Barge Emissions Estimates

Southeast Texas Photochemical Modeling Technical Committee Meeting

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Barge Emissions Estimates

The TCEQ has contracted with the Eastern Research Group (ERG) to determine barge transit emissions that occurred in calendar year 2008 in the Houston-Galveston-Brazoria, Beaumont/Port Arthur, and Corpus Christi industrial waterways.

- Volatile Organic Compound (VOC) emissions at the county level
- Speciation of Hazardous Air Pollutants (HAPs), Toxics, and Highly Reactive Volatile Organic Compounds (HRVOCs)

Background Information

Barge emissions currently included in Texas' Emissions Inventory:

- Non-road mobile
  - Engine combustion Nitrogen Oxides (NO_X) and Carbon Monoxide (CO) emissions
- Point source
  - Loading/unloading VOC emissions
- Area source
  - In-transit evaporative VOC emissions
    - Limited to a few petroleum products
    - NO chemical product emissions

Current Calculation Methodology

- EPA's Emissions Inventory Improvement Program (EIIP) document: *Marine Vessel Loading, Ballasting, and Transit*
- Factors available for only 5 petroleum products
  - Gasoline
  - Crude Oil
  - Distillate Oil
  - Residual Oil
  - Jet Naphtha
- Factors don't take into account temperature
  - Factors based on 60 degrees Fahrenheit

Calculation Methodology for this Project

- Barge transit emissions are similar to breathing losses from a storage tank

- Using the calculation methodology from AP-42, Section 7.1, with some modifications
  - Barge relief valves are set at 1 psi, 3 psi, or 6 psi, making them low-pressure vessels
    - API Bulletin 2516 calculation to account for this
  - Bulk liquid temperature affected more by water temperature than outside air temperature

Data Required

- Volumes of products transported
  - Waterborne Commerce of the United States (WCUS) data from the United States Army Corps of Engineers
- Barge trip transit times
  - Coast Guard Vessel Traffic Service (VTS) data
- Spatial Distribution
  - VTS data combined with a Geographic Information System (GIS)
- Barge fleet information
  - Stakeholder involvement
    - American Waterways Operators (AWO)
    - Texas Waterway Operators Association (TWOA)

Volumes of Product Transported

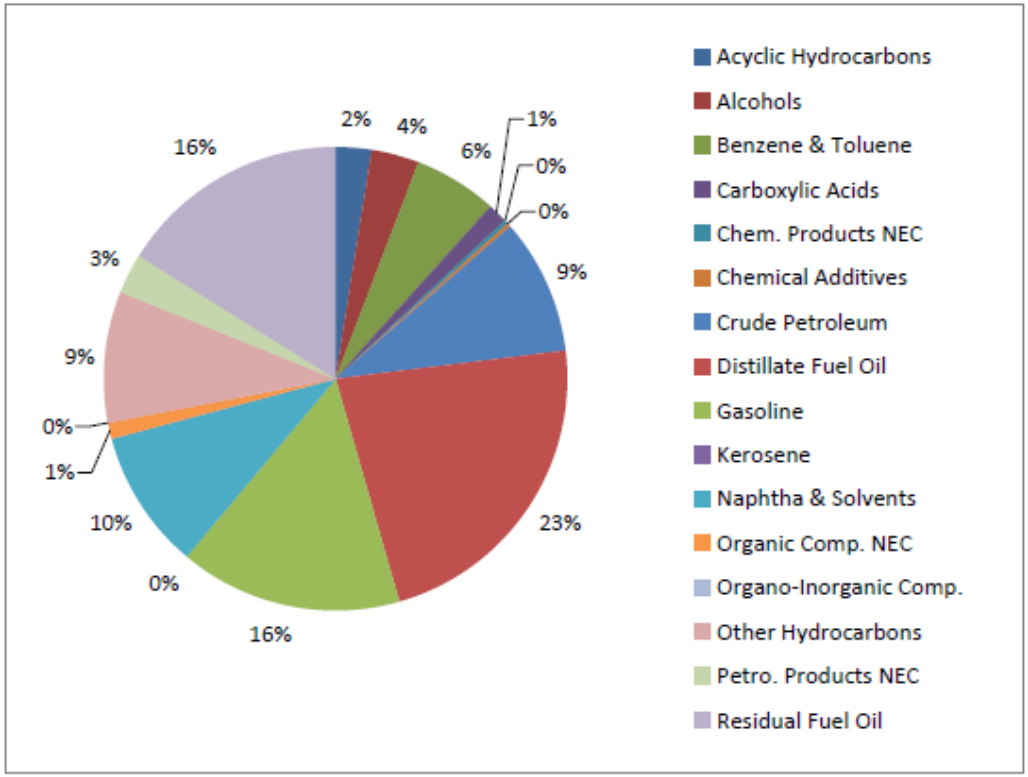
- WCUS data is available for all three areas

- Data is aggregated into 16 compound categories, the largest are:
  - Distillate Fuel Oil - 22%
  - Gasoline – 16%
  - Residual Fuel Oil – 16%
  - Naphtha & Solvents – 10%
  - Other Hydrocarbons – 9%
  - Crude Petroleum – 9%
  - Benzene & Toluene – 6%

WCUS Product Volumes

Chemical Category	Millions of gallons	Percent
Acyclic Hydrocarbons	1,970	2%
Alcohols	2,967	4%
Benzene & Toluene	4,772	6%
Carboxylic Acids	1,204	1%
Chem. Products NEC	117	0%
Chemical Additives	297	0%
Crude Petroleum	7,872	9%
Distillate Fuel Oil	18,518	22%
Gasoline	12,974	16%
Kerosene	67	0%
Naphtha & Solvents	8,002	10%
Organic Comp. NEC	906	1%
Organo-Inorganic Comp.	27	0%
Other Hydrocarbons	7,624	9%
Petro. Products NEC	2,329	3%
Residual Fuel Oil	13,322	16%
Total:	**82,968**	

Initial Run: Combined Profile for BPG, HGA, and CC



Volumes of Product Transported

- The general product categories needed to be allocated into specific chemicals
- AWO/TWOA provided representative compounds for each of the general categories
  - Used an average Molecular Weight (MW) and Vapor Pressure (VP) in the calculations
- For 4 categories, AWO/TWOA indicated the compounds were non-volatile
  - Chemical Products Not Elsewhere Classified (NEC), Chemical Additives, Organic Compounds NEC, Organo-Inorganic Compounds
  - Each category made up < 1% of the total volume

Product Category Allocations

WCUS Category	Compounds Chosen for Modeling (% Allocation)	Comments:
Acyclic Hydrocarbons	Hexane, Heptane, Decane, Nonene, and Heptene (20% each)	A range of light, mid-weight, and heavy compounds
Alcohols	Methanol, Ethanol, Isopropanol, Butanol, Decanol, Hexanol, and 2-Ethylhexanol (14% each)	A range of ultra-light, light, mid weight, and heavy compounds
Benzene & Toluene	Benzene and Toluene (50% each)	From industry
Carboxylic Acids	Acetic Acid, Propionic Acid, and Butyric Acid (33% each)	
Chem. Products NEC	N/A	Assume non-volatile *
Chemical Additives	N/A	Assume non-volatile *
Crude Petroleum	Crude Oil RVP 5 (100%)	As per API
Distillate Fuel Oil	#1 Diesel Fuel, #2 Diesel Fuel, and Marine Diesel (33% each)	
Gasoline	Gasoline – Various RVPs	RVP determined from regional sampling
Kerosene	Kerosene, Jet Kerosene, and Jet Naphtha (33% each)	
Naphtha & Solvents	Naphtha and JP-4 (50% each)	JP-4 is a substitute for “Solvents”
Organic Comp. NEC	N/A	Assume non-volatile *
Organo-Inorganic Comp.	N/A	Assume non-volatile *
Other Hydrocarbons	MEK, MTBE, Vinyl Acetate, MIBK, Propyl Acetate, Styrene, Xylene, Butyl Acrylate, and Cumene (11% each)	A range of light, mid, and heavy-weight compounds
Petro. Products NEC	Lube Oils (100%)	Assume non-volatile *
Residual Fuel Oil	No. 6 Fuel Oil (100%)	Assume non-volatile *

* Non-volatile products are those products with a vapor pressure less than 0.1 psi at 100 degrees Fahrenheit. These products are expected to have zero or negligible evaporative emissions during transport on a 1-pound barge under normal operating conditions.

Barge Trip Transit Times

Trip transit times determined using VTS data

- VTS data includes origination and destination coordinates
- Assume that barges travel at 6 knots
- Assume that barges take 30 minutes to dock

Spatial Distribution

Barge trips are allocated to specific counties using the origination and destination coordinates from VTS

- GIS used to define inland waterways
- The waterways are divided into segments with known coordinates and lengths

Barge Fleet Information

Based on stakeholder input, the following assumptions were made:

- Vapor space: set equal to 3% of the barge cargo volume for loaded barges
- Barge color: 53% red, 36% gray, 10% light green, 2% black

Barge Fleet Information (cont.)

- Barge pressure settings:
  - VP < 1 psi: 100% transported in 1 psi barges
  - 1 psi < VP < 3 psi: 30% 1 psi barges, 70% 3 psi barges
  - VP > 3 psi: 95% 3 psi barges, 5% 6 psi barges

- Barge dimensions:
  - 10,000 barrel: 195 ft long x 35 ft wide x 12 ft deep
  - 20,000 barrel: 250 ft long x 50 ft wide x 12 ft deep
  - 30,000 barrel: 298 ft long x 54 ft wide x 13 ft deep

Barge Fleet Information (cont.)

- Barge cargo trends:
  - Specialty chemicals: 85% in 10k barrel barges, 5% in 20k barrel barges, 10% in 30k barrel barges
  - Gasoline, kerosene, diesel fuel: 20% in 20k barrel barges, 80% in 30k barrel barges
  - Lube oil, residual fuel: 90% in 10k barrel barges, 5% in 20k barrel barges, 5% in 30k barrel barges
  - Feedstocks (naphtha, solvents, etc): 5% in 10k barrel barges, 5% in 20k barrel barges, 90% in 30k barrel barges

Current Status of the Project

- ERG is currently developing emission factors for each barge scenario, taking into account:
  - 16 chemical categories
  - 3 geographic areas
  - 3 barge sizes
  - 3 barge pressure settings

- Final project report is due to the TCEQ on August 31st and will be posted to the TCEQ Web site in September:

  http://www.tceq.state.tx.us/implementation/air/airmod/project/pj_report_ei.html

Questions?

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