CHAPTER 5

RESULTS

According to the previous chapter, the results of S and Pb analysis are as follows:

5.1 Sample-Source-Detector Geometry

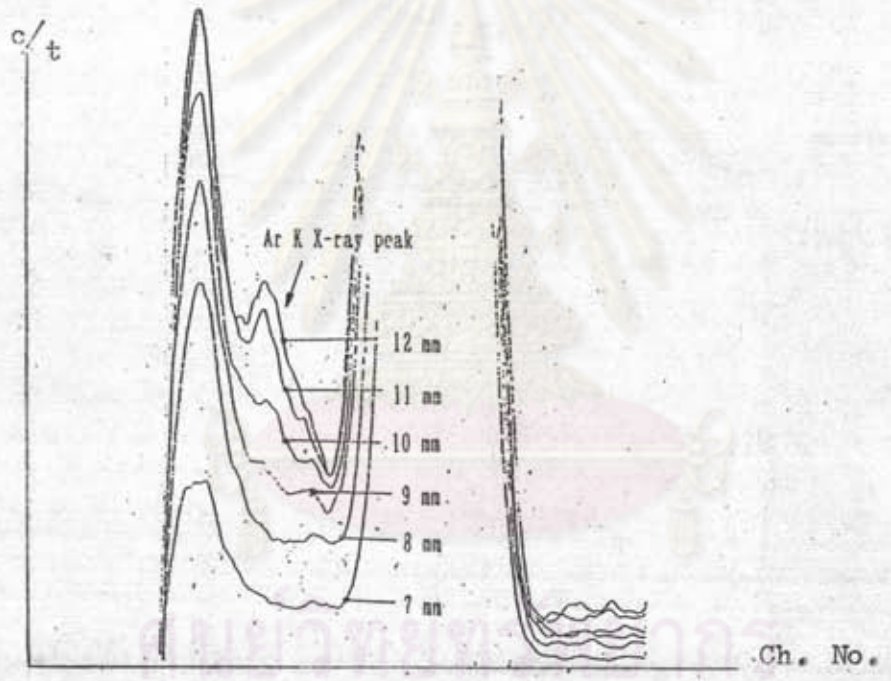


Fig. 5.1 The spectra of white oil with different source-to-sample distances from the MCA.

The graph in Fig. 5.1 shows that the acrylic cylindrical tube 9 mm. is appropriate to be used for the S analysis. The height of Fe-55 is 6.5 mm. and the appropriate cylindrical tube, covering the source, is 9 mm. high, therefore, the optimum distance is 2.5 mm.

5.2 Energy Calibration

Table 5.1 The relation between the fluorescent X-ray energy and the LLD level of the SCA.

Fluorescent X-ray	Energy (keV)	LLD	Peak count rate cps
S K X-rays	2.308	0.80	597
Ar K X-rays	2.957	1.10	302
Fe K X-rays	6.403	2.20	229
Ni K X-rays	7.477	2.65	317
Zn K X-rays	8.638	3.00	254
As K X-rays	10.543	3.65	376
Pb L X-rays	10.549	3.65	376
Pb L X-rays	12.611	4.15	263

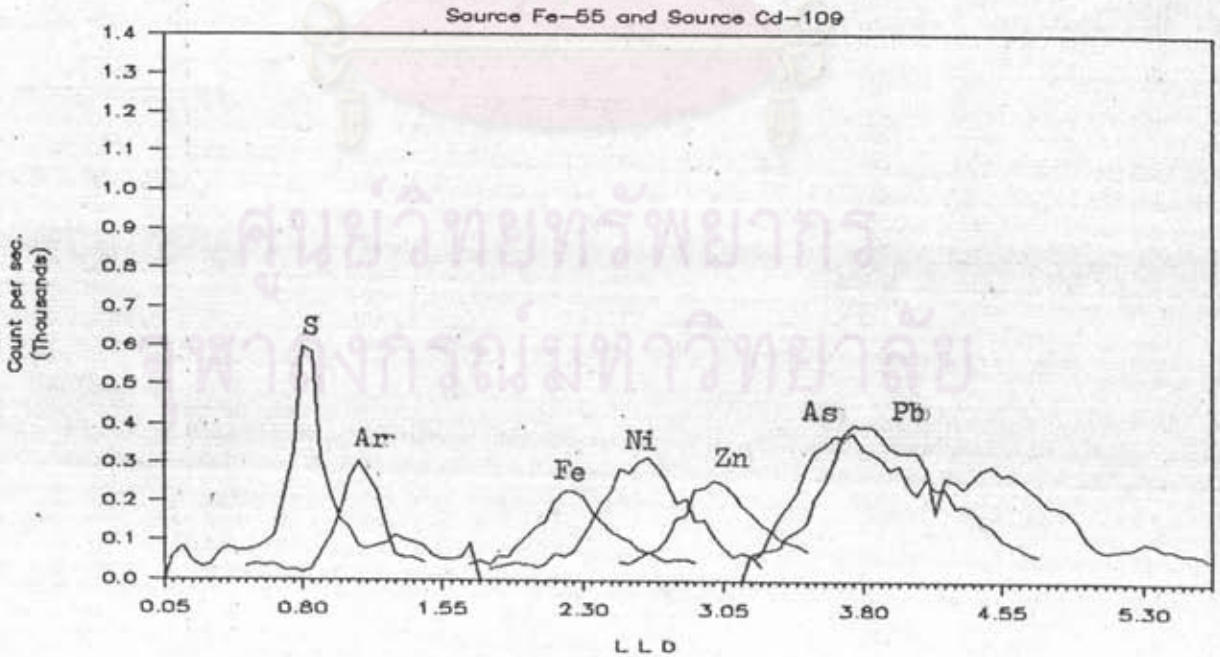


Fig. 5.2 X-ray fluorescence spectra of S, Ar, Fe, Ni, Zn, As and Pb obtained from the SCA.

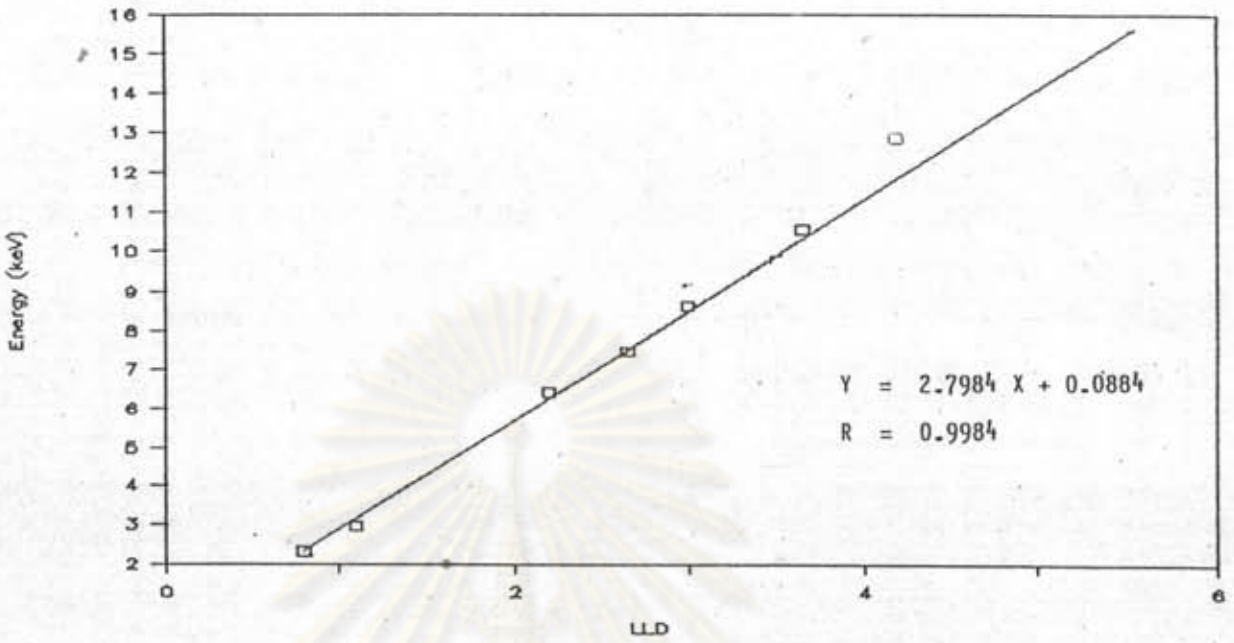


Fig. 5.3 Energy calibration curve of the SCA.

5.3 Sulfur Content in the Diesel Oils

Table 5.2 The relation between S content in the diesel oils and the count rate in 300 sec. using the SCA.

		Count rate in 300 sec.				S content
		1	2	3	average	% wt.
Standards	White oil (Blank)	2161	2148	2156	2155	0.20
	Standard No.1	2229	2240	2238	2235	0.50
	Standard No.2	2302	2290	2309	2300	0.75
	Standard No.3	2382	2372	2390	2381	1.05
Samples	Diesel oil No.1	2212	2200	2200	2204	0.385
	Diesel oil No.2	2250	2248	2262	2253	0.569
	Diesel oil No.3	2255	2243	2233	2243	0.532
	Diesel oil No.4	2205	2202	2195	2200	0.370

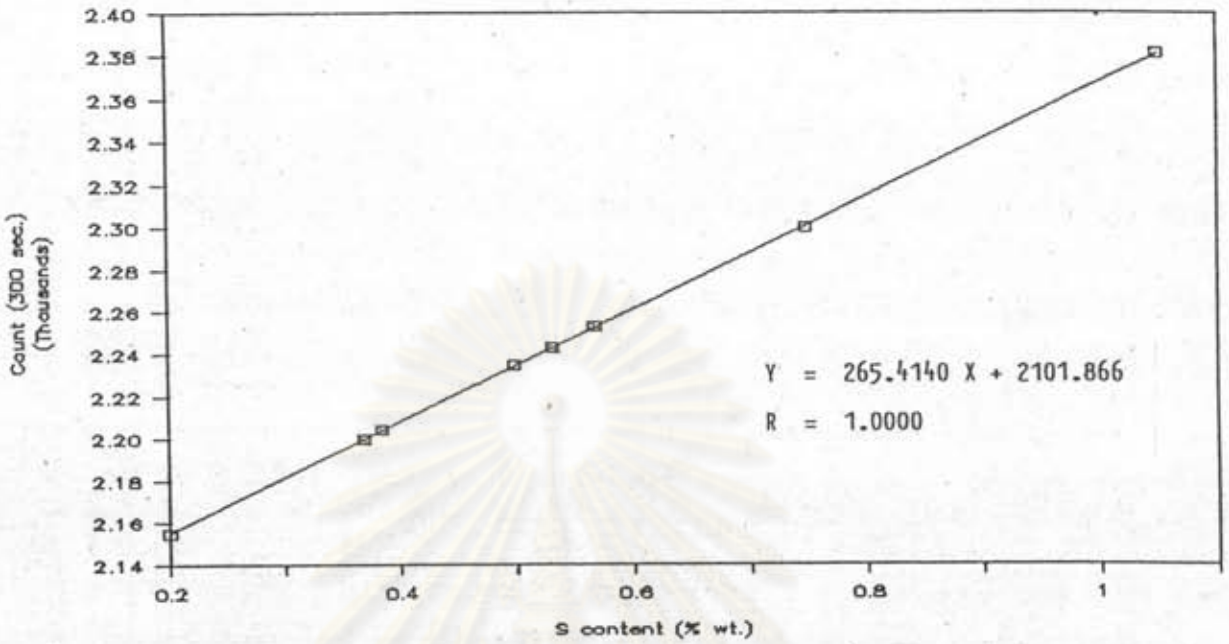


Fig. 5.4 The calibration curve showing the relation between the count rate in 300 sec. and S content in the diesel oils using the SCA.

Table 5.3 Comparison of S content in the diesel oils obtained from the SCA and the S and Pb analyzer.

Fuel oil samples	S content (% wt.)		% Deviation
	SCA	S and Pb analyzer	
Diesel oil No. 1	0.385	0.378	+1.852
Diesel oil No. 2	0.569	0.570	-0.175
Diesel oil No. 3	0.532	0.531	+0.188
Diesel oil No. 4	0.370	0.362	+2.210

5.3 Lead Content in the High Octane Gasolines

Table 5.4 The relation between Pb content in the high octane gasolines and the count rate in 300 sec. using the SCA.

		Count rate in 300 sec.				Pb content
		1	2	3	average	gm/l
Standards	Isooctane(Blank)	1203	1230	1205	1212	0
	Standard No.1	1266	1271	1259	1265	0.15
	Standard No.2	1346	1358	1344	1349	0.25
	Standard No.3	1366	1362	1370	1366	0.30
	Standard No.4	1410	1420	1422	1417	0.415
Samples	Gasoline No.1	1390	1395	1384	1389	0.353
	Gasoline No.2	1440	1440	1446	1442	0.455
	Gasoline No.3	1470	1468	1458	1465	0.499
	Gasoline No.4	1415	1409	1410	1411	0.395

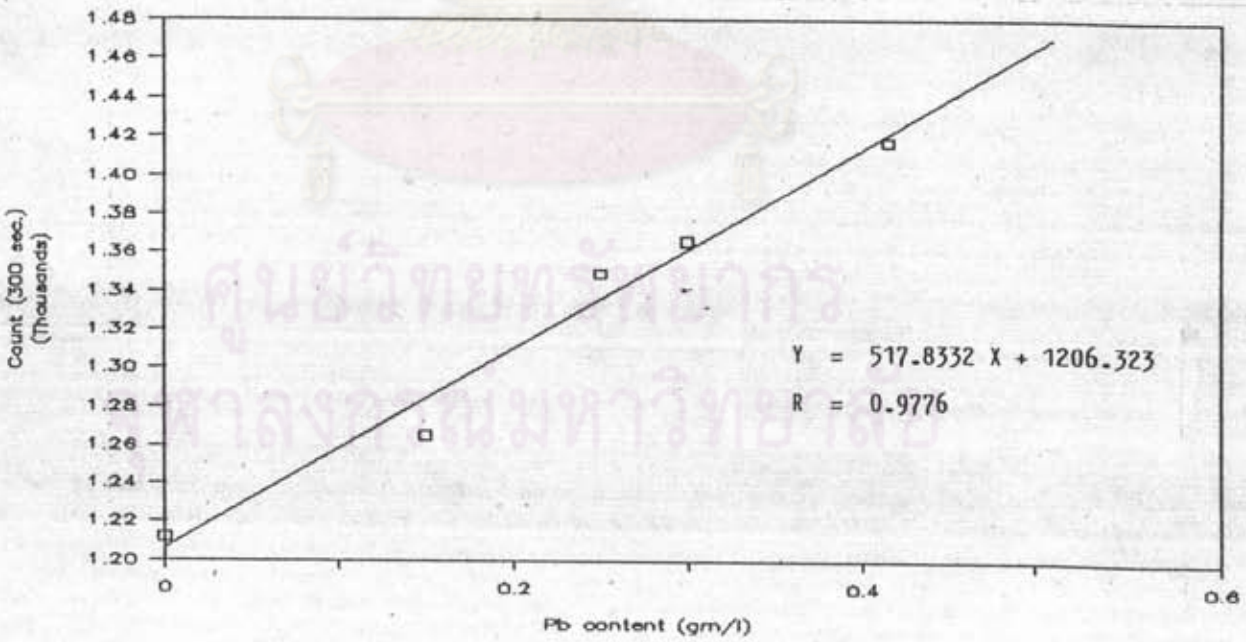


Fig. 5.5 The calibration curve showing the relation between count rate in 300 sec. and Pb content in the high octane gasolines using the SCA.

Table 5.5 Comparison of Pb content in the high octane gasolines obtained from the SCA and the S and Pb analyzer.

Fuel oil samples	Pb content (gm/l)		% Deviation
	SCA	S and Pb analyzer	
Gasoline No. 1	0.353	0.349	+1.146
Gasoline No. 2	0.455	0.451	+0.887
Gasoline No. 3	0.499	0.495	+0.808
Gasoline No. 4	0.395	0.391	+1.023

5.4 Two Channel Analyzer.

5.4.1 The linearity of HV.

Table 5.6 The relation between dial reading and high voltage output.

Dial reading	Voltage Output	Dial reading	Voltage Output
2.10	600	6.42	1600
2.70	700	6.84	1700
3.10	800	7.22	1800
3.50	900	7.65	1900
3.85	1000	8.06	2000
4.30	1100	8.53	2100
4.72	1200	8.98	2200
5.16	1300	9.42	2300
5.55	1400	9.80	2400
5.98	1500	10.00	2450

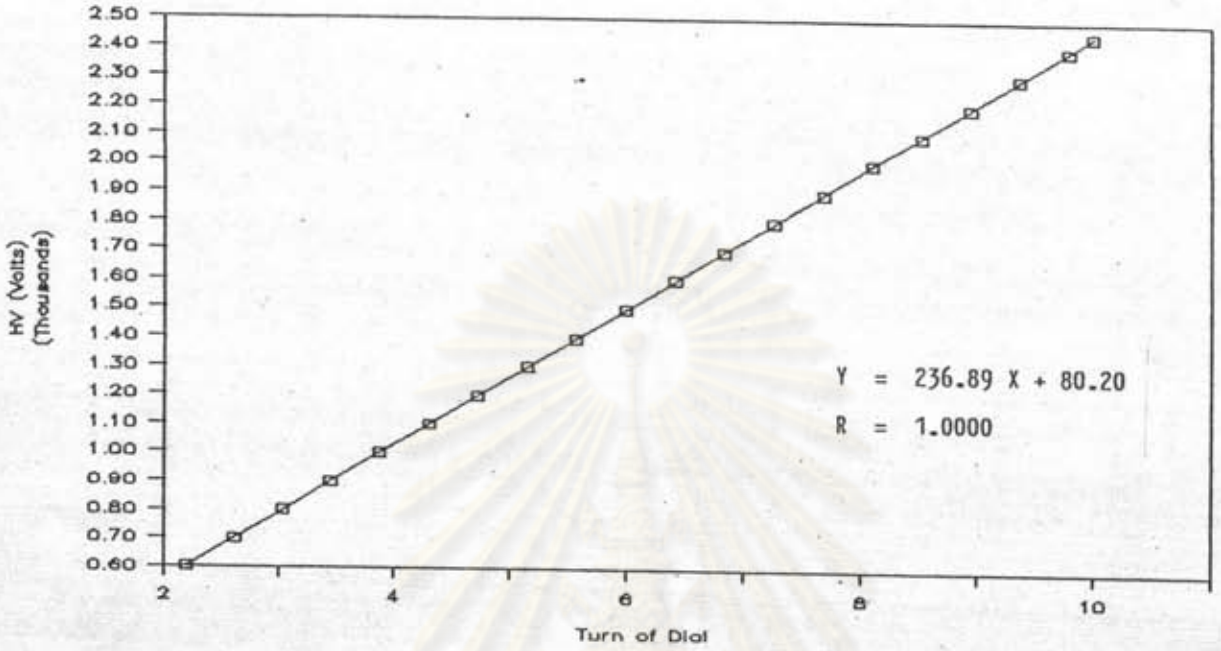


Fig. 5.6 The relation between dial reading and high voltage output.

5.4.2 Amplified Gain

Table 5.7 The stability of the amplifier gain.

Input pulse height	Output pulse height	Gain
0.30	2.0	6.67
0.45	3.0	6.67
0.60	4.0	6.67
0.75	5.0	6.67
0.90	6.0	6.67
1.05	7.0	6.67
1.21	8.0	6.61
1.36	9.0	6.62

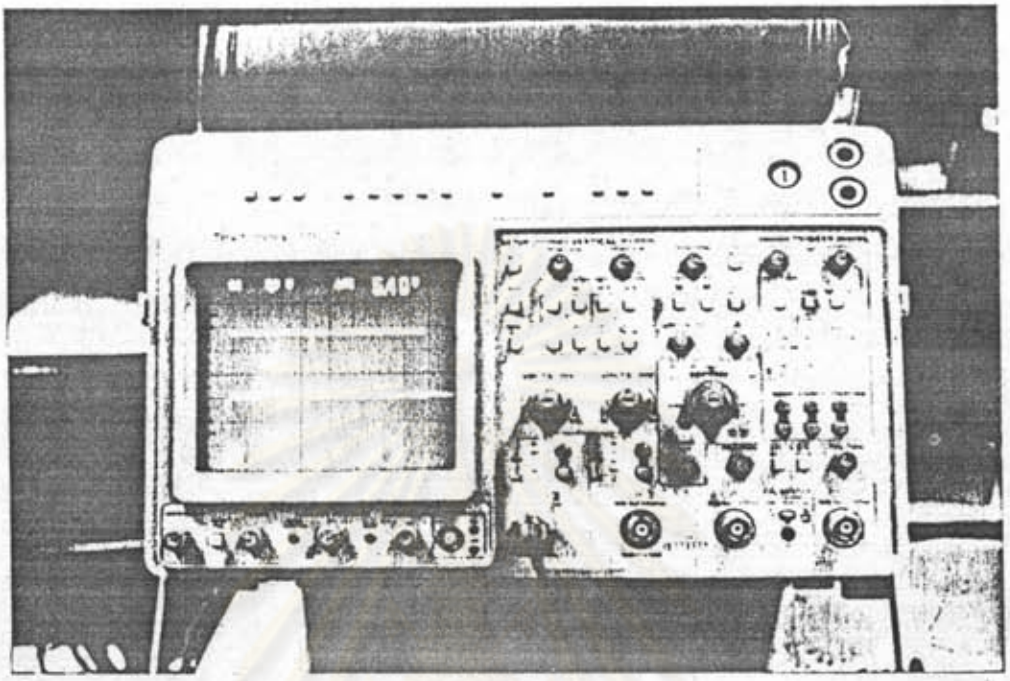
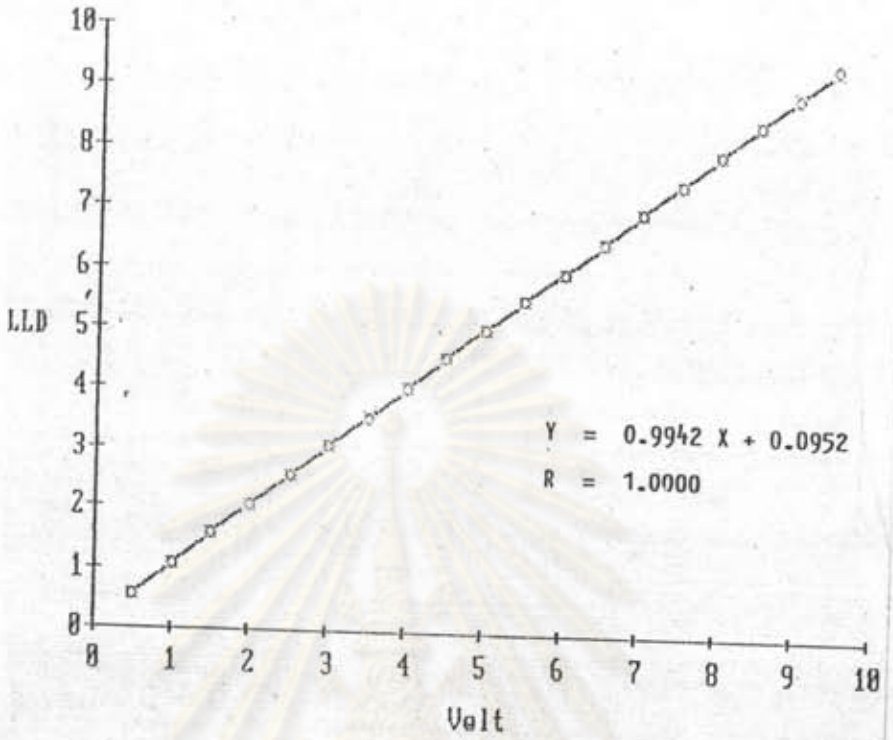


Fig. 5.7 Photograph of a Guassian shaping pulse from the amplifier seen from the oscilloscope.

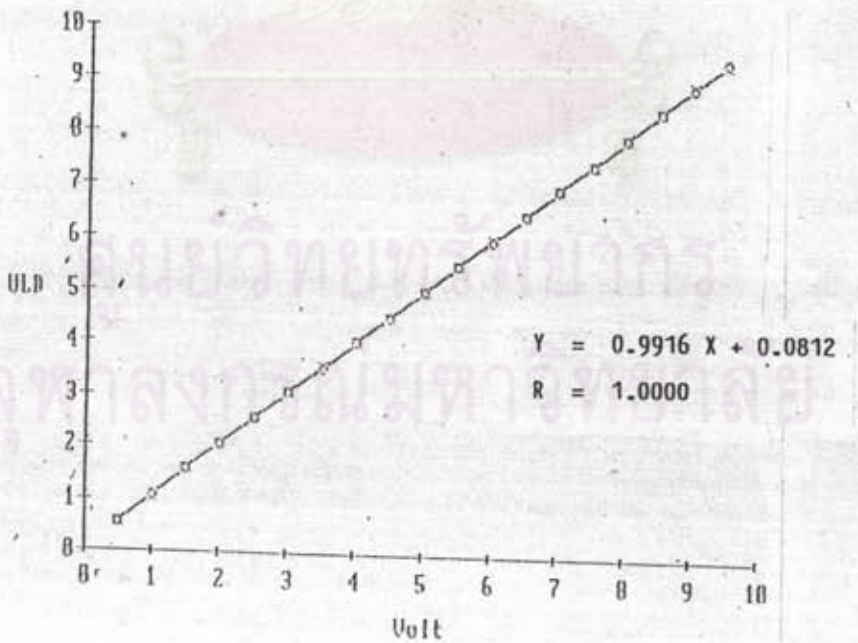
5.4.3 Linearity of Voltage Discriminators

Table 5.8 The relation between voltage from a pulser and voltage discriminator of the two channel analyzer.

Pulse height (Volt)	1st Channel		2nd Channel	
	LLD	ULD	LLD	ULD
0.50	0.58	0.56	0.55	0.56
1.00	1.08	1.05	1.04	1.06
1.50	1.56	1.56	1.56	1.56
2.00	2.08	2.06	2.06	2.06
2.50	2.58	2.56	2.56	2.56
3.00	3.08	3.06	3.06	3.06
3.50	3.58	3.58	3.56	3.56
4.00	4.08	4.05	4.04	4.04
4.50	4.58	4.56	4.53	4.54
5.00	5.08	5.05	5.04	5.04
5.50	5.58	5.54	5.54	5.54
6.00	6.08	6.04	6.03	6.02
6.50	6.58	6.54	6.52	6.52
7.00	7.06	7.03	7.02	7.01
7.50	7.56	7.52	7.50	7.50
8.00	8.05	8.02	8.00	8.00
8.50	8.55	8.51	8.50	8.50
9.00	9.04	9.01	9.00	9.00
9.50	9.48	9.45	9.46	9.44

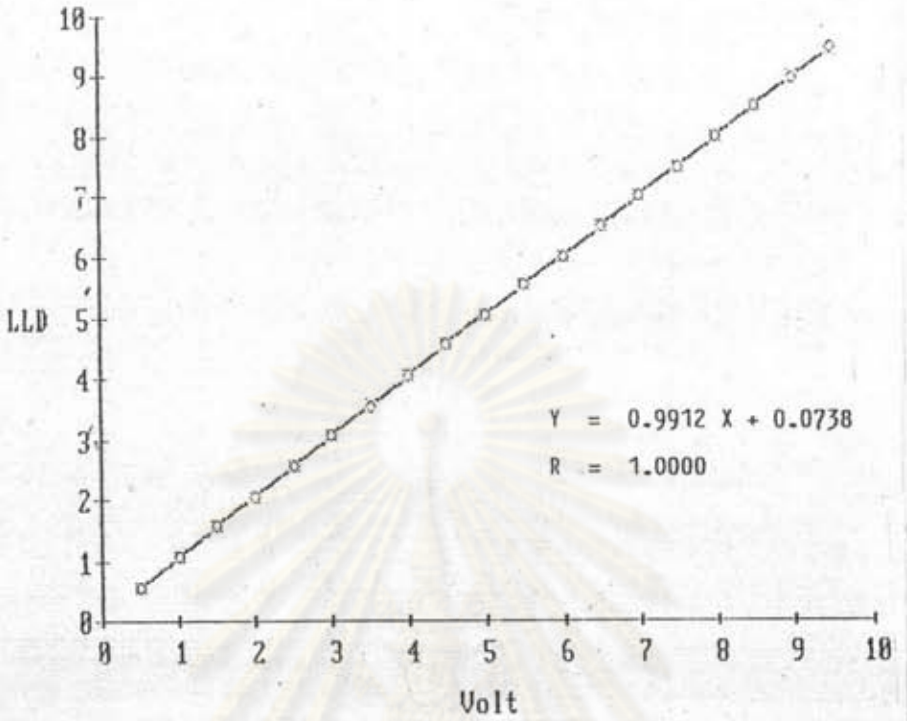


(a) LLD of 1st channel

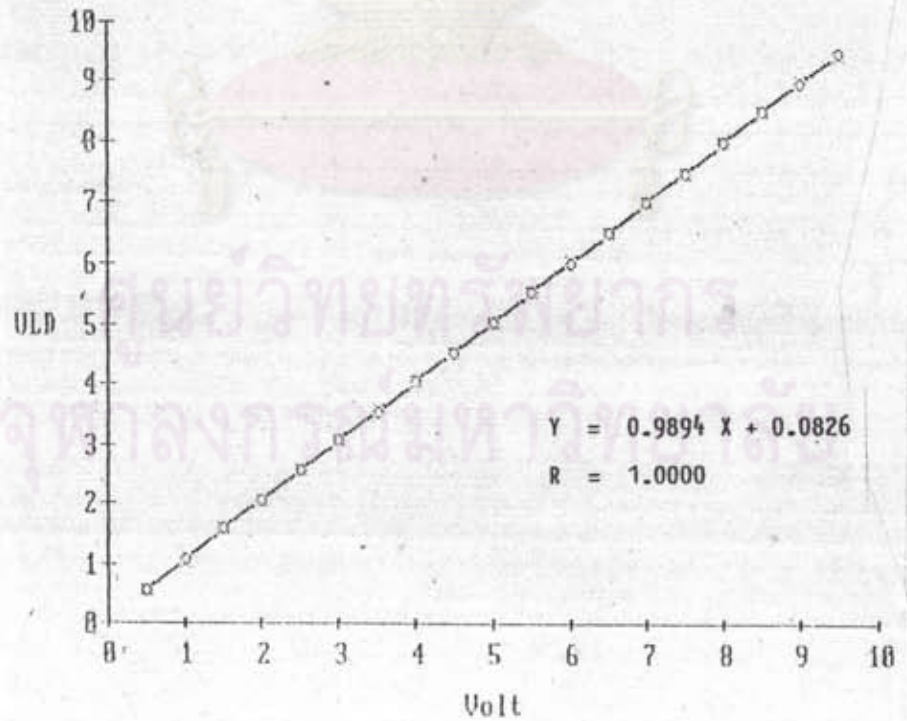


(b) ULD of 1st channel

Fig. 5.8 The linearity of the voltage discriminators.



(c) LLD in 2nd channel



(d) ULD in 2nd channel

Fig. 5.8 (continued)

5.4.4 Energy Calibration of the Two Channel Analyzer.

Table 5.9 The relation between the fluorescent X-ray energy and the LLD level of the two channel analyzer.

Fluorescent X-ray	Energy (keV)	LLD	Peak count rate cps
S X-rays	2.308	0.50	1,229
Ar X-rays	2.957	0.65	520
Fe X-rays	6.403	1.55	570
Ni X-rays	7.477	1.85	656
Zn X-rays	8.638	2.15	593
As X-rays	10.543	2.65	643
Pb L-rays	10.549	2.65	638
Pb L-rays	12.611	3.20	402

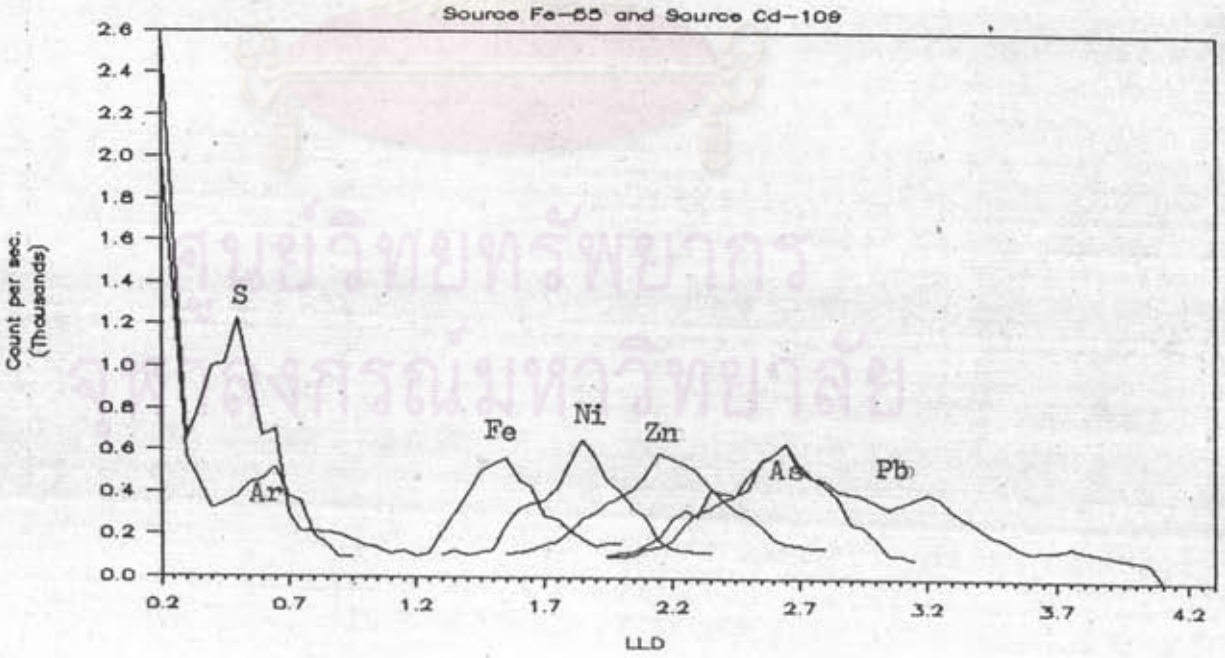


Fig. 5.9 X-ray fluorescence spectra of S, Ar, Fe, Ni, Zn, As and Pb obtained from the two channel analyzer.

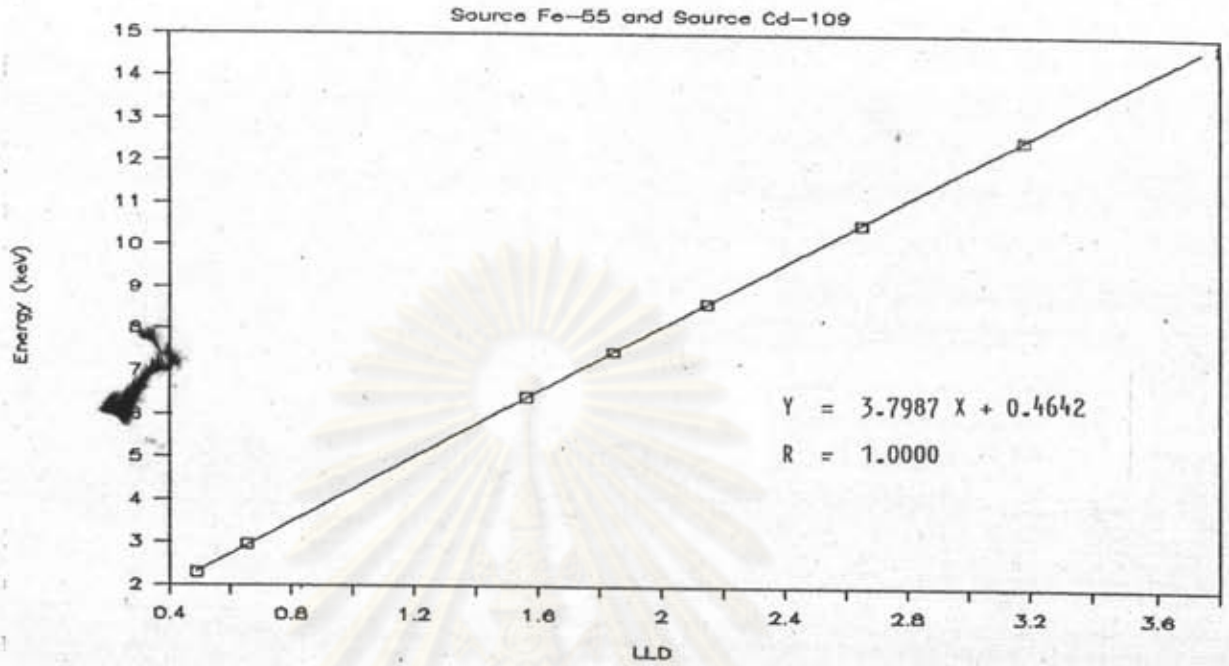


Fig. 5.10 Energy calibration curve of two channel analyzer.

5.4.5 S and Pb Analysis with the Two Channel Analyzer.

Table 5.10 The relation between S content in the diesel oils and the count rate in 300 sec. using the two channel analyzer.

		Count rate in 300 sec.						S content
		1	2	3	4	5	average	% wt.
Standards	White oil (Blank)	6982	6944	6931	6952	6933	6948	0.20
	Standard No. 1	7330	7284	7353	7291	7292	7289	0.50
	Standard No. 2	7583	7583	7561	7569	7572	7573	0.75
	Standard No. 3	7909	7921	7889	7918	7913	7931	1.05
Samples	Diesel oil No. 1	7102	7131	7111	7129	7099	7114	0.345
	Diesel oil No. 2	7389	7351	7375	73704	7375	7372	0.571
	Diesel oil No. 3	7339	7388	7334	7343	7368	7354	0.556
	Diesel oil No. 4	7228	7141	7186	7197	7170	7184	0.406

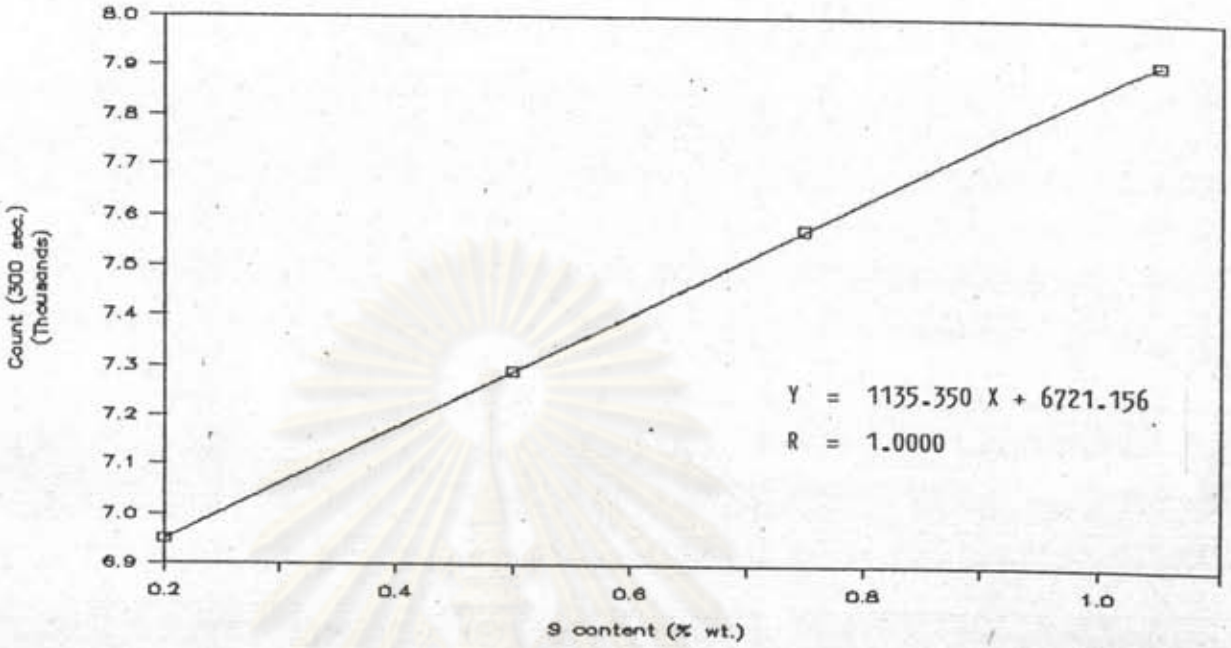


Fig. 5.11 The calibration curve showing the relation between the count rate in 300 sec. and S content in the diesel oils using the two channel analyzer.

Table 5.11 Comparison of S content in the diesel oils obtained from the two channel analyzer and the S and Pb analyzer.

Fuel oil samples	S content (% wt.)		% Deviation
	Two channel analyzer	S and Pb analyzer	
Diesel No. 1	0.345	0.378	-8.73
Diesel No. 2	0.571	0.570	+0.17
Diesel No. 3	0.556	0.531	+4.70
Diesel No. 4	0.406	0.362	+12.15

Table 5.12 The relation between Pb content in the high octane gasolines and the count rate in 300 sec. using the two channel analyzer.

		Count rate in 300 sec.						Pb content
		1	2	3	4	5	average	gm/l
Standards	Isooctane (Blank)	7707	7713	7717	7702	7711	7710	0.00
	Standard No. 1	7853	7864	7902	7897	7905	7884	0.15
	Standard No. 2	8031	8027	8014	8009	8019	8020	0.25
	Standard No. 3	8043	8057	8113	8101	8093	8081	0.30
	Standard No. 4	8215	8236	8225	8241	8222	8228	0.415
Samples	Gasoline No. 1	8058	8068	8111	8069	8078	8077	0.296
	Gasoline No. 2	8270	8256	8319	8285	8277	8281	0.459
	Gasoline No. 3	8378	8341	8356	8331	8343	8350	0.514
	Gasoline No. 4	8186	8183	8163	8155	8196	8177	0.376

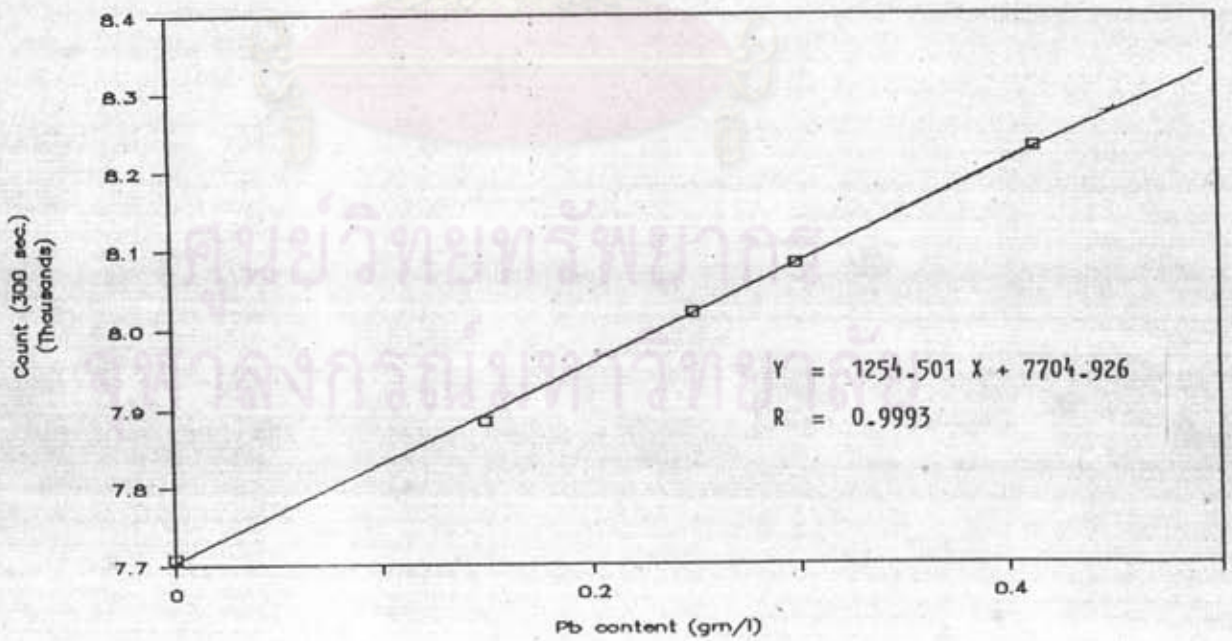


Fig. 5.12 The calibration curve showing the relation between the count rate in 300 sec. and Pb content in the high octane gasolines using the two channel analyzer.

Table 5.13 Comparison of Pb content in the high octane gasolines obtained from the two channel analyzer and the S and Pb analyzer.

Fuel oil samples	Pb content (gm/l)		% Deviation
	Two channel analyzer	S and Pb analyzer	
Gasoline No. 1	0.296	0.349	-15.18
Gasoline No. 2	0.459	0.451	+1.77
Gasoline No. 3	0.514	0.495	+3.83
Gasoline No. 4	0.376	0.391	+3.83

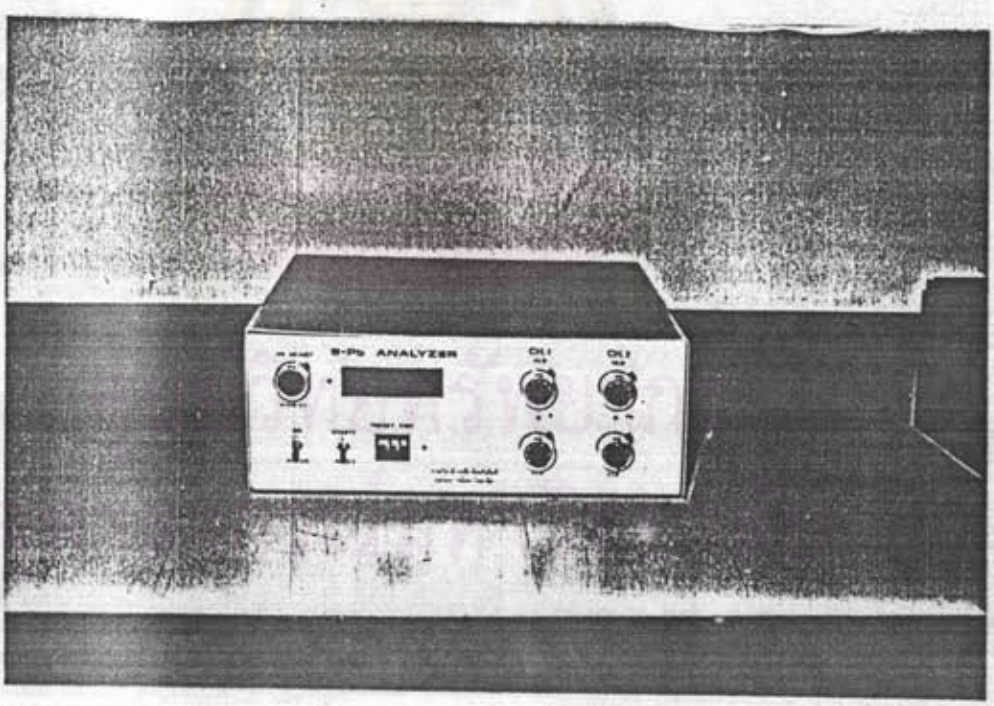


Fig. 5.13 Photograph shows two channel analyzer.