

Recap of Day 1

Dan Rutherford, Ph.D.

CCAC Workshop
7-8 September, 2016
Vancouver, BC, Canada

The logo for the International Council on Clean Transportation (icct). It features the lowercase letters 'icct' in a bold, dark brown font. The letter 'i' has a small blue circle above it. Below the letters, the full name 'THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION' is written in a smaller, blue, all-caps font.

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Reminder of Workshop Goals

1. Solidify recommendations for marine **BC measurement approaches**
2. Identify effective technological and operational **strategies to control BC** from marine engines

Day 1 Takeaways: Measuring Marine BC

- Two order variability of BC EF is not attributable to differences across instruments.
- Limitations seen in thermo-optical methods, with EC/OC fractions varying across labs and even approaches within a lab for a given sample.
- Good correlation seen between some thermo-optical methods (EC/OC), PAX, FSN (e.g. AVL 415-SE) [and LII] on engine/fuel combinations with lower OC content. High dilution ratios for instruments designed for ambient measurement (MAAP, aethalometers) introduces considerable uncertainty in measurement.
- Clear value seen in instrument calibration, need for sample conditioning (thermal denuding and/or catalytic stripping) is more ambiguous and introduces high losses to deal with.
- Generally, research suggests lower BC emission factors for large slow speed engines and newer engines (i.e. Tier II engine) than being quoted in the literature.
- Value in having a reference fuel to allow comparative testing across engines.

Day 1 Takeaways: Marine Fuels and BC

- Chemical composition of fuels influence physical properties and BC formation. Aromatic and olefin content drives BC formation.
- Most evidence suggests that shifting from conventional HFO to distillate fuels such as MGO reduces black carbon, but lower sulfur hybrid fuels created by blending residual and light fraction blends may not. More research is needed on those fuels.
- Some interaction seen between engine load and relative BC emissions of fuels. At lower loads (e.g 25%) metallic impurities in HFO may promote more complete combustion compared to distillates.
- Simple metrics need to be developed to link fuel chemical properties directly to black carbon emissions (e.g. carbon/hydrogen ratio as a start).

Day 1 Takeaways: BC Control Strategies

- Some existing technologies to control BC from OGVs, but none being directly promoted by standards and deployment rates remain low
- Existing technologies include: NG engines, SCR, scrubbers (~20% reduction seen), engine timing and fuel injection changes at low loads.
- Diesel particulate filters are a well-established technology for on-road engines that can provide <99% reduction in EC, but there are significant challenges to using DPFs on marine vessels: space, fuel quality, back pressure, filter maintenance, etc.
- Standards in place in the US and Europe for smaller vessels with heavy-duty or locomotive derivative engines (C1/C2) that could drive DPF adoption in those vessels.

Day 1 Takeaways: BC Control Policies

- HFO is a serious risk to the environment, particularly in Arctic regions, due to toxicity, risk of spillage, BC emissions etc.
- Potential control policies for BC control in and outside the Arctic include MARPOL Annex VI standards, Polar Code requirements, PSSA's routing restrictions, and "Club-like Approaches"
- Value in thinking short-term and concrete, but also need to consider holistic impacts (OC/EC ratios and not just BC emissions), knock-on effects of regional rather than global regulation) and wider approaches (e.g. ABC)
- Research is limited by emission factors, but existing policies (e.g. ECAs) to control NO_x, SO_x, and PM₁₀ are unlikely to reduce BC emissions on an absolute basis given projected traffic growth.

Breakout Session Instructions

Dan Rutherford, Ph.D.
Bryan Comer, Ph.D.

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Revised breakout group assignments

BC Measurement Protocols	BC Control Policy Alternatives
Dan Rutherford, ICCT (Facilitator)	Bryan Comer, ICCT (Facilitator)
Chiori Takahashi, NMRI, Japan	Alissa Boardley, TC
Daniel Yuska, US MARAD	Bryan Wood-Thomas, WSC
George Lin, Caterpillar	Christine Rigby, Vancouver Fraser PA
Greg Smallwood, NRC Canada	Greg Rideout, ECCC
James Hoffele, Vancouver Fraser, PA	Jan Hulskotte, TNO, Netherlands
Jiacheng Yang, UCR	Karin Jacobs, IenM, Netherlands
Kent Johnson, UCR	Michael Geller, MECA
Monica Tutuianu, AVL	Monica Hilborn, ECCC
Päivi Aakko-Saksa, VTT, Finland	Ralf Oldenburg, MAN
Paul Izdebski, ECCC	Richard Holt, ECCC
Per Einang, MARINTEK	Sarah-Jane Bailey, Lloyds Register
Peter Lauer, MAN	Sunday Augustine Leonard, CCAC
	Thomas L. Brewer, ICTSD
	Wayne Miller, UCR

Breakout Group 1:

BC Measurement Protocols

- **Goal:** Identify promising BC measurement protocols appropriate for controlling marine BC emissions
- **Potential Discussion Questions:**
 - IMO's black carbon workplan calls for PPR to identify "appropriate methods for measuring Black Carbon emissions from international shipping". How close are we to achieving this goal?
 - PPR had previously identified several promising measurement methods for consideration. Have we identified any methods that we consider *inappropriate* for measuring marine BC?
 - EUROMOT has developed a marine BC "measurement reporting protocol". Does the methodology itself need to be standardized further? If so, how?
 - Is a standardized marine BC measurement protocol needed before marine BC control measures are considered? How detailed does it have to be?
 - What are the necessary components of a marine BC measurement protocol? Can we prioritize developing those in terms of time sensitivity (i.e. what must be completed now vs. could be completed at a later date)?
 - How can the results of voluntary marine BC emissions testing campaigns inform the development of a marine BC measurement protocol?

Breakout Group 2:

BC Control Policy Alternatives

- **Goal:** Identify promising potential BC control policies
- **Potential Discussion Questions:**
 - Is it important to reduce marine BC emissions?
 - Who are the key stakeholders and where do they stand on regulating BC emissions?
 - Who is potentially responsible for regulating marine BC emissions, and who ought to regulate marine BC emissions?
 - What control policies already exist, and what are the necessary components of a marine BC control policy (i.e., what gaps do we think need to be filled)?
 - Based on the results of voluntary marine BC emissions testing campaigns and other research, can we rank effectiveness of relative control strategies (e.g. fuel switching, engine standards, operational restrictions) and relate them to current or needed policies?
 - What marine BC control policies could be pursued in the near- and medium-term?