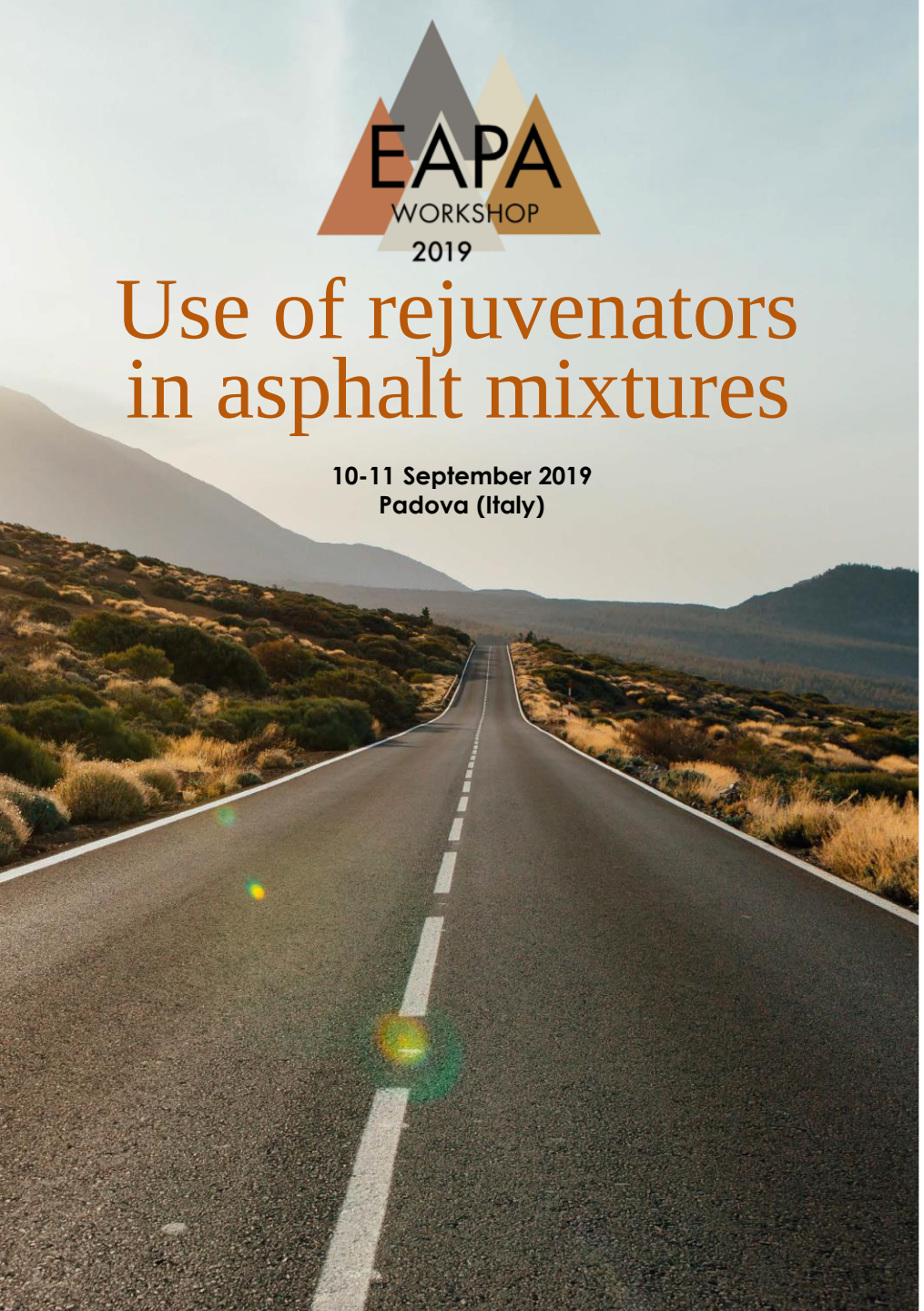


EAPA

HSE evaluation for the use of rejuvenators - BioRePavation case study

Emmanuel CHAILLEUX

Plan

- Main objectives
- Project outline
- Short feedback concerning lab and full-scale validation
- HSE evaluation (fume emission)
  - Motivation
  - Procedure
  - Results
- Conclusions

Main objectives

BioRePavation

- Towards a more environmentally friendly **pavement**
  - Save natural resources
    - virgin petroleum bitumen
    - virgin aggregate from quarries

Increase recycling rate

rate targeted : 50 – 70 %

Take most advantages from the old brittle bitumen remaining from reclaim materials

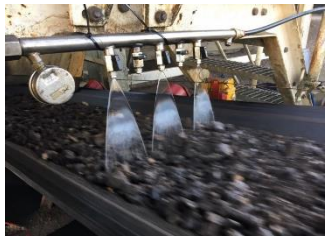
At least: same level of quality in comparison to conventional technics

Project outline

BioRePavation

- Evaluation of 3 alternative bio-materials designed to help recycling (rejuvenators → full replacement)
- Comparison with conventional high performances mix (EME)

Sylvaroad™

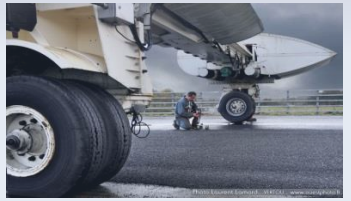


Biophalt®

Epoxidized methyl soyate

- Technical assessment
  - Demonstrator: IFSTTAR accelerated pavement testing facility
    - Distress mechanism monitoring
    - Innovative non-destructive method

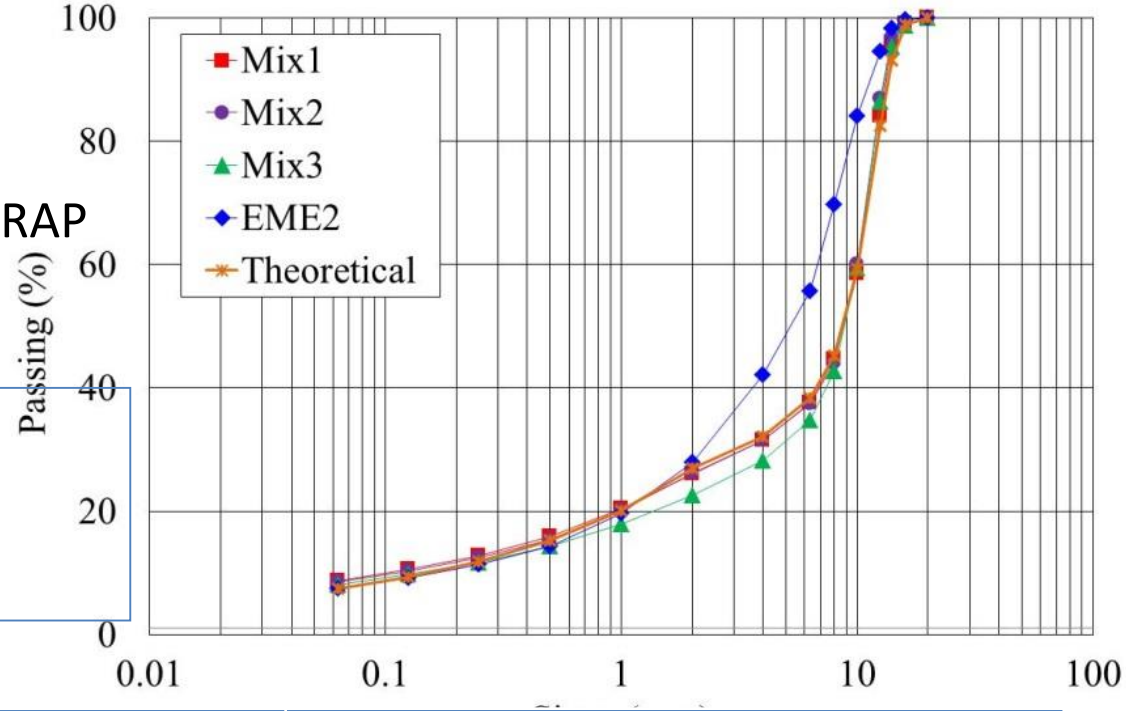
- Environmental assessment
  - Life cycle assessment
  - Fume emission measurements



lab and full-scale validation

- A new type of base course mix has been designed : GB5 type mix (50 % RAP and 70% RAP) using aggregate packing concept (by maximizing their interlock)
  - Designed according to:
    - Aggregate availability on the plant
    - Lab studies of blends with virgin binder and recovered RAP binder in order to determine optimal dosage

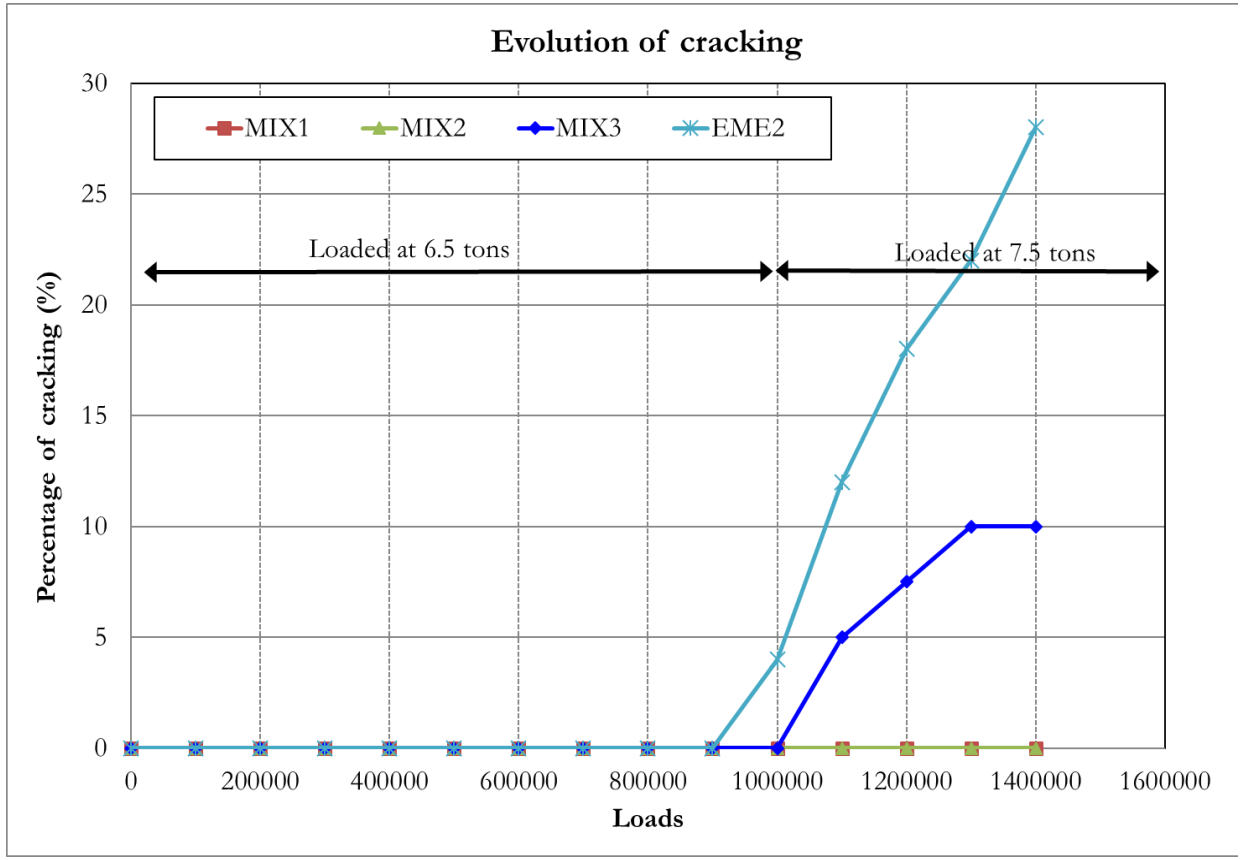
- Main mix properties:
  - Very dense mix
  - High modulus with a relatively equivalent « soft binder »
  - Low binder content 4.5%



Fraction	10-14mm	0-2mm	Filler	8-12mm RAP	0-8mm RAP	Added Binder	
%	37.2	7.7	2.3	34	16	2.8	MIX1: 0.1%BM1+2.7%FB
							MIX2: 2.8%BM2
							MIX3: 0.1%BM3+2.7%FB

lab and full-scale validation

	Field materials		
	Void ratio	Stiffness parameter (15°C, 10Hz)	Fatigue parameter (10°C, 25Hz)
Mix	%	|E*|(MPa)	ε_6 (µstrain)
EME 2	2.5	16 770	126
Mix 1	1.5	14 540	115
Mix 2	1.7	16 200	100
Mix 3	2.2	16 360	109

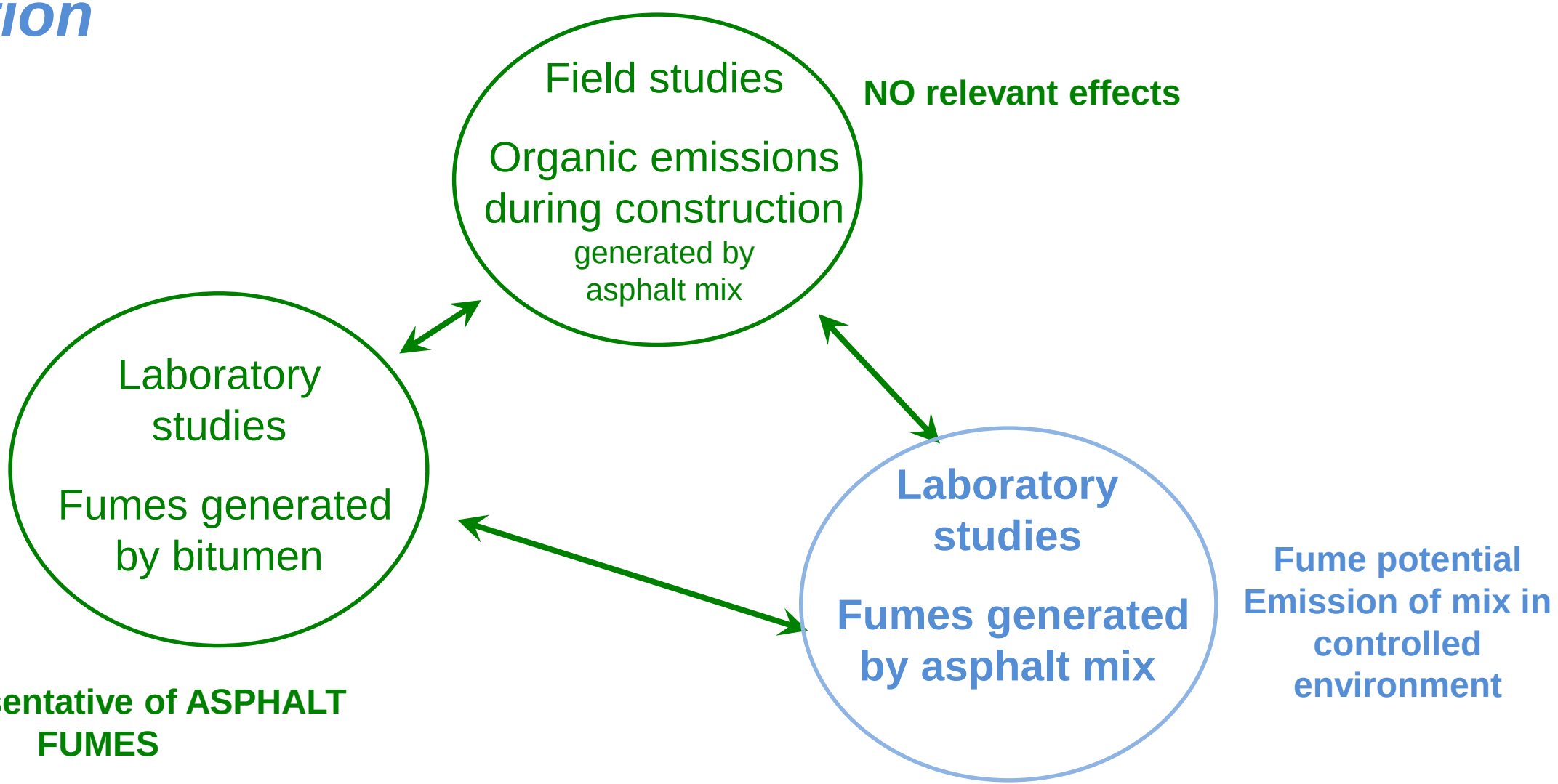


→possible to produce, in plant, these materials with high RAP content and biobinders or bio-additives

→Moderate performances in lab but high performance at full scale in comparison to the conventional mix

HSE evaluation (fume emission)

Motivation



IFSTTAR experimental method

Objective

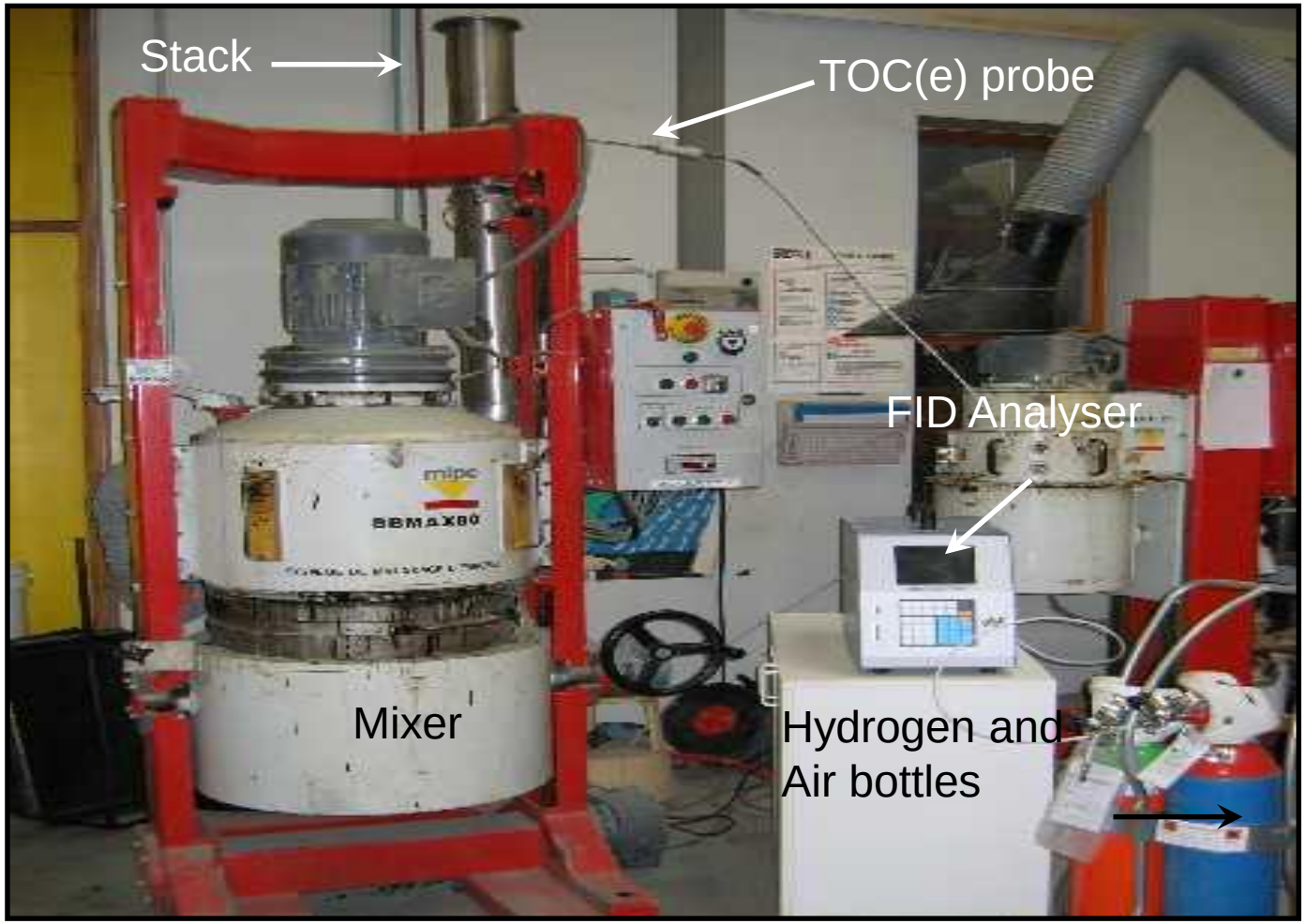
Environmental Assessement and ranking of **bituminous mixes** in lab

Functions

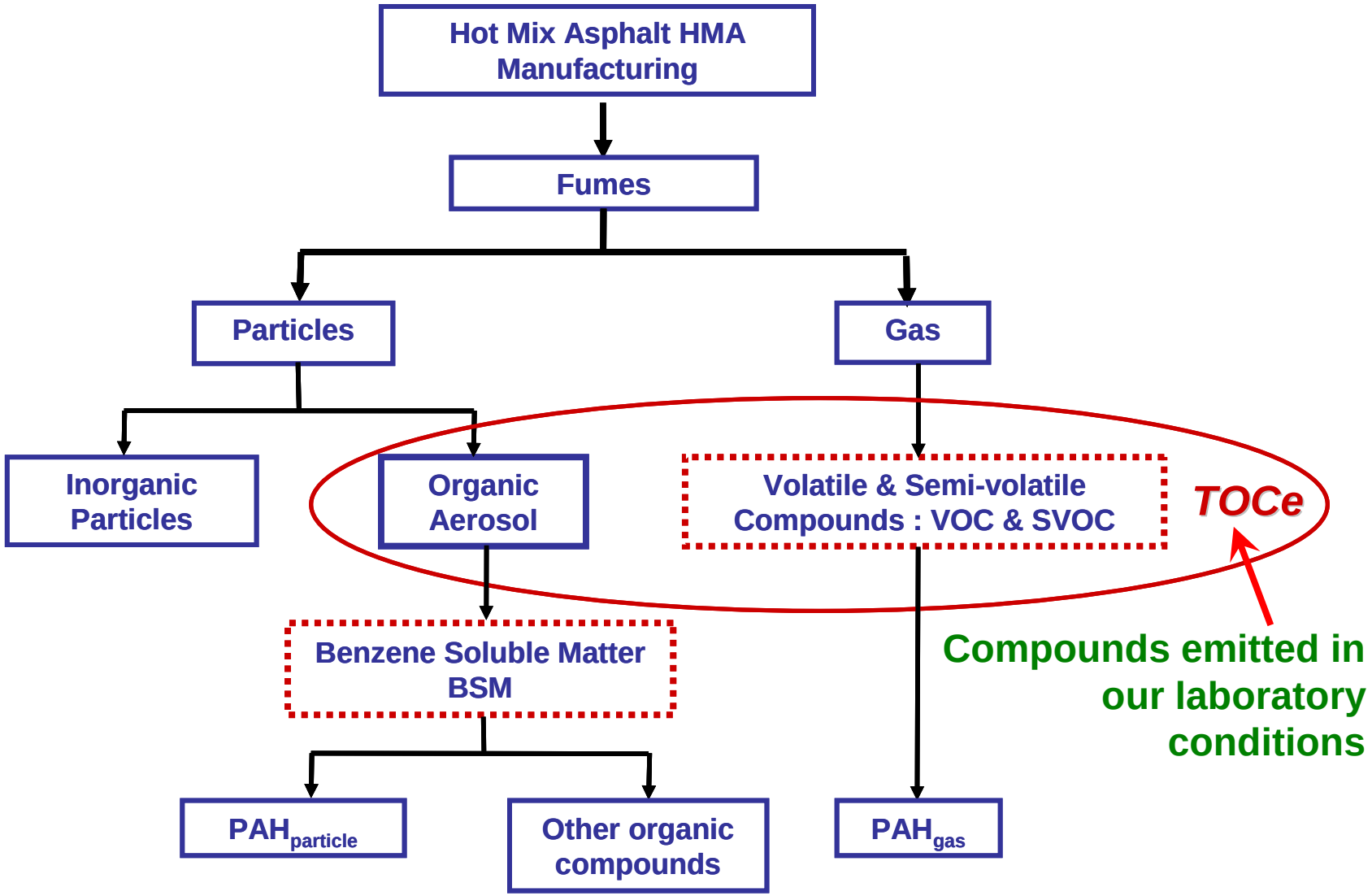
- Generate fumes
- Collect / Sample
- Analyse

Parameters studied

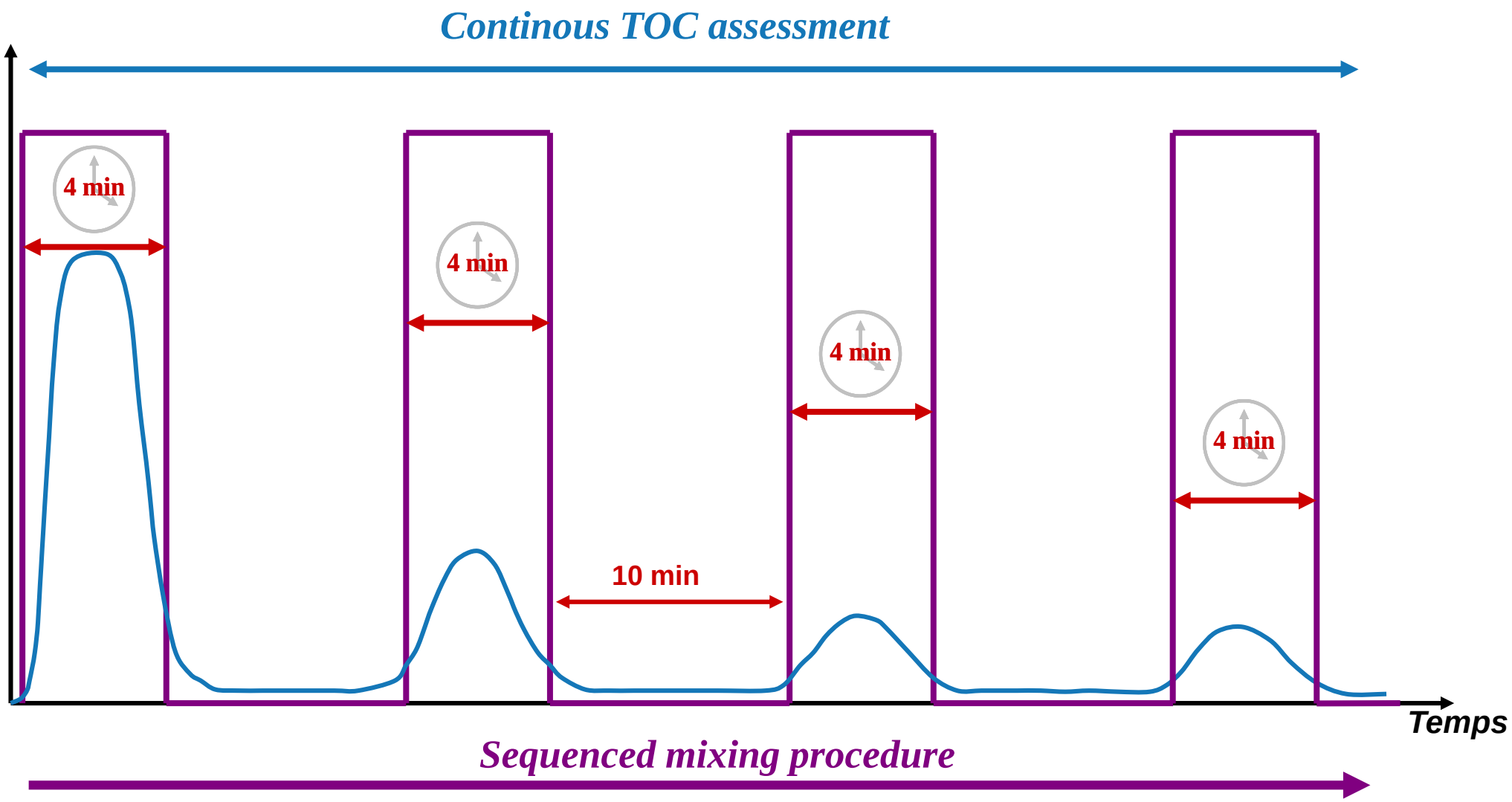
- Formula
- Binder
- Process



Composition of bituminous fumes



Sampling protocol



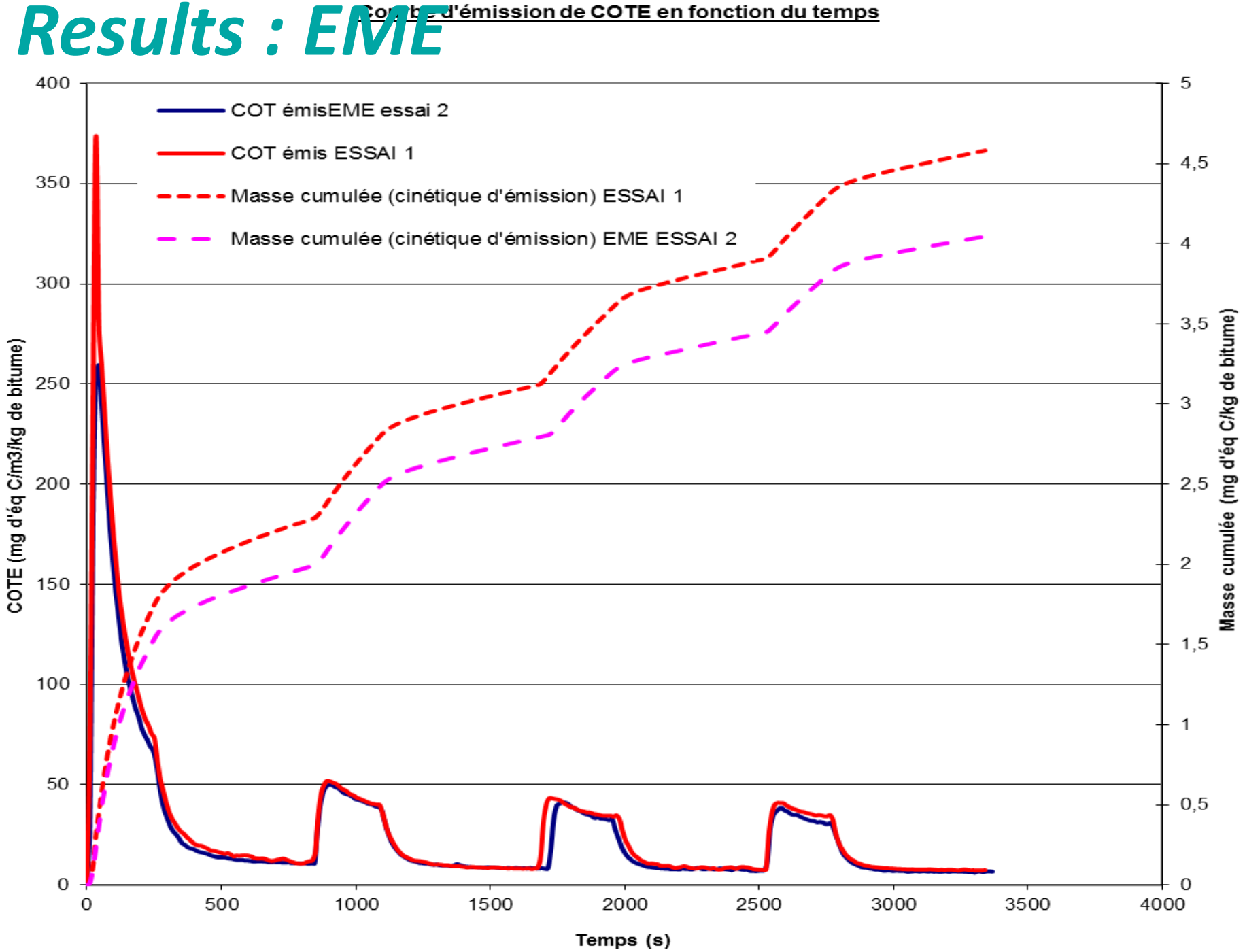
Formula studied

Formula	Name	Mix	RA content (%)	Fresh binder	Fresh Binder content (%)	Additive content (%)	Manufacturing temperature (°C)
Control	EME	A	20	20/30	4.8	-	175
BioRepavation	MIX2	B	50	Biophalt	2.8	-	120 150 180
	MIX1	C	50	50/70	2.7	0.1	120 150 180
	MIX3	D	50	50/70	2.7	0.1	120 150 180

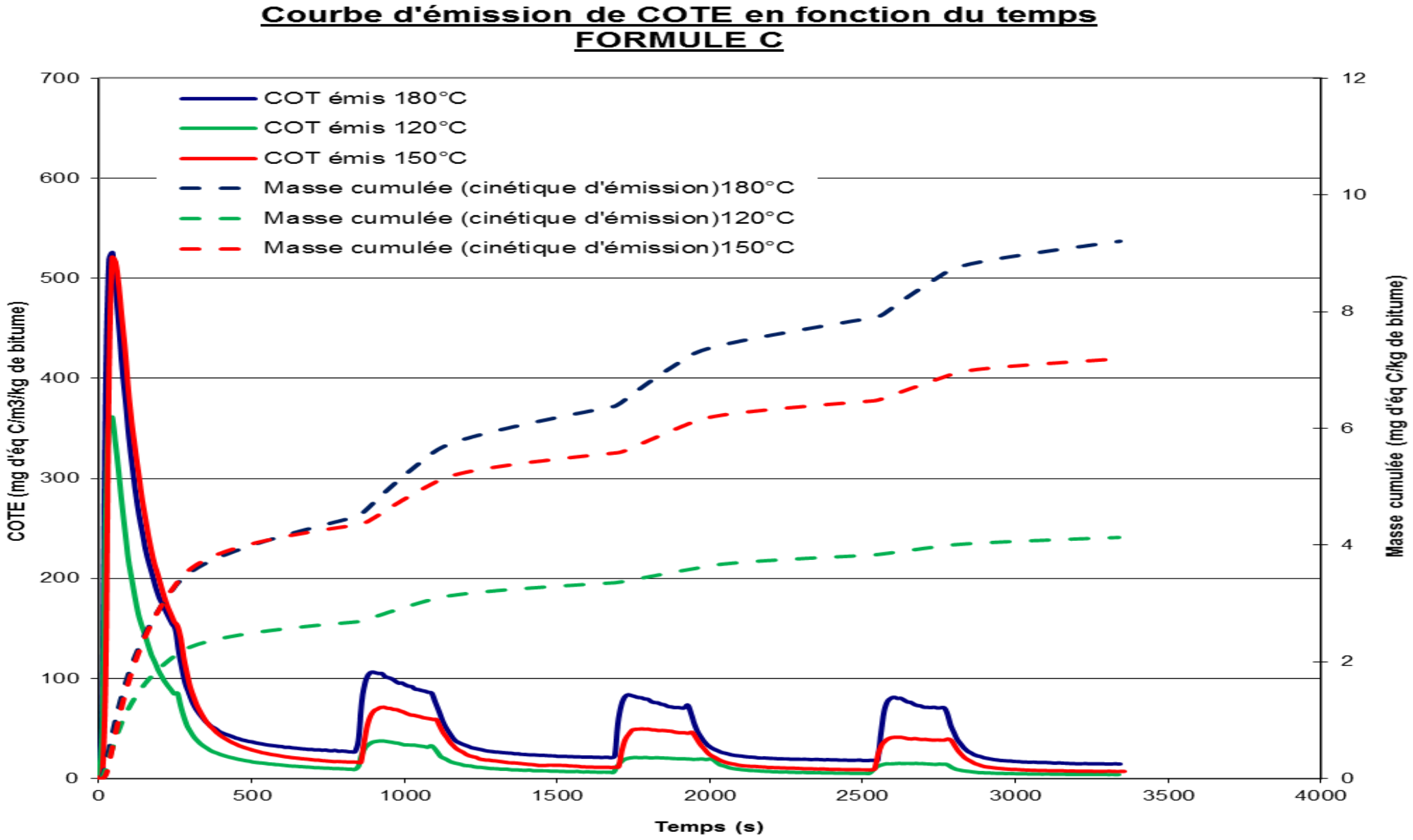
Experimental program (temperatures)

Mixing temperature (°C)	120		150		180		
Mix	Virgin aggregate (°C)	RA material (°C)	Virgin aggregate (°C)	RA material (°C)	Virgin aggregate (°C)	RA material (°C)	Binder (°C)
A (EME)	-	-	-	-	195	120	**170**
B (MIX2)	120	120	200	120	230	130	**130**
C (MIX1)	120	120	200	120	230	130	**150**
D (MIX3)	120	120	200	120	230	130	**150**

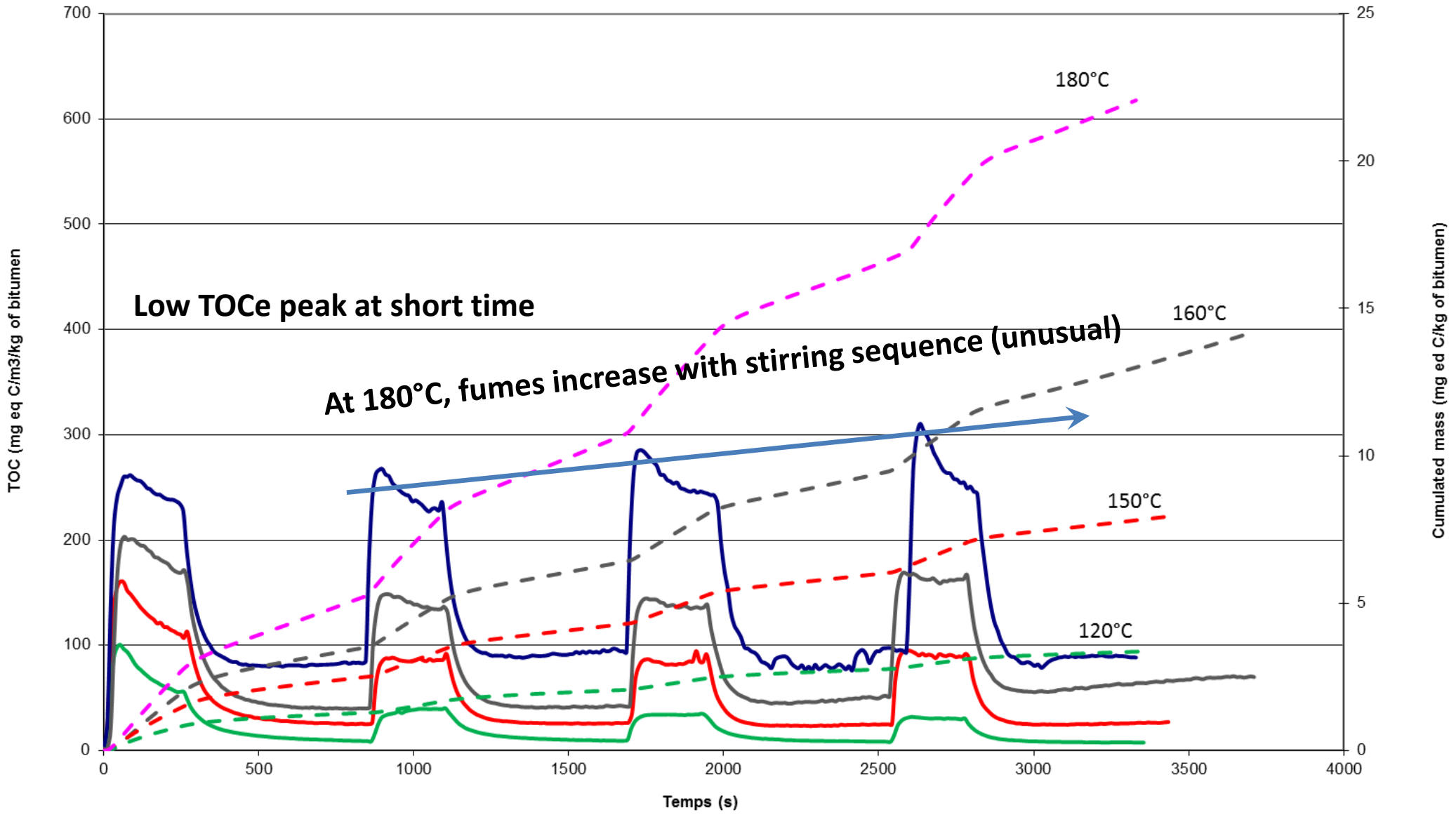
TOCs Results : EME



TOCs Results : MIX3 *(mix1 similar)*



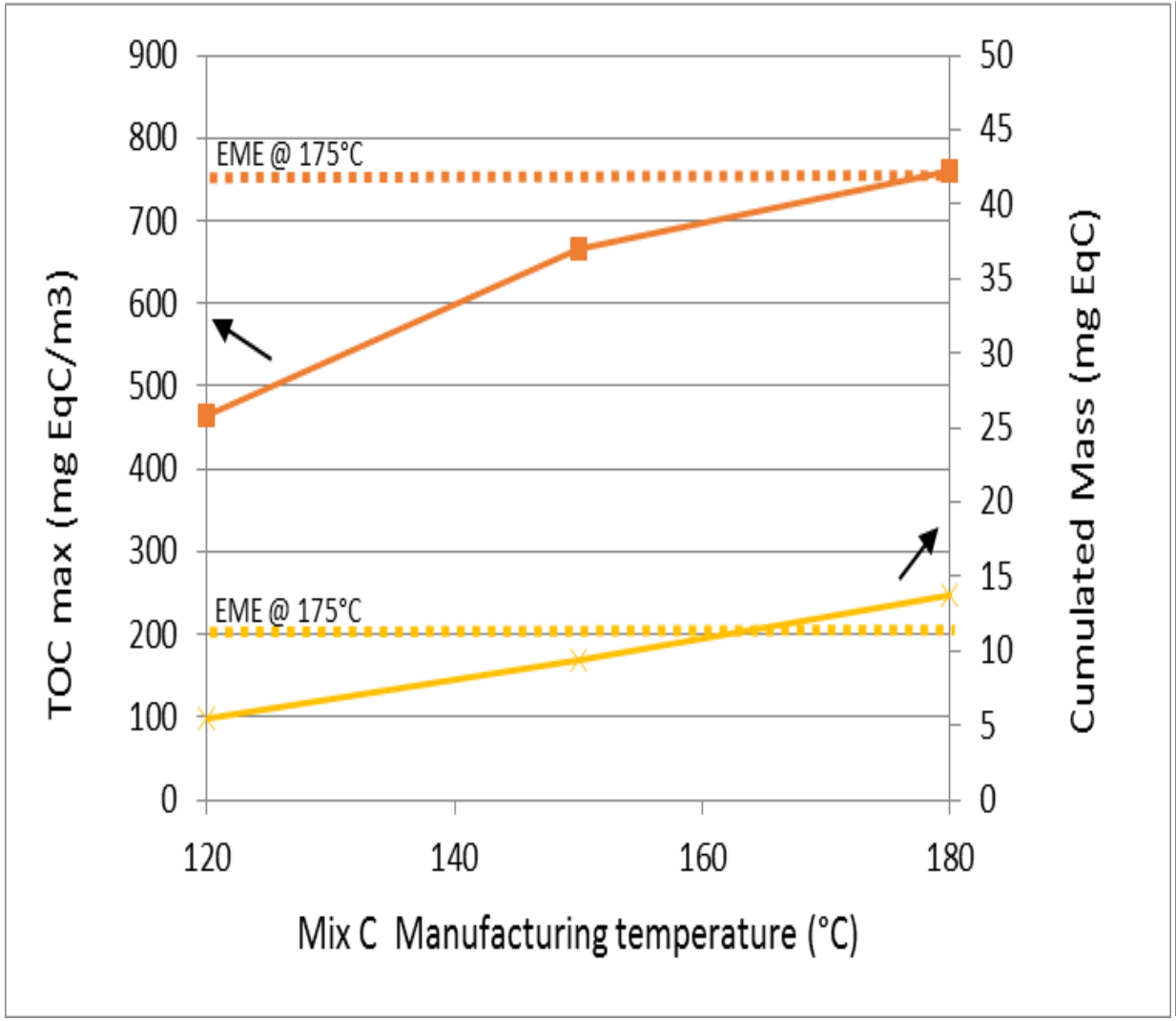
TOCs Results : MIX2



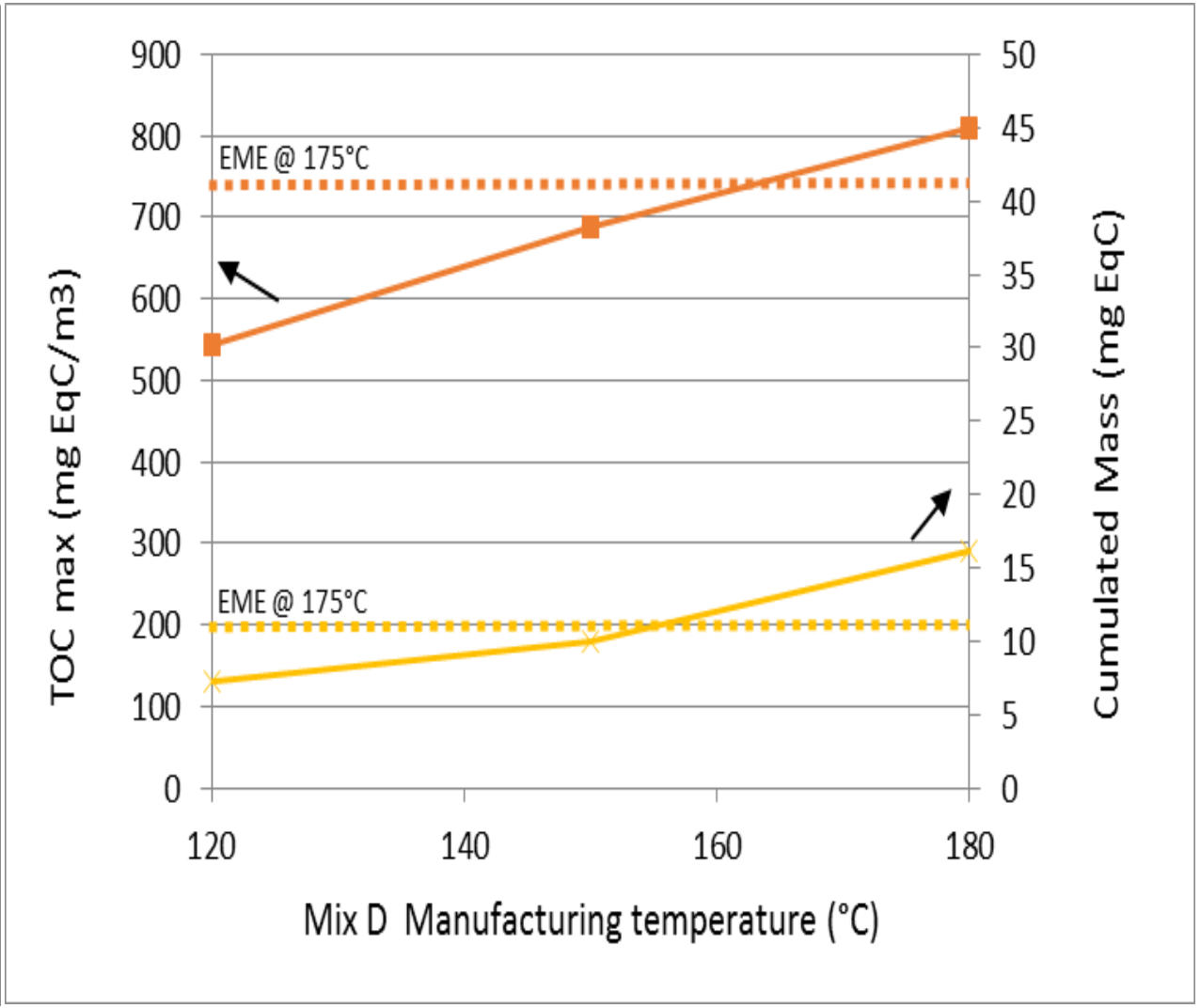
Temperature influence on fume

Regeneration versus conventional mix

MIX1

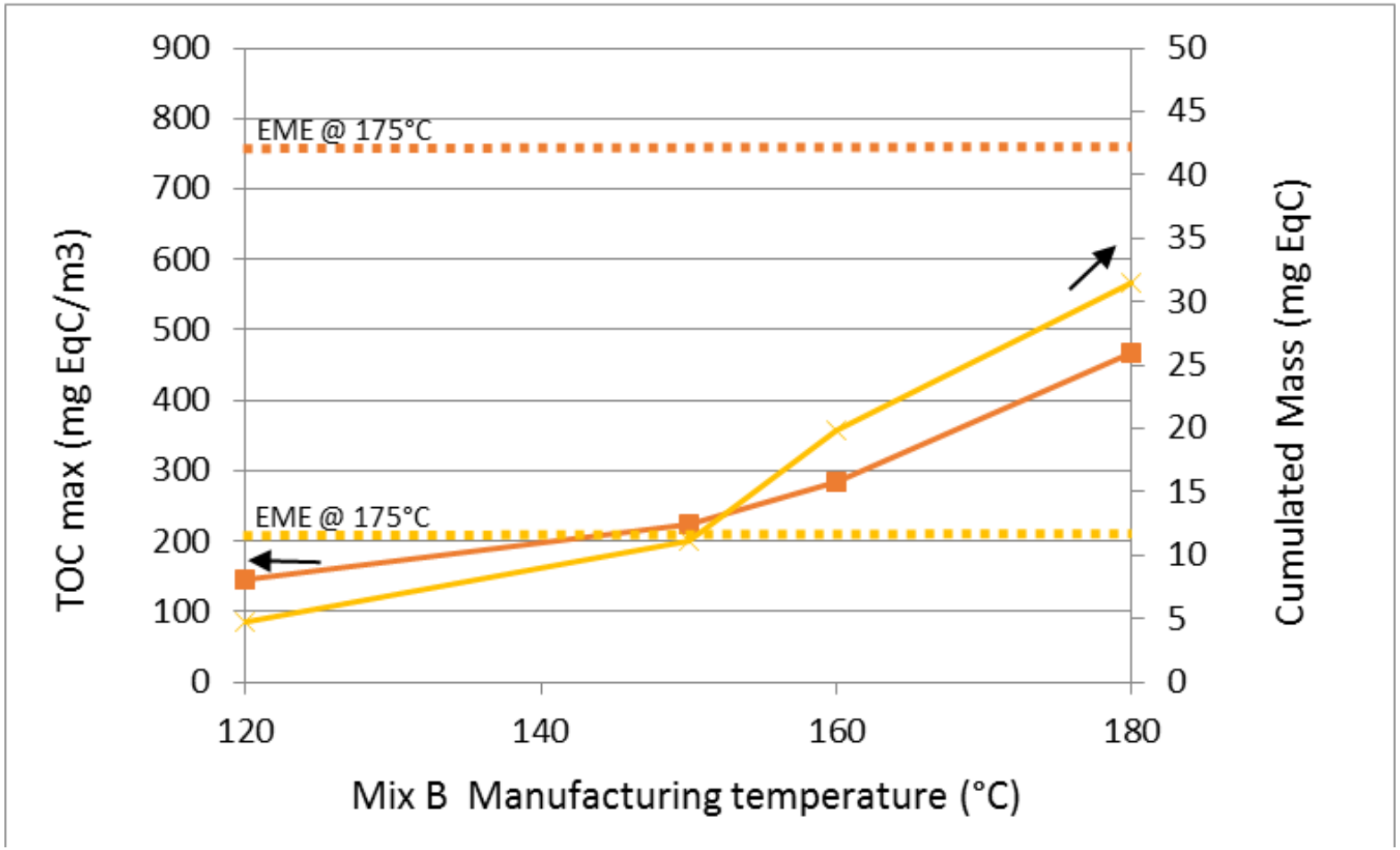


MIX3



Temperature influence on fume
full replacement versus conventional mix

MIX2



Recommandation to no-overheated Biophalt higher than 150°C
(lower TOC max and Cum mass is equal at 150°C)

Conclusions

- It is possible to manufacture (in conventional asphalt plant) and also to lay (at full scale) a road material with 50% of RA while reducing the amount of fresh bitumen (up to full replacement)
  - Durability: the 3 innovative materials behave better that the reference one which is largely used in Europe for base courses

- Measurements of fume emissions were performed on bituminous materials to characterize total organic compounds generated by asphalt material

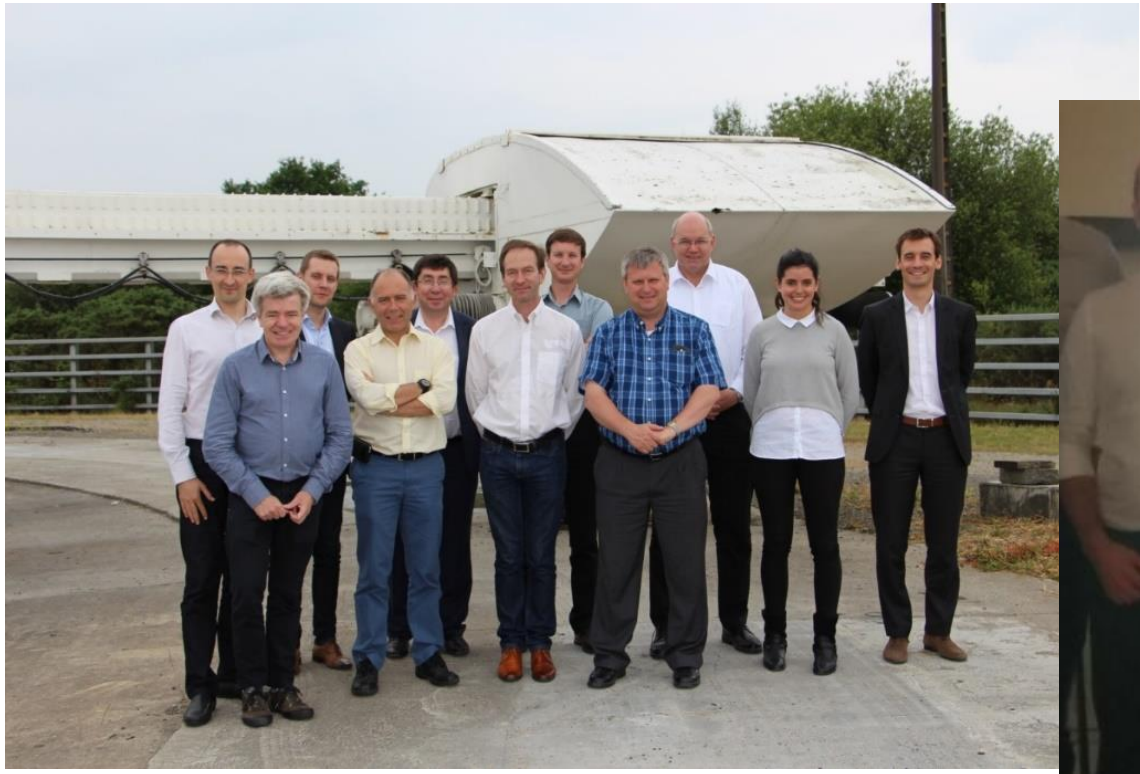
  - Strong link between bituminous material composition and their emission potential
  - At the usual manufacturing temperature, 160°C, no additional fumes on mix with rejuvenators (MIX 1 and 3) are observed in comparison to the reference mix (EME)
  - Concerning mix with full binder replacement (Mix 2), the best emission performance in comparison to reference mix (EME) is below 150°C.

Thanks to the BioRePavationConsortium

- IFSTTAR (France - coordination – has evaluated durability at full scale)
- EIFFAGE Infrastructures (France – has produced an alternative binder & carried out mix design tests)
- IOWA STATE UNIVERSITY (USA – has produced a bioasphalt & carried out mix design tests)
- KRATON chemical (Netherlands – has produced a bio-based performance additive)
- WESTERN RESEARCH INSTITUTE (USA – has carried out non-destructive in-situ evaluation and binder tests)
- UNIVERSITY OF NOTTINGHAM (UK - has conducted life cycle and risk assessment, and binder tests)

Thank you for your attention

Emmanuel.chaileux@ifsttar.fr



Infravation
An Infrastructure Innovation Programme

lab and full-scale validation

high performance in comparison to the conventional mix

- Low rutting level
- After 1 million cycles: no cracks on the innovative materials, some cracks on the reference material (High modulus mix – EME)
- After 1.8 million equivalent loadings at 65 kN, no cracks on two innovative materials, 10% on one innovative material, 27% on the reference EME
- Results confirmed by FWD measurements and in-situ micro-sampling and testing

MIXES	Air voids	Rutting estimates after initial consolidation
Reference: EME	3.4%	1%
Mix1	3.3%	2%
Mix2	1.6%	2%
Mix3	2.0%	1%