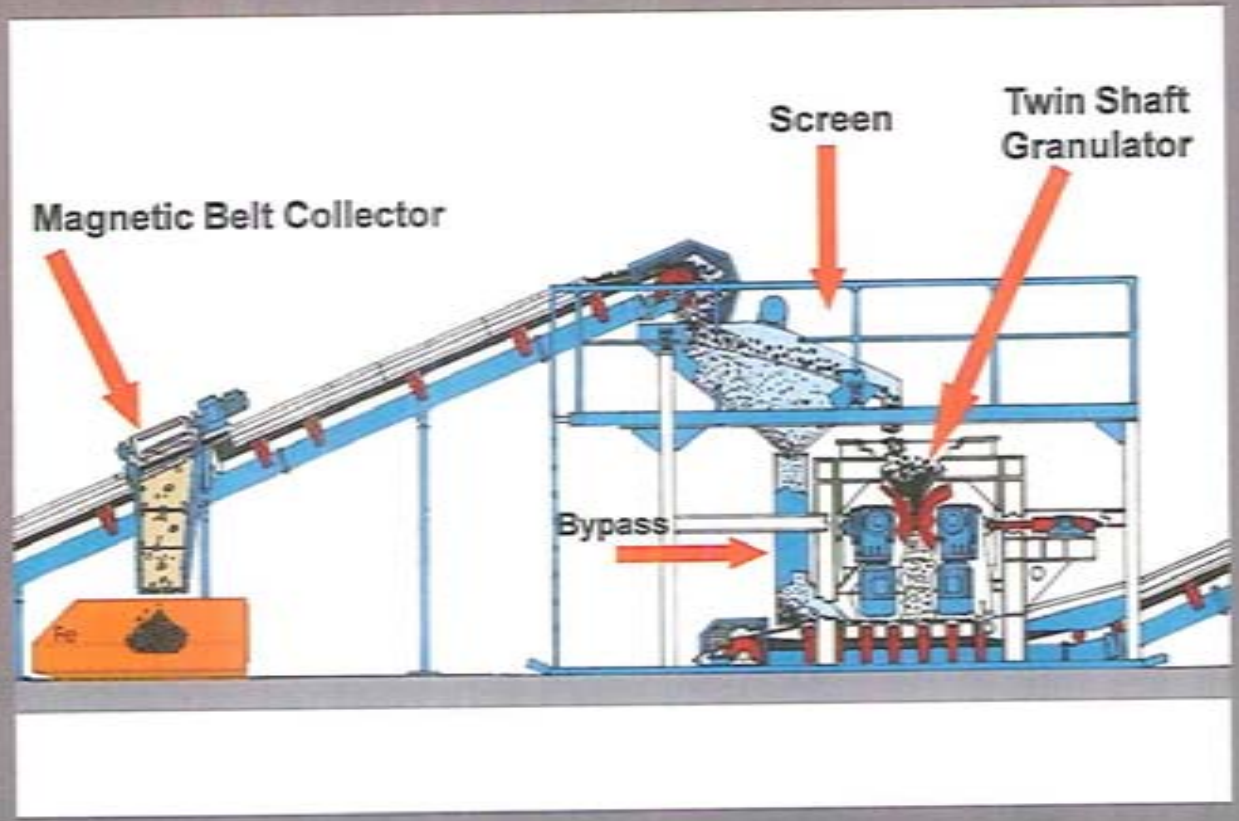
Single Shaft Granulator



Recycling Granulator

BENNINGHOVEN

Double Shaft Granulator

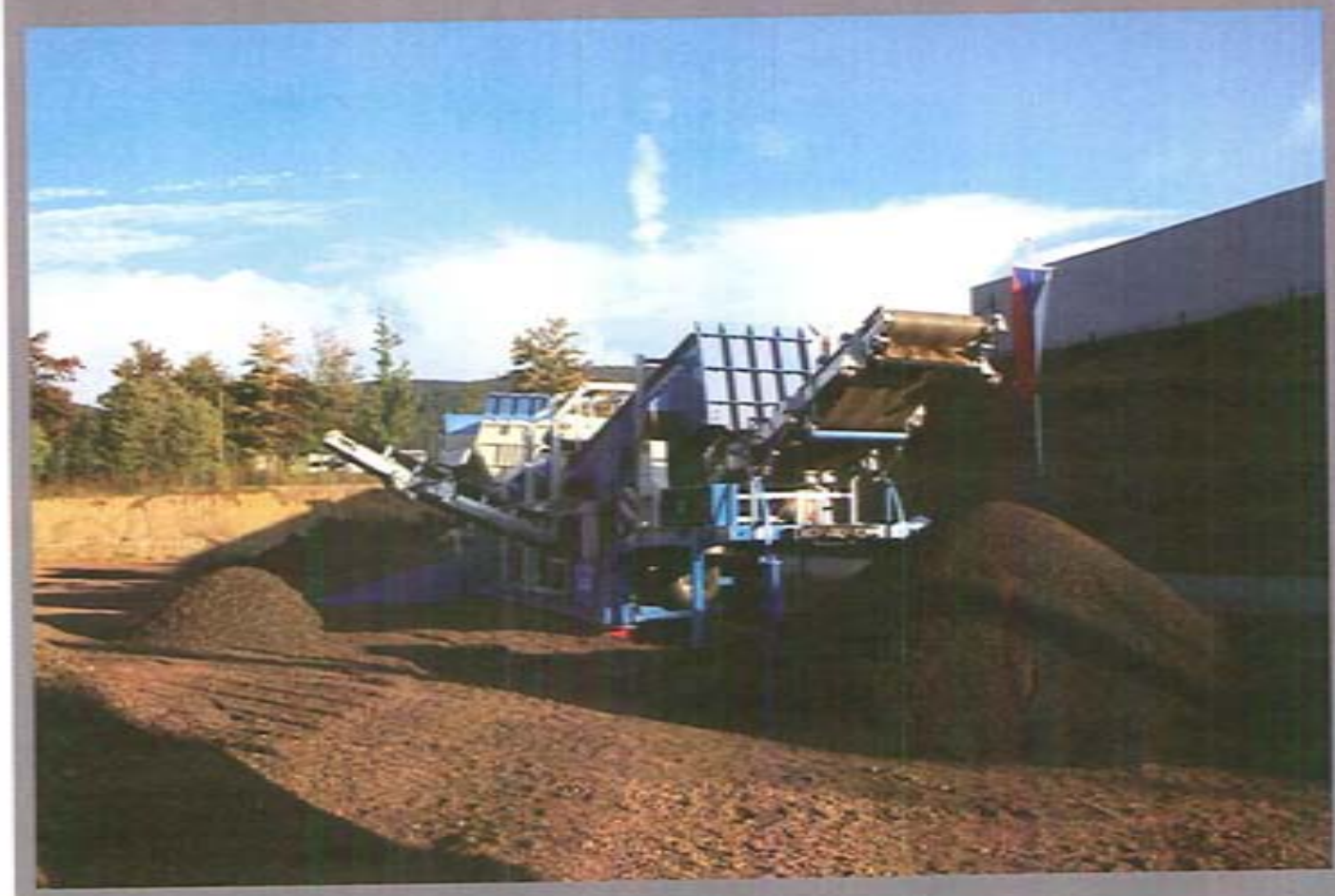


Recycling Granulator

BENNINGHOVEN

Location:

St. Petersburg



Specification:

- MBRG 2000-2

Specification:

MBRG 2000-2

Recycling End Product

8-22 mm
0-8 mm

Recycling Storage

Arguments for the RAP usage

Environment protection

Cost advantage due to row materials

Image Advantage

Innovation advantage against the competition

Recycling –cost advantage

Demonstration of cost advantage as a basis for an Investment Plan.
Recipe for Asphalt Base Course 0/32 C:

Filler	7	Weight -%
Sand 0/2	21	Weight -%
Aggregates 0/32	68	Weight -%
Bitumen	4	Weight -%

Actual Parameter:

Price for Bitumen:	350 €/t	x	0,04 t	€ 14,00
Cost for Aggregates:	10 €/t	x	0,86 t	€ 6,80
Cost for Filler:	8 €/t	x	0,07 t	€ 0,56
Cost for Sand:	3 €/t	x	0,21 t	€ 0,63
Total amount per tonne of asphalt				€ 21,99

Using 40 % of RAP in the mixture compiles a price advantage per tonne as follows:

Bitumen		0,016 t	x 350 €/t =	€ 5,60
Aggregate	0,272 t x	10 €/t =	€ 2,72	
Filler		0,028 t	x 8 €/t =	€ 0,224
Sand		0,084 t	x 3 €/t =	€ 0,252

Total amount of the recourse advantage per tonne: € 8,79

Deducting the additional cost for Production, Storage and Laboratory, the price advantage still will be approx. 60 %, which means 4,80 €/t.

At an annual production of approx. 50.000 tonnes an advantage of 240.000 € can be achieved

! This makes everybody think !

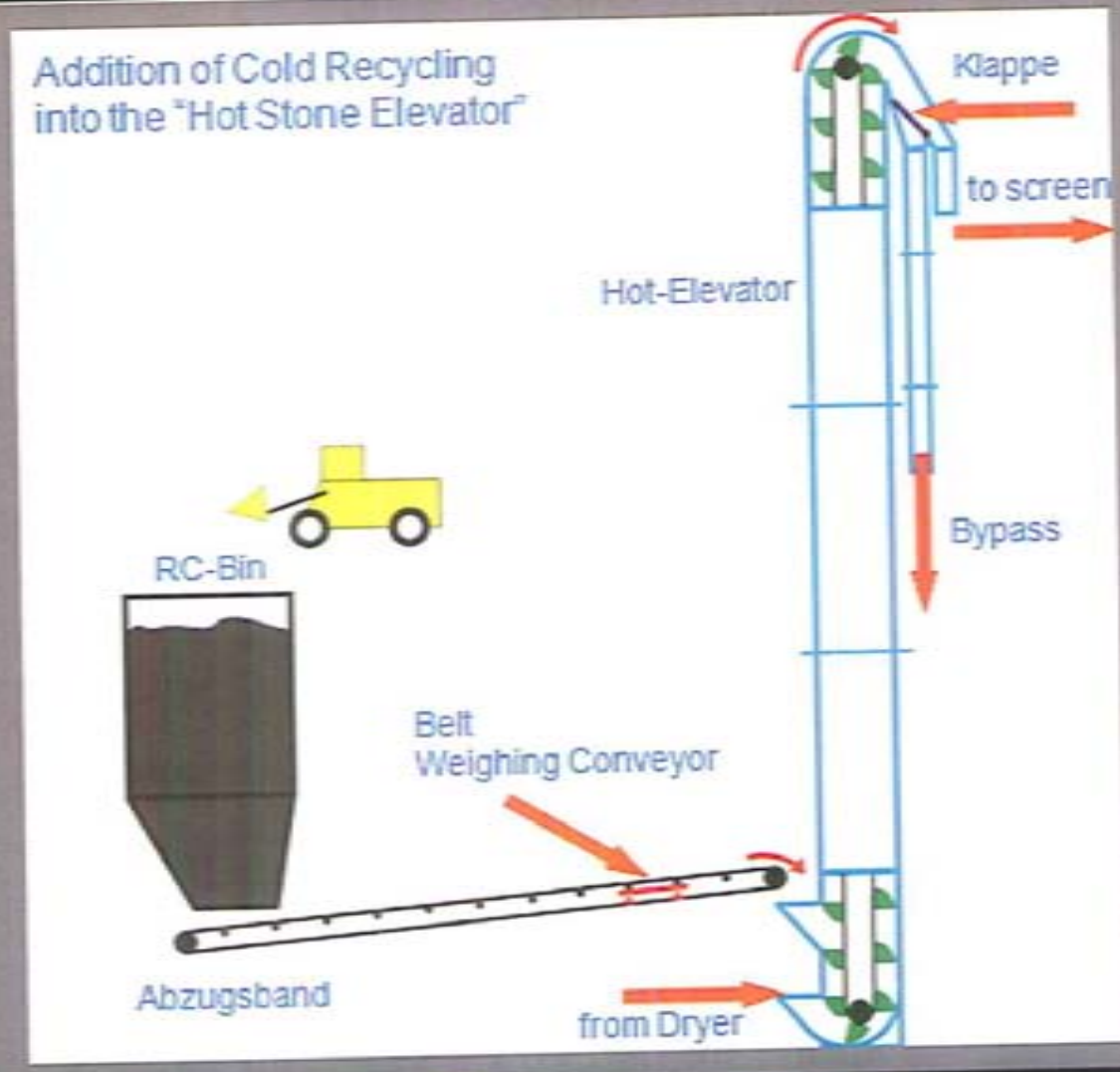
Cold RAP into the Hot-Elevator

Regarding the technical scope of supply it is the cheapest solution.

Smallest Area of space required.

Capacities of adding:	Approx.: 10-15 % at 3 % Moisture
Essential Requirements:	Enough Capacity of the Hot Stone Elevator Screen-Bypass Facility on the Hot Stone Elevator Bypass chute must be without wear angle plate within the Hot Bins
Adavantages:	Cost No additional Moisture within the Mixing Tower
Disadvantages:	Lower percentages of RAP are added. Everything runs through bypass.

Cold RAP into the Hot-Elevator



Cold RAP into the Hot-Elevator

BENNINGHOVEN

Cold RAP into the Mixer

Cold Rap Adding System into the Mixer via Cold RAP Elevator and Belt Weighing Conveyor

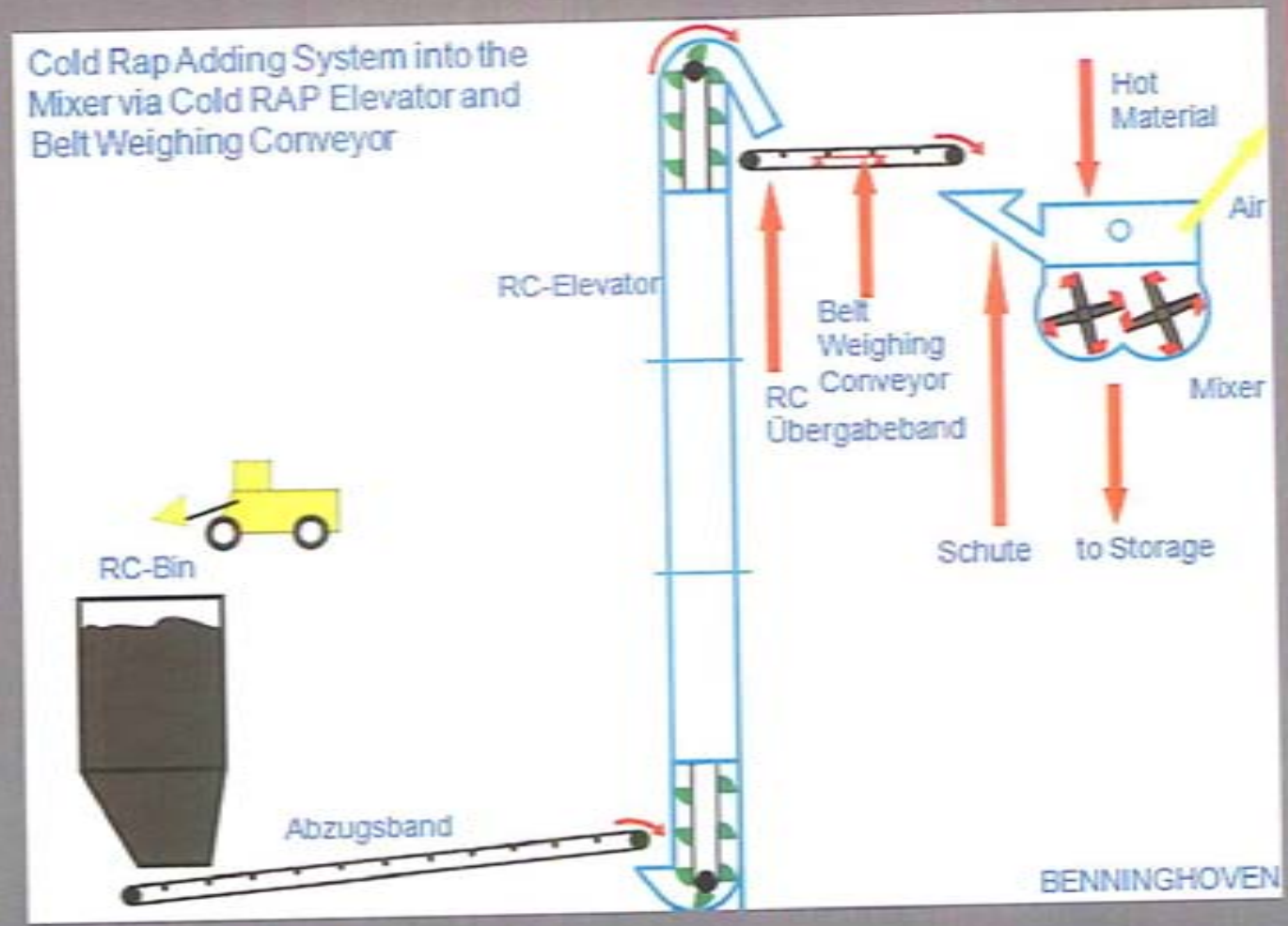
Capacities of adding: Approx.: 25 % at 3 % Moisture

Essential Requirements: Sufficient Volume in the mixer housing for steam expansion.
Sufficient Filter Capacity
Space for feed chute to be added

Advantage: Accurate Dosing Control
High percentages can be utilized

Disadvantages: Higher Capital Cost
Higher Moisture in the system increases maintenance.

Cold RAP into the Mixer



Cold RAP into the Mixer

BENNINGHOVEN

Cold RAP into the Mixer

BENNINGHOVEN

Warm Recycling

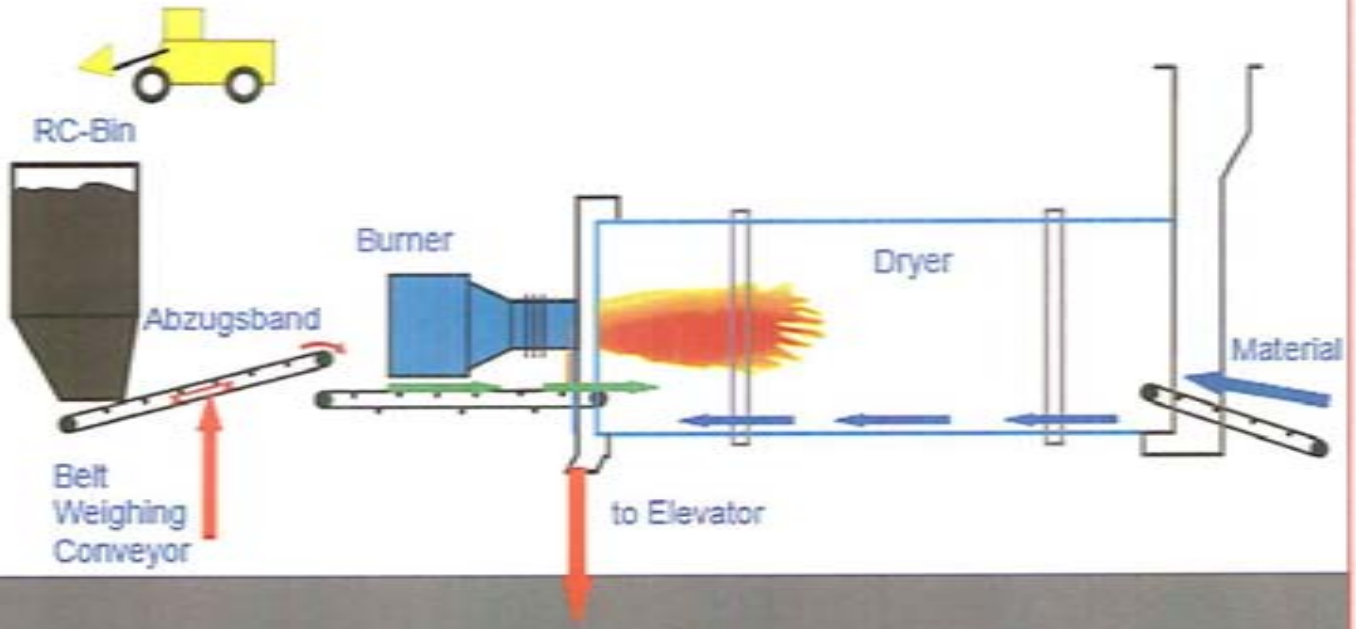
Equal heat distribution due to the consistency of the added RAP material.

Bigger Fractions which need more heat transfer stay longer in the drying process than the fines.

Capacities of adding:	Approx.: 25 % at 3 % Moisture
Essential Requirements:	The diameter of the existing drum must be minimum 2.2 m.
	Sufficient space next to the burner
	Sufficient space between dryer and elevator. Mixing tower must be fitted with screen bypass facility.
Advantages:	Perfect Heat Distribution of the RAP No Humidity within the mixing tower High feed rate possible Low cost retrofit
Disadvantages:	Asphalt production with RAP only can bypass the screen.

Warm Recycling

Equal heat distribution due to the consistency of the added RAP material. Bigger Fractions which need more heat transfer stay longer in the drying process than the fines.



Warm-Recycling

BENNINGHOVEN

Warm-Recycling

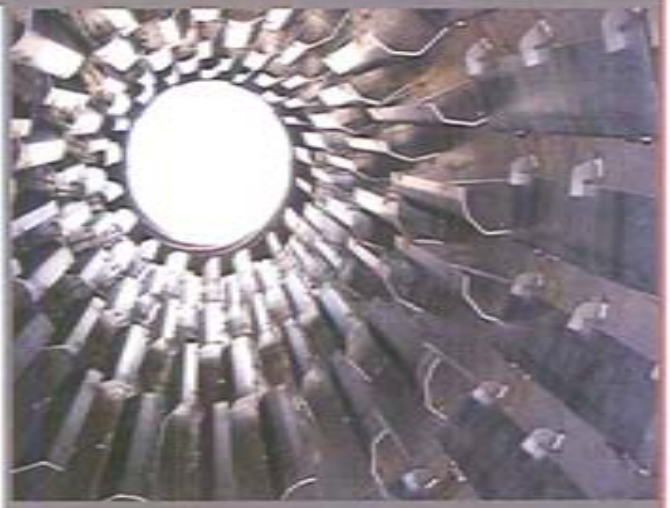
BENNINGHOVEN

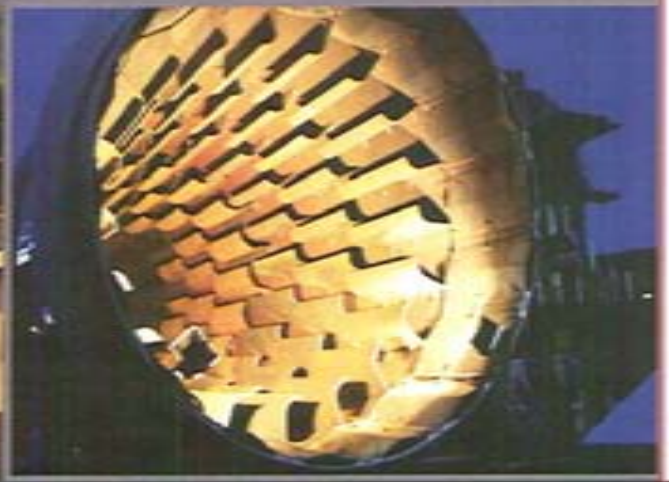
Hot-Recycling

Capacities of adding:	up to 100 %
Essential Requirements:	Sufficient stocks of graded RAP material Sufficient space next to the mixing tower
Advantages:	Perfect Heat Distribution of the RAP No Humidity within the mixing tower Highest possible feed rate Most efficient at operating with high ratio of RAP Fast return of investment
Disadvantages:	High capital cost Planning permission required Larger site area required

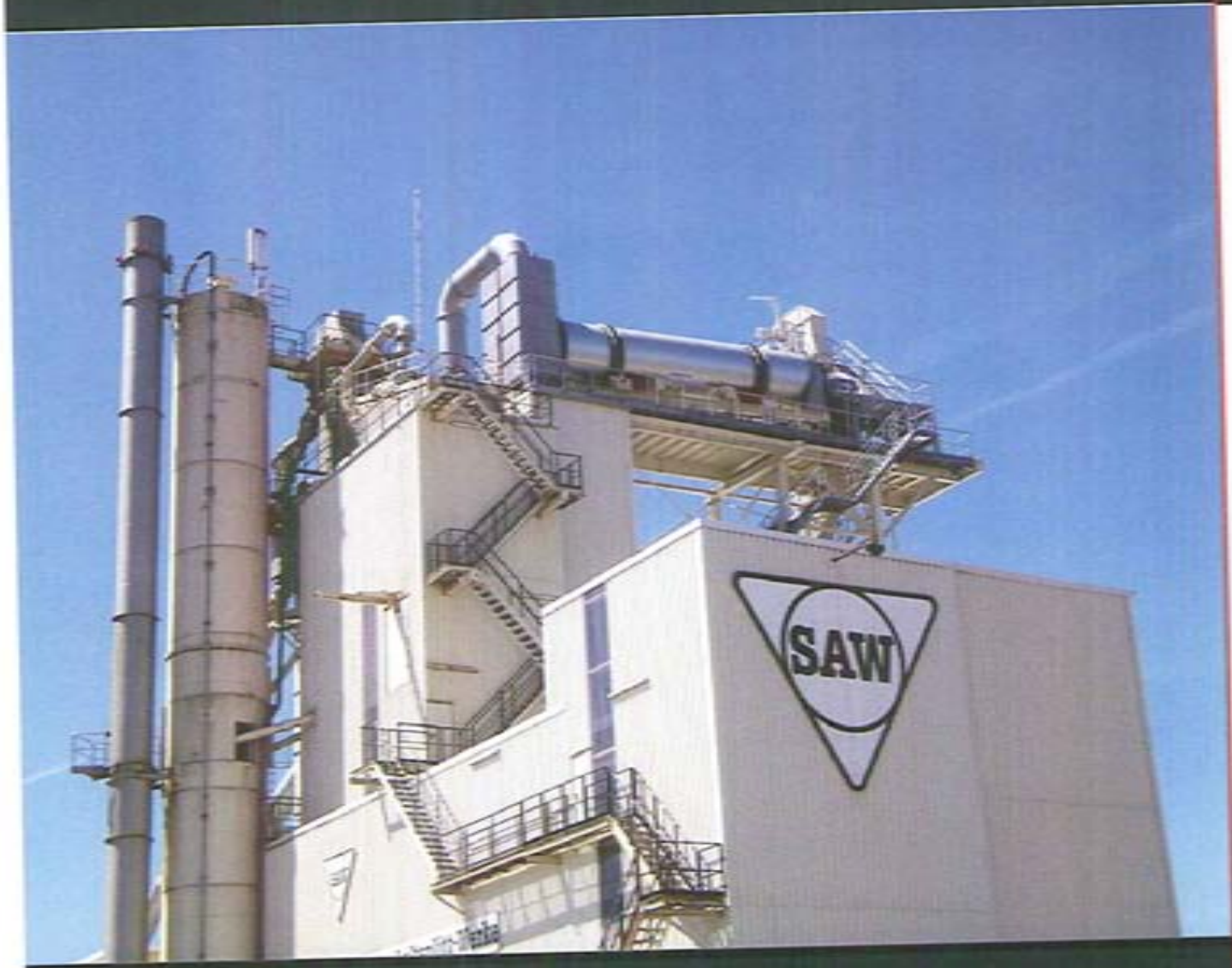
Hot Recycling

BENNINGHOVEN





BENNINGHOVEN



Recycling – Parallel Drum System

Shall we repeat our example from the beginning?

Recipe for Asphalt Base Course 0/32 C:

Filler	7	Weight -%
Sand 0/2	21	Weight -%
Aggregates 0/32	68	Weight -%
Bitumen	4	Weight -%

Actual Parameter:

Price for Bitumen:	350 €/t	x	0,04 t	€ 14,00
Cost for Aggregates:	10 €/t	x	0,86 t	€ 6,80
Cost for Filler:	8 €/t	x	0,07 t	€ 0,56
Cost for Sand:	3 €/t	x	0,21 t	€ 0,63
Total cost per tonne				€ 21,99

Using 70 % of RAP by means of a Parallel Drum System:

Bitumen	0,028 t	x	350 €/t =	€ 9,80
Aggregate	0,476 t	x	10 €/t =	€ 4,76
Filler	0,049 t	x	8 €/t =	€ 0,39
Sand	0,147 t	x	3 €/t =	€ 0,44
Total saving of the recourses per tonne				€15,39

Deducting the additional cost for Production, Storage and Laboratory. The price advantage still will be approx. 60 %, which then will be 9,24 €/t

At an annual production of approx. 50.000 tonnes an advantage of 462.000 € can be achieved

! This makes everybody think !

Input Quantities relative to various processes

RC-Cold Input

- up to 35% in Base Course
- up to 15% in binding
- none in Wearing Coarse

RC-Warm Input

- up to 30% in BC by hot elevator
- up to 30% in head plate dryer drum
- up to 30% by middle drum input

RC-Parallel Drum (Hot-Input)

- up to 100% possible
- 50-80% in BC is normal

Pros and Cons of the three Processes

RC-Cold Input	- Simplified Technical Plant - Possible to input small quantities - Flexible under stop/start working conditions - Steam extraction via the mixer/tower - Bitumen thermal overload - Water as "foaming agent" in mix process - Up to 30% additional input possible
RC-Warm Input	- Simplified Technical Plant - Possible to input small quantities - Steam extraction via the dryer - Up to 30% additional input possible
RC-Parallel Drums (Hot-Input)	- High investment on plant technology - Expensive to process small quantities - Steam extraction in the dryer - Easier to heat the RC material - Continuous processing of large quantities - Better emission control - Possible to process up to 100% RC material

New Regulations covering the RC Input Levels application in all German States

BENNINGHOVEN

Continuing efforts are being made by all Asphalt Producers to increase the input percentage of RC material.
For example, in Bavaria at present the Regional Regulations are being worked out with a view to applying them nationwide. As a result there is a need for increased investment in this field.
In addition costs are being inflated by higher energy prices which is leading to every opportunity to increase cost effectiveness being investigated.

Target:

Up to 80% in base course
Up to 50% in binding
Up to 30% in wearing course
Up to 20% in mastic asphalt

Outlook for RC Input

1. In Germany there is an increasing trend towards RC parallel drums as higher bitumen costs impact the industry.
2. The new installations now combine both cold and warm input. This gives the flexibility to input small or large quantities.
3. The following quality control and financial requirements are already the subject of discussion.

- Lowering mixing temperature by adding RC material to all material mix combinations.
- Preparation of acceptable quality bitumen even with inputs higher than 30%
- It should be possible to continue this practice up to 100% input

Thank you very much

Dipl.-Ing. Ralf Port