15772

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JOEL SCHMITIGAL

Near-Infrared Fuel Analysis

SUPERIOR TECHNOLOGY

FOR A

SUPERIOR ARMY

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U.S. ARMY TANK AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Report Documentation Page

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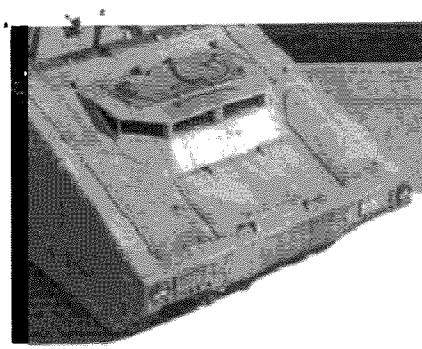
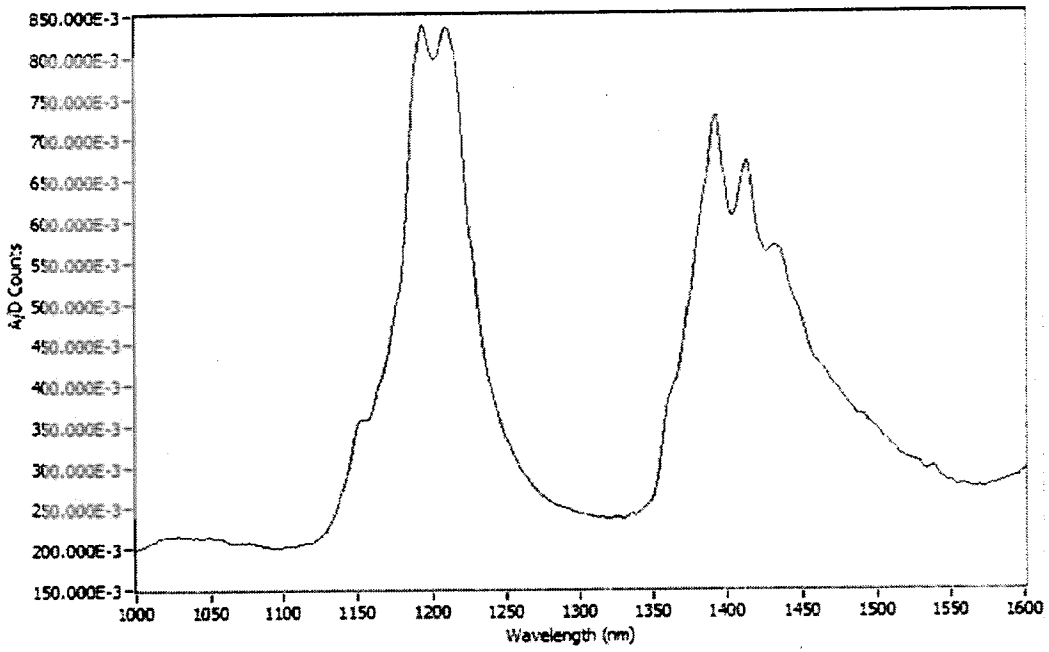


METHODOLOGY

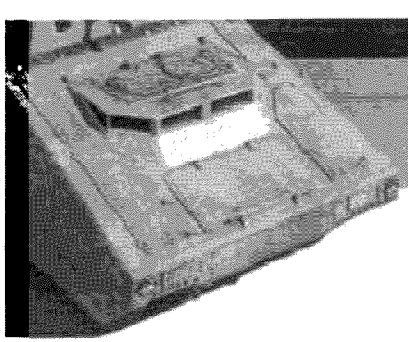
- Portable, Ruggedized, Near Infrared Spectrometer
- Chemometrics using Principal Component Analysis and Partial Least Squares or Soft Independent Modeling of Class Analogies Method (SIMCA)
- Manufactured by Micron Optical Systems Inc.
  - Suffolk, VA

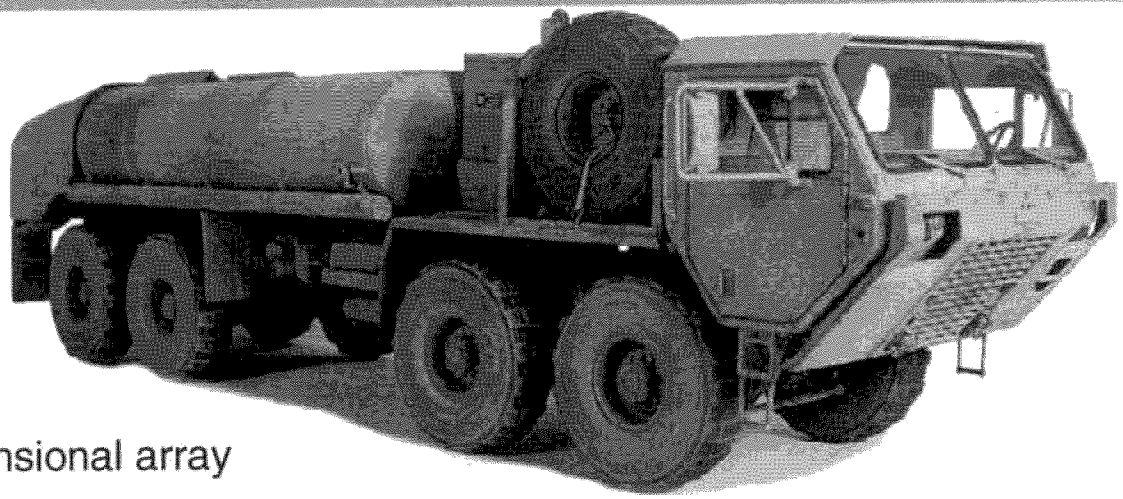
• Army Small Business Innovative Research (SBIR)

  – Phase II awarded 1/11/2001



SPECTROMETER CONFIGURATION



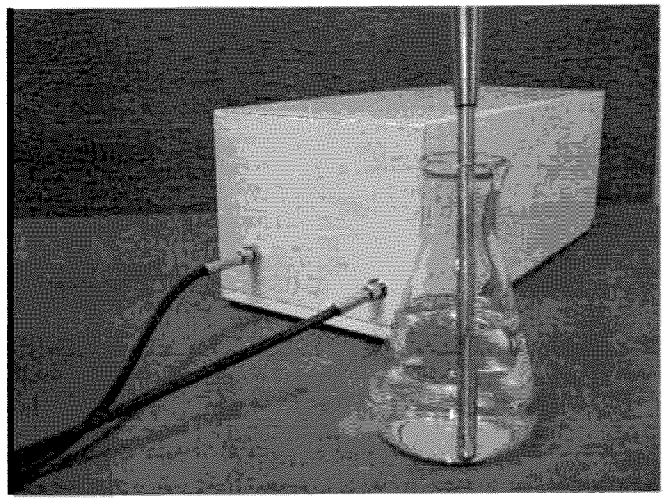


Size

– 4.25" x 5.25" x 11.75"

Detector

– Substrate: InGaAs one dimensional array
– Pixels: 512 pixels
– Electronic Shutter: Integration from 1 ms to minutes
– Readout and Display Update: 50 specta / second



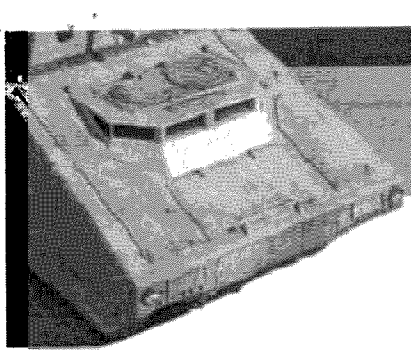
Spectrograph

– Grating: Volume Holographic transmission grating
– Spectral Range: 1000-1600 nm
– Spectral Dispersion: 1.56 or 0.98 nm/pixel

Source

– Feedback-Stabilized High-Intensity tungsten halide lamp with peak intensity at 1100nm.

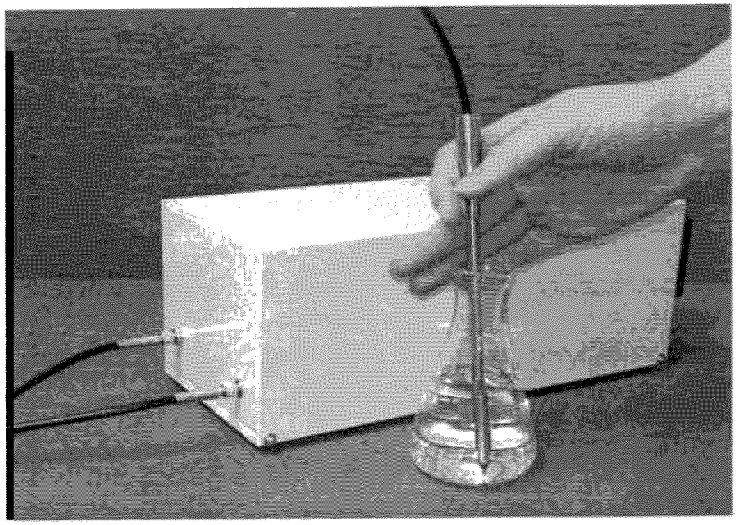
SPECTROMETER CONFIGURATION



ADVANTAGES AND LIMITATIONS

ADVANTAGES

- Small Size : 4.25" x 5.25" x 11.75"
- Light Weight
- Adaptable fiber optic probe
- Easy to use
- Fast Analysis: Results in less than 1s
- No hazardous waste generated



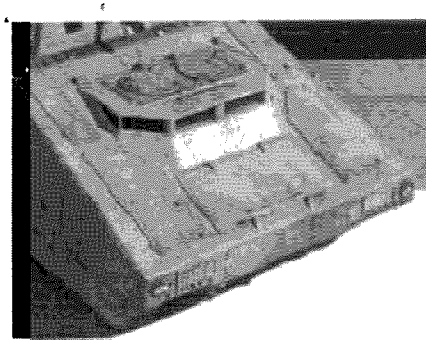
LIMITATIONS

- Correlative measurement: the accuracy of your results are dependant on the accuracy of the ASTM data used to build the models

- Correlation to properties dependent on molecular structure

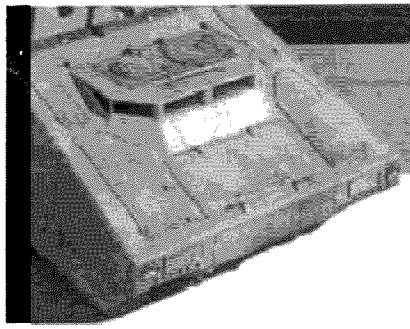
- Range/Quantity of fuel samples

- Sensitivity directly related to composition of fuel

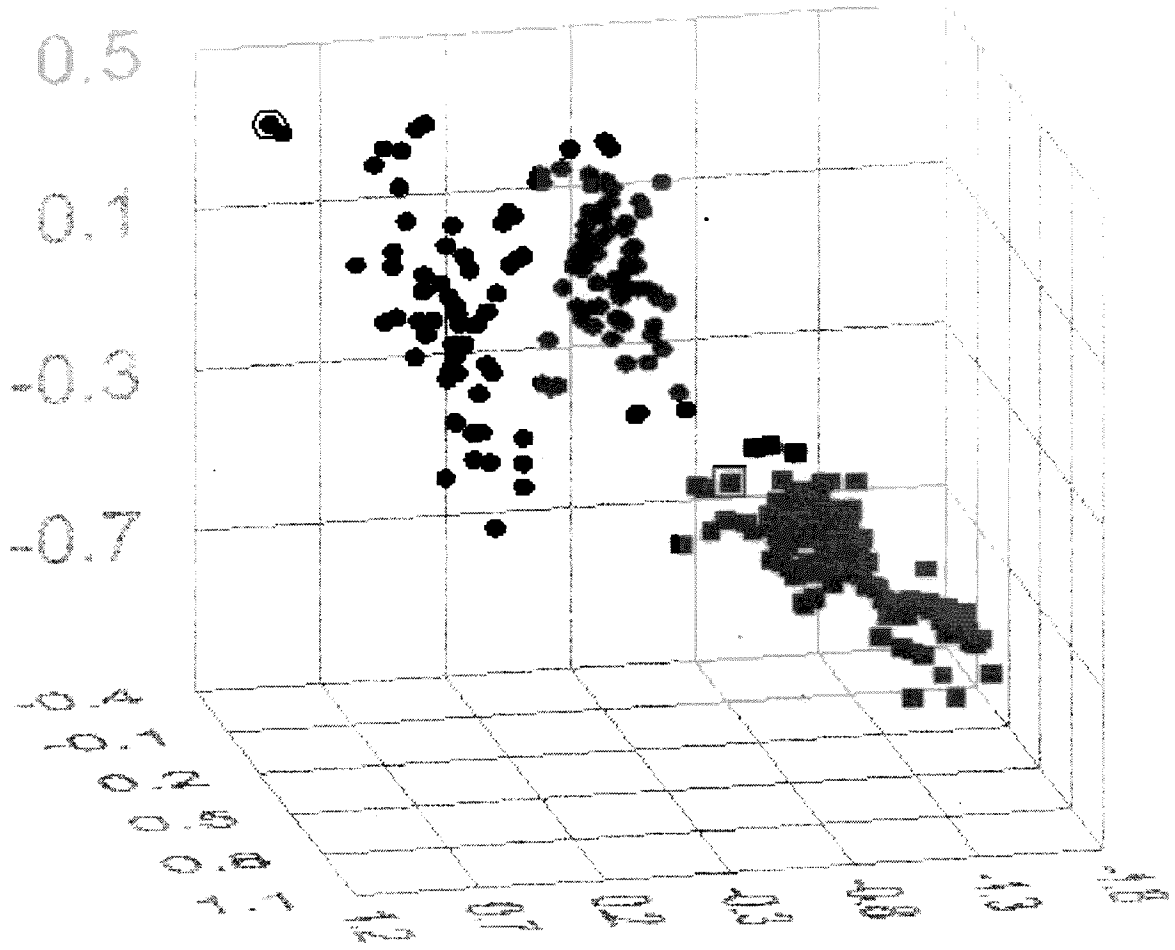


FUEL PROPERTIES MODELED

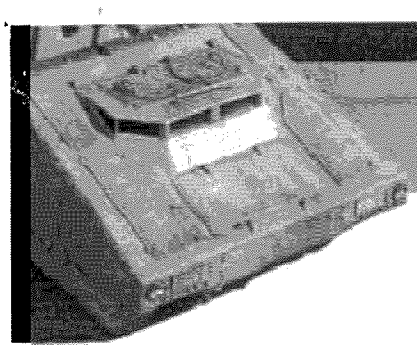
Property	ASTM Method	ASTM Reproducibility	SEV
Boiling point at 10% dist	D 86	3.74 - 12.02 °C	8.35 °C
Boiling point at 90% dist	D 86	3.74-10.52 °C	9.40 °C
Dist End Point	D 86	10.5 °C	12.87 °C
Density	D 1298	0.0012 g/mL	0.0041 g/mL
API Gravity	D 1298	0.3	0.9384
Flashpoint	D 93	6 °C	5.141 °C
Viscosity at 40 °C	D 445	0.013 - 0.046 cSt	0.156 cSt
Cetane Index	D 976	2	1.183
Aromatics %	D 1319	1.5-3.3%	1.9%
Cloud Point	D 2500	4 °C	5.8 °C
Freeze Point	D 5972	.80 °C	0.75 °C
Net Heat of Combustion	D 4809	0.046 MJ/kg	0.098 MJ/kg
Hydrogen Content	D 3343	0.012-0.015%	0.22 %

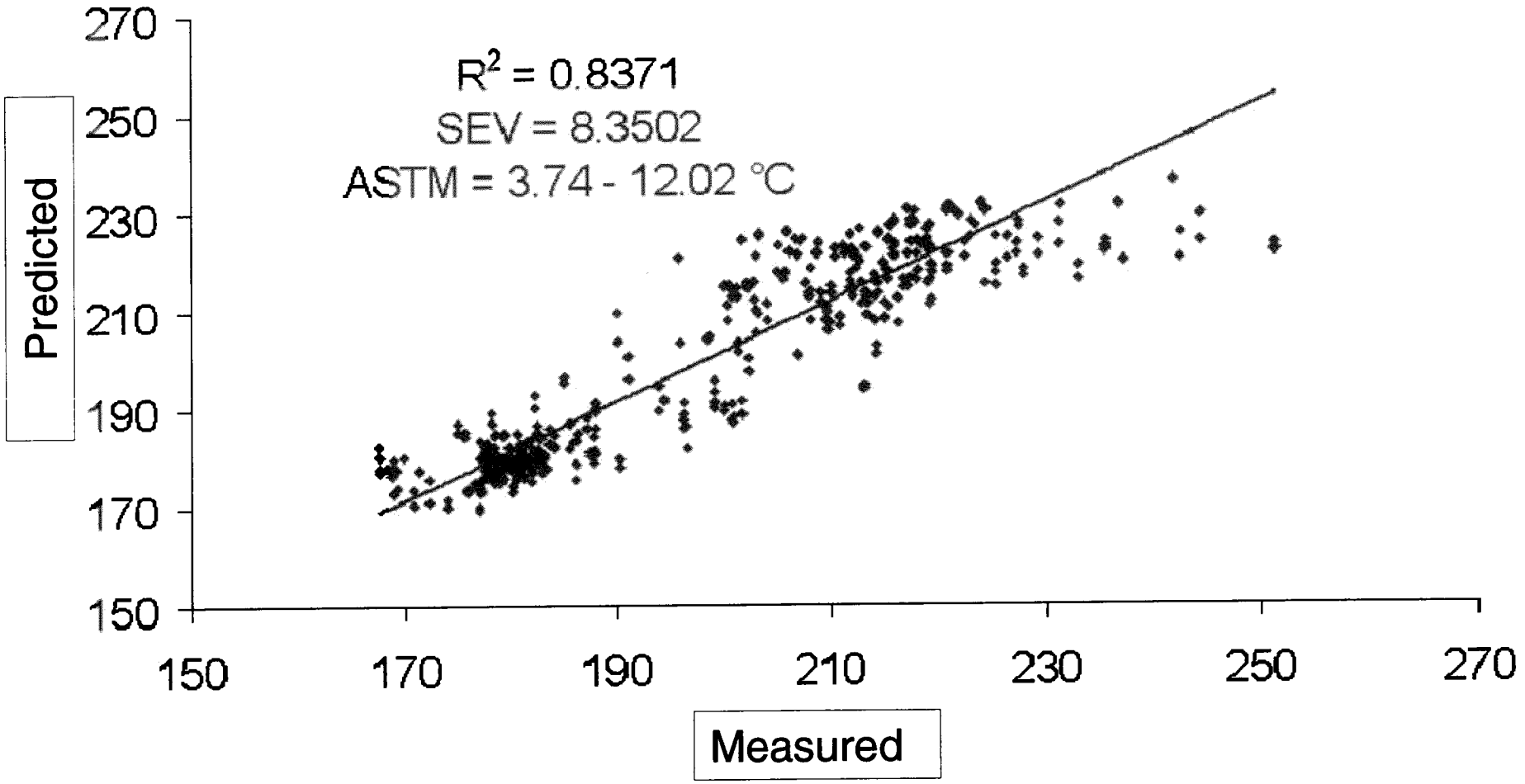


SIMCA

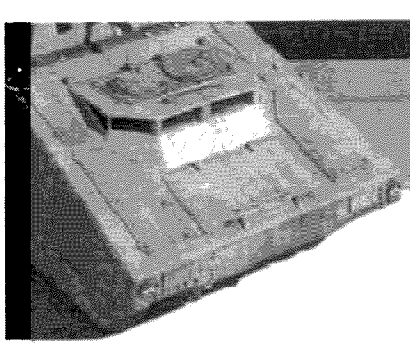


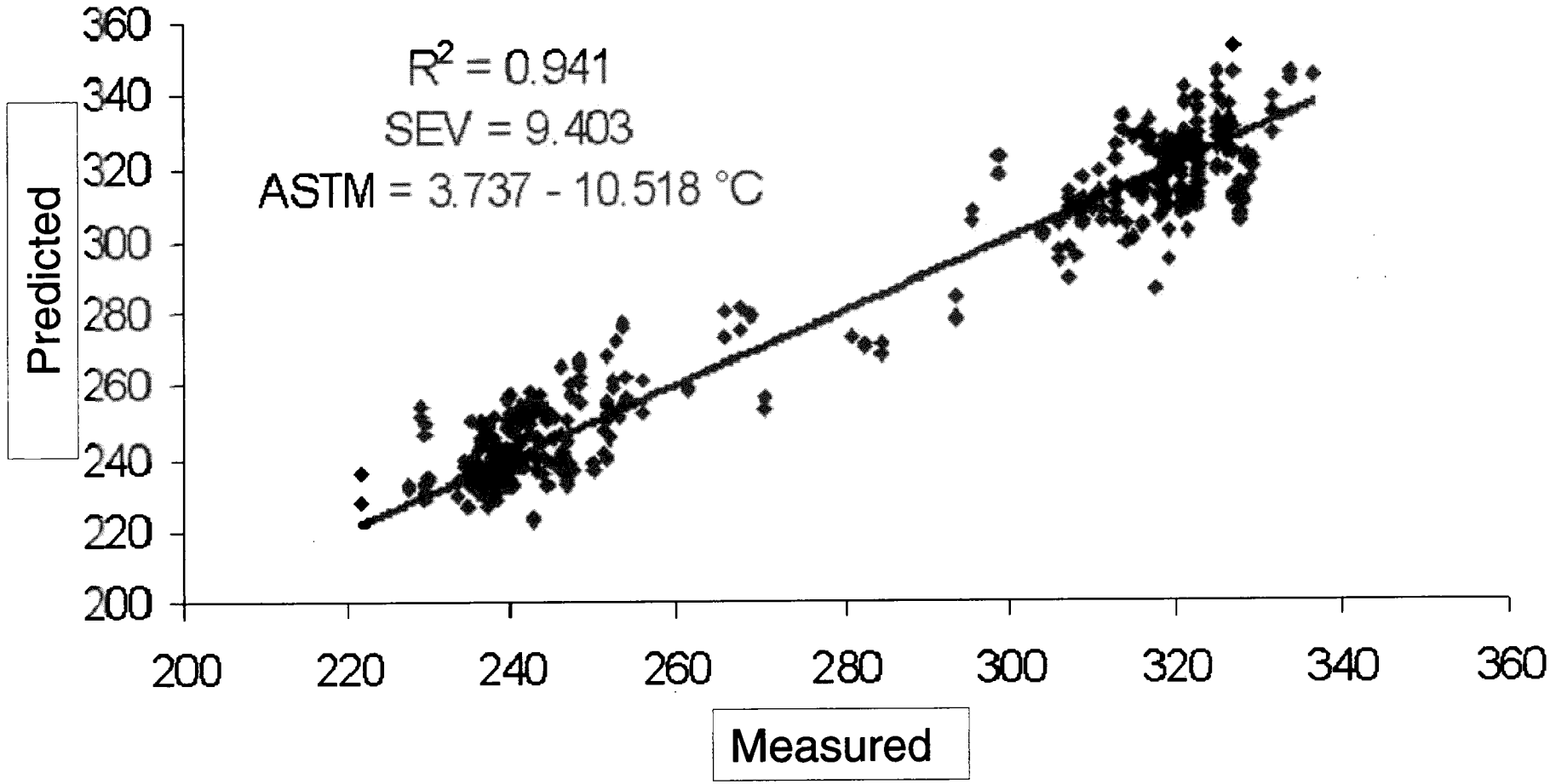
BOILING POINT AT 10% DISTILLED



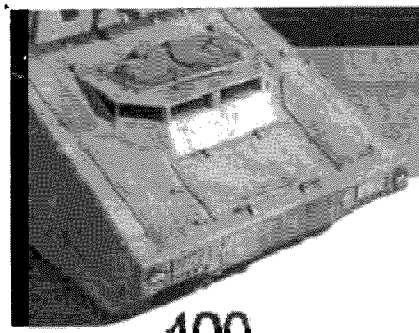


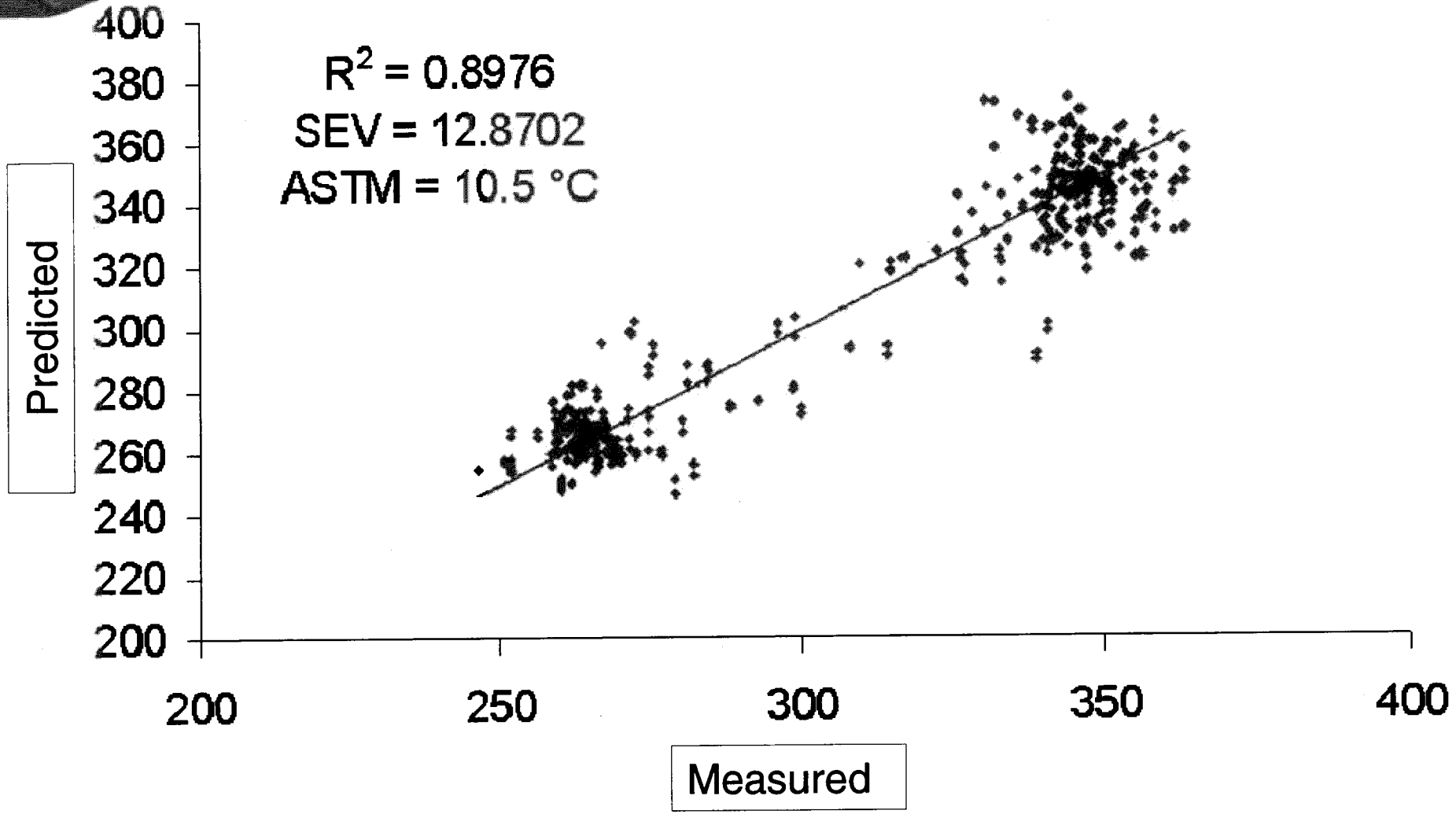
BOILING POINT AT 90% DISTILLED



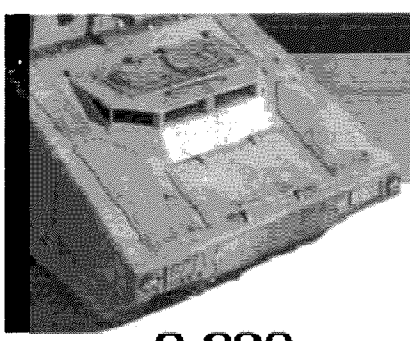


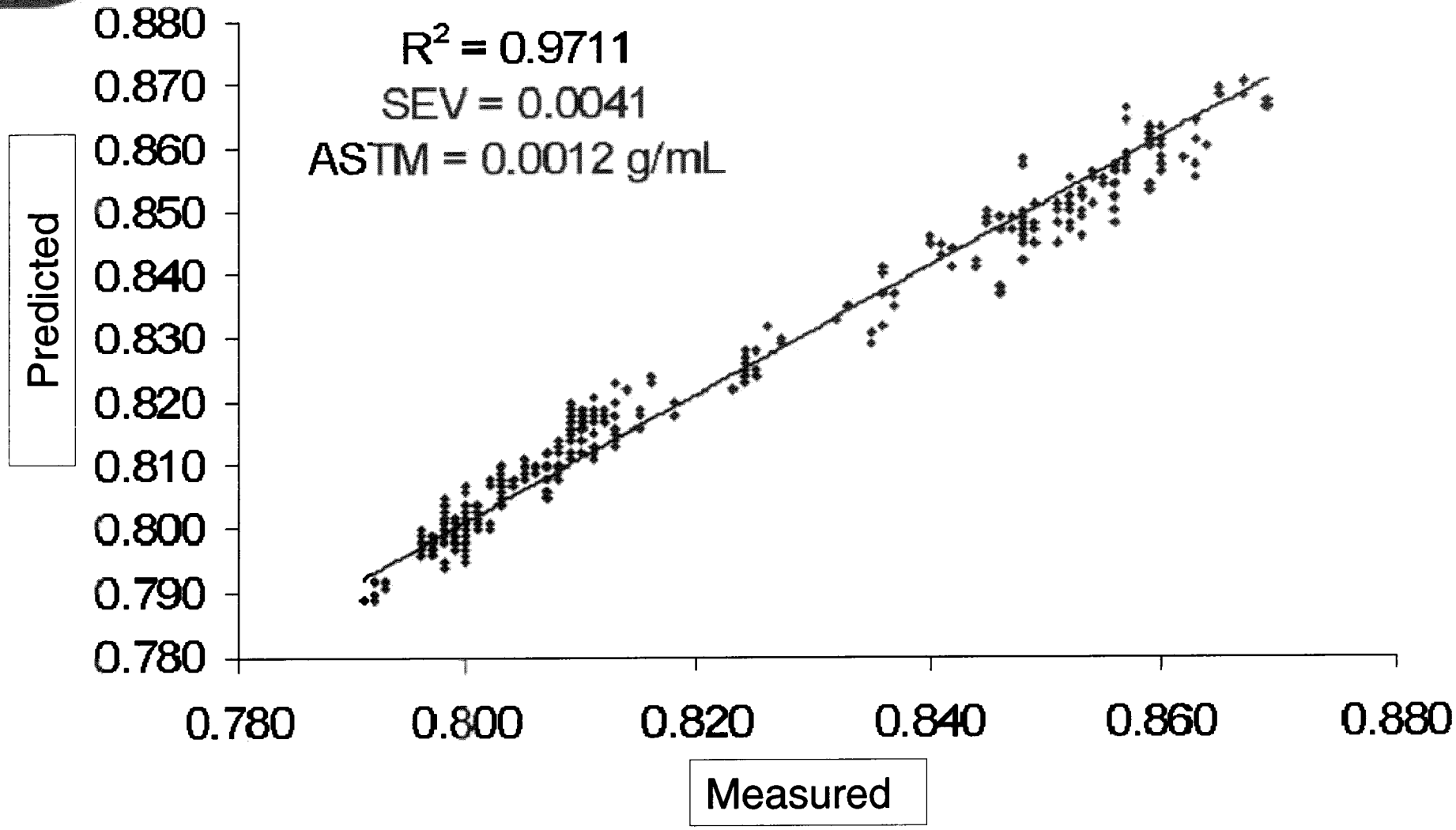
DISTALLATION END POINT



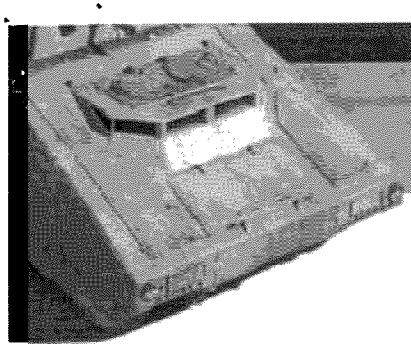


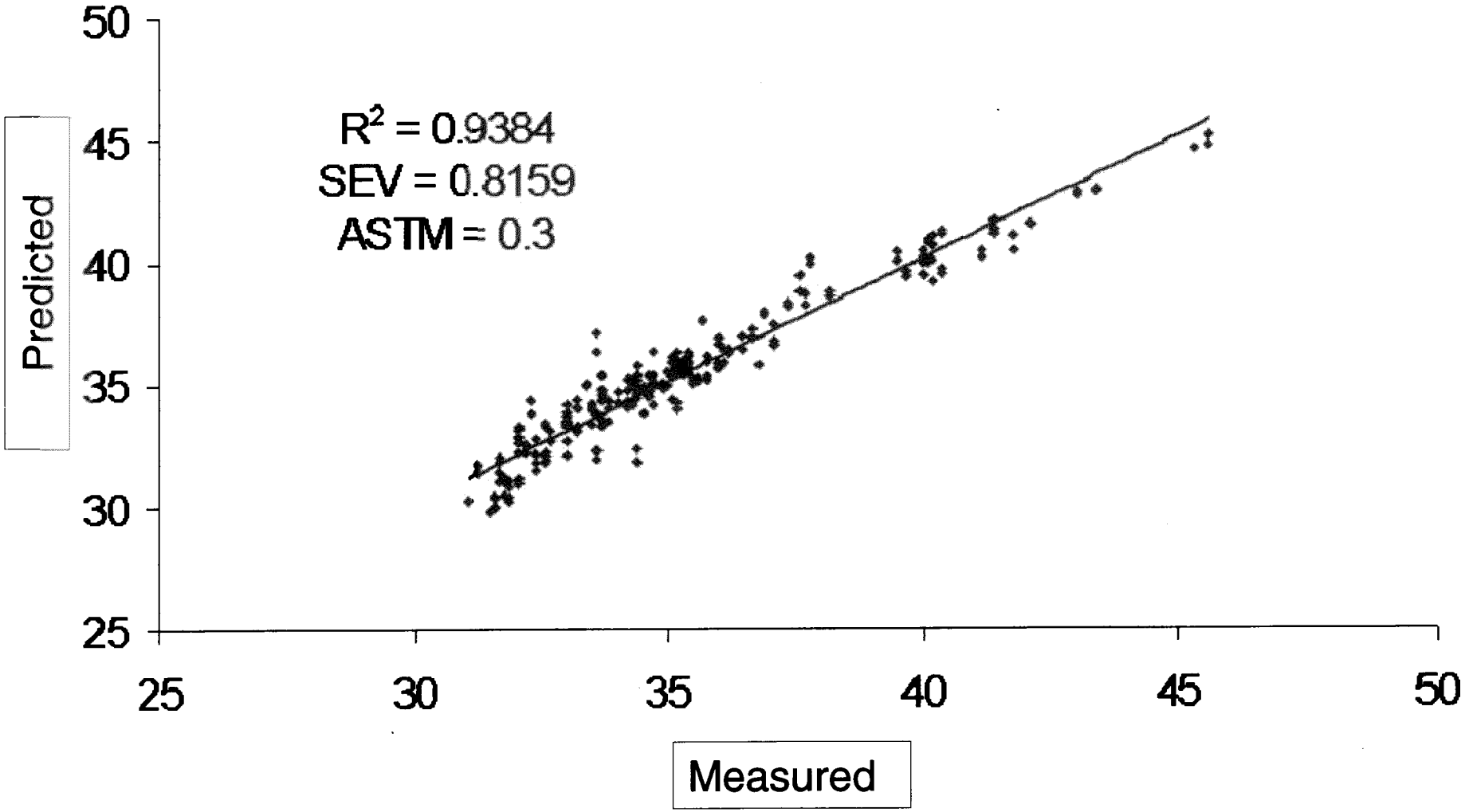
DENSITY

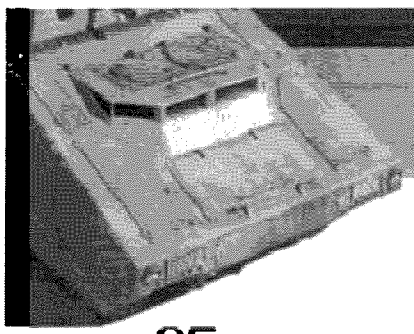



R^2 = 0.9711
SEV = 0.0041
ASTM = 0.0012 g/mL
Predicted
0.880
0.870
0.860
0.850
0.840
0.830
0.820
0.810
0.800
0.790
0.780
0.780
0.800
0.820
0.840
0.860
0.880
Measured

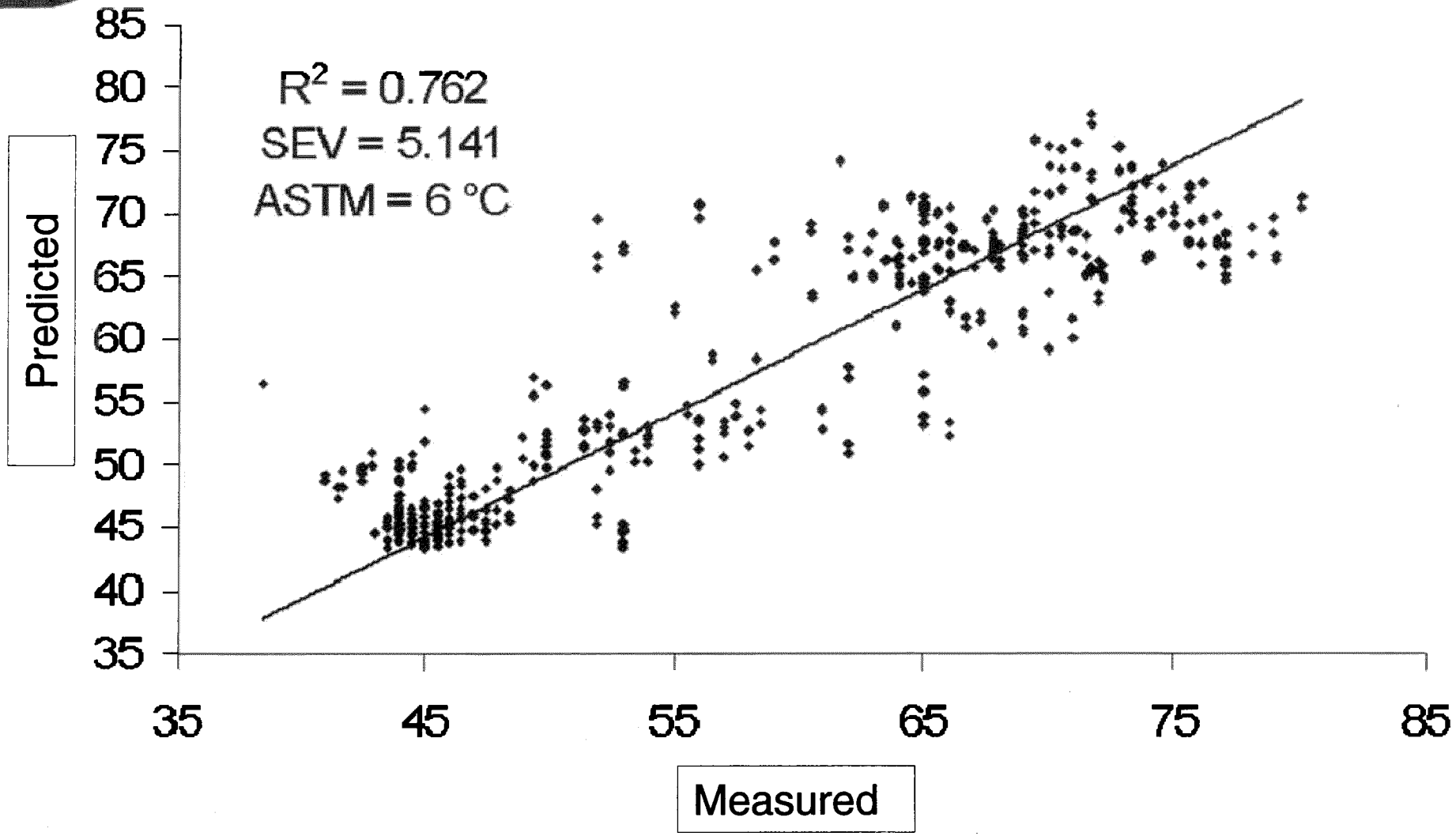
API GRAVITY



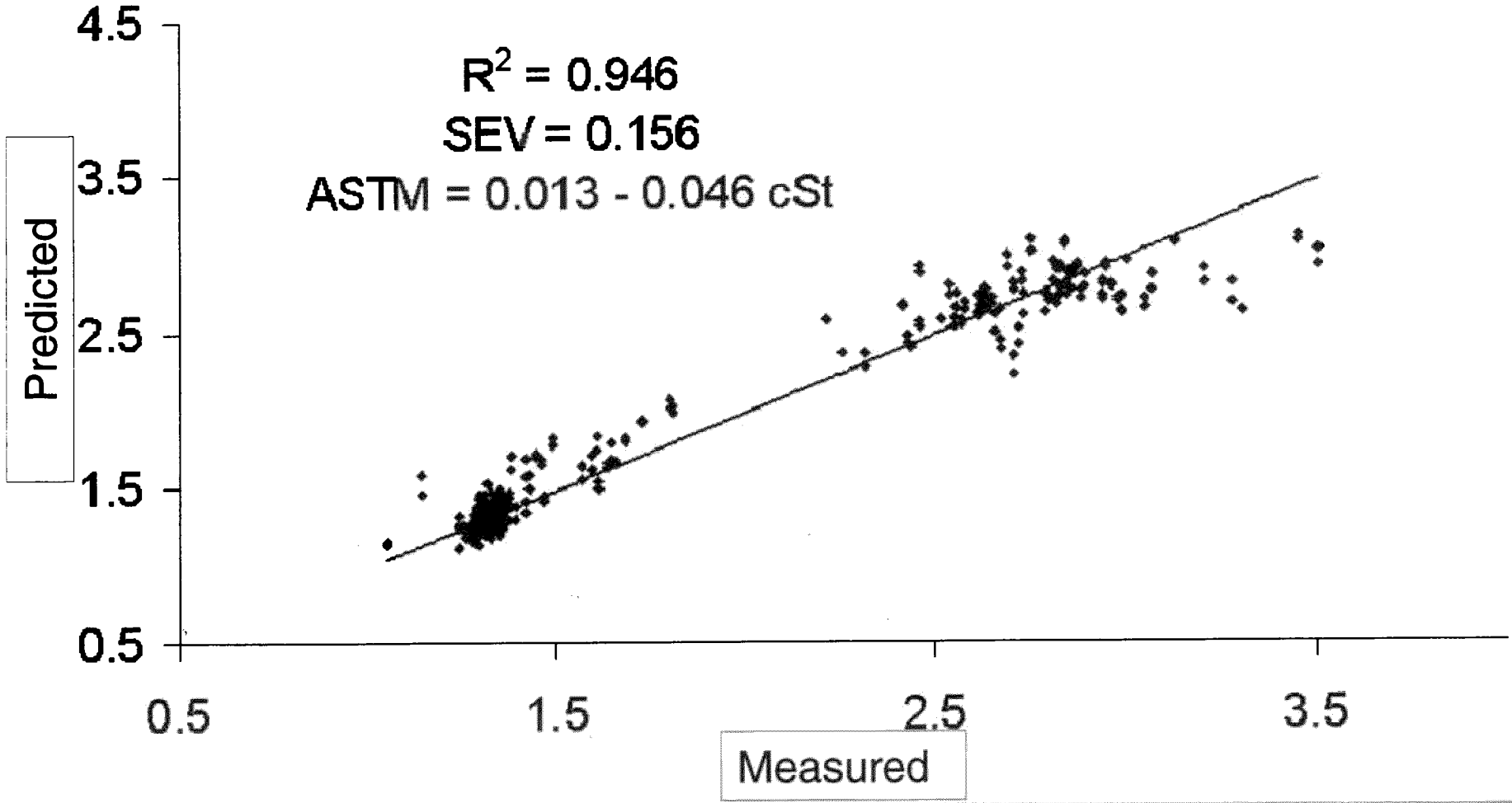

R^2 = 0.9384
SEV = 0.8159
ASTM = 0.3
Predicted
50
45
40
35
30
25
25
30
35
40
45
50
Measured



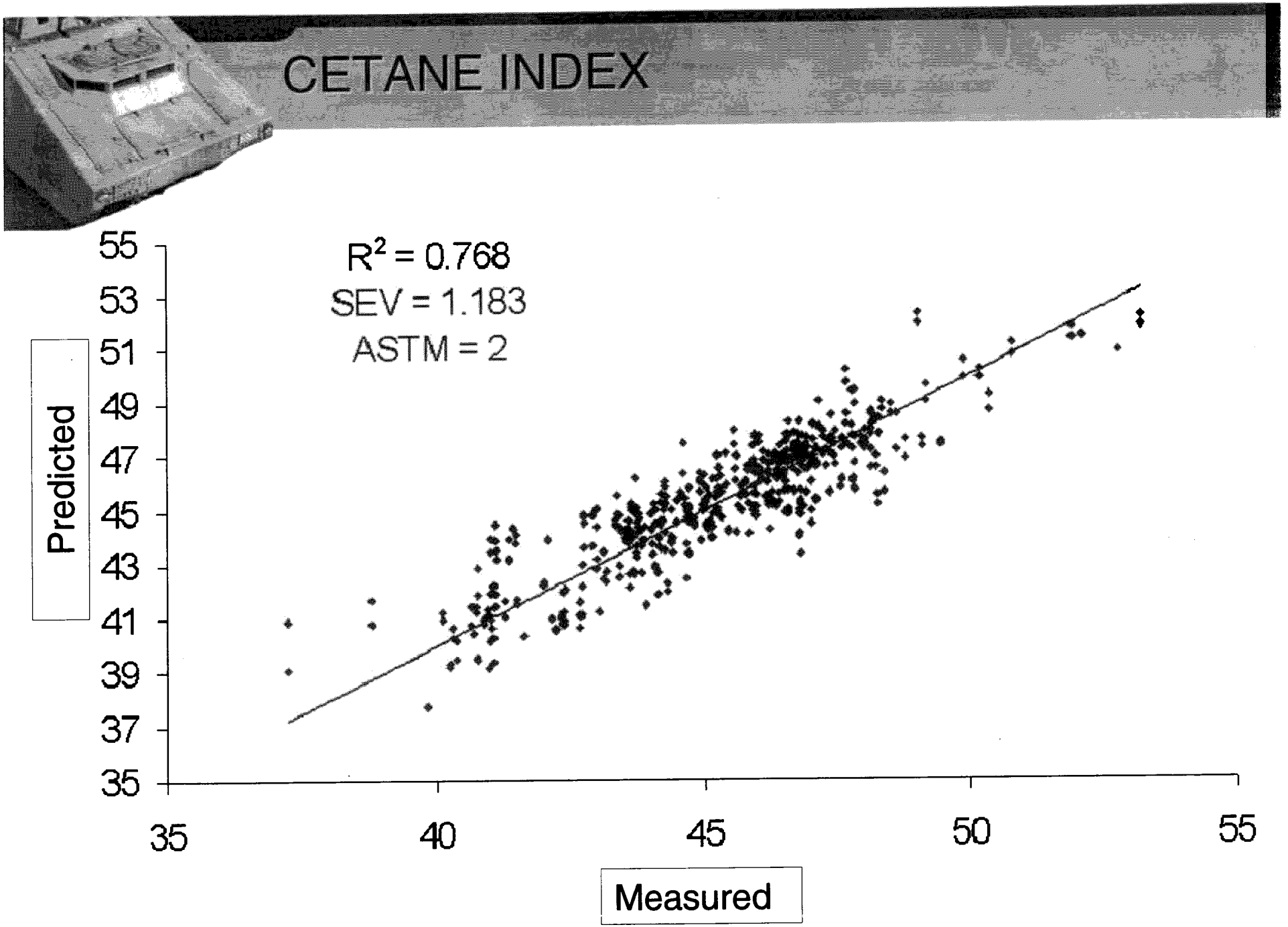
FLASHPOINT °C

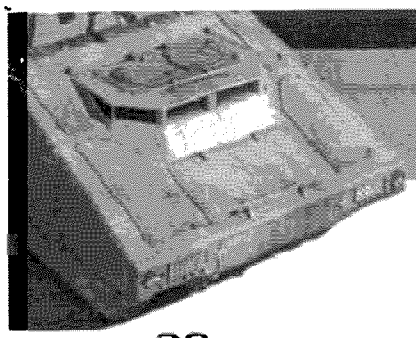


VISCOSITY AT 40 °C

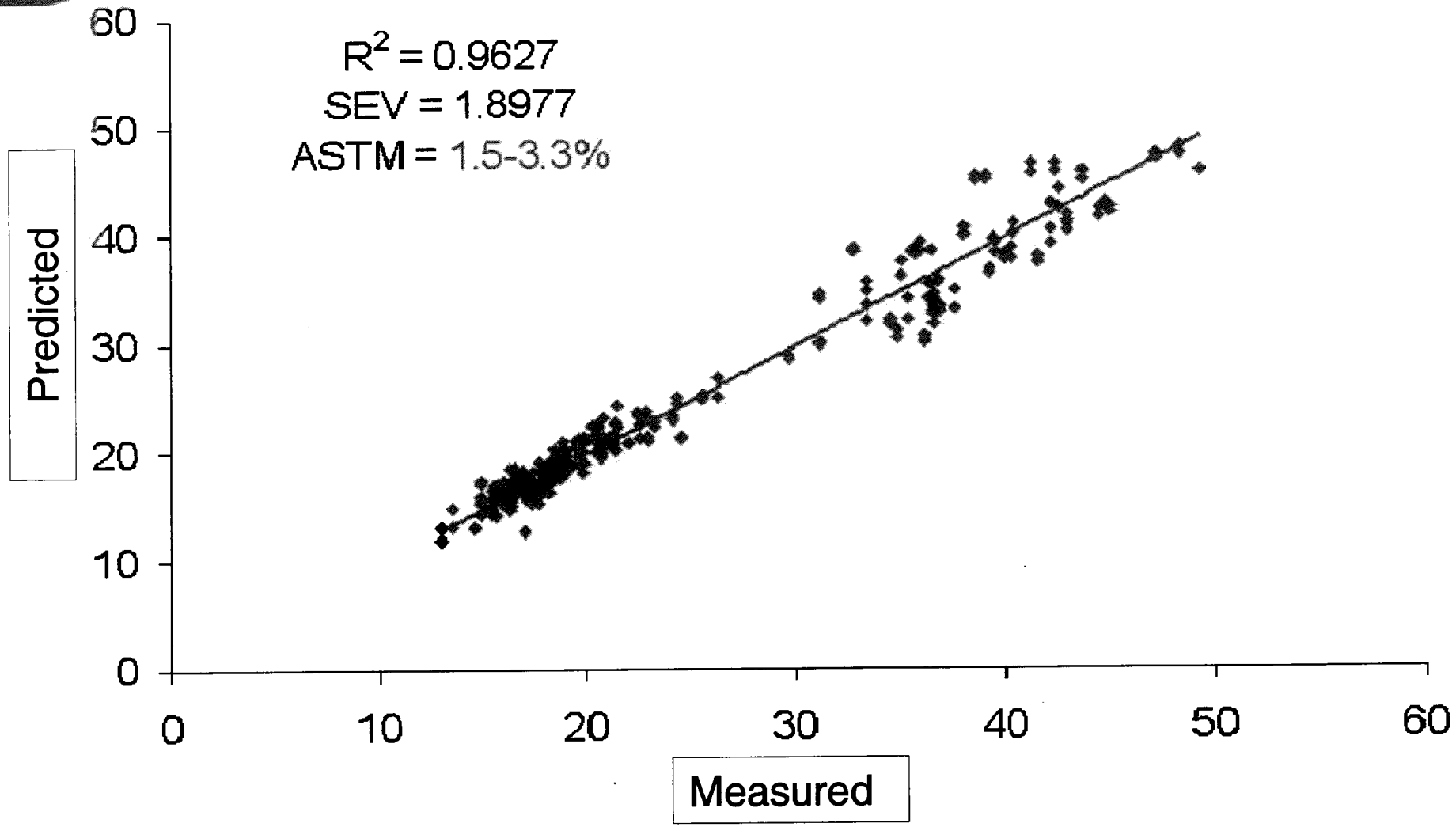


CETANE INDEX

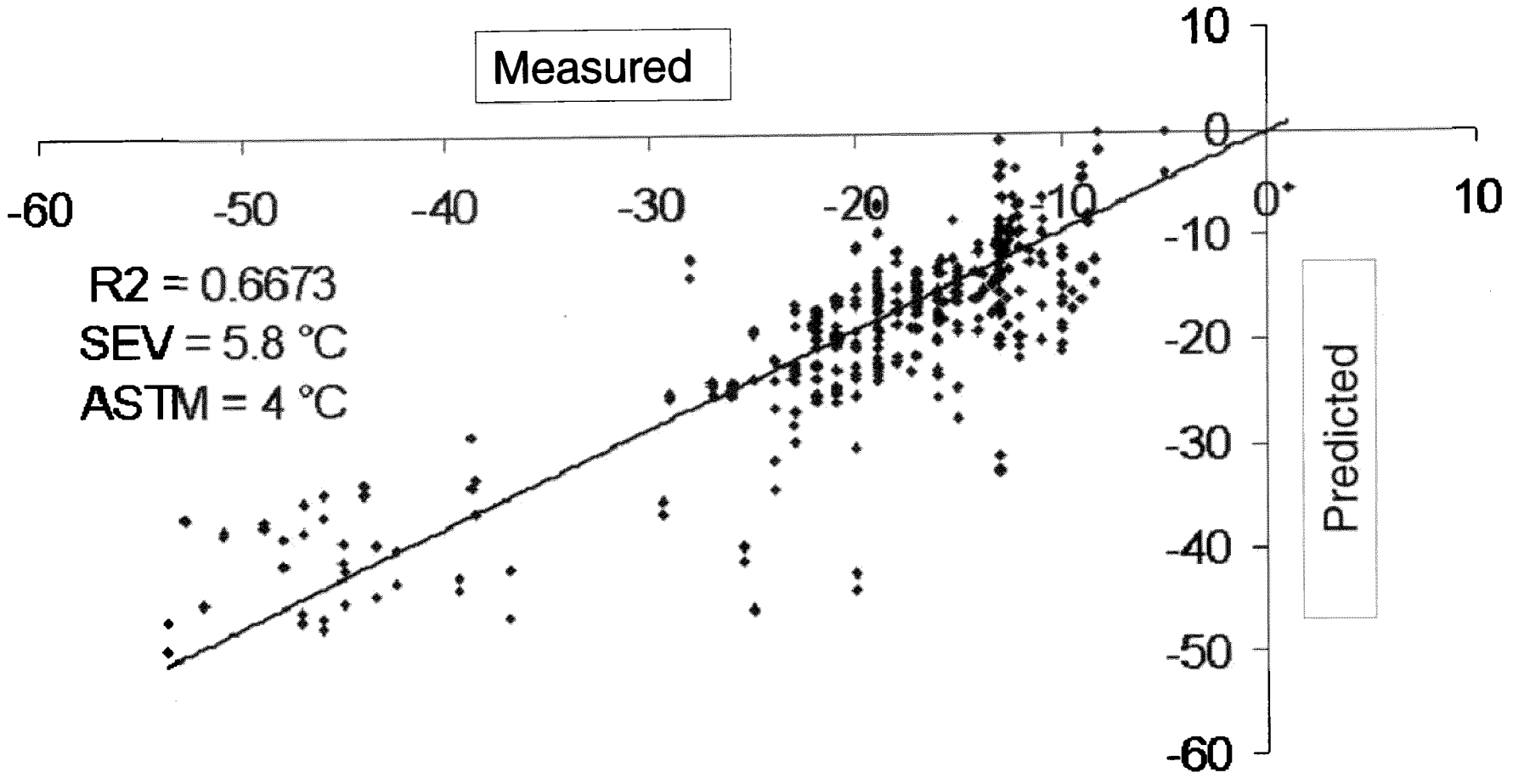




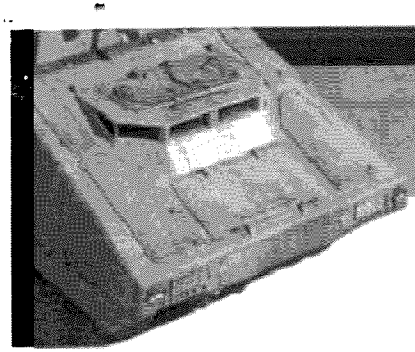
PERCENT AROMATICS

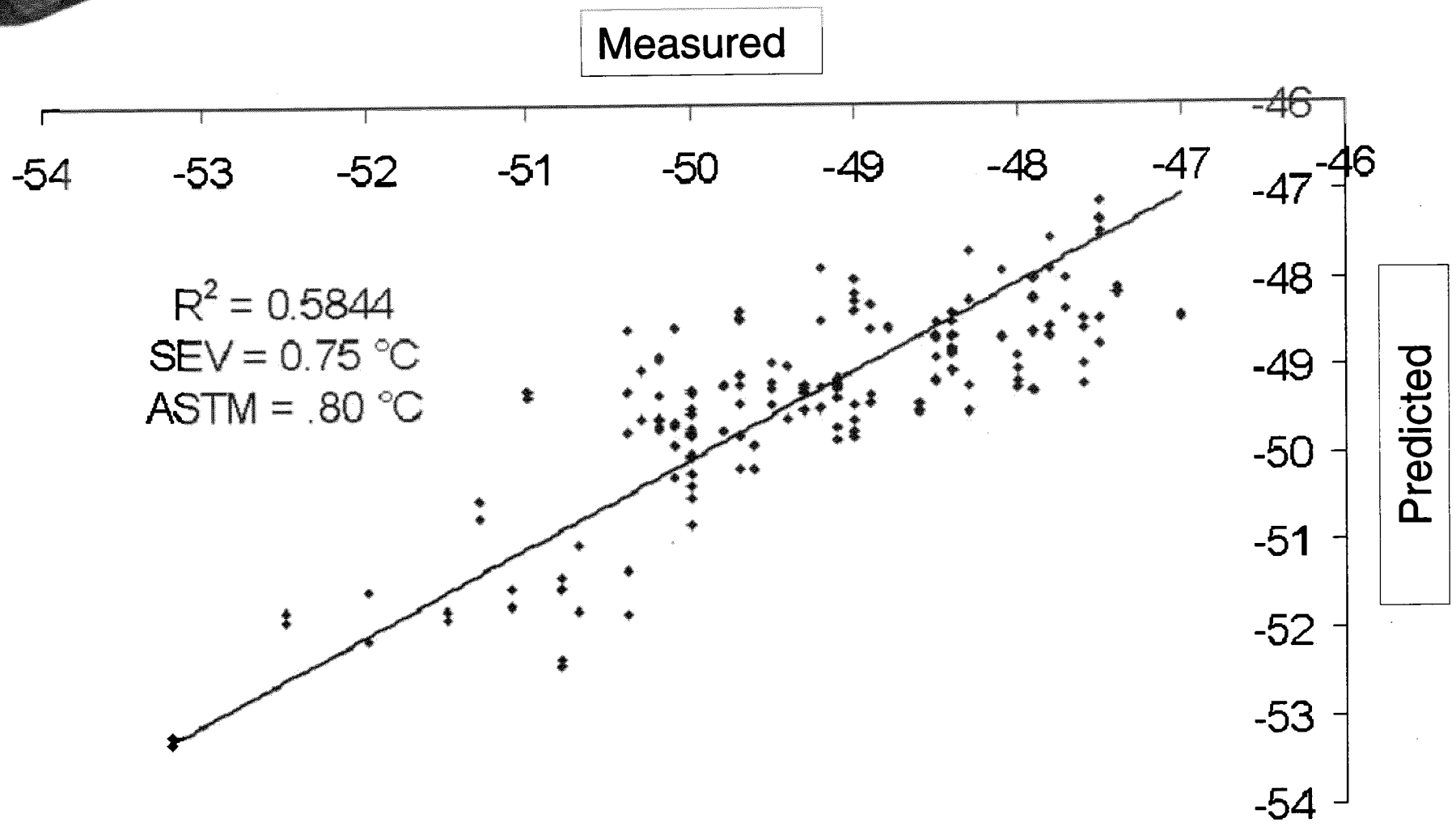


CLOUD POINT

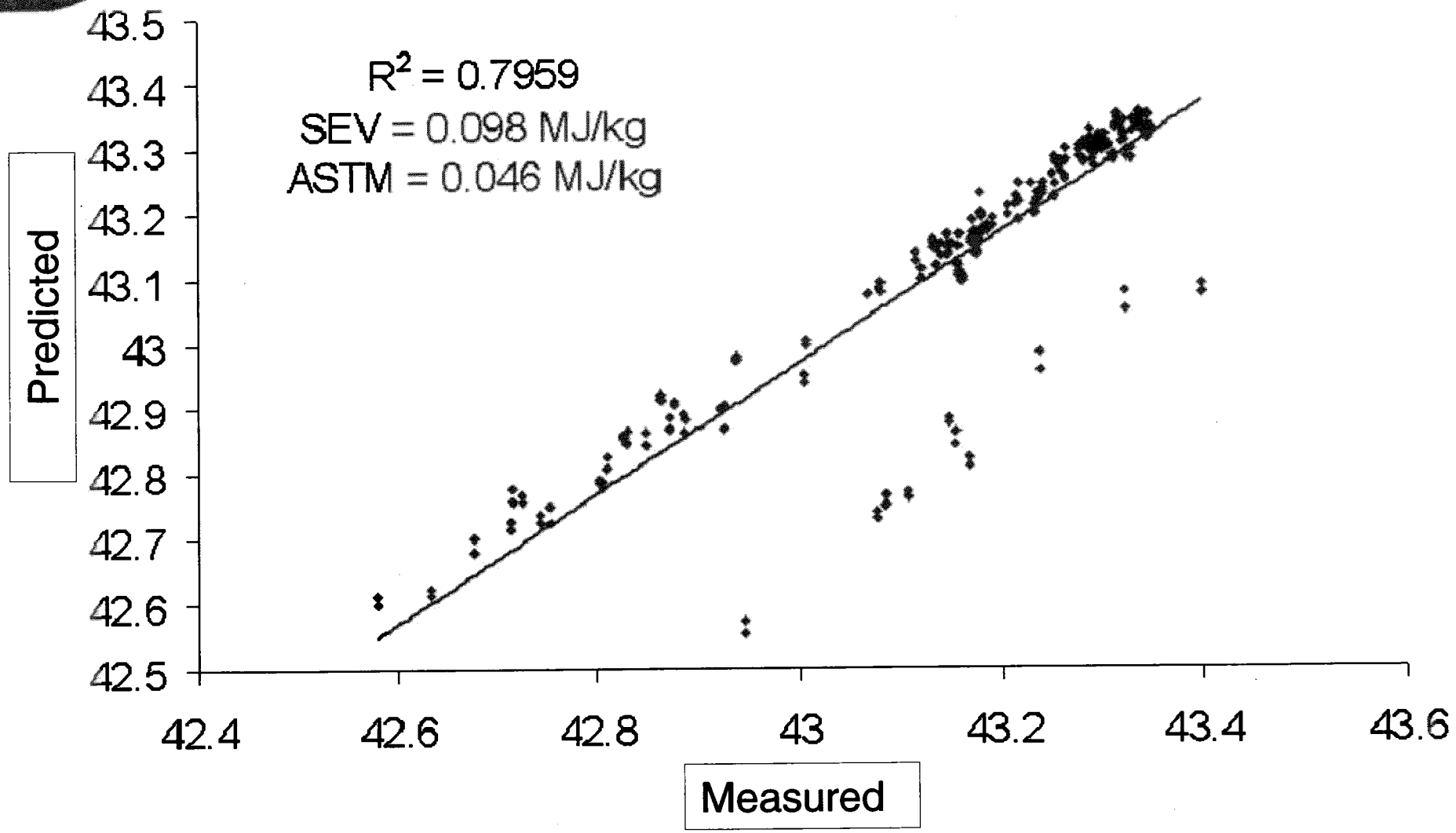

Measured
Predicted
R2 = 0.6673
SEV = 5.8 °C
ASTM = 4 °C
-60
-50
-40
-30
-20
-10
0
10
10
0
-10
-20
-30
-40
-50
-60

FREEZE POINT

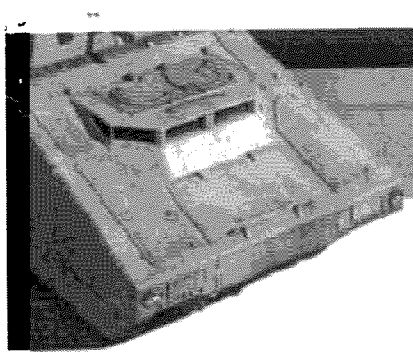


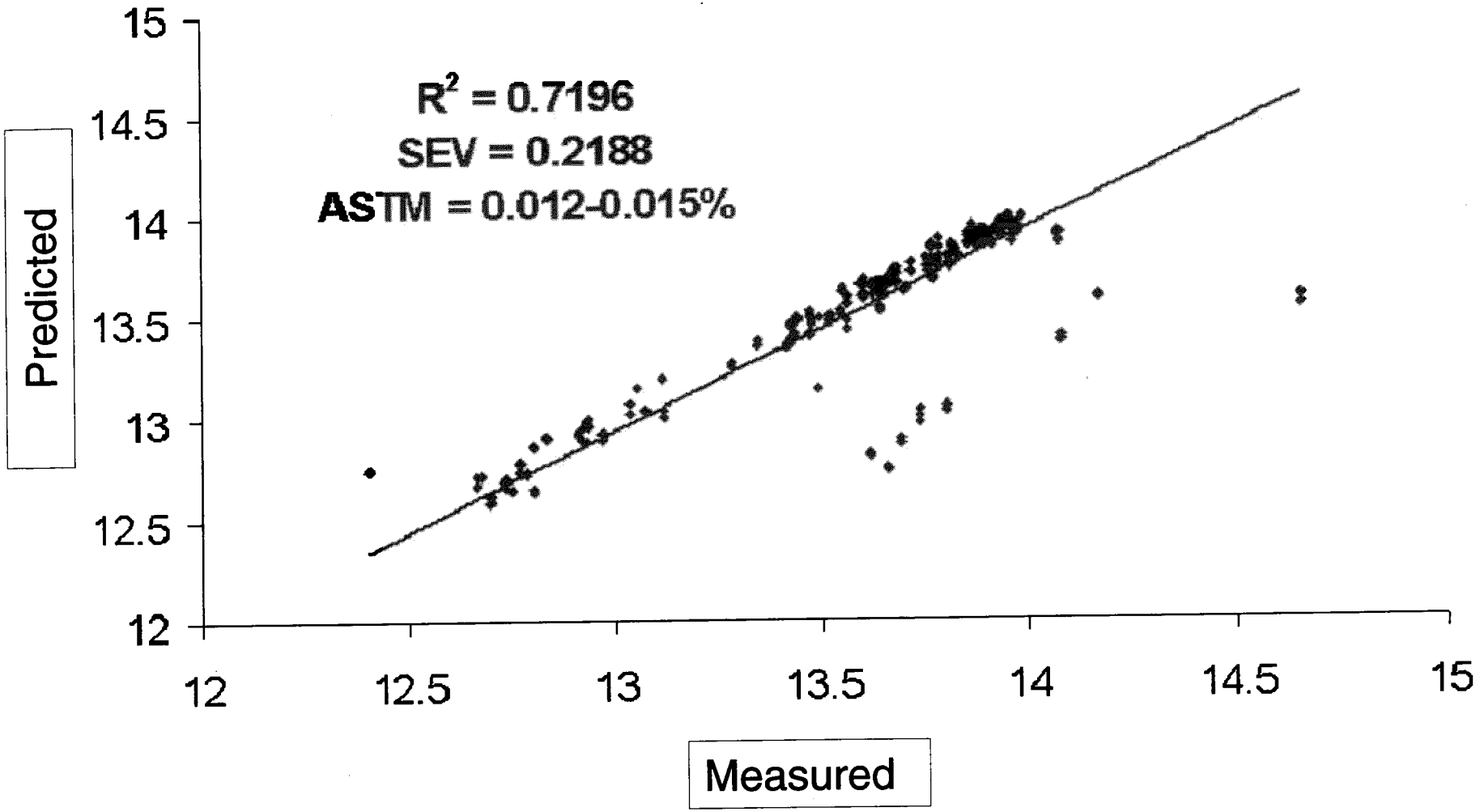


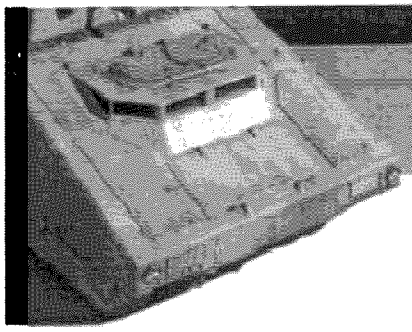
NET HEAT OF COMBUSTION



HYDROGEN CONTENT







TECHNICAL CHALLENGES

Obtaining fuels needed for modeling effort:

- Jet A
- Diesel 1
- JP-5
- Off Specification fuels (procuring or manufacturing)

Improve laboratory results for modeling

- Pour Point
- FSII detection