Mercury Removal Trends in Full-Scale ESPs and Fabric Filters

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Presentation Outline

- Background of Mercury Control Program
- Approach to Data Analysis
- Results
- Conclusions

DOE National Energy Technology Laboratory (NETL) Program

- Testing and Evaluation of Promising Mercury Control Technologies for Coal-Fired Power Systems
- DOE/NETL and ADA-ES cooperative agreement
- Industry partners include:
  - PG&E National Energy Group
  - Wisconsin Electric
  - Alabama Power / Southern Company
  - EPRI
  - Ontario Power Generation

Test Sites

Test Site	Coal	Particulate Control	Test Dates
Alabama Power Gaston	Bituminous	HS ESP COHPAC FF	Spring 2001
WEPCO Pleasant Prairie	PRB	Cold Side ESP	Fall 2001
PG&E NEG Salem Harbor	Bituminous	Cold Side ESP	Spring 2002
PG&E NEG Brayton Point	Bituminous	Cold Side ESP	Fall 2002

Status of Program

- Full-scale carbon injection tests completed at Alabama Power E.C. Gaston. Carbon injected upstream of COHPAC baghouse.
- S-CEM mercury measurements completed by Apogee at all four test sites.
- Full-scale test at Pleasant Prairie in fall. Tour of equipment installation part of A&WMA Mercury Specialty Conference in August.

Data Integration Task

- Integrate data obtained from program with data available from EPA's Phase III ICR measurements and other EPRI and DOE R&D.
- Goal is to develop mercury removal trends that can be used in the design of mercury control systems.

Factors that Influence Mercury Measurement and Capture

- *Fly ash on sample filter can alter measured speciation (particulate / oxidized / elemental ratios)*
- Temperature affects mercury capture differently depending on various factors including coal type, mercury speciation, and fly ash type
- LOI carbon (amount, size distribution, and type)
- Greater effectiveness of dustcake (FF) for mercury removal versus in-flight / surface capture (ESP)
- Mass transfer surfaces (turning vanes, perforated plates, ESP plates)
- Exposure (residence) time at optimal temperature

Primary Variables for Analysis

- Specific collection area of ESP (ft^2/kacfm)
- Flue gas temperature at ESP or FF inlet
- Coal chloride concentration
- NO_x control devices
- Carbon in the ash (LOI)
- Percent mercury on Ontario Hydro sampling filter
- Flue gas conditioning

Breakdown of Sample Units

- 19 Cold-Side ESPs
  - 7 bituminous
  - 4 lignite
  - 5 subbituminous
  - 3 mix of bituminous with subbituminous and/or pet coke
- 9 Hot-Side ESPs
  - 3 bituminous
  - 3 subbituminous
  - 3 mix of bituminous with subbituminous and/or pet coke

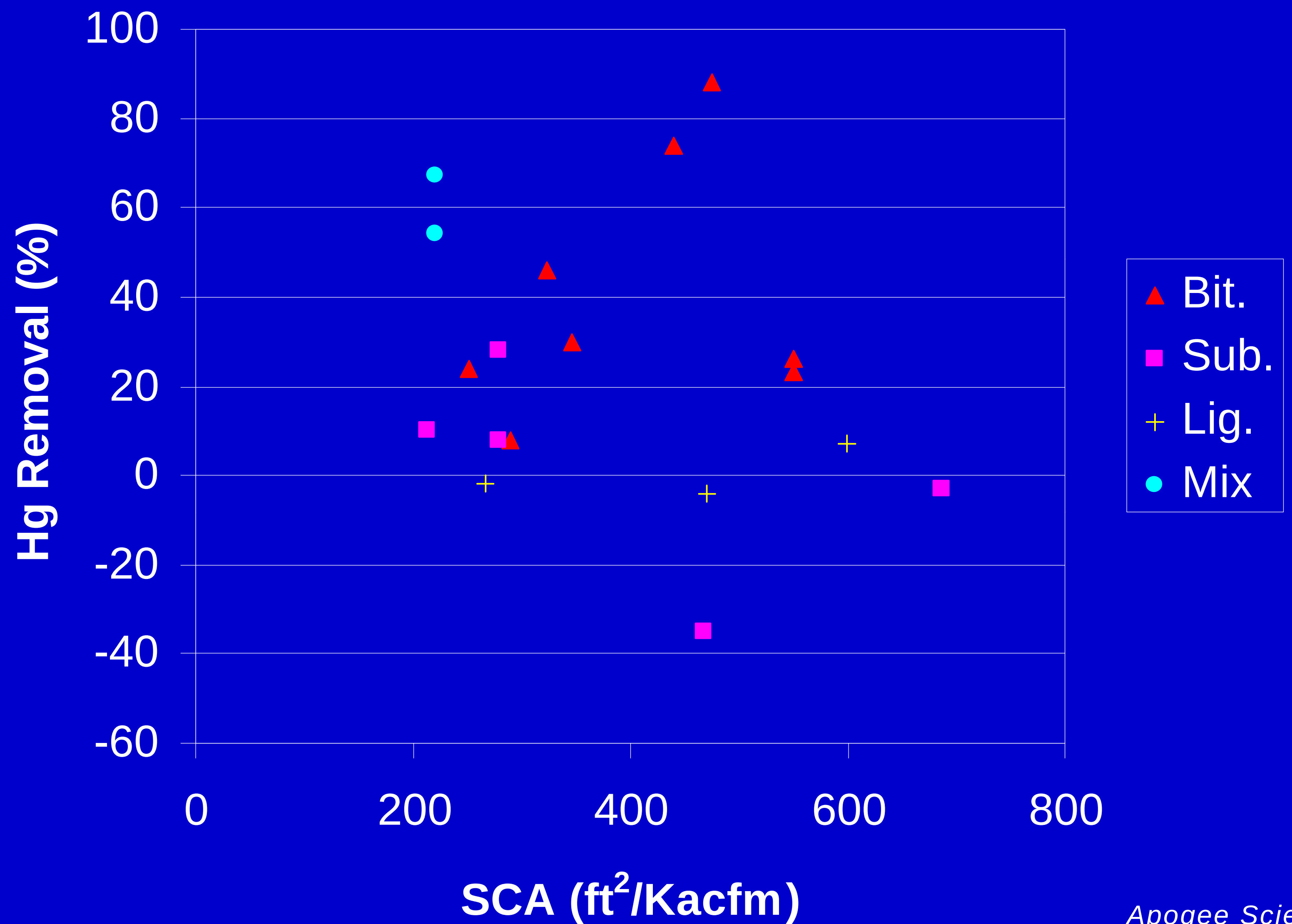
Breakdown of Sample Units

- 9 Primary Fabric Filters
  - 4 bituminous
  - 3 subbituminous
  - 1 lignite
  - 1 mix
- 2 Polishing Fabric Filters (COHPAC)
  - 1 bituminous
  - 1 lignite

Average Mercury Removal

	(% Hg Removal)			
Coal	**Hot-Side ESPs**	**Cold-Side ESPs**	**COHPAC**	**Fabric Filters**
Bituminous	16	35	0	84
Subbituminous	4	9	NA	70
Lignite	NA	2	0	0
Bit/Sub/Pet Coke Mix	12	66	NA	NA

Cold-Side ESP SCA Trends



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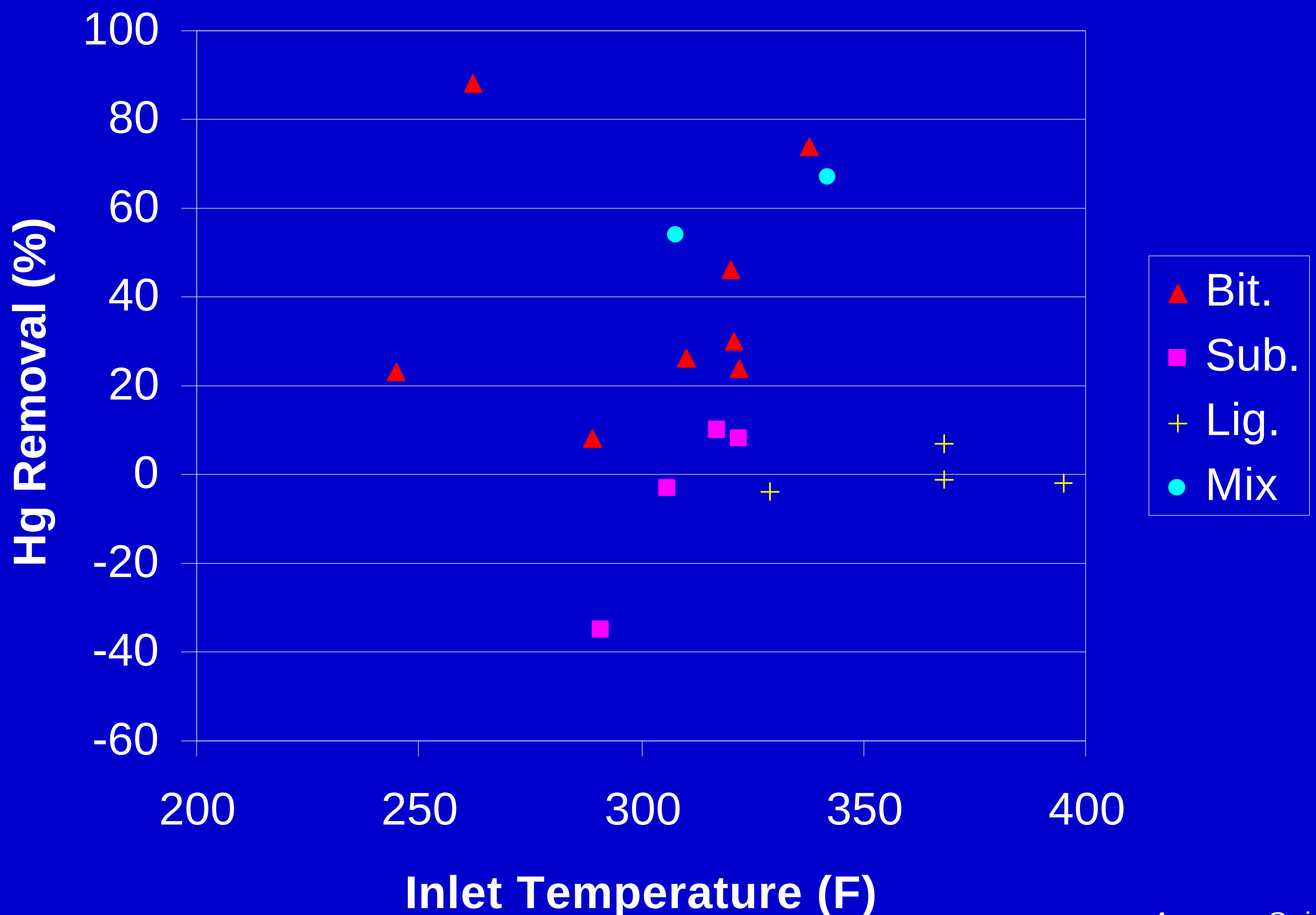
Cold-Side ESP Temperature Trends



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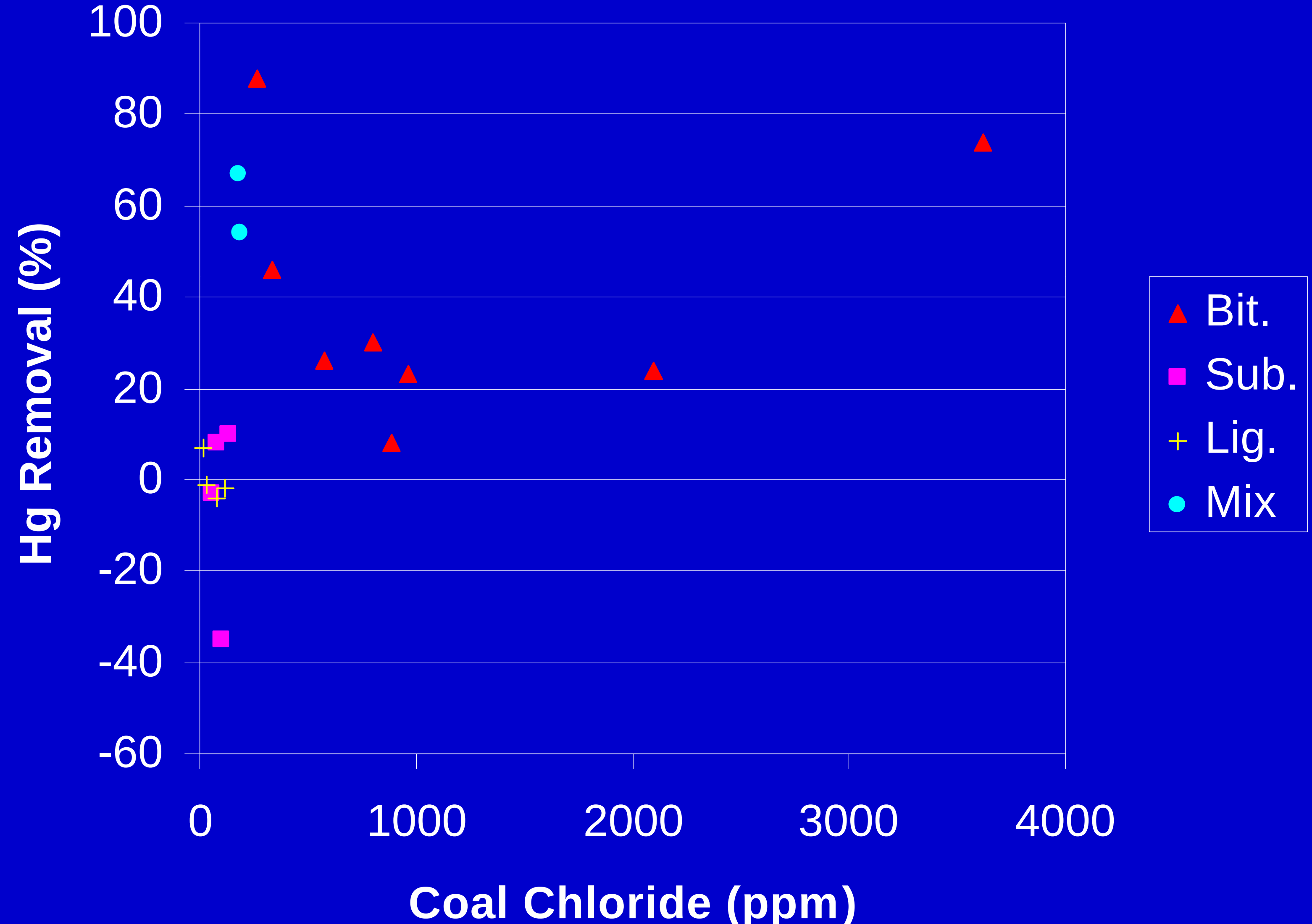
Cold-Side ESP Chloride Trends



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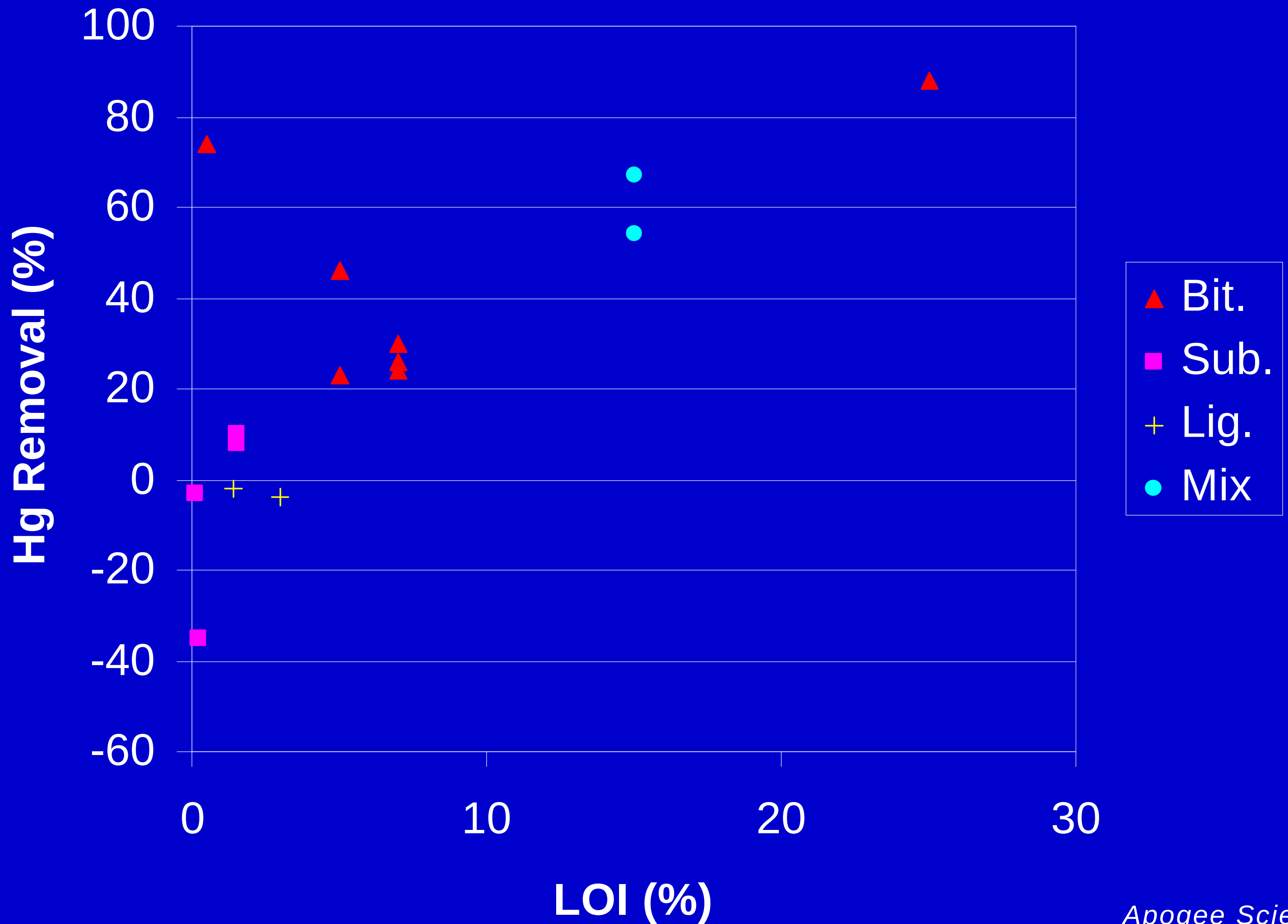
Cold-Side ESP LOI Trends



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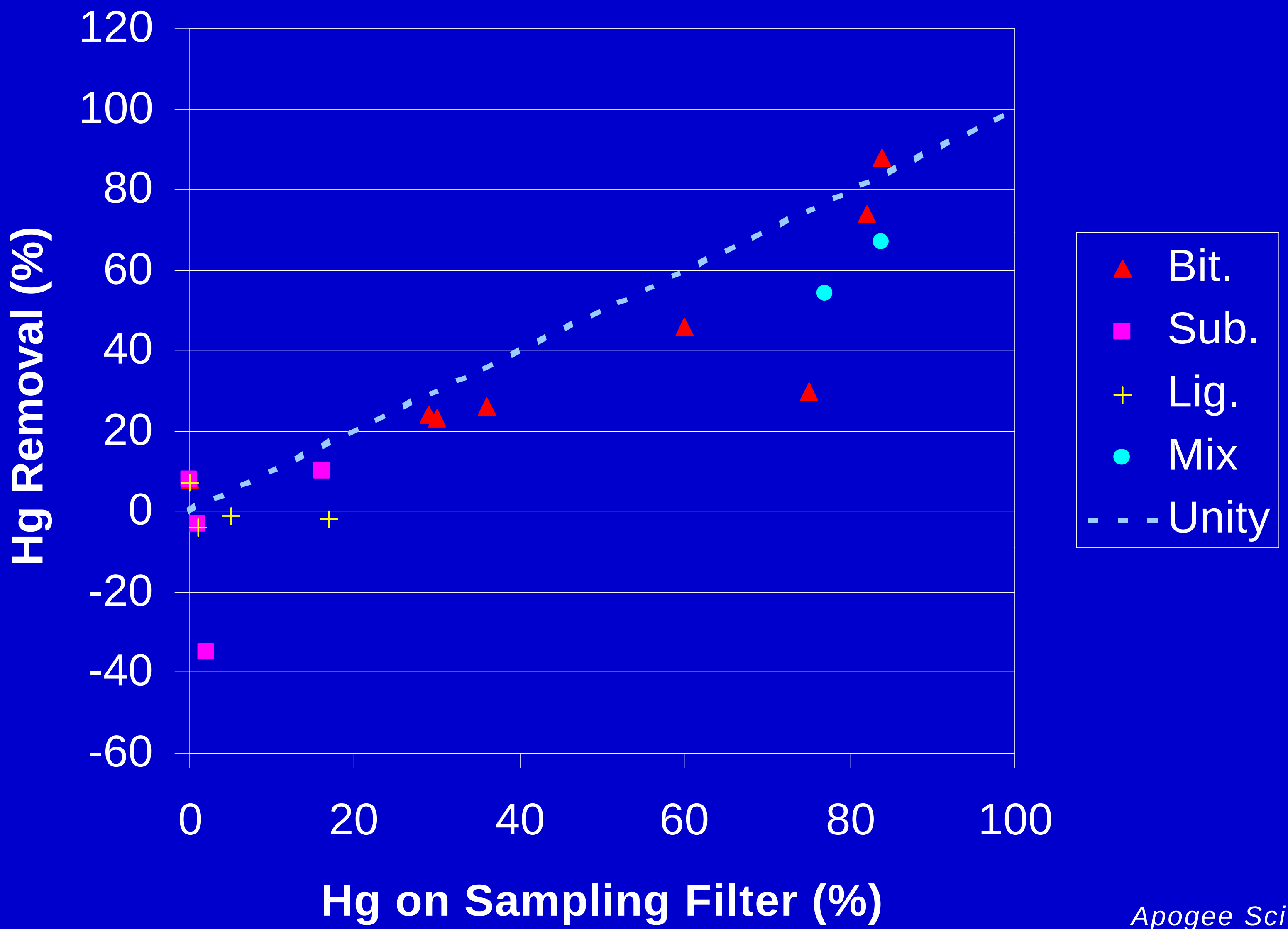
Cold-Side ESP Filter Trends



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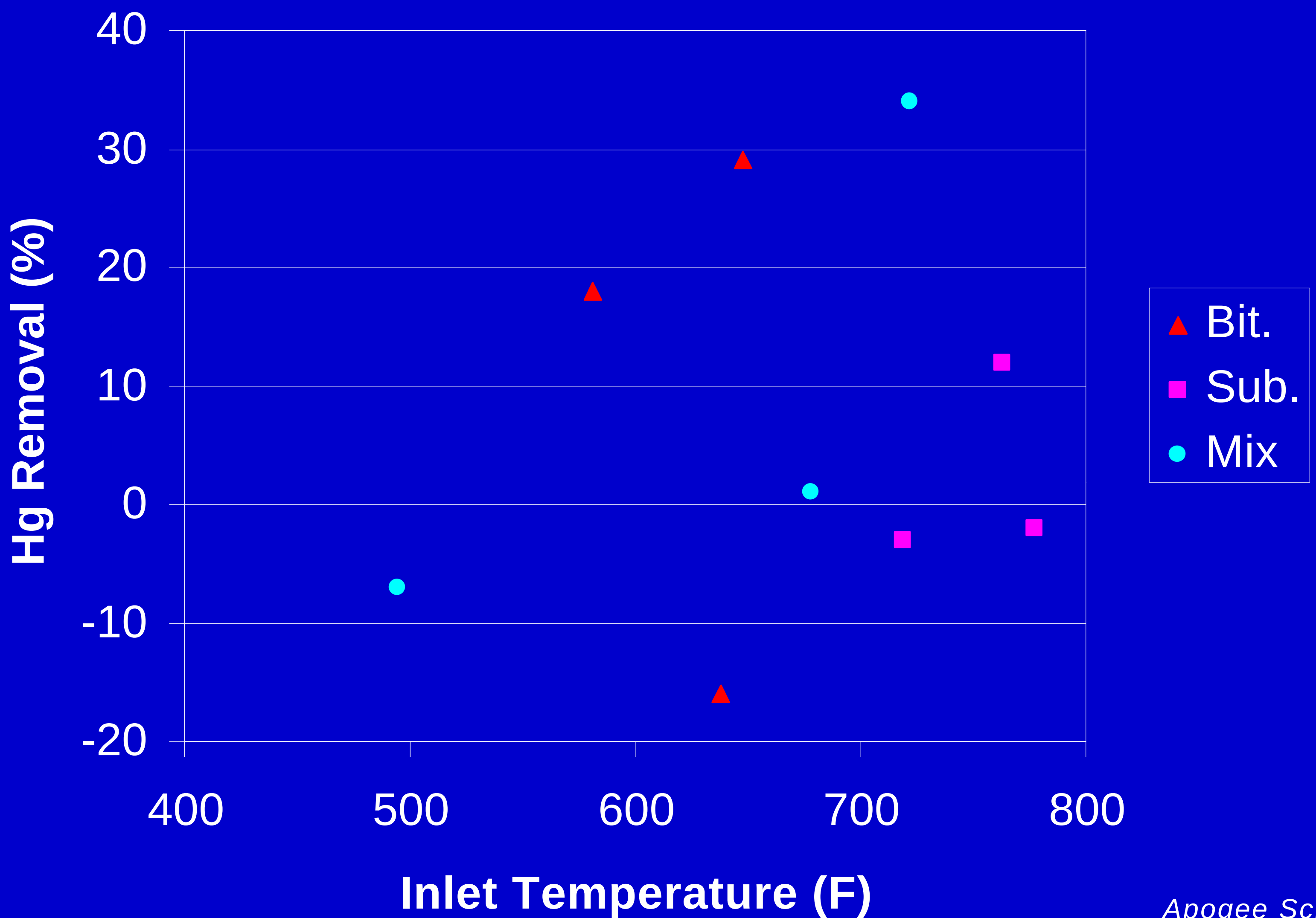
Cold-Side ESP Trends

- Bituminous Coals
  - Higher mercury when ash contained higher LOI
  - *High mercury removal when coal contained high chloride (single data point)*
- Subbituminous
  - Low mercury removal
  - The use of SO_3 conditioning did not appear to influence mercury control
- Lignite
  - Low mercury removal
- Mix
  - Insufficient data

Hot-Side ESP Temperature Trends



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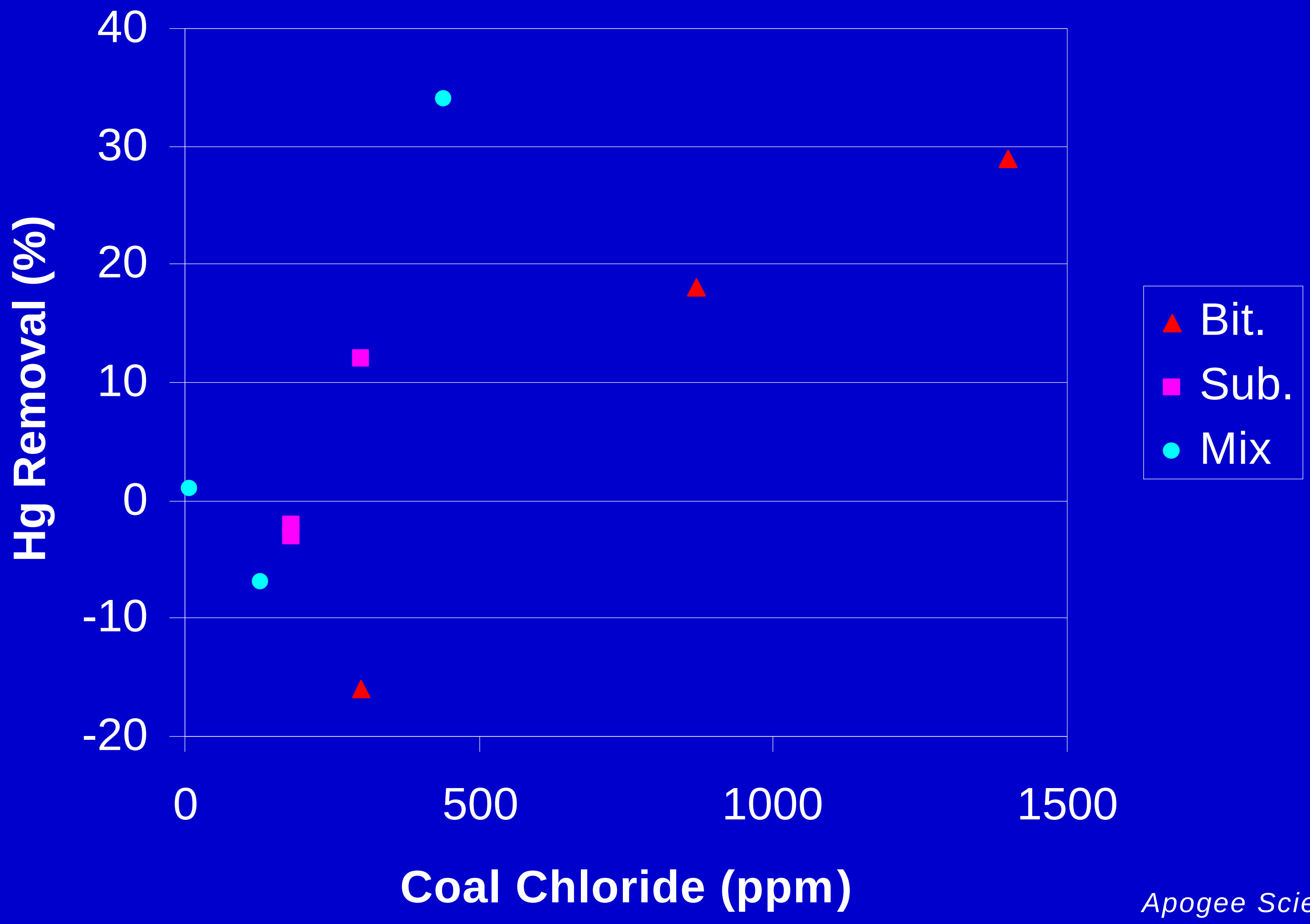
Hot-Side ESP Chloride Trends



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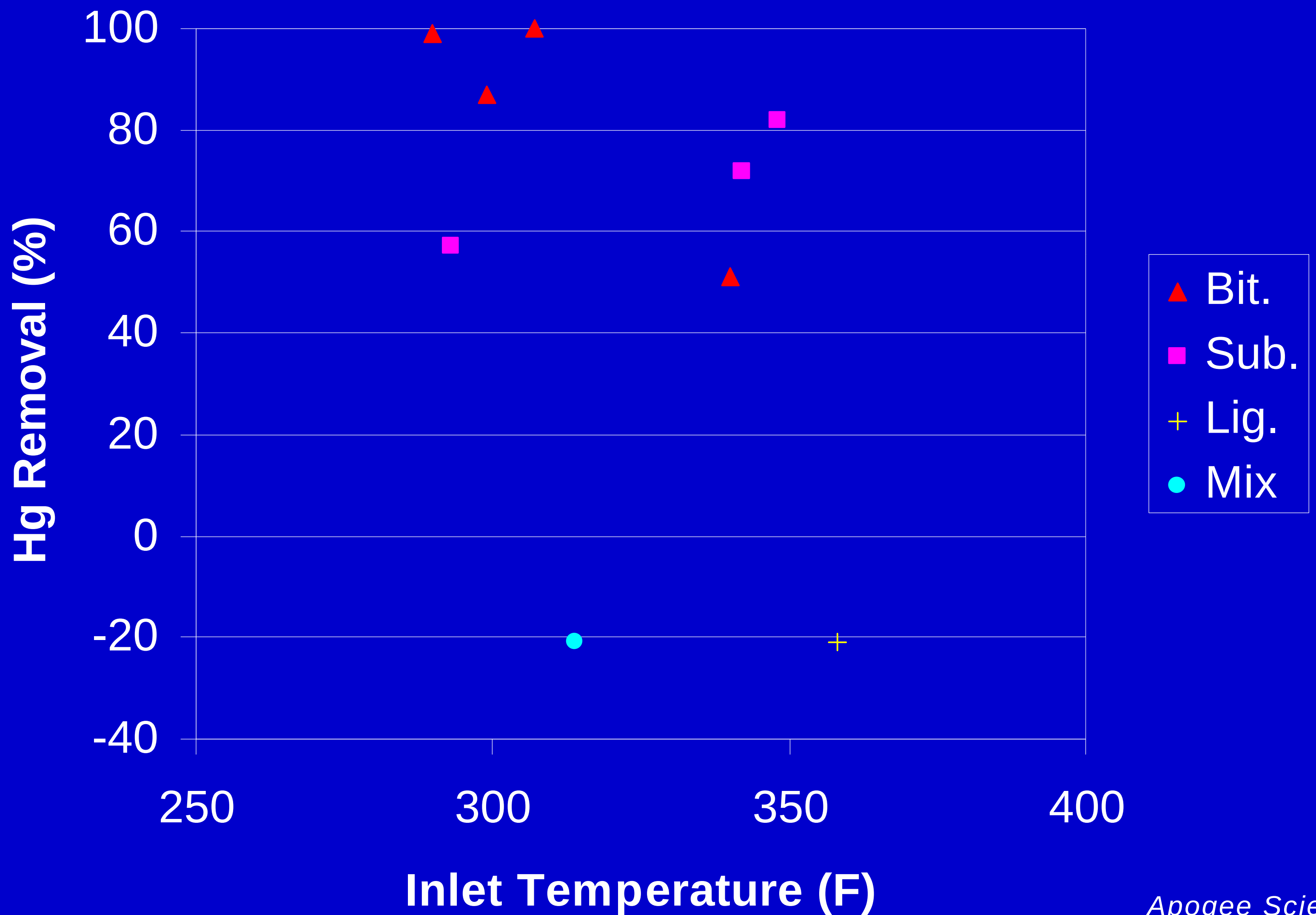
Hot-Side ESP Trends

- Higher mercury removal when coal contained higher chloride

FF Temperature Trends



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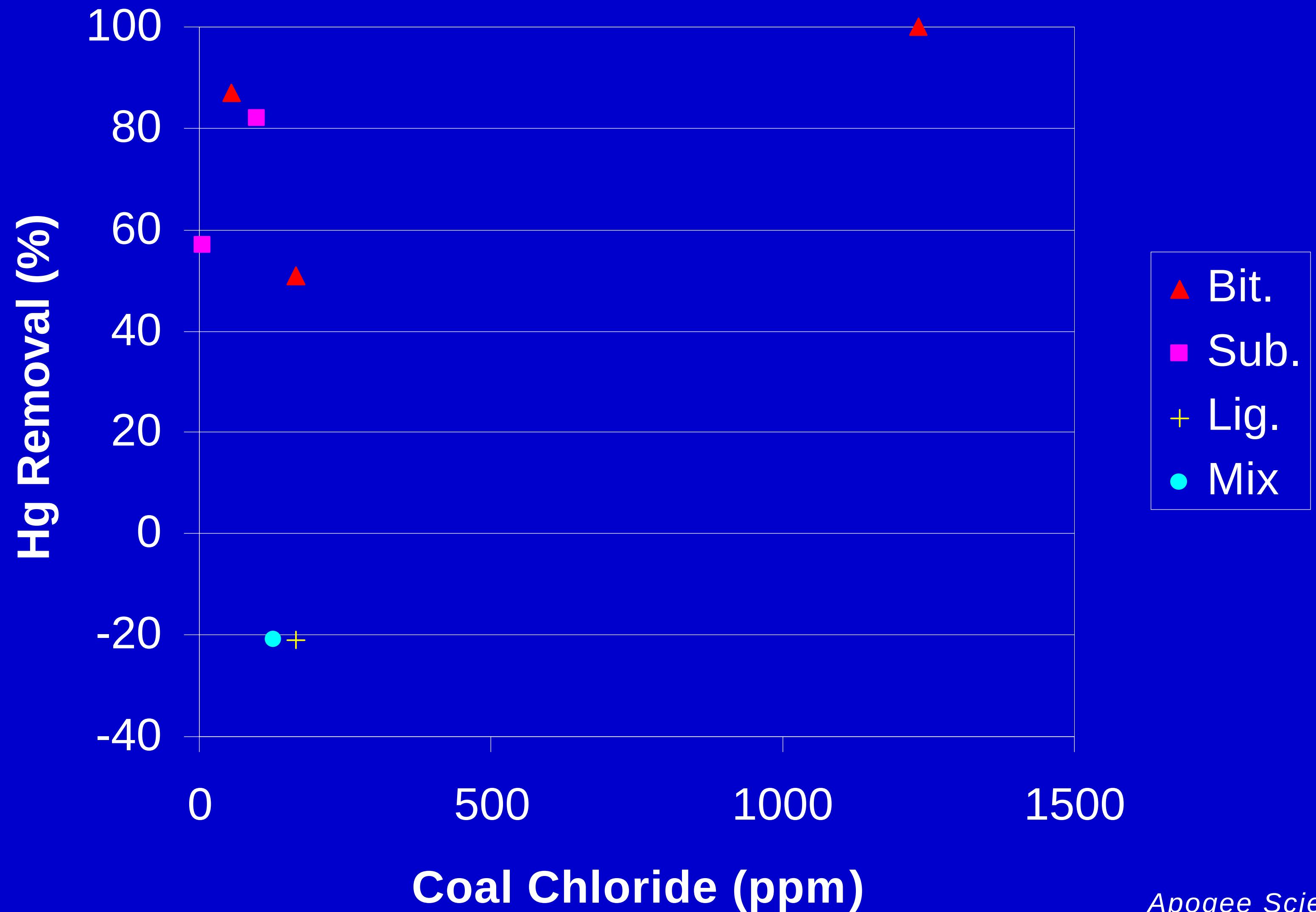
FF Chloride Trends



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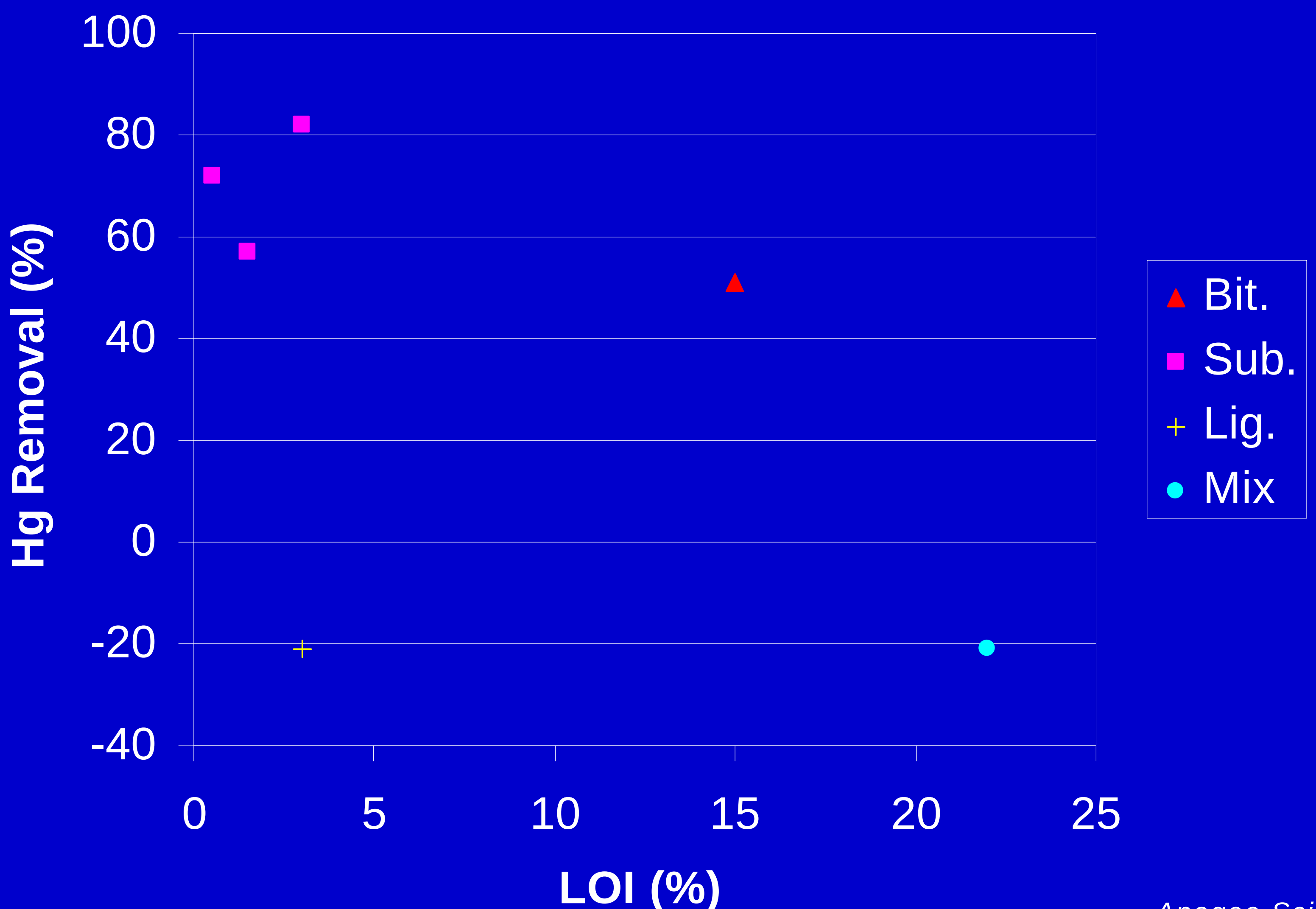
FF LOI Trends



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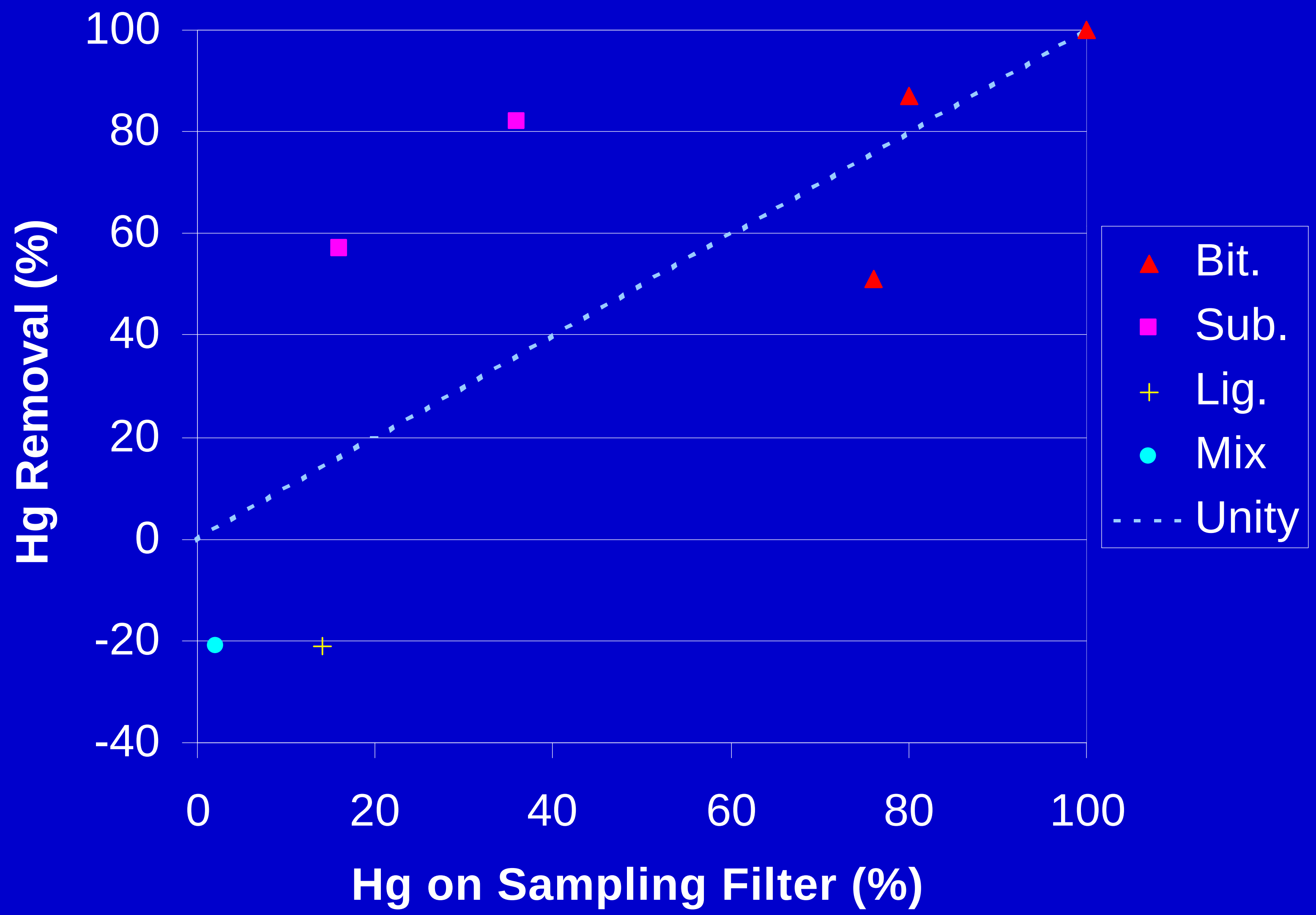
FF Sampling Filter Trends



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Fabric Filter Trends

- No significant trends specific to primary variables

Conclusions – Cold-Side ESPs

- Bituminous *(7 plants)* - **Fair mercury removal** (average 35% at T < 325ºF).
  Increased LOI carbon and increased coal chloride correlates with higher mercury removal.
- Subbituminous *(5 plants)* - **Poor mercury removal** (average 9% at 290 – 320ºF).
- Lignite *(4 plants)* - **Poor mercury removal** (average 2% at 330ºF).
- Mixed (3 plants) - **Good mercury removal** (average 66% at 308 - 338ºF).

Conclusions – Hot-Side ESPs

- Bituminous Coal - Data indicates that small amounts of mercury removal (average 16%) may be possible at hot-side conditions. Removal appears to trend with coal chloride content.

Conclusions - Fabric Filters

- Bituminous *(4 plants)* **Good mercury removal** (average 84% at temperatures < 310^{o}F)
- Subbituminous *(3 plants)* **Good mercury removal** (average 70% at temperatures < 350^{o}F)
- Lignite (*1 plant*) **Poor mercury removal** (average 0% with temperature near 330^{o}F)

Conclusions - COHPAC

- Poor mercury removal was observed for COHPAC units.
- *Based upon pilot and full-scale test results, good mercury removal can be achieved with activated carbon injection upstream of COHPAC without affecting bulk fly ash.*