Industry Technical Advisory Committee

Cedre's activities – Update

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Content

- Overview of recent activities of potential interest for the industry
  - Short-termed or multiyears/multipartners projects :
    - Scientific studies (e.g. : substances fate/behaviour, etc.)
    - Mechanical equipment/techniques assessments
    - …
- Scope :
  - Oil spills
  - … foreword: enduring or *growing* activities in other fields of interest (HNS, *marine litter/microplastics*)

HNS-related activities : equipment

- 2014 – 2017 : *POLLUPROOF*

  "PROOF improvement of HNS maritime POLLution by airborne radar and optical facilities"

  – ANR funded (Program ECOtechnologies & EcoServices)
    - Leader : ONERA (French aeronautics, space and defense research lab)
    - Partners : FR (Agenium IT / AVdef / Cedre / Ceppol / DGDDI) + CAN (DRDC/TC)

  – Aim : improve authorities' capacity to detect, and categorize HNS spills (gathering evidence in order to prosecute offenders and/or informing spill response)

  – Tools: airborne radar + optical / hyperspectral sensors

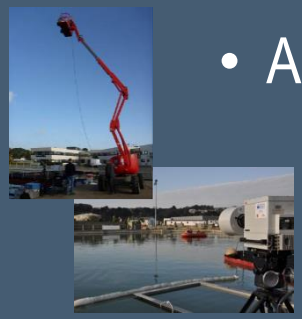
  – Outcome : model software and HMI (Human Machine Interface), to provide proof (data and images) of HNS spills at sea

HNS-related activities : equipment

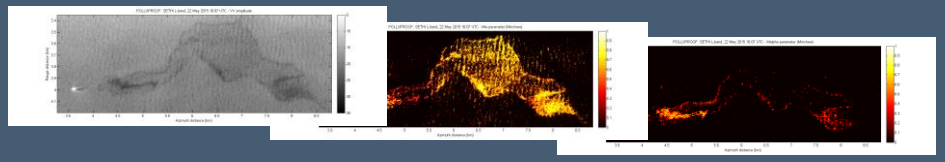
- 2014 – 2017 : *POLLUPROOF*

"PROOF improvement of HNS maritime POLLution by airborne radar and optical facilities"

– Cedre's involvement :



- Assessment of sensors (optical, hyperspectral,…) performances
  - in Cedre's outdoor basins
  - trials at sea
  - on 6 HNS (incl. vegetal oils and esters, noxious petrochemicals, alcohols and derivatives)



– Further info:

- http://w3.onera.fr/polluproof/
- **Angelliaume, S., B. Minchew, S. Chataing, P. Martineau and V. Miegebielle, 2016.** Multifrequency Radar Imagery and Characterization of Hazardous and Noxious Substances at Sea, *Proc. 39th AMOP Technical Seminar*, Environment and Climate Change Canada, Ottawa, ON, pp. 364-382.

HNS-related activities : preparedness

- 2015 – 2017 : *HNS-MS*

  "Improving Member States preparedness to face an HNS pollution of the Marine System"

  – EC DG/ECHO (Humanitarian aid and Civil Protection department) funded
    - Leader : Royal Belgian Inst. of Natural Sci. / Operational Directorate Natural Environ. (BE)
    - Partners : BE (Belgian DG Environment) + FR (Cedre / Ecole des Mines d'Alès / Alyotech Technologies)
    - Aim : decision-support tool (national maritime authorities, coastguard stations) to anticipate drift, fate/behaviour and risks of HNS marine spills.

  – Cedre's involvement :

    - Lab analyses : Physicochemical properties (20 chemicals) under various conditions (S‰, Temp…) → database
    - Experiments: "HNS bench" : persistence, evaporation, dissolution (for 10 chemicals) under controlled parameters (wind, waves, temp….) ; "water column" ;
    - Vulnerability mapping: build upon previously-developed GIS (*B-AWARE* project)

  – Further info: https://www.hns-ms.eu/

HNS-related activities : training

- 2016 – 2017 : *MARINER*

"Enhancing HNS marine spill response preparedness through training and exercising"

  - EC DG/ECHO funded
    - Leader : CETMAR (Centro Tecnologico del Mar) (SP)
    - Partners : UK (PHE) + FR (Cedre) + PT (CIIMAR, Action Modulers) + SP (INTECMAR, Vigo Univ.)
    - Aim : reinforcing regional cooperation (HNS spill preparedness & response)

  - Tasks incl.: review of literature, of previous EU projects/models, …

    → training package (.ppt presentations, posters, videos, e-learning materials, online models…). Further info: http://mariner-project.eu/

  - Cedre's main contribution:
    - Training and exercise material/tools (ppt presentations, posters)
    - Hosting / conducting a 'test-run' of the courses (w. partners) ; September 2017

HNS-related activities : training

- Ongoing HNS activities/projects
  - Fate / behaviour (floating cells, lab. various scale studies)
  - …

Marine litter / microplastics

- Cedre's growing involvement:
  - support for national public policies, as:
    - France' scientific representative at **OSPAR** *Intersessional Correspondence Group on Marine Litter* (ICG-ML)
    - French National Co-lead (w. Ifremer) on EU **MSFD**'s descriptor **Marine Litter** (D10) (specifically for litter & µplastics on beaches)
      - National surveillance network (of NGOs) building up & coord.;
      - Data management (compilation, processing, control and qualification);
      - Reporting (quantif./qualif./trends)
      - Definition of a protocol (µPs) incl. assessment of a specific tool : MPSS (µplastics sediment separator);
  - knowledge/research + impact assessment studies:
    - µPs behaviour in water column
    - Contaminant (POPs) adsorption/desorption
    - Ecotoxicological studies

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Ifremer

Marine litter / microplastics

- Cedre's growing involvement:
  - through 2 newly launched EU funded (*INTERREG*) projects
    - *Ocean Wise (leader: DGRM, Portugal)* >> *EPS impacts and EPS substitute*
      - main Cedre contrib./WPs : POPs (de)sorption kinetics on EPS + ecotoxicity (fishes)
    - *Clean Atlantic (leader: CETMAR, Spain)* >> *ML in marine environment (gaps in knowledge)*
      - main Cedre contrib./WPs: Behaviour and ecotoxicity (cigarette butts); *hotspots* identification (localisation, quantification) ; clean-up techniques (guidelines), etc.
    - Further info : … forthcoming dedicated websites

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Oil spill response related studies
(Recent / ongoing / forthcoming)

Scientific studies – Response techniques

Chemical dispersion

- Aim: better understand oil viscosity limits for dispersant application (prediction of dispersibility @ lab scale → decision making)
- Context :
  - Standardized IFP and MNS dispersants effectiveness tests (agreement procedures) may also be used to :

    → estimate "dispersibility" of oil emulsions (% used as an index compared to threshold values defined for both protocols) using one given dispersant

Good > 50 %
Poor < 20 %

Good > 70-75 %
Poor < 5 %

Scientific studies – Response techniques

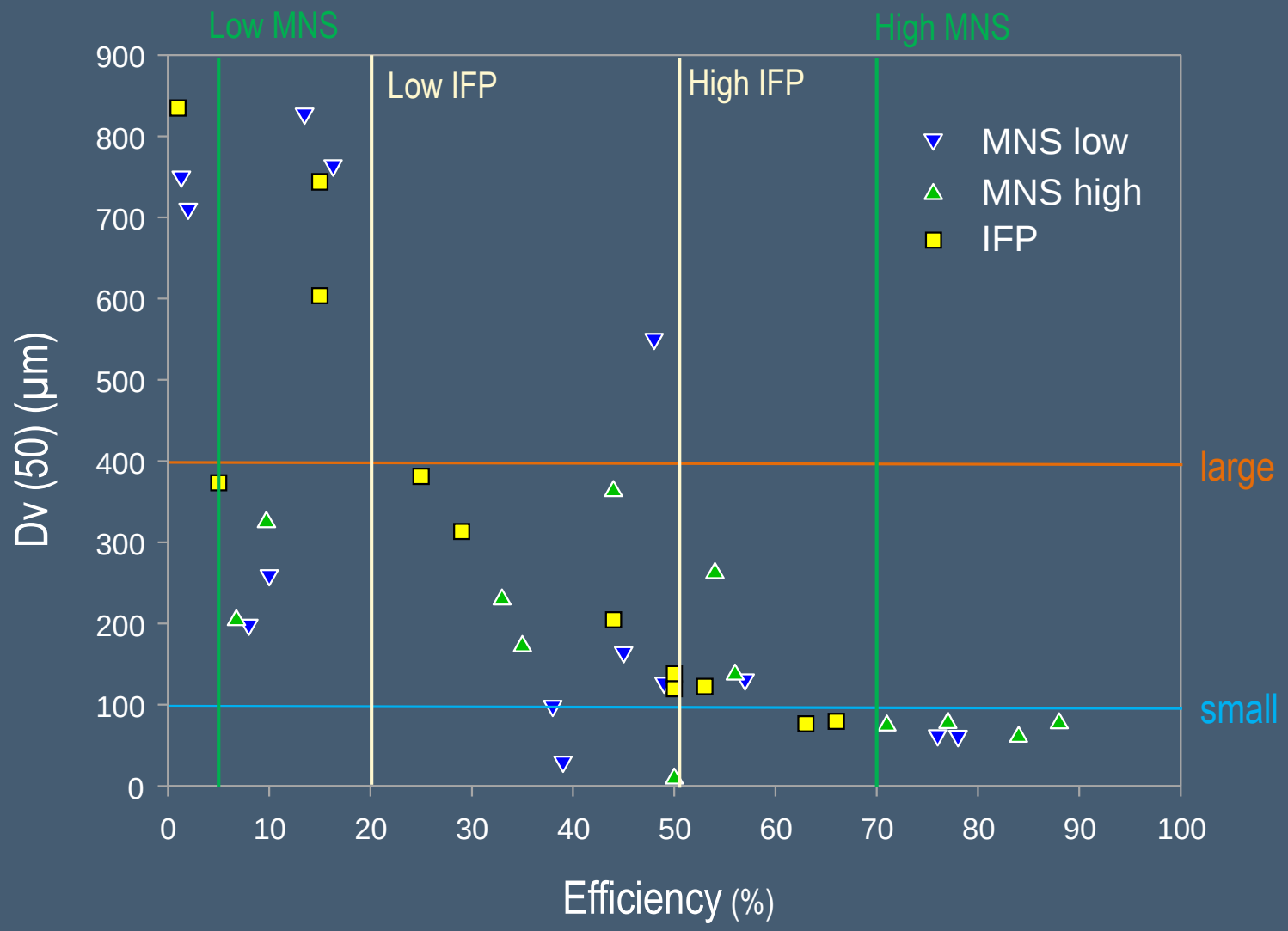
Chemical dispersion

- Objectives:
  - Assess lab tests' reliability/accurracy to estimate dispersion efficiency in real conditions
    - Measurements of efficiency through lab and pilot scale (flume tank) experiments (same temperature, dispersant, oil, DOR…);
    - Qualitative analysis of the dispersion through oil droplets size distributions
    - Changes in quantitative and qualitative parameters for a wide range of viscosities
    - Review/confirmation of "dispersibility" threshold values

Chever F., Duboscq K., Receveur J., Audegond C. & Guyomarch J., 2016. Determination of Limits of Viscosity for Dispersant Use: Quantitative and qualitative assessment of the dispersibility of water-in-oil emulsions at the laboratory (IFP and MNS tests) and in the *Polludrome*. *Proc. 39th AMOP Technical Seminar*, Environment and Climate Change Canada, Ottawa, ON, pp. 916-932.

Scientific studies – Response techniques

Example of results : lab scale ; droplet size distrib.Vs efficiency



Scientific studies – Response techniques

Laboratory – Quantitative / qualitative results

% water	Viscosity (mPa.s)	Dv50 (µM)	MNS		IFP
			Low	High	
0	6 000	< 100	77	86	65
10	9 300		53	74	52
20	14 000	100 - 400	47	55	47
30	15 000		39	47	27
40	23 000		15		20
50	28 500	> 400	9	34	15
57	36 500		2	8	3

Scientific studies – Response techniques

Laboratory tests

→ Proposal of % values as dispersibility thresholds

Dispersibility	MNS	IFP
Good	E > 60 %	E > 50 %
Uncertain	15 % < E < 60 %	20% < E < 50 %
Poor	E < 15 %	E < 20 %

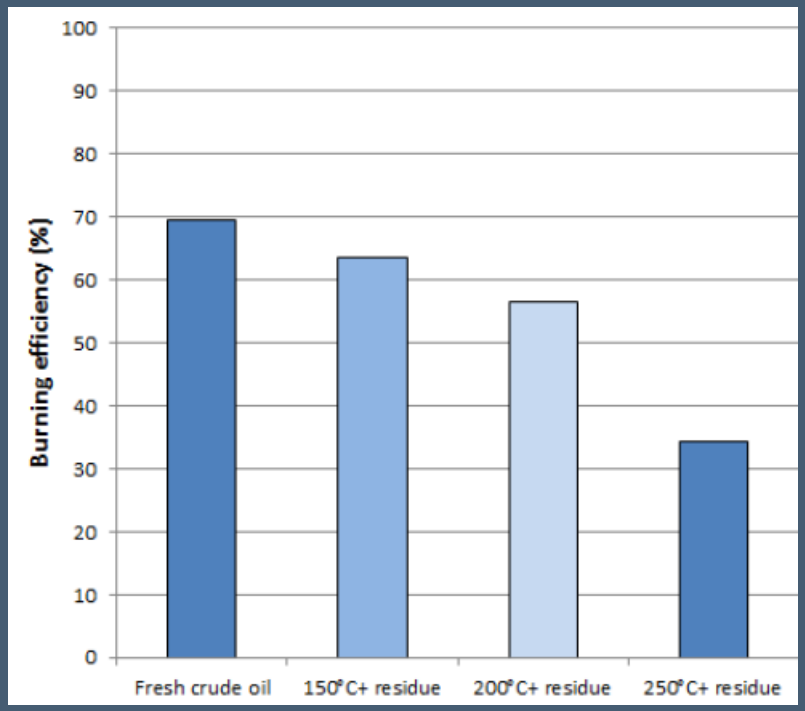
– To be confirmed with oils of different physicochemical properties (and also different dispersant…)

– Need for field validations including concentrations and droplets size measurements

Scientific studies – Response techniques

In Situ burning – 2017 activities

Tests with "*Burning bench*": results obtained with heavy (API= 44.5) condensate (100 mL)



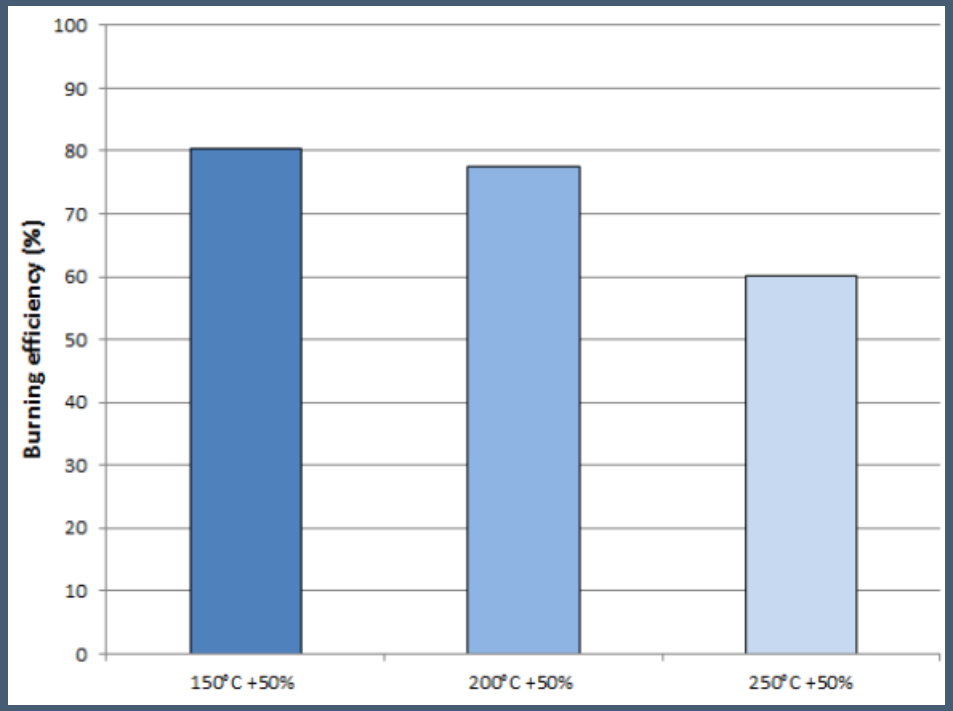
Burning efficiency decreases (logically) with evaporation:

- fresh sample = 70%
- topped @ 150°C sample = 63%
- topped @ 250°C sample = 32%

Scientific studies – Response techniques

In Situ burning – 2017 activities

Tests with "*Burning bench*": results obtained with heavy (API= 44.5) condensate (100 mL)



Burning efficiency increases with emulsification (!!?)

- topped @ 150°C sample + 50% H_2O = 80%
- topped @ 250°C sample + 50% H_2O = 60%

Scientific studies – Response techniques

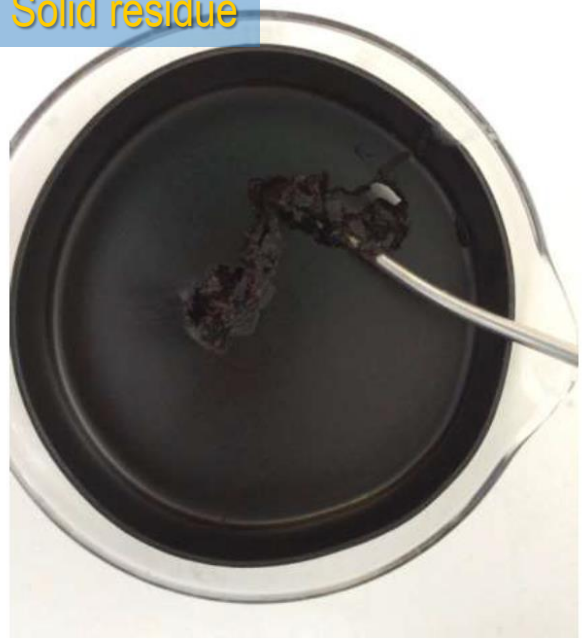
In Situ burning – 2017 activities

Tests with "*Burning bench*": results obtained with heavy (API= 44.5) condensate:

For a given oil, physical properties of burn residue change according to weathering degree (*and* burn efficiency)

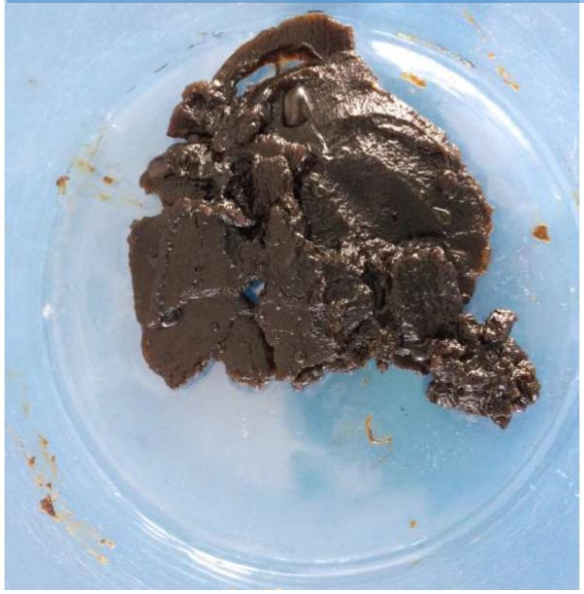
Visual observation:

Solid residue



250°C+ residue photo-ox. after burning

Semi-solid; very brittle residue



Fresh condensate after burning

Scientific studies – Response techniques

In Situ burning – 2017 activities

Tests with "*Burning bench*": results obtained with heavy (API= 44.5) condensate:

Observation of a «yellow foam » sinking in seawater for emulsified oil samples (not for fresh or topped samples)

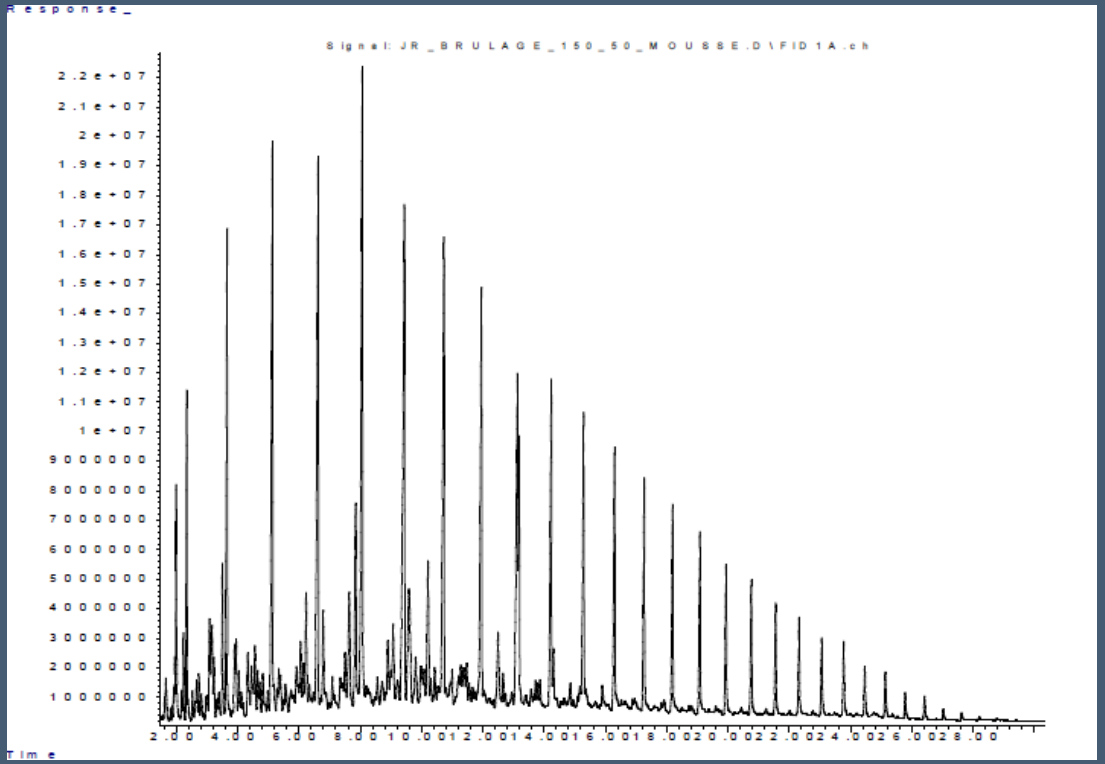
Scientific studies – Response techniques

In Situ burning – 2017 activities

Tests with "*Burning bench*": results obtained with heavy (API= 44.5) condensate:

"foam" analysis (GCFID): presence of n-alkanes, distribution not unlike a slightly evaporated oil (loss of lighter alkanes ; UCM higher than for fresh oil)

Several question about this « foam »:
- already observed?
- systematic for each condensate?
- behavior and persistence in water column / seabottom



Scientific studies – Response techniques

In Situ burning – 2017 activities

Cedre invited as an observer

- Tests of catalyst application to reduce ISB smoke emissions (*Merl consulting*)
  - Burning of Jet A (Darlington, UK)
  - Visual (pic/vid) comparison with/without catalyst application

Preliminary assessments suggest efficiency but:

- need to improve catalyst preparation/delivery system (catalyst encapsulated in a porous material)
- need to quantify soot reduction (2018 activities? Not selected for award by BSEE BAA E17PS00024 for *Proposed Research on Oil Spill Response Operations on the U.S. Outer Continental Shelf*)

Scientific studies – Oil fate/behaviour

Fate and impact of oil in mangrove ecosystem

PRISME Project (2015 – 2016) / French Guiana

- Cedre w/ 4 French Universities (Pau, Marseille, Brest, Toulouse)

- Prospective *in situ* experiments (30 k€)

Scientific studies – Oil fate/behaviour

Fate and impact of oil in mangrove ecosystem

PRISME Project (2015 – 2016)

– Main conclusions:

- Migration of oil in the sediment was highlighted through TPH concentrations profiles ; confirmed by microsphere vertical distribution (bioturbation / sediment mixing processes);
- 90 % of n-alkanes and PAHs appeared degraded after (only) one month in the environment;
- n-alkanes analyses highlighted a decrease of n-C17/pr and n-C18/ph ratios suggesting an effective biodegradation ; supported by molecular identification of 16S DNA sequences belonging to well-known oil-degrading bacterial genera (*Alcanivorax* , *Marinobacter*..)
- Oil had an effect on meio/macrobenthic diversity and abundances

Scientific studies – Oil fate/behaviour

Fate and impact of oil in mangrove ecosystem

Next? Research needs

- Due to the peculiarities of FG coastal ecosystem, from what we know so far, it is extremely difficult to predict the fate and potential effects of significant oil spill:
  - Behaviour/interaction/degradation of spilled oil in contact with the mobile/liquid mud is unknown → fate of oil slicks in such an environment ?
  - It is not known how oil contamination of the mobile mud would affect the early stages of mangrove development (propagules settlement and pioneer mangrove), the associated benthic system, and implications for growth of the older mangrove stages

Scientific studies – Oil fate/behaviour

Fate and impact of oil in mangrove ecosystem

Perspectives : a larger project (incl. larger-scale field experiments…);

- *GANESH* : French GuiANa mangrove Ecosystem: potential effects of an oil Spill on the benthic communities, resilience capacities and oil Hydrocarbons dynamics;
- will be submitted again for funding to ANR (French National Agency for Research) in oct. 2017 ; estimated total budget ≈ 900 k$
  - *In situ* mesocosms studies involving liquid mud behaviour (e.g. floating vs. adsorption, etc.)
  - Experimental contamination in young mangrove areas
- Pre-project selections: feb./march 2018 ; refined draft april/may 2018
- coll./support from Industry (pre-proposal)

- For 2018 : interest from Cedre's Industry partners = plans to pre-assess oil (crude) short-term behaviour in heavily turbid waters

Scientific studies – Bioremediation

Bioremediation Agents (BA)

Development of a test protocol

Objective: assessment of BA efficiency in a semi open environment (recreates dilution as it would occur *in situ* -tidal cycles…)

Principle:

- sediment layer ("shoreline") in small tanks
- contamination with crude oil
- treatments / BA application
- oil biodegradation is measured/compared to controls, extend. time-scale

Scientific studies – Bioremediation

Bioremediation Agents (BA)

Development of a test protocol

- automated tool :
  - generates identical waves/agitation in each tank (n=12);
  - wave energy from sheltered to exposed shores;
  - “tidal cycles” / natural seawater;
  - allows controlled and reproducible tests.

Scientific studies – Bioremediation

Bioremediation Agents (BA)

Development of a test protocol

- Preliminary experiments
  - Biodegradation occurs after 48 days for biostimulation treatments:
    - long duration compared to standard efficiency test protocol (28 days);
    - more realistic in terms of expectations (efficiency, delay) for i*n situ* treatments;
  - Bioaugmentation treatments
    - short-term induction of oil biodegradation, compared with biostimulation treatments, but less efficient on a mid-term (3 months);
    - different results compared with tests at lab scale;
    - but consistent with field observations (competition between native/non-native bacteria, adaptive changes in communities) as documented in literature – guidelines, articles…
- Ongoing…

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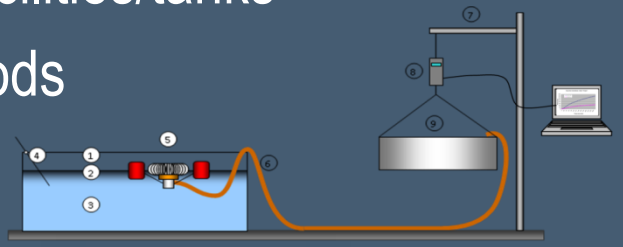
Oil spill response equipment – tests/assessments

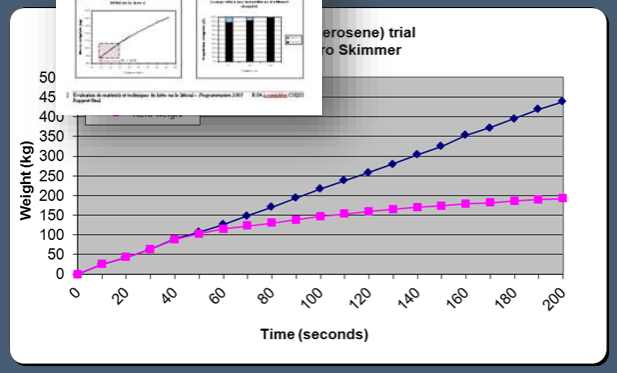
Examples 2016-2017

Oil spill response equipment – Recovery

Skimmers, pumps, indoor tests “as usual”

- measurement of performances
  - in controlled environment ; Cedre’s own facilities/tanks
  - according to standard (AFNOR) test methods
- 2016 examples…





Oil spill response equipment – Recovery

Field assessments

– C&R booms for fast current/high speed waters

- 2013, 2015: NOFI *Current Busters 4* & 2
- 2017 (oct.): Lamor/Egersund *MOS 15*
  DESMI *Speed-Sweep*
- Plans being considered for 2018

2015:

Oil spill response equipment – Recovery

Field assessments

– C&R booms for fast current/high speed waters

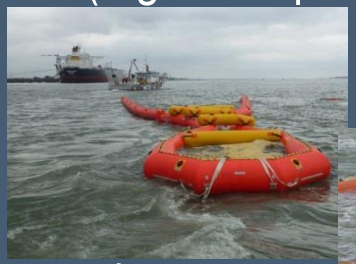
Aim : Identify operational constraints and requirements (+ improvements?)

Dynamic mode

2015:

– 2 vessels (pair towing) vs. single vessel w. BoomVane

– Compare maneuverability, tech. requirements (e.g. horsepower, hull, etc.);

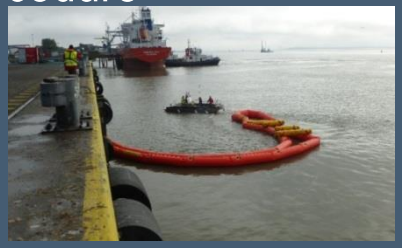


Static mode (w. BoomVane)

– Definition and validation of a deployment procedure

– Logistics (boats, personnel, etc.)

– Challenges in estuaries : reverse of the tide / “flip over” procedure



Oil spill response equipment – Recovery

- Learnings from 2013 -*Current Buster 4*

Static

- Requirements for deployment (e.g.: current ≥ 1 knot; hp≥ *ca.* 350; 6 persons; 15 mn…)
- Validated 'flip-over' procedure during slack (e.g. manoeuvring; hp = *ca.* 225 min; …)
- Know-how (settings, …), needs (staging area, …), etc.
- Bottom net prone to be caught (quay, infrastructures) when folding up

Dynamic

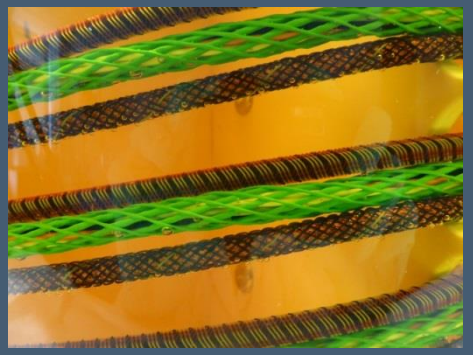
- Single vessel w. *BoomVane* more 'workable' than pair towing (manoeuvrability, coordination…)
- *Current Buster* 'delivered' up until *ca*. 3.5-3.7 knots (speed thru water)
- Requirements (boat): hp≥ *ca.* 350 ch ; 18 m ; bow thruster; …
- Welcomed: crane (*BoomVane* deployment)
- Others… (non « *CB*-specific »): guidance system (small boat/outboard motor + VHF)

- 2015 follow-up (*Current Buster 2*)
  - Lighter/smaller equipment & nautical resources (e.g., hp≥ *ca.* 225 ch) ;
  - *CB2* containment/efficiency (*ca*. 3.6 knots, depending on waves orientation) ;
  - Ancillary equipment added to the ops chain : skimming (*MicroFoilex*)/pumping (peristaltic pump)/storage (towable open tank) ;
  - …

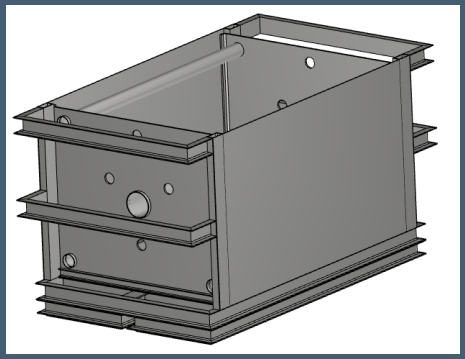
Miscellaneous

Assessment of oil sensing wires to detect leaks from underground pipelines

- Lab scale (completed) : immersion of 3 different sensing cables within an closed tanks (13 HC tested ; vapours + polluted sand)



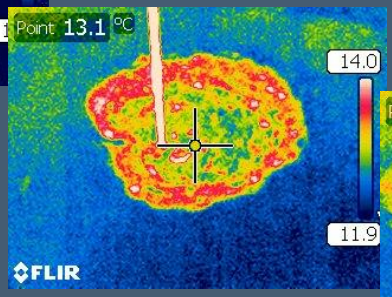
- Pilot scale (in progr) : test bench/device under construction to simulate leakage from a pipeline

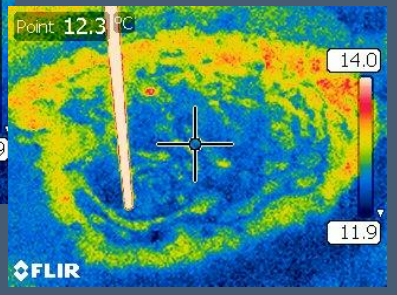


Miscellaneaous

Assessment of an IR sensor for detection of organics in confined/poorly accessible spaces

- Industrial application
  - Waste (muds) treatment process
    - Detect/recover





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