CECABASE® RT BY ARKEMA

Additives for Warm Mix Asphalt

CECA ARKEMA GROUP

Content :

CECA
ARKEMA GROUP

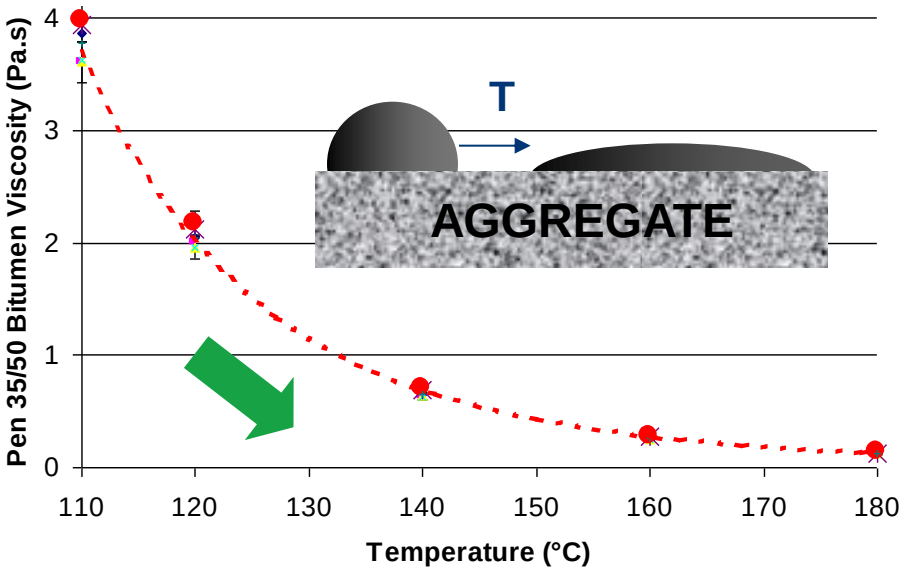
Warm Mix Asphalt technologies

CECA
ARKEMA GROUP

Why do we use **hot** mixes ?

High temperatures are necessary**:**

- To **remove water** from the aggregates
- To **reduce the asphalt viscosity**



Innovative warm mix technologies can decrease process temperatures while keeping a sufficient workability

- Reduction of the heating of aggregates (~ 95% of the mix) is used by all techniques
- Warm Mix Asphalt (WMA) is typically produced and laid with a 15 to 50°C reduction compared to Hot Mix Asphalt (HMA) – No universal standard definition of WMA

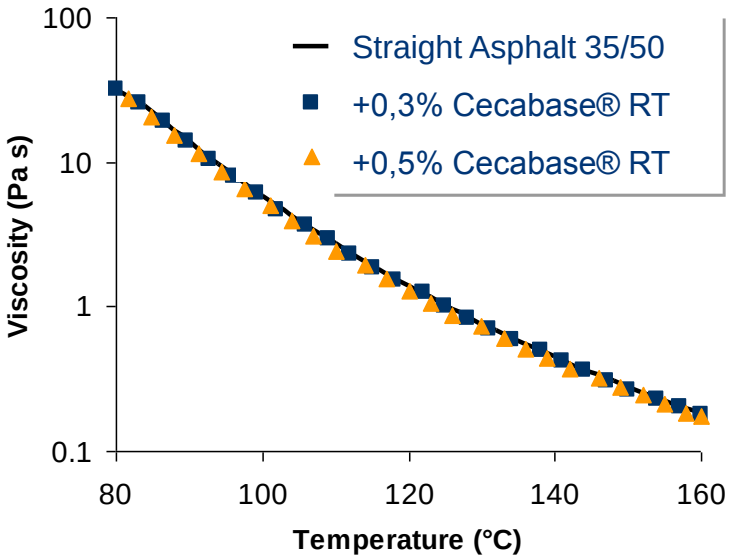
CECA ARKEMA GROUP

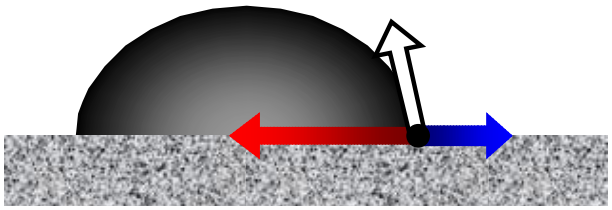
Surfactant additives – How it works

The addition of a liquid **surfactant** (< 1 wt% in the binder) changes interfacial properties of the mix without changing the asphalt binder rheology

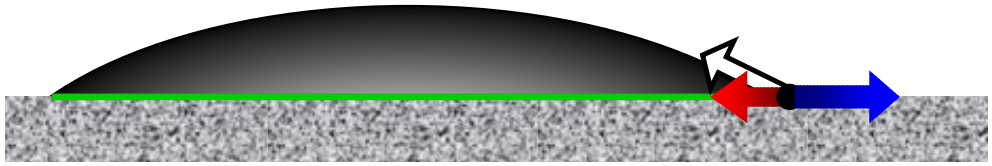
Three main effects :

- Improved **coating** at lower temperature thanks to surface tension reduction at the binder/ aggregate interface
- Improved workability of the mix thanks to the **reduction of internal frictions** at the various interfaces
- Improved **stripping resistance** with the surfactant at the interface





Chemical additive

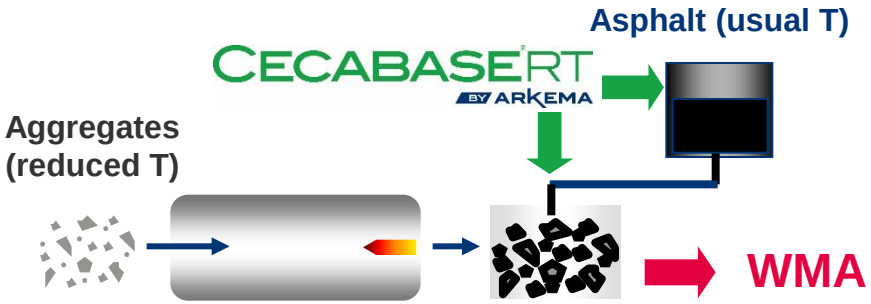


Cecabase® RT technology

CECA
ARKEMA GROUP

How to use Cecabase® RT

- Typical properties of the additive :
  - **Liquid** – Viscosity < 1000 cPo at 20°C
  - Density : ~ 1.00
  - **Flash point :** > 200°C
  - Readily soluble in asphalt binder
  - **Packaging** : bulk, ~1000 kg IBC, ~200 kg drums (1 drum eq. to 1000T of mix)



- How to use Cecabase® RT :
  - **In line** or **batch** addition to the asphalt binder
  - **0.3 to 0.5%** dosage based on total binder weight
  - **Compatible** with all kinds of binders – no curing time
  - **Stable** in stored asphalt binder over 7 days

- Mix production temperature is reduced to 120-140°C depending on mix type :
  - Heating of aggregates is typically ~ 40°C less than the corresponding HMA
  - Binder temperature remains the same as HMA
- Good compaction is ensured down to 90-110°C

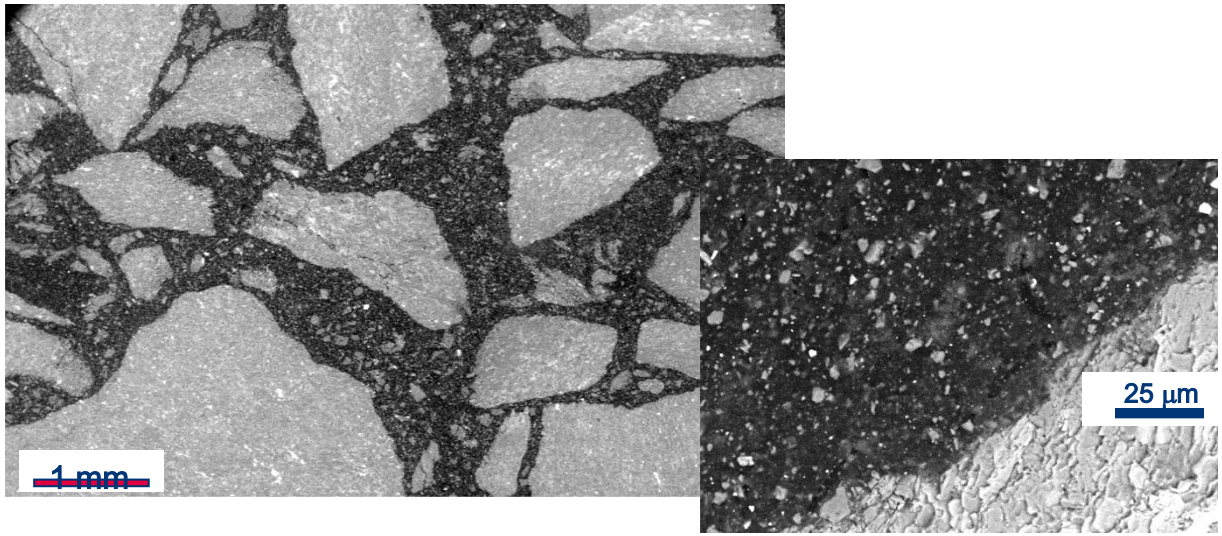
CECA ARKEMA GROUP

Effects of Cecabase® RT

- No change in Asphalt penetration grade or R&B temperature

	50/70 Asphalt	50/70 Asphalt + 0.5% CB RT	30/45 Asphalt	30/45 Asphalt +0.5% CB RT	SBS modified Asphalt	SBS modified Asphalt +0.5% RT
Penetration (1/10mm)	51	50	33	37	52	56
Ring and Ball (°C)	51.2	50.8	54.2	53.6	57.8	57.2

- Electron microscopy shows no difference of mix with HMA :



- Good distribution of aggregates
- Good coverage of aggregates (even fines)

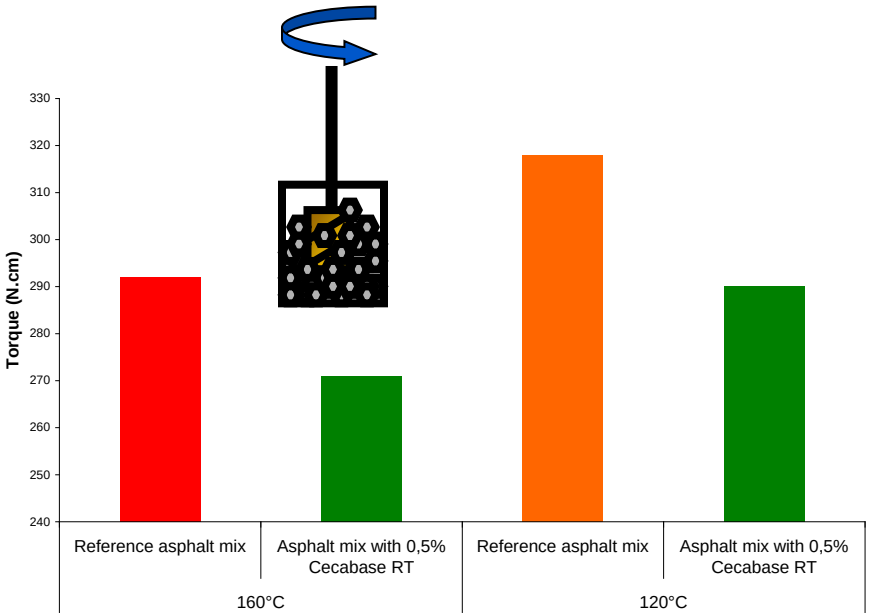
CECA ARKEMA GROUP

Workability effect of Cecabase® RT

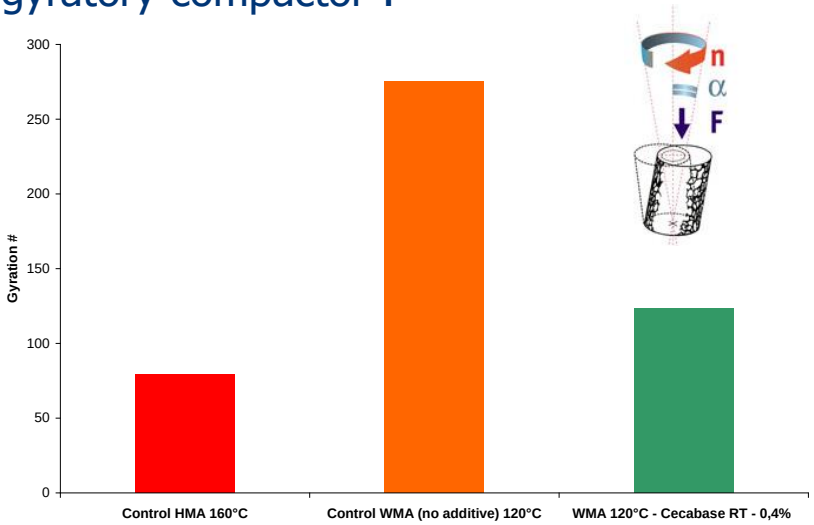
Evaluation of the workability of WMA in the lab is challenging

Only small differences are observed with standard compaction tests (Marshall)

- Evaluation by laboratory Baustofflabor Hamburg, following standard German test for workability
- Torque recording of a screw type rotational device introduced in the mix :



- Test based on the recommendations on report 691 from NCHRP (US)
- Comparison of the number of gyrations required to achieve a given void % with a gyratory compactor :

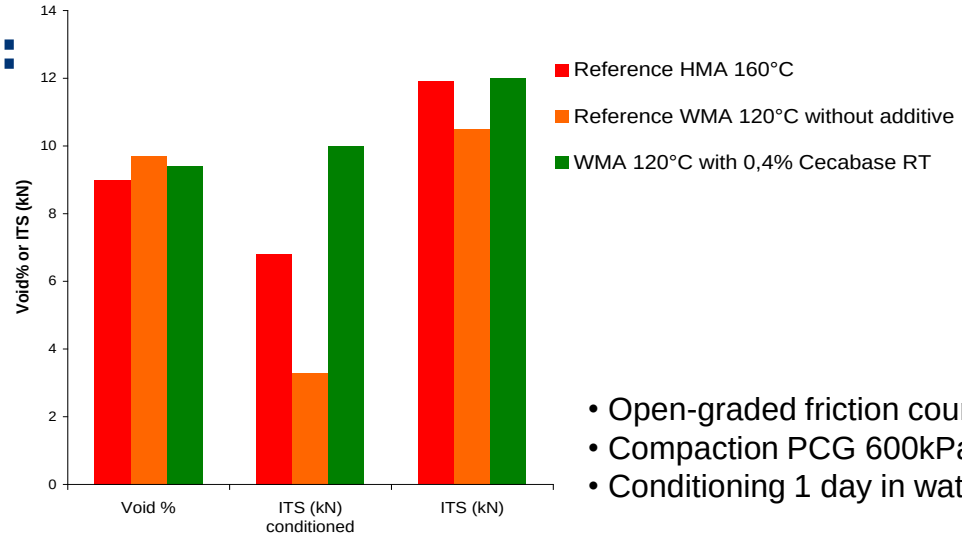


Mixing at 120°C, measurement at 90°C, 8% void

CECA ARKEMA GROUP

Mechanical characterization

- **Improvements of adhesion are achieved with Cecabase® RT**
- **ITSR :**



	TSR
Hot Mix Asphalt	0.58
WMA without Additive	0.31
WMA with Cecabase RT	0.84

- Open-graded friction course with modified binder, PG 76-28
- Compaction PCG 600kPa, 40 gyrations
- Conditioning 1 day in water at 60°C

- **Hamburg test :**

	Gmm (Max. theor. Specific gravity)	Air voids (%)	Max. rut depth (mm)
Hot Mix Asphalt	2.425	6.95	-13.3
WMA with Cecabase RT	2.445	7.2	-9.1

AASHTO T324 - 0/25mm mix - Shear Gyratory Compactor - 20,000 wheel passes - In water at 50°C

- **Other results are available : Duriez, rutting test, Fatigue …**

CECA ARKEMA GROUP

Advantages of Cecabase® RT

CECA
ARKEMA GROUP

WMA Advantages with Cecabase® RT

Environment

- Less emissions
- Energy savings
- Increase use of RAP

Comfort

- Compaction aid
- Fast opening to traffic
- Less heat & fumes

Flexibility

- Increased capacity
- Night or winter work
- Longer hauling

CECA ARKEMA GROUP

Reduction of gas emissions

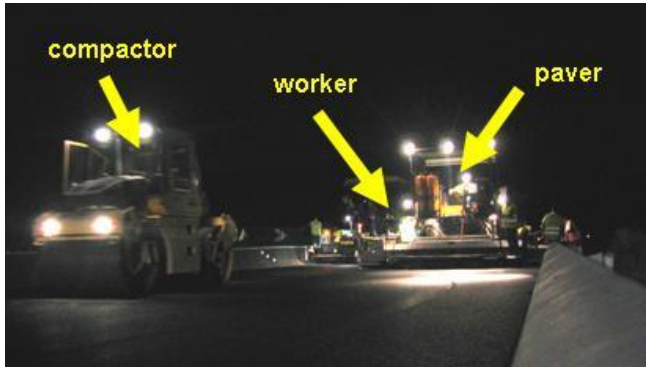
- Typical values measured at the **plant** stack (production of very thin asphalt cement) :

	CO_2 (Nm³/ton)	Eq. NO_2 (g/ton)	TVOC (g/ton)	PAH (µg/ton)
HMA	14.6	6.8	80.6	78.6
WMA	9.0	5.0	14.3	35.5
	-38%	**-26%**	**-83%**	**-55%**

- Measurements taken **on job site**, on a worker, a paver driver and a compactor driver :

More than 20 different polyaromatics (PAH) measured – example :

Naphthalene (mg/m3)	Worker	Paver	Compactor
HMA	0.01549	0.0097	*
WMA	0.0053	0.0045	0.0019
	-66%	**-54%**	*



Both HMA and WMA are well below exposure limits (close to detection limits)

CECA ARKEMA GROUP

Energy cost – typically 20-30% savings

- Two examples of measurements at different mixing plants :

Very Thin Asphalt Concrete

- French 'BBTM' wearing course
- Polymer modified asphalt
- HMA: at 170°C
- WMA: 0.4wt% of additive in the binder

	Production T°C	Energy m3 gas / ton
Hot Mix Asphalt	170	5,94
Warm Mix Asphalt	130	4,94

31% gas savings

Stone Mastic Asphalt (SMA)

- Polymer modified asphalt and fibers
- HMA: at 172°C
- WMA: 0.35wt% of additive in the binder

	Production T°C	Energy m3 gas / ton
Hot Mix Asphalt	172	6,34
Warm Mix Asphalt	135	4,64

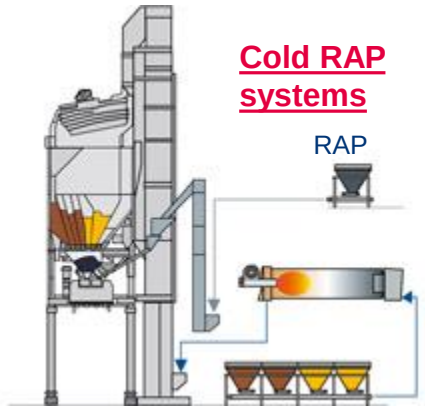
23% gas savings

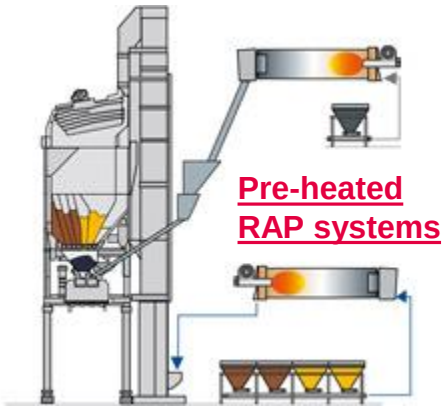
- In some cases the savings compensate the cost of the additive
- A simple but well-correlated calculation sheet is available from CECA to evaluate energy savings at your plant

CECA ARKEMA GROUP

Increased use of recycled material

- Using Cecabase® RT you can increase the amount of RAP introduced in the mix by 10-15% :
  - Easier mix compaction
  - Less overheating of virgin aggregates
  - Working for plants with and without heating systems for RAP
  - Significant reductions of the asphalt mix cost
  - Also possible with shingles (RAS) and crumb rubber (CRA)





Use as Compaction Aid

- The workability effect of Cecabase® RT can be used to achieve the desired compaction target at Hot Mix temperatures in various cases :
  - Faster progression : typically fewer compaction passes are required compared to HMA without additive
  - Gives more security for "difficult" mixes (high-end void%)
  - Increase chance of getting compaction bonus
  - Improve workability of stiff mixes (high RAP …)
  - Ability to work at <0°C outside temperature
- Workability effect disappear upon cooling (<~90°C) ; the additive does not alter mechanical performances at cold temperatures (no rutting or brittling effects)
- The faster compaction and cooling is also useful for quicker opening to traffic :
  - Work in areas with heavy traffic
  - Work in airports
  - Less disturbances to the neighborhood

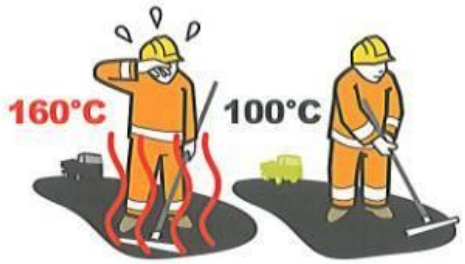
CECA ARKEMA GROUP

Reduction of dust and fumes

- Typical reductions measured on the paver (SMA job) :

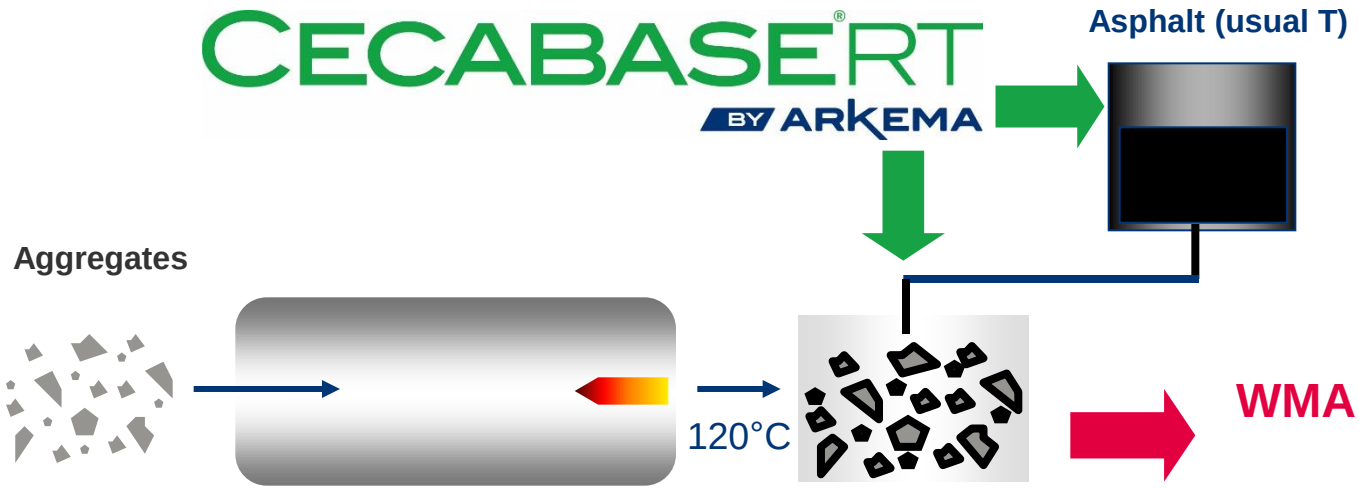
	Dust (mg/m³)	Fumes (mg/m³)	"Mix of Pollutants" (mg/m³)
HMA	12	11.4	12
WMA	3.5	3	2.9
	-71%	**-74%**	**-76%**

- Similar reductions are measured at the plant :



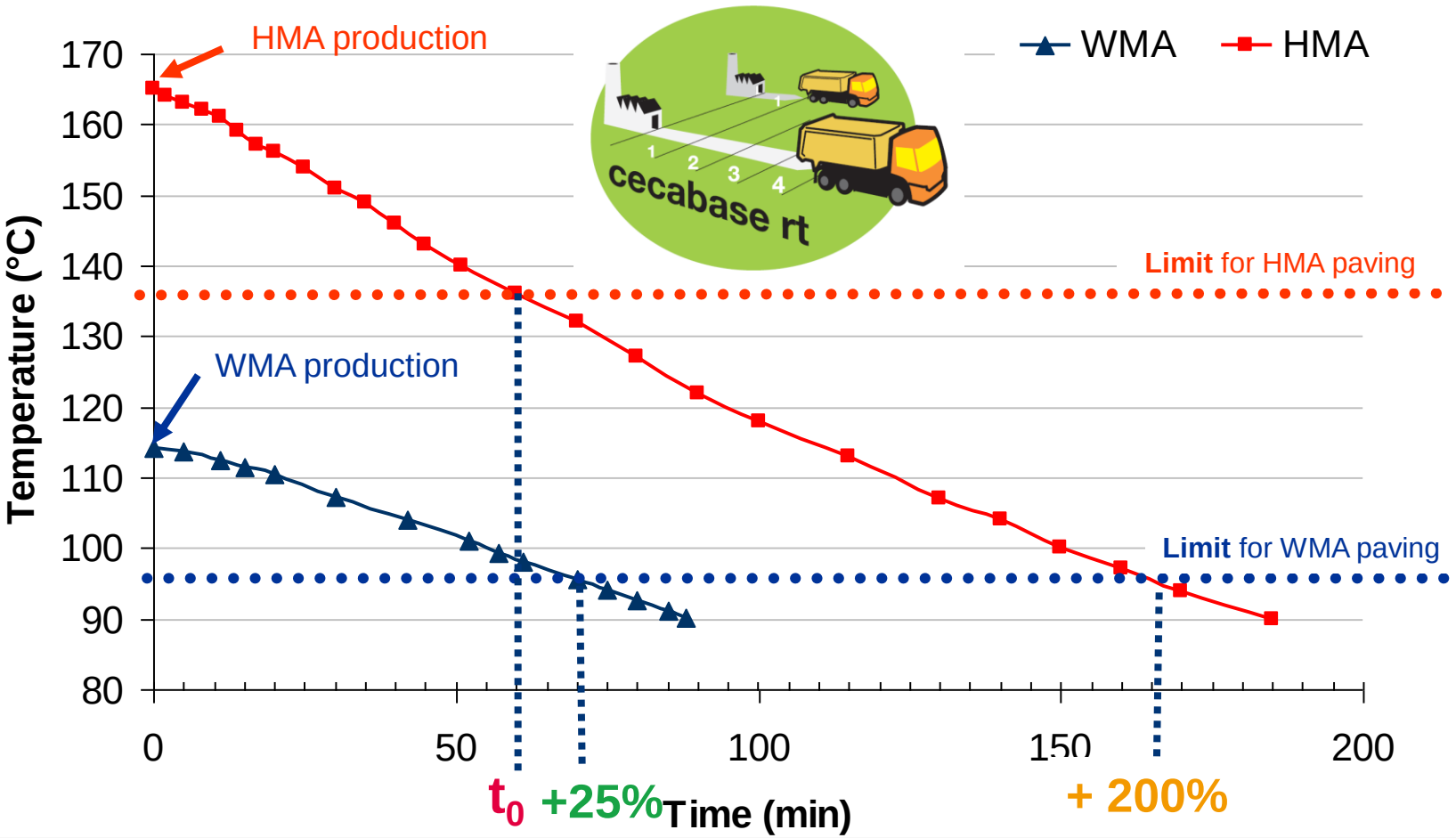
CECA ARKEMA GROUP

Increase of Production rate



- In some cases, residence time of aggregates in the barrel can be decreased (lower heating T) without changing the burner settings
- Case study : an increase from 210 to 280 tons of mix/hr (~ 30% increase) was possible when switching from HMA to WMA
- Useful during peak season or for debottlenecking
- Flexible technology : easy to switch from HMA to WMA and back

Longer hauling



- A **WMA with Cecabase® RT** may be paved up to 25% later than standard HMA
- A **HMA with Cecabase® RT** may be paved after a hauling time **up to 3 times** longer

Examples of field jobs

CECA
ARKEMA GROUP

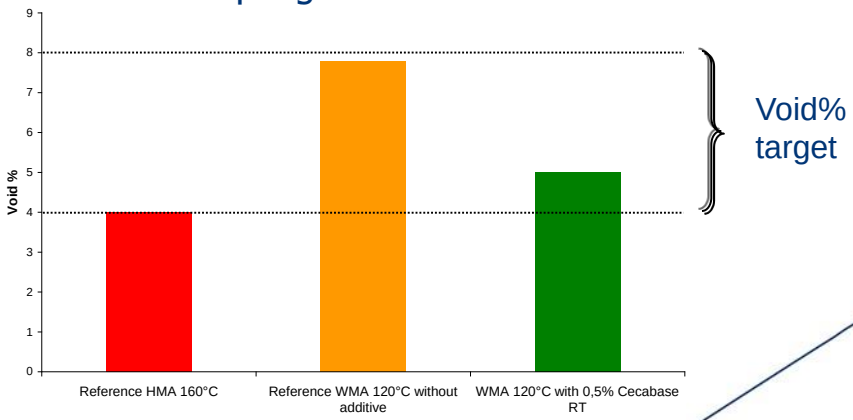
Atlanroute (France) - 2004

First field test for technology validation :

- 300 tons of mix using standard equipment (plant & paving machines)
- Continuous dryer/mixer ; All production parameters followed
- 10 mm nominal max aggregate size dense coarse graded mix
- Asphalt binder 35/50 penetration :

	Production (°C)	Laying (°C)	Compaction (°C)
Hot Mix Asphalt	160	160	135
WMA without Additive	120	115	90
WMA with Cecabase® RT	120	115	90

- Constant compaction conditions
- Troxler (gamma rays absorption)
- Core sampling to double-check :



Examples of field jobs - France

Bordeaux 2008 – High traffic road

- High modulus asphalt cement (“EME”)
- 10/20 [1/10mm] asphalt
- Produced at 130°C (normally 170°C). Laid down at 125°C
- Average density 95,6%

St Flour 2009 – Highway A75

- Open graded friction course (“BBTM”) – Thin layer 2,5 cm
- 5,6% binder, polymer modified Styrelf 13-60 – 0,4% Cecabase® RT
- 4000 tons produced at 135°C, paved at 120°C, compacted at 110°C

Gaillac 2011 – BBSG

- Standard 0/10 mm wearing course (BBSG), 6 cm layer
- Cecabase® RT used at 0.4%, added in tank 5 days before
- 500 tons paved at 120°C

CECA ARKEMA GROUP

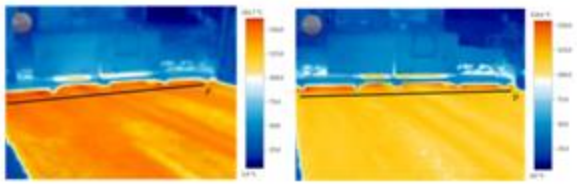
Examples of field jobs - Europe

Poland 2007 – Stone Mastic Asphalt (SMA)

- 0-8 mm aggregates - 0.4% fibers in the mix
- Asphalt binder Pen. 50 + 3% SBS – 0,4% Cecabase® RT
- 3000 tons produced at 130°C, paved at 120°C, compacted at 100°C

Russia (Kazan) 2009 – Freezing conditions

- Base course layer - Asphalt 60/90 penetration - 0,4% Cecabase® RT
- 120 km transport time (2 hours), outside temperature -5°C
- 800 tons produced at 165°C and paved at 130°C



Denmark 2011 – Stone Mastic Asphalt (SMA)

- 0-11 mm wearing course, high traffic – Fibers into the mix
- 5,7% of polymer modified asphalt – 0,35% Cecabase® RT
- Mix produced at 135°C vs 172°C for the control HMA

Italy (Padova) 2012

- Fine gradation D8 type – 15% RAP added cold at the plant
- Asphalt 70/100 penetration – 0,4% Cecabase® RT Bio10
- Mix produced at 150°C, paved at 130°C, compacted at <130°C

CECA ARKEMA GROUP

Examples of field jobs - America

New York State 2008 – 2 different jobs

- 1300T dense-graded mix with 30% RAP (Road 31 along Seneca River)
- 1000T dense-graded mix without RAP (Road 18 near Utica)
- Production at 120-130°C, paved at 120°C with good workability

Canada (Alberta) 2009 – 25,000 tons job

- Dense graded mix without RAP (gravel pit aggregates) – Interstate 35
- Asphalt binder 200-300 Pen. with antistrip + 0.2% Cecabase® RT
- Produced at 120°C (vs 150°C for control HMA)

California 2010 – Caltrans project with crumb rubber

- 12.5mm gap graded mix – Asphalt PG 64-16 with 18% scrap tire
- 0.4% Cecabase® RT - Produced at 130°C (vs 165°C for control HMA)
- Tested on Heavy Vehicle Simulator (HVS) ➔ Cecabase® RT WMA is more rut resistant than control HMA

Tennessee (Sevierville) 2012

- Mix with difficult limestone aggregate – 15% RAP – high traffic road
- Asphalt PG64-22 – Cecabase® RT and antistrip
- Night work, light rain - Mix produced at 130°C, compacted at 113°C

CECA ARKEMA GROUP

Examples of field jobs – Asia & LatAm

Australia 2008 – High %RAP mix

- Base and Wearing Courses Type H-10mm – 30 and 40% RAP respectively
- Paving temperatures : 108-115°C
- Average compaction around 95%

Japan 2009

- Open graded type
- -30°C to -50°C temperature decrease - Rainy conditions
- 3000 tons produced at 130°C, paved at 120°C, compacted at 100°C

Argentina 2010

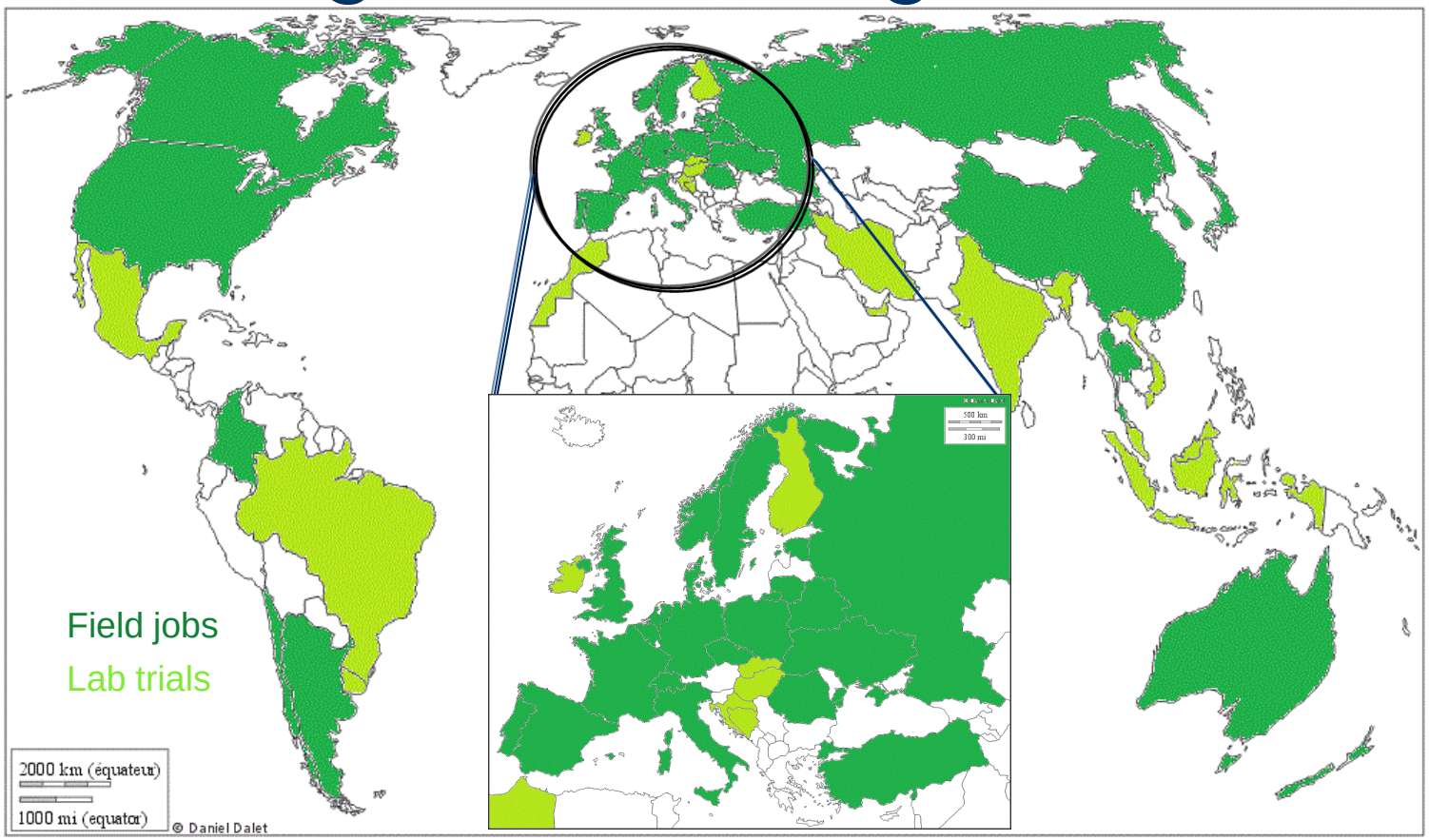
- Open graded type mix – Asphalt grade CA-30 (pen 50/60) with 0,4% Cecabase® RT
- Temperature decreased to 130°C
- Core sampling

China 2011

- 0-8 mm aggregates - 0.4% fibers in the mix
- Asphalt binder Pen. 50 + 3% SBS – 0,4% Cecabase® RT
- 3000 tons produced at 130°C, paved at 120°C, compacted at 100°C

CECA ARKEMA GROUP

A real global coverage



- Today Cecabase® RT is present in more than 50 countries
- More than 150 different customers have chosen Cecabase® RT additives
- Several millions tons of Warm Mix Asphalt are produced each year with Cecabase® RT technology

CECA ARKEMA GROUP

Cecabase® RT - the right choice !

- A simple way to reduce temperature of asphalt mixes by ~ 40°C by the addition of a liquid additive :
  - **Patented technology used since 2004 on the field**
  - **Robust, work with all binders and asphalt mixes**
  - **No plant modification or high maintenance costs**
  - **Most cost-competitive solution among additives**
  - **Systematic back-up of CECA technical experts**
- Mechanical properties of WMA are similar to those obtained with a control HMA
- Benefit from immediate advantages :
  - **Environment : reduction of emissions, gas savings, use of RAP**
  - **Comfort : compaction aid, less heat & fumes, quick opening to traffic**
  - **Flexibility : increased plant capacity, longer hauling, night or off-season work**

PRIX PIERRE POTIER 2007 – L'innovation en chimie au bénéfice de l'environnement

INTERNATIONAL ROAD FEDERATION – IRF – 1948

ICIS INNOVATION AWARDS2009 Sponsored by Dow Corning

CECA ARKEMA GROUP

CECABASE® RT
BY ARKEMA

Thank you !

CECA
ARKEMA GROUP