

Holland America Line Sea Water Scrubber Technology Demonstration Update



A Partnership:

U.S. Environmental Protection Agency*
B.C. Clean Air Research Fund
Environment Canada*
B.C. Ministry of the Environment*, and the
Canadian Petroleum Products Institute*
Alaska Department of Environmental
Conservation
Washington Department of Ecology
Puget Sound Clean Air Agency*
Port of Seattle, Washington*
Port of Vancouver, B.C.*
California Air Resources Board
California Water Resources Board
Hawaii Department of Health
Krystallon/BP*
Carnival Corporation companies* including
Carnival Cruise Line, Princess Cruises, and
Costa Cruises
Caterpillar Marine Power Systems – MAK*

* Denotes funding partner.

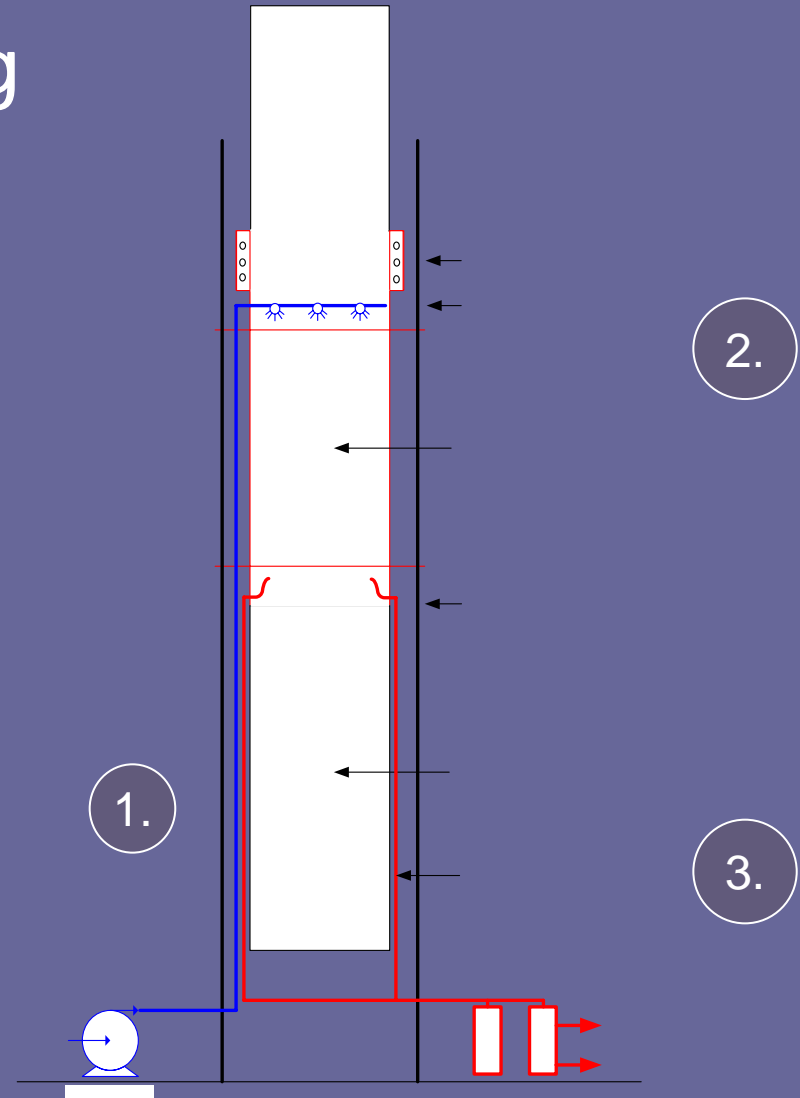
[Source: Original presentations from Holland America Line
have been updated by Dave Kircher of Puget Sound Clean
Air Agency]

Dave Kircher, Puget Sound Clean Air Agency
WCC Conference Call - June 4, 2008

Seawater Scrubbing

How does it work?

1. **Mechanics** - Seawater is pumped to the top of the stack and sprayed down through the engine exhaust.
2. **Chemistry** - Calcium carbonate (CaCO_3) in the seawater reacts with sulfur dioxide (SO_2) in the exhaust gas to form calcium sulfate (gypsum) and carbon dioxide (CO_2). 98% of the SO_2 and 50-90% of the particulate matter is removed from engine exhaust.
3. **Treatment** – Wash water accumulated below is treated and discharged to the sea while the solids are landed ashore.



Outline

- **Environment Canada Stack Test**
- **Review of Continuous and Periodic Wash Water Monitoring Data Sea Water Scrubber Operations in 2008**
- **Planned Operations and Environmental Monitoring for the 2008 Alaska Season**

Environment Canada Stack Tests

- **Krystallon seawater scrubber**
- **Engine 5 of MS Zaandam (8.64 MW MCR)**
- **IFO-380 (1.77% S) fuel**
- **September 2007 tests during a Vancouver-Alaska cruise**

Test Plan

- **Scrubber efficiency for PM, SO₂ and NO_x (simultaneous inlet - outlet testing)**
- **3 power levels, 3 repeat tests at each level**
- **Stationary source (non-dilution) vs Mobile source (dilution) methods**

Test Site



Field Conditions



Sampling at scrubber outlet



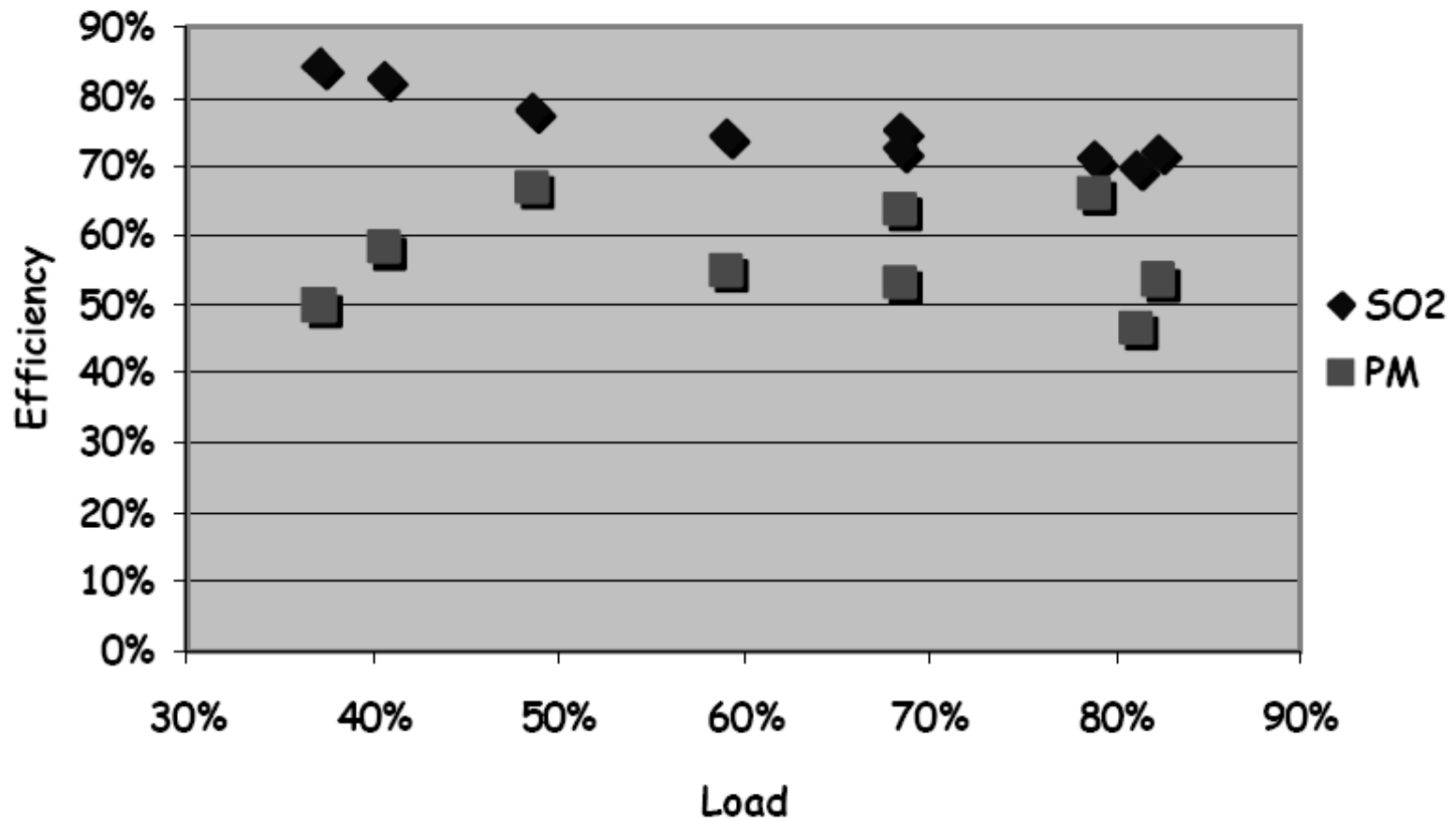
Scrubber access ladder

Average Results

Scrubber	Units	PM	SO ₂	NO _x	CO
Inlet	g/kWh	0.83	6.7	11.2	0.5
Outlet	g/kWh	0.35	1.6	11.5	0.5
Efficiency	%	57%	75%	0%	0%

Based on stationary source methods

Scrubber Efficiency Variation



Comments about scrubber performance during the test

Two points....

- **Status of scrubber installation during the test.** The demister was not fitted into the system. The stack test tested the efficiency of 2 out of 3 elements of the scrubber.
- **Effect of differing salinities on scrubber efficiency.**

Continuous Wash Water Monitoring

DO, Temperature, Turbidity, PAHs, and pH

- Two new data sets:
 - October 16th to December 10th 2007 (CA-HI)
 - December 11th to February 1st 2008 (CA-HI)
- Data reduced to “**Scrubber operations**” defined as:
 - Wash water pump speed > 50%.
 - Exhaust gas temperature >220 degrees.
 - EGS pressure >20 mm.

Periodic Wash Water Sampling

Results from Skagway, Juneau, Vancouver, and San Diego

- Graphical results of laboratory samples that exceeded water quality standards. Constituents that exceeded include:
 - Dissolved oxygen
 - Total and dissolved metals including:
 - Arsenic
 - Beryllium
 - Copper
 - Lead
 - Nickel
 - Selenium
 - Zinc
- **In general, where an effluent sample exceeds a water quality criterion, the influent sample exceeds the criterion as well.**

Proposed Operations and Environmental Monitoring during the 2008 Alaska Cruise Season

- **May 2008 – Repair multicyclone.** Inspect system to ensure proper operation.
- **June 2008**
 - Operate scrubber during Alaska season (5/11 – 9/21). 7-day itinerary includes:
 - Vancouver, B.C.
 - Ketchikan, AK
 - Juneau, AK
 - Skagway, AK
 - Glacier Bay*
 - College Fjord*
 - Seward, AK
 - No scrubber operations in these locations.
 - **Install Cascade Technologies CT 2000**
 - **Modify demister**

Proposed Operations and Environmental Monitoring- *cont'd*

- **July 2008**

- Round 2 wash water samples in Vancouver, B.C.
- Perform ambient water quality sampling in Vancouver

- **August 2008**

- Round 2 wash water samples in Juneau, AK

- **September 2008**

- Round 2 wash water samples in Skagway, AK

- **October 2008**

- Round 1 wash water samples in Hawaii

- **November 2008**

- Round 2 wash water samples in Hawaii

- **December 2008**

- End of pilot test