

MERCURY in U.S. CRUDE OIL

**Crude Oil Quality Group
February, 2007**



**U.S. Environmental Protection Agency
National Petrochemical and Refiners Association
American Petroleum Institute
Mercury Technology Services
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PARTICIPANTS

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Norbert Dee

PURPOSE

- Data will be acquired to estimate the upper limit to atmospheric emissions attributable to petroleum.
- The industry is also interested to develop the science necessary to understand mercury in hydrocarbons and its fate in processing.

OBJECTIVES

- **Determine the mean concentration and range of concentrations of mercury in crude oil processed in the U.S.**
- **Data must be statistically significant**
- **Sampling and analysis methods must reflect the best science currently available**

LABORATORIES

- **CEBAM ANALYTICAL (Combustion CVAF)**
- **FRONTIER GEOSCIENCES (Digestion CVAF)**
- **U.S. EPA (Combustion CVAF)**
- **TEXAS A&M (Neutron Activation)**

TECHNICAL APPROACH

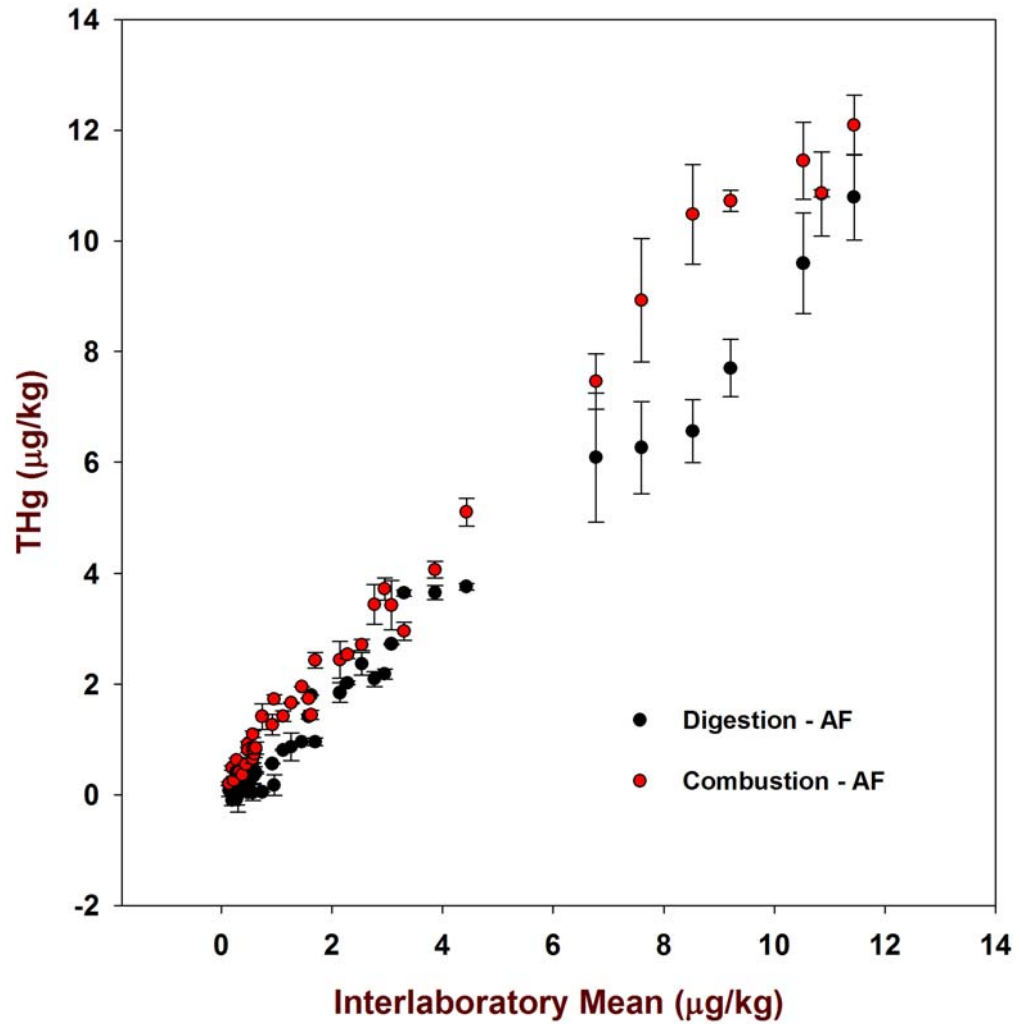
- **Phase 1 – Analytical Methods**
- **Phase 2 – Sampling Methods and Oil Variability**
- **Phase 3 – Statistical Sampling and Analysis**

Sample Ensemble

- **170 market-named oils were sampled and analyzed.**
- **Oils come from both domestic and foreign sources.**
- **Each oil is sampled and analyzed a minimum of 3 times**
- **Inter-laboratory replication - 20%**

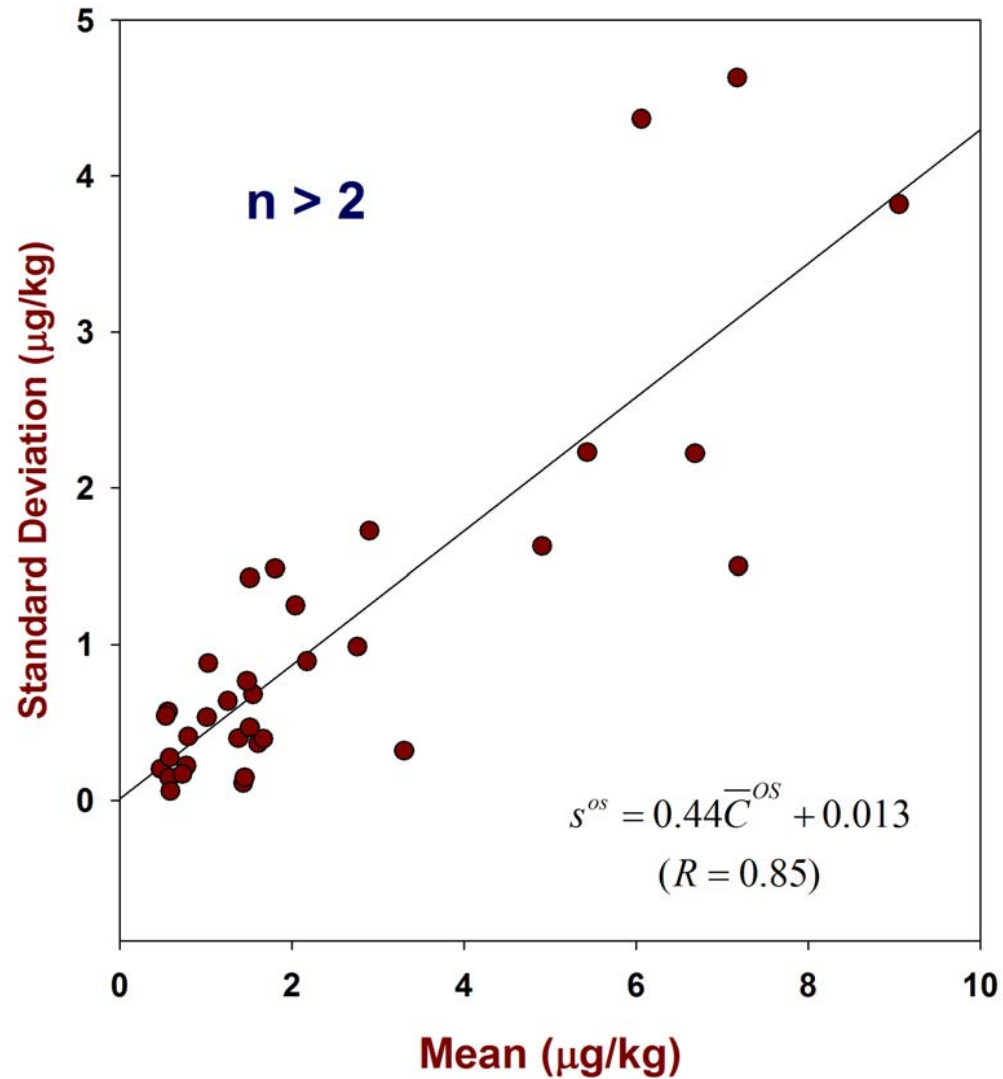
Mercury in US Crude

Laboratory Comparison



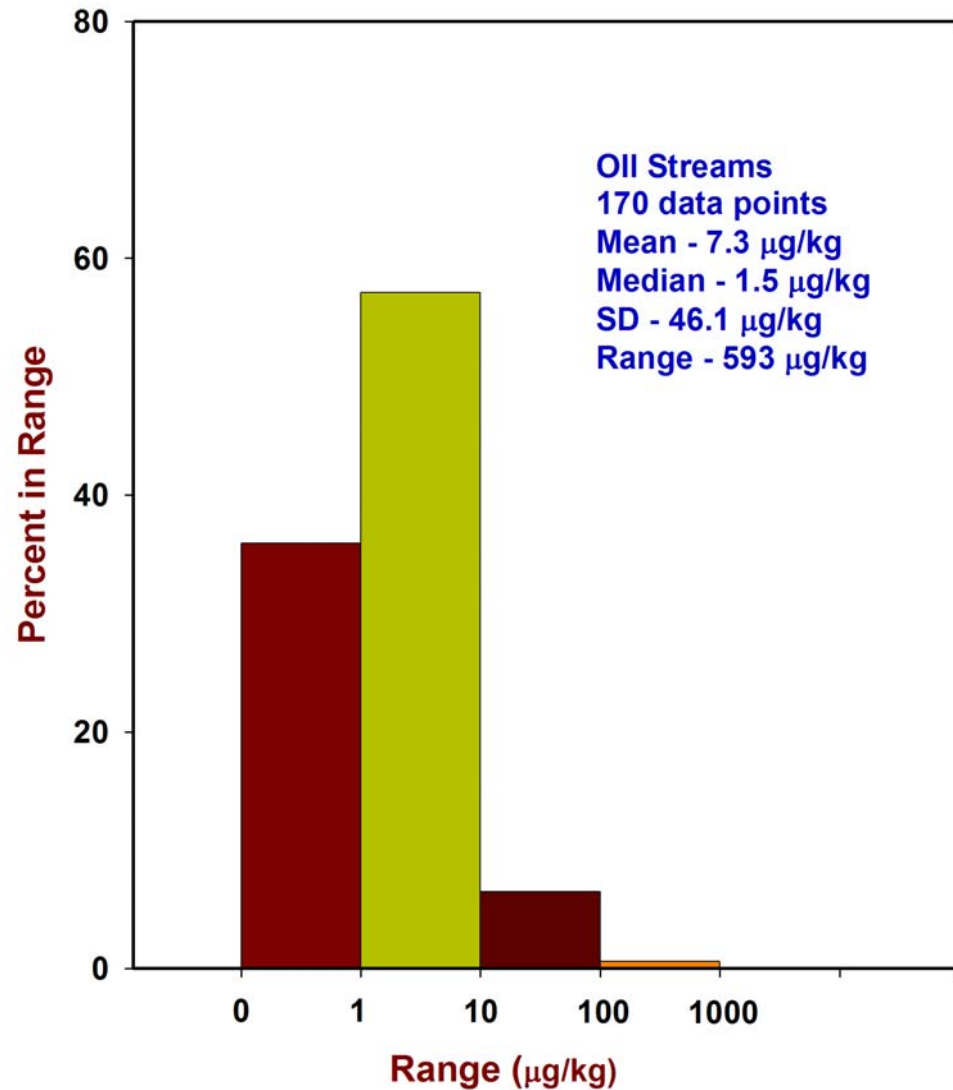
Mercury in US Crude

Standard
Deviation



Mercury in US Crude

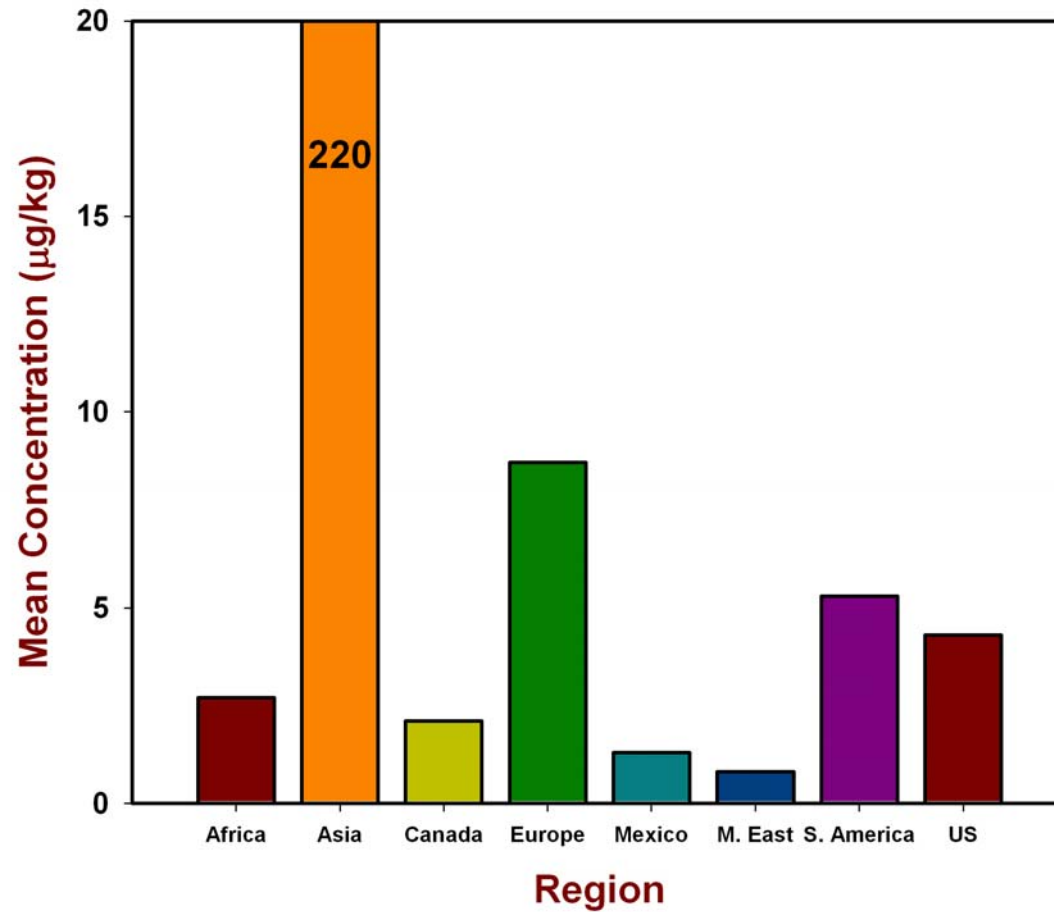
Mean
Concentration
and
Range



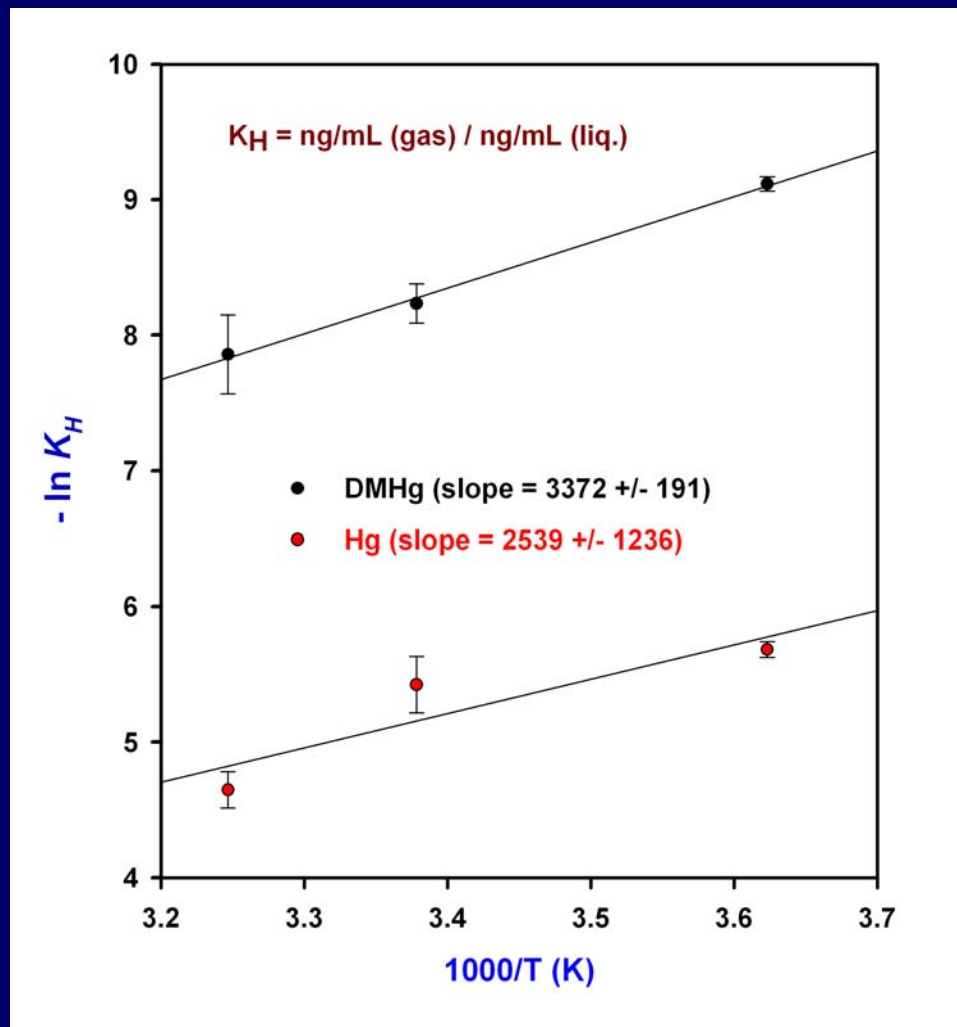
Mercury in U.S. Crude

Country	Country Volume (1000 barrels)	% US Supply	($\mu\text{g}/\text{kg}$)	<i>N</i>
Africa	705,714	11.75	2.7	21
Asia	50,333	0.84	220.1	4
Canada	591,489	9.845	2.1	32
Europe	198,389	3.30	8.7	9
Mexico	585,023	9.74	1.3	9
Middle East	883,946	14.71	0.8	24
S. America	677,169	11.27	5.3	28
US	2,315,760	38.55	4.3	42
Total	6,007,823		3.5 \pm 0.6	170

Mercury in U.S. Crude



Volatile Species



Henry's Constant for Hg^0 and DMHg in Toluene

Asphaltene Hg by Differential Solubility

Sediment Mercury

THg Oil – THg Filtered Oil

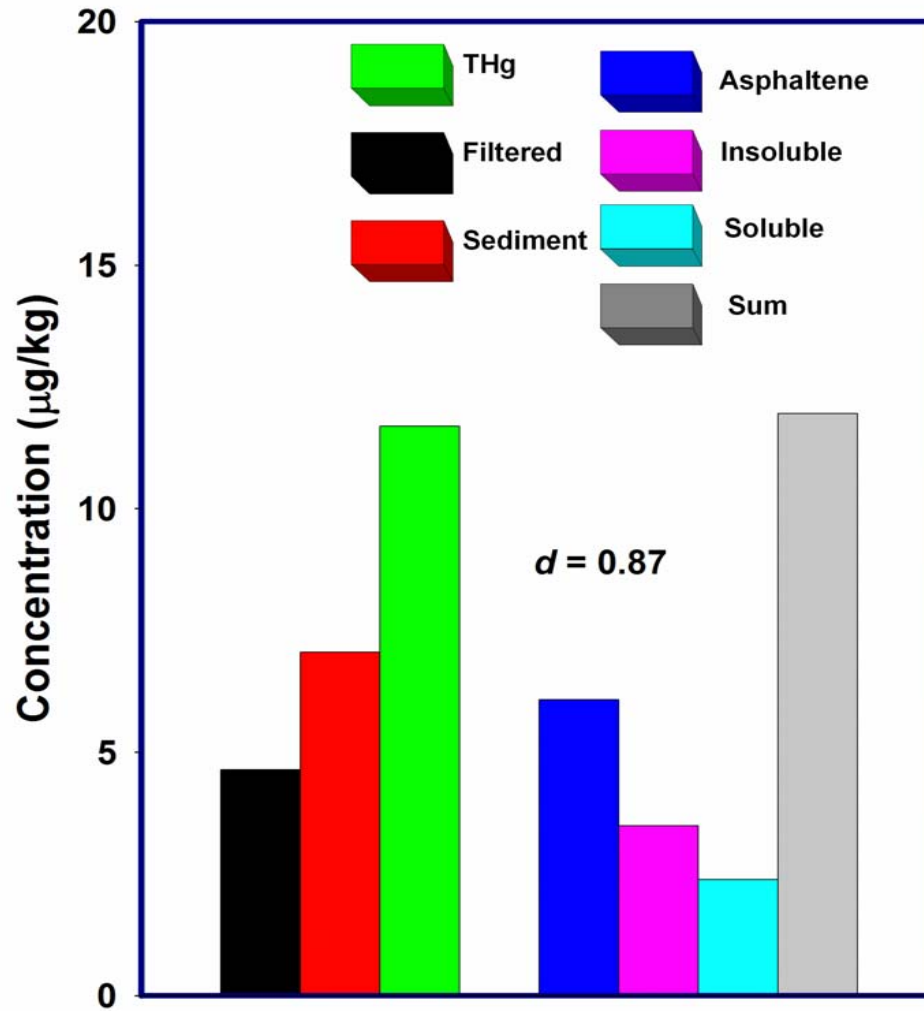
Asphaltene Mercury

C7 Insoluble & Toluene Soluble

Insoluble Mercury (HgS, HgSe)

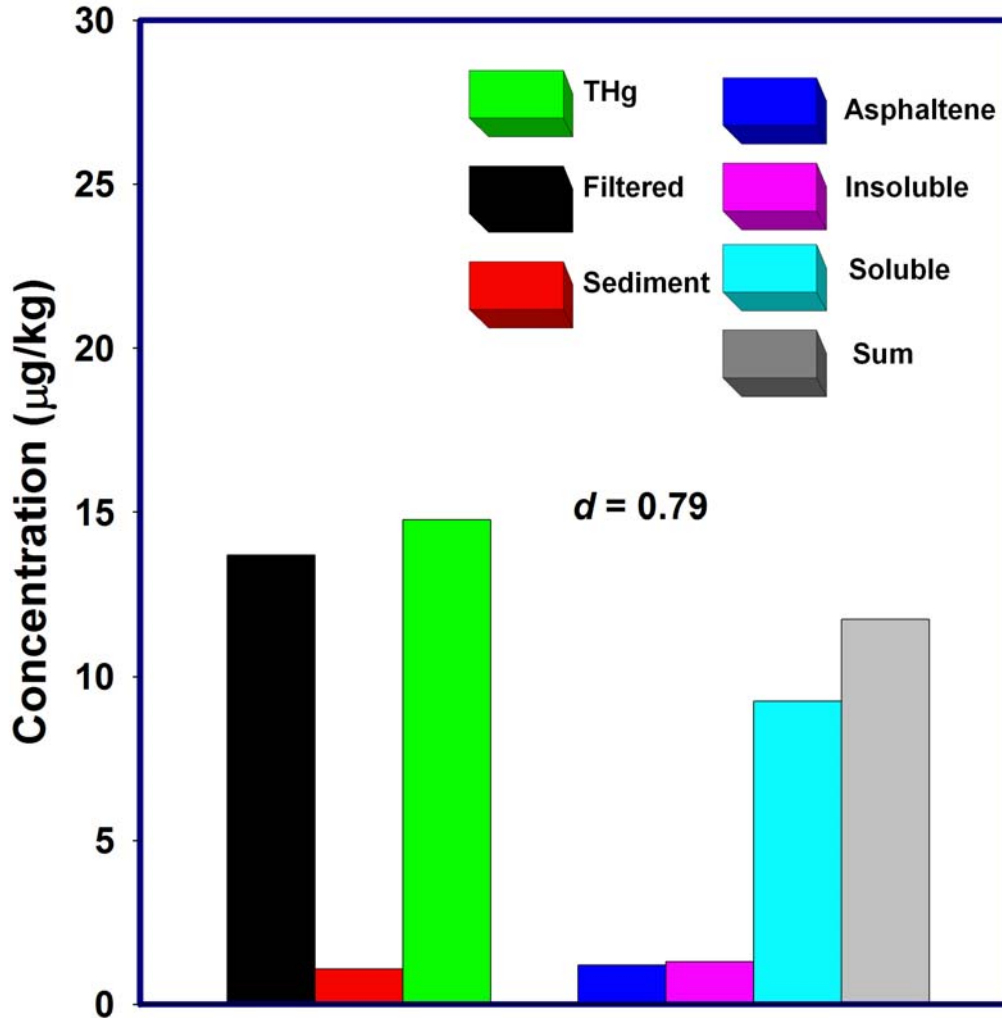
C7 Insoluble & Toluene Insoluble

Asphaltene Mercury



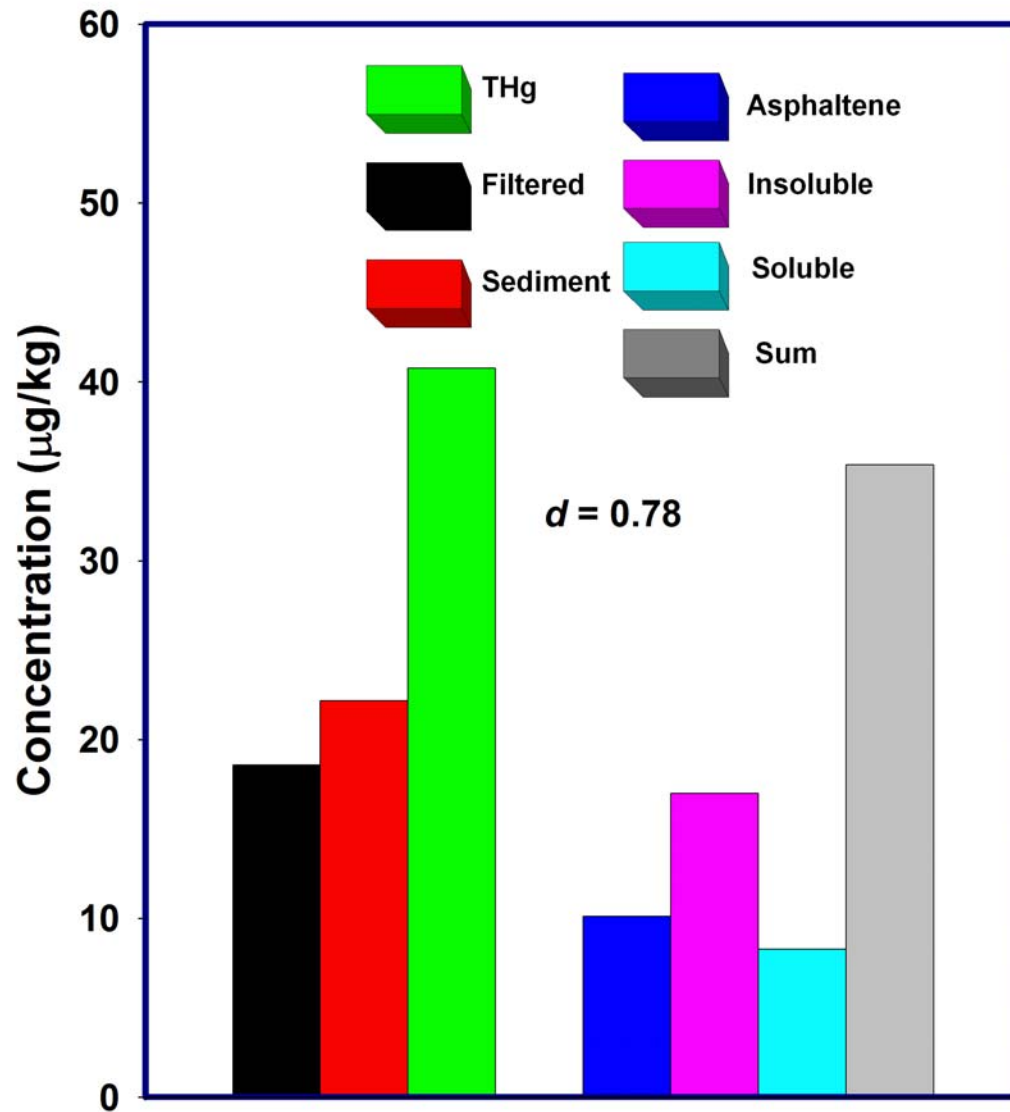
Mostly Asphaltene

Asphaltene Mercury



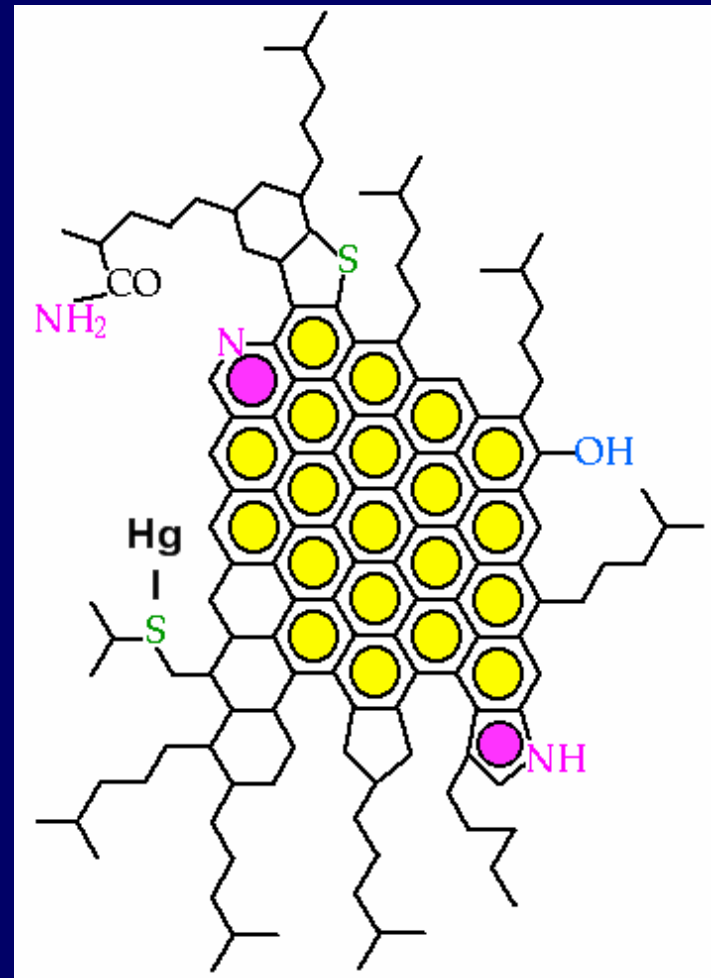
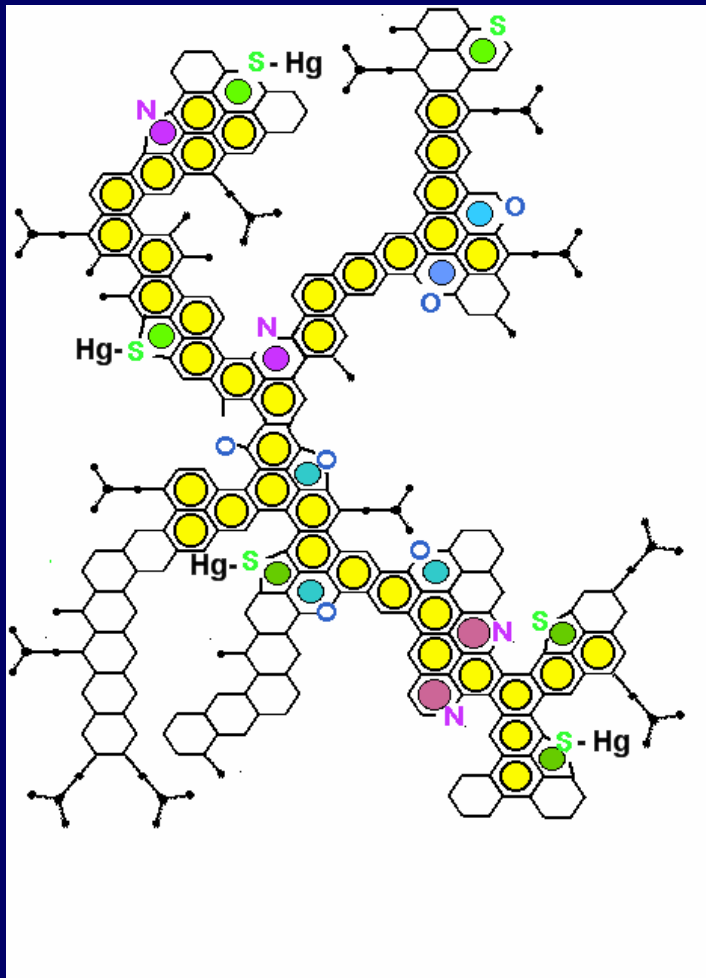
Mostly
Soluble
(Elemental)

Asphaltene Mercury

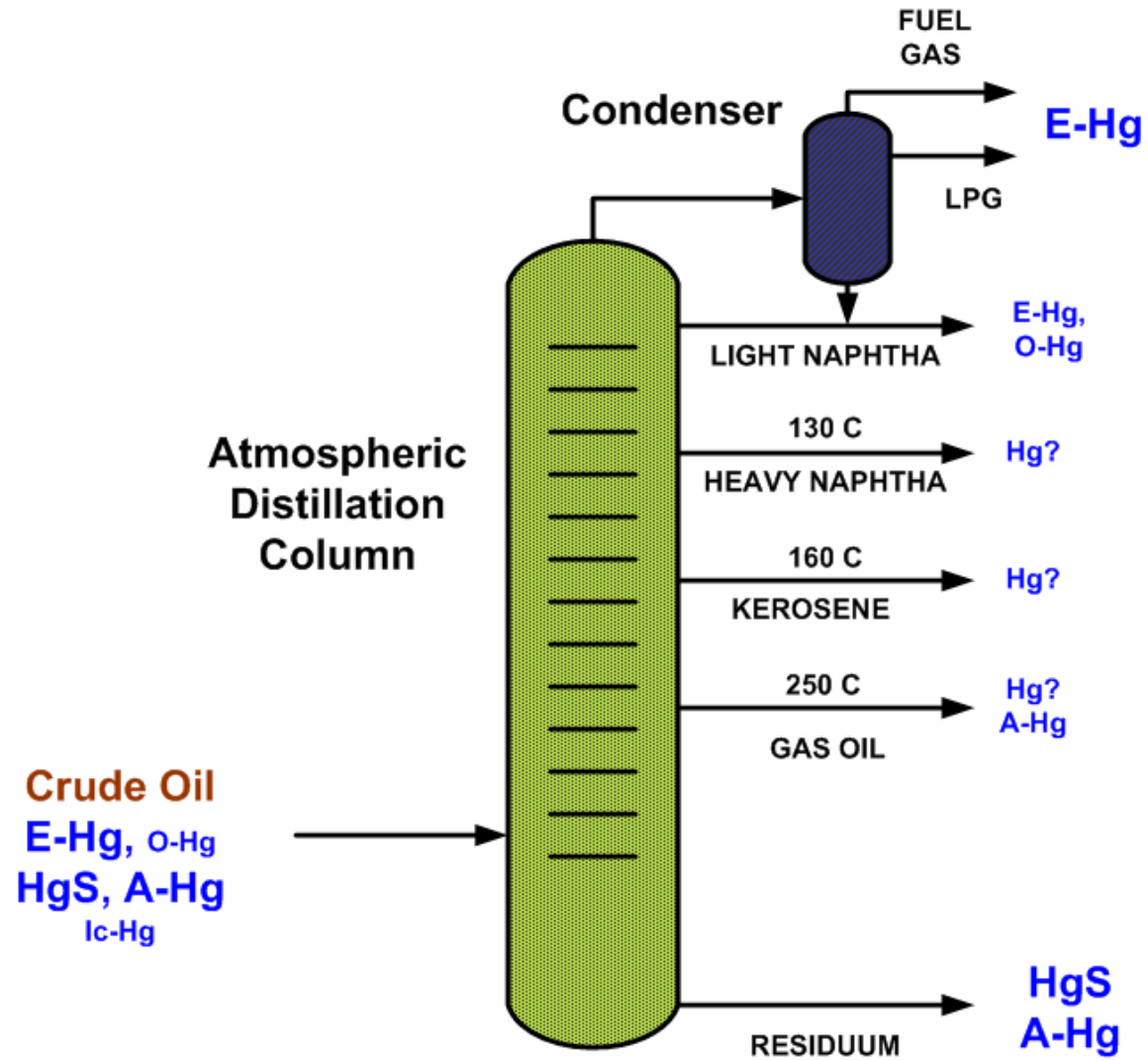


Balanced Species

Asphaltene Mercury



Asphaltene



Processing Mercury-Laden Crudes

- Water
- Product Quality
- Catalysts
- Waste
- HSE

