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TITLE

Chemical Analysis of Nickel Aluminum Bronze Alloys

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Chemical Analysis of Nickel Aluminum Bronze Alloys

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ABSTRACT

A modern laboratory involved in the quantitative chemical analysis of metal alloys has a variety of methodologies from which to select. These methods range from the destructive techniques of traditional wet chemistry and spectrometric methods to the nondestructive optical emission or x-ray techniques that have recently come into vogue. Non-destructive methods are attractive, both in terms of sample integrity and their ability to yield quick results. This paper compares the abilities of destructive techniques (atomic absorption and inductively coupled plasma) with some currently available nondestructive methods (energy dispersive x-ray analysis and spark emission).

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CHEMICAL ANALYSIS OF NICKEL ALUMINUM BRONZE ALLOYS

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OUTLINE

- Purpose
- Alloys
- Methodologies
  - Rapid, non-destructive
  - Spectrometric, destructive
- Results
- Conclusions

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PURPOSE

- Rapid, non-destructive chemical analysis of metal alloys has been readily available since late 1980's
- Techniques are attractive:
  - quick
  - non-destructive
  - inexpensive
  - field analysis

PURPOSE

- How accurate?
- Compare rapid, non-destructive technique results to results from more rigorous, but destructive, laboratory techniques using a series of metal alloys

ALLOYS

- Series of 18 nickel aluminum bronzes:

Al: 9.1 - 12.5	Mn: 0.3 - 1.3
Fe: 3.8 - 6.5	Ti: 0 - 3.6
Ni: 3.7 - 6.5	

- Lack of certified nickel aluminum bronze standards
  - assumed foundry analysis to be correct
  - unable to quantitate Ti

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METHODOLOGIES

- Rapid, non-destructive methods
  - Energy dispersive x-ray microanalysis (EDXA)
    - Si(Li) detector mounted on SEM
    - HgI detector on portable instrument
- Laboratory techniques
  - Flame atomic absorption spectrometry (FAAS)
  - Inductively coupled plasma/atomic emission spectrometry (ICP/AES)

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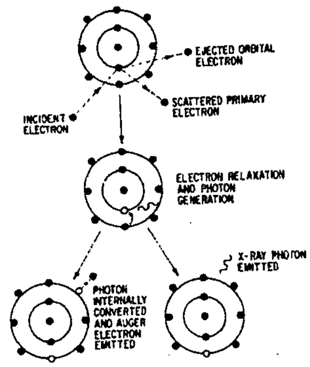
RAPID METHODS

- EDXA relies on x-ray generation by bombardment of sample by incident particles
- Si(Li) detector system used beam electrons
- HgI detector system utilized radiation from Cd109 and/or Fe55 sources



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RAPID METHODS

HgI Detector

- Predetermined methods
  - Intermediate level
- Orientation less critical
  - flat surface, 600 grit
- Standardless ZAF calculations

- Si(Li) Detector
- Beam energy variable
  - 20 KV accelerating voltage
  - 100 sec count at ~3000 cps
- Orientation critical
  - 30 mm working distance
  - 37.5° take-off angle
- Standardless ZAF calculations

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LABORATORY METHODS

- Both methods require acid dissolution
  - 50 mg for FAAS; 20 mg for ICP/AES
- Solution aspirated into flame/plasma
  - FAAS: flame yields sample atoms which absorb energy shone through flame. Amount absorbed related to concentration through Beers' Law.
  - ICP/AES: thermal energy of plasma yields excited state atoms which return to ground state via fluorescence

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RESULTS

METHOD	% RELATIVE ERROR			
	Al	Fe	Ni	Mn
Si(Li)	9.6 ± 2.1	20.5 ± 4.4	18.0 ± 3.5	15.2 ± 5.4
HgI	NA	8.2 ± 3.7	5.4 ± 2.3	15.4 ± 4.3
FAAS	2.5 ± 0.8	6.5 ± 2.9	2.9 ± 1.5	3.4 ± 1.0
ICP/AES	1.8 ± 0.6	4.5 ± 1.8	2.3 ± 0.8	3.2 ± 1.1

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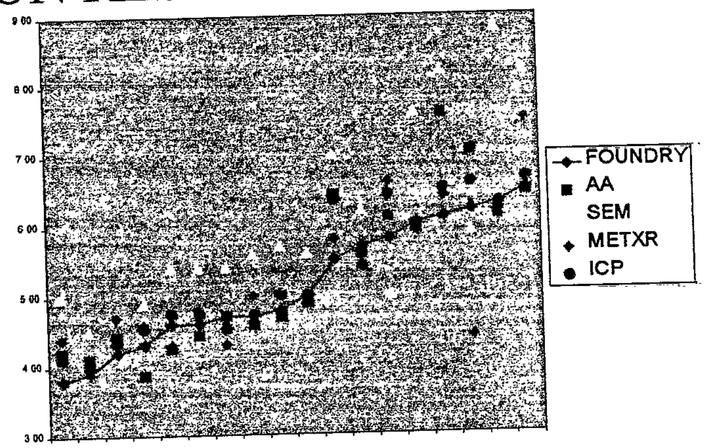
IRON RESULTS



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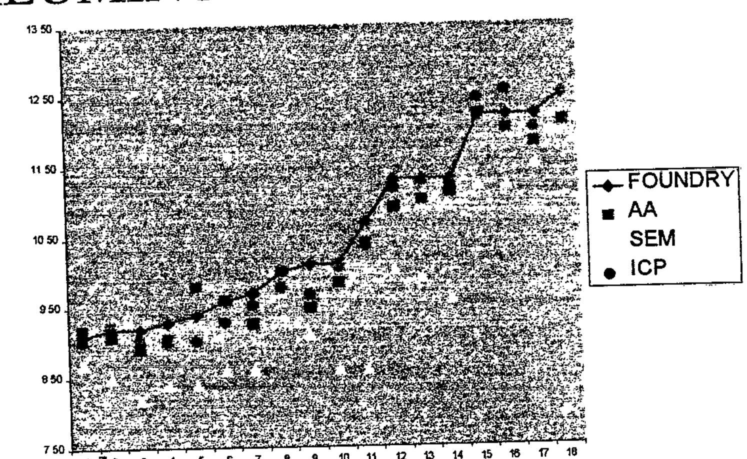
ALUMINUM RESULTS



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CONCLUSIONS

- Rapid techniques yield less accurate results
- HgI detector was acceptable
  - performed much better than Si(Li) detector
  - lack of aluminum data problem
- Rapid, non-destructive detectors can be used with care
  - skilled operators
  - understand limitations

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