REFERENCES

Battlele Seattle Research Center.1996.What are waste minimization and pollution prevention [Online], Available from : http://www.seattle.battelle.org/services/e&s/P2LabMan/ch02.htm

Chuaykul R. 1998. Fluidized Bed Combustion of Sludge Mixing with Waste Lubricating Oil. Master Thesis King Mongkut University of Technology Thonburi, Environmental Technology Department.

Environmental Assistant Division,Vermont of Natural Resource.2002. Used oil [Online], Available from : http://www.anr.state.vt.us/dec/ead/eadhome/PDF%20Files/FSSalvage/FS_UsedOil.pdf

Environmental Health and Safety,University of Maryland. (n.d.).Waste minimization and Pollution prevention plan[Online], Available from: http://www.ehs.umaryland.edu/Waste/pollutio.htm

Environmental Regulations and Technology Managing Used Motor Oil. EPA/625/R-94/010 December 1994.

European Environment Agency. Waste oil [Online]. Available from: http://glossary.eea.eu.int/EEAGlossary/W/waste_oil

Graziano, D.J. and Daniels, E.J. New approaches to waste oil reduction and reuse. 1996.Journal of Solid Waste Technology and Management 23,2 (May): 84-96.

International Iron and Steel Institute.2002. The Steel Industry [Online], Available from : http://www.natural-resources.org/minerals/generalforum/docs/pdfs/UNEP%20WSSD%20Sector%20Report%20-%20Steel.pdf

Iron and Steel Institute of Thailand.2002. Technical Information : Colf Rolling of Flat Products [Online], Available from : http://www.isit.or.th/techinfoview.asp?lnk=/object/1000000000/ColdRollingofFlatProducts.htm&ContentID=214&CatID=1000000000

Iron and Steel Institute of Thailand.2002. Technical Information : Hot Rolling of Flat Products [Online], Available from : http://www.isit.or.th/techinfoview.asp?lnk=/object/1000000000/HotRollingofFlatProducts.htm&ContentID=212&CatID=1000000000

John R. Dean. (n.d.).Extraction methods for environmental analysis: University of Northumbria at Newcastle.Chichester, Wste Sussex, UK. John Wiley&Sons,.

Krissana,Marubeni (Thailand) co.,th. Sales Manager. Interview,21 June 2002.

Khumkeaw C. 1997. The situation and problems of Used Lubricating Oil in Thailand and the Assessment for Appropriate Treatment Technologies. Master Thesis King Mongkut University of Technology Thonburi, Environmental Technology Department.

Moliner, R Lazaro, M and Suelves, I. 1997."Valorization of Lube Oil Waste by Pyrolysis". Energy Fuels, 11,6 : 1165-1170.

Montana State University, Pollution prevention program. Hazardous waste management.2001: A reference for small businesses [Online], Available from : http://www.montana.edu/~wwwated/hazwaste.htm

Muller Associates, Inc.1989. Waste oil: Reclaiming Technology, Utilization and Disposal. New Jersey: Noyesdata coperatuion.

Nitchapanit P. 1996. Waste Lube Oil Collection Systems in Thailand: A Case Study in Bangkok Metropolitan Areas. Thesis Master Thesis Asian Institute of Technology, School of Environment, Resources and Development, Bangkok, Thailand.

Peter K., Markus L., and Peter K.2001 . The new wave in laboratory analysis: Time and cost-saving solutions with microwave technology. American Laboratory News [Online]. Available from : http://www.iscpubs.com/articles/aln/n0102ket.pdf

Steven E. Frazier,Virginia Department of Environmental Quality.2001. Waste management [Online], Available from : http://www.deq.state.va.us/waste/hazardous5.html

U. S. Department of Commerce.2000.Thailand:The Steel Industry [Online], Available from : http://www.tradeport.org/ts/countries/thailand/mrr/mark0075.html

U.S Department of Energy, Office of Industrial Technologies.1998.Steel Technology Roadmap : Iron Unit Recycling [Online], Available from : http://www.oit.doe.gov/steel/pdfs/chap_3_final.pdf

Wilson Bill. Used oil reclamation processes. Industrial Lubrication and Tribology. 49,4 (July/August 1997) : 178-180.

ต้นฉบับ หน้าขาดหาย

APPENDIX A

Sample Appearances

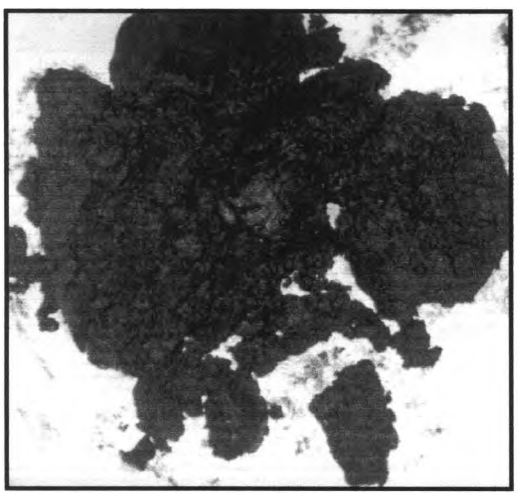

Figure Appendix A-1 SSI's sludge

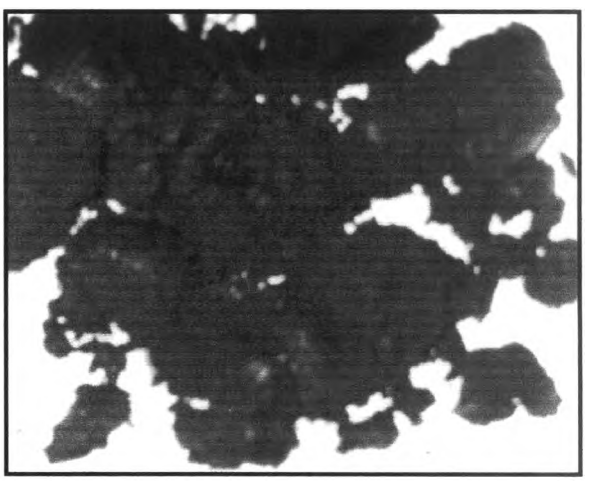

Figure Appendix A-2 SSM's sludge

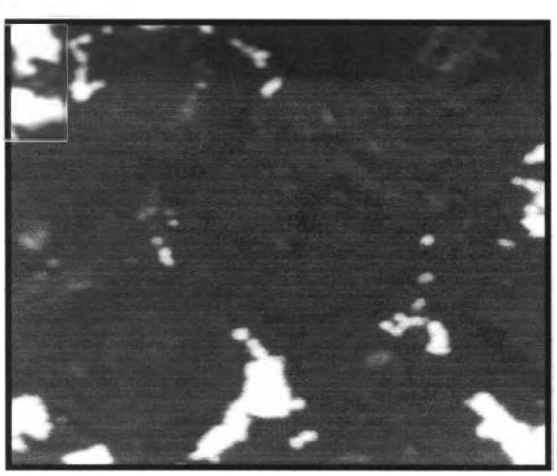

Figure Appendix A-3 TCRSS's sludge

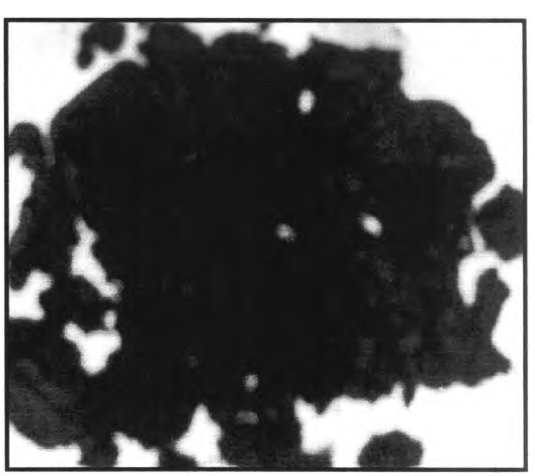

Figure Appendix A-4 SUS's sludge

APPENDIX B

Experimental Procedure

1. Moisture content of sample

1. Weigh empty dried evaporation dish (already dry in oven) and sample (50 g.)
2. Dry the sample in drying oven at 105 c for 24 hr. (over night)
3. Weigh the sample again
4. Calculate % moisture content of sample as follow:-

$$\% \text{ moisture content} = \frac{\text{Weigh of dry sample}}{\text{Weigh of sample}} * 100$$

5.Analyze 2 portions.

2. Sample preparation and Microwave extraction

1. Samples are prepared for extraction by air-drying for 48 hr. and grinding to a powder with mortar and screen 20 mesh and loaded into the extraction vessel.
1. Weight the empty extraction vessel and containing the sample.(1 g.)
2. Immediately after weighing the sample for extraction, weigh 5-10 g. sample of dried evaporation dish and take it into drying oven overnight at 105 c. Allow to cool in dessicator before re-weighing (% Moisture is calculated as 3.4.1)
3. The considered solvent system is added 30 ml. to the vessel , fill the magnetic stirrer (in case of non-polarity solvent using, the black magnetic is used. In the other hand, the white solvent is filled) and sealed. (There are 4 types - Acetone , Acetone+Hexane (1:1 v/v), N-Hexane and Petroleum Ether)
4. Set extraction temperature programs and extracted each condition.(see in figure 3-1)
4. After extraction stop. The mixture is allowed to cool in water bath. The vessel is opened and the contents are filtered.
5. Take filtered paper (whatman no.43) into drying oven for 2 hr. and cool it in dessicator. Weigh the filter paper.
7. Filter the content and then the solid material is rinsed 3 times with extracted solvent.
8. Solid part, evaporate the solvent from the solid material and filtered paper in drying oven (85 C) for 2 hr. , cool it in dessicator and weigh it.

9. Liquid part, evaporate the solvent with setting in hood for overnight and weigh it. (Have to make sure that the solvent have no more)
10. Quality control - Method blank should be done in every condition.

Table B-1 Experimental Condition of Microwave Extraction

Microwave Temperature Program	Solvent Type			
	Acetone	N-Hexane	Acetone + N-Hexane	Petroleum Ether
90 C	√	√	√	√
120 C	√	√	√	√
150 C	√	√	√	-

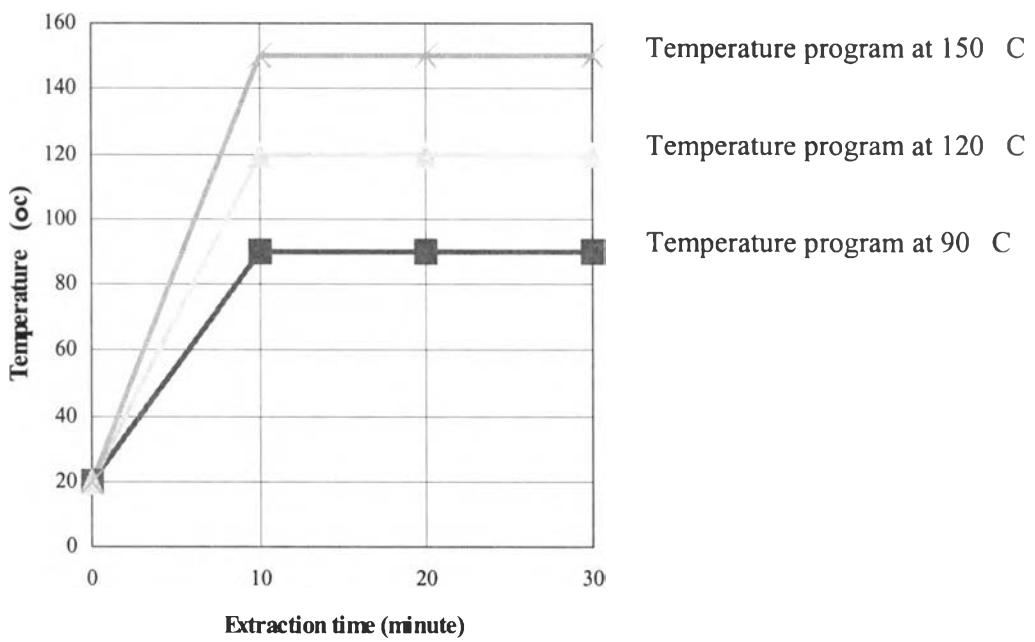

Figure B-1 Temperature profile with times during experimental extraction of each controlled temperature programming

3. Determining fine iron oxide property (%Fe)

1. Contain solid from extraction will be sample for X-ray fluorescence Spectrophotometer (XRF).
2. Fill the sample (5-10 g.) in pellet and press it.
3. Tray the pellet and start the XRF-spectrophotometer.
4. Result will be calculated and interpreted automatically from by software program.

4. Determining oil property for being secondary fuel in cement kiln.

4.1 Heating value

1. Weight of sample 1 g. (± 0.0001 g). If the sample weight is less than 1 g., the benzoic acid fills to be binder. Total weight of sample and benzoic acid was 1 g. and fill to the cup.
2. Add 1.0 ml. Of water to the bomb from a pipet.
3. Insert the firing wire (known length) to ignition terminal. The wire has to touch the sample. If the wire did not touch, bind the wire with thread that contacts the sample.
4. Charge the bomb with oxygen to 30 atm.
5. Adjust the calorimeter water temperature below room temperature 1-1.4 C but does not less than 20 C. (The initial adjustment would ensure a final temperature slightly above that of the jacket for calorimeters having an energy equivalent of approximately 10.2 kJ/ C . some operators prefer a lower initial temperature so that the final temperature is slightly below that of the jacket. This procedure is acceptable, provided it is used in all tests, including standardization.)
6. Use the same amount (± 0.5 g) of distilled water in the calorimeter vessel for each test for 2000 ml of calorimeter.
7. Assemble the calorimeter in the jacket and start the stirrers. Adjust the jacket temperature to be equal to or slightly lower than the calorimeter, and run for 5 min. to obtain equilibrium. Adjust the jacket temperature to match the calorimeter within ± 0.01 C and hold for 3 min. Record the initial temperature.
8. Fire the charge
9. Adjust the jacket temperature to match that of the calorimeter during the period of rise, keeping the two temperatures as nearly equal as possible during the rapid rise, and adjusting to within ±0.01 C when approaching the final equilibrium

temperature. Take calorimeter readings at 1-min intervals until the remain same temperature. Record the as the final temperature.

10. Remove the bomb and release the pressure at a uniform rate.
11. Wash the interior of the bomb, including the electrodes and sample holder, with a fine jet of water and quantitatively collect the washings in a beaker. Use a minimum of wash water, preferably less than 200 ml.
12. Pour it in the beaker and warm at water bath and titrate with standard alkali solution to fine acid value.
13. Measure the combined pieces of unburned firing wire, and subtract from the original length. Record the difference as wire consumed.
14. Calculation of heating value :- (In actually, the software will automatically calculate)

$$W = \frac{G * Q + \sum R}{\Delta T}$$

$$H.V = \frac{W * \Delta T - \sum R}{G}$$

Where:

W	=	Water equivalent
G	=	Benzoic acid and sample weight (g)
Q	=	Calorific value of benzoic acid (cal/g)
R	=	Correction heat
ΔT	=	Final temperature – Initial temperature
H.V	=	Heating value of sample

4.2 Sulfur content (Bomb washing method)

1. After analyze heating value with bomb calorimeter until titrate with standard alkali solution, divided solution to two part (100 ml./bottle) for sulfur and chloride content.

2. Boil the solution and remain about 75 ml. And add Hydrochloric acid (1:9 v/v) 1 ml.
3. Filter with filter paper no. 40 (whatman) and add 10% BaCl2 in filtrate.
4. Precipitate will be generated. Filter the supernatant liquid through an ashless, quantitative filter paper (whatman no.40). Wash the precipitate with warm water until free of chloride. (Check with silver nitrate)
5. Transfer the paper and precipitate to a weighed crucible and dry at a low heat until the moisture has evaporated.
6. Char the paper completely without igniting it, and finally ignite at a bright red heat in muffle furnace at 950 C until the residue is white in color and remain still weight.
7. After ignition is complete, allow the crucible to cool in desiccator and weigh.
8. Make a blank determination.
9. Calculate the sulfur content of the sample as follows :-

$$\% \text{ Sulfur content} = \frac{(P - B) * 13.73}{W}$$

Where:

P = grams of BaSO4 obtained from sample,
B = grams of BaSO4 obtained from blank, and
W = grams of sample used.

4.3 Chloride content

1. Another solution bottle that was from dividing solution after analyzed heating value to two parts (100 ml./bottle) for sulfur and chloride content.
2. Add Potassium Chlomate 1 ml. in sample.
3. Titrate sample with standard silver nitrate solution until the solution change to orange color.
4. Record volume of silver nitrate solution.
5. Make a blank determination.
6. Calculate chloride content of the sample as follows:-

$$\% \text{ Chloride content} = \frac{(A - B) * N * 35.45 * 1000}{C}$$

Where :

A = volume of silver nitrate in titration from sample (ml)

B = volume of silver nitrate in titration from blank (ml)

N = concentration of standard silver nitrate solution (N)

C = volume of water sample (ml)

4.4 Heavy metal content

1. Sample preparation by microwave digestion.
2. Insert the sample solution to inject by ICP – AES

APPENDIX C

Extracted oil content (%w/w at Temp. program : 90 °c)

Sample	Solvent	Vessel W (g)	Vessel+ sample W. (g)	Sample W. (g)	Magnetic stirrer W.(g)	vessel+ sample+ magnetic W.(g)	residual sample W (g)	dish W.(g)	dish+filter paper+ sample W.(g)	filter paper W.(g)	Remained sample W.(g)	Total remained sample W.(g)	Oil W.(g)	% oil	% oil-blank
SSI no.1	Acetone	116.2033	117.2223	1.0190	24.7950	141.8851	0.8868	161.1217	161.3460	0.1679	0.0564	0.9432	0.0758	7.44	7.31
TCRSS no.1	Acetone	116.3418	117.3510	1.0092	2.2806	119.5457	0.9233	167.9673	168.1591	0.1625	0.0293	0.9526	0.0566	5.61	5.48
SSM no.1	Acetone	116.3178	117.3106	0.9928	2.2581	119.3704	0.7945	167.0669	167.2877	0.1627	0.0581	0.8526	0.1402	14.12	13.99
SUS no.1	Acetone	116.4677	117.4865	1.0188	2.3009	119.3196	0.551	158.6941	158.8716	0.1588	0.0187	0.5697	0.4491	44.08	43.95
SSI no.1	Acetone+Hexane	116.4931	117.4674	0.9743	2.3314	119.6931	0.8686	0	0.195	0.1646	0.0304	0.899	0.0753	7.73	7.75
TCRSS no.1	Acetone+Hexane	116.3334	117.3080	0.9746	2.2938	119.2308	0.6036	142.647	143.1127	0.1617	0.3040	0.9076	0.067	6.87	6.90
SSM no.1	Acetone+Hexane	116.2203	117.2566	1.0363	2.2536	118.524	0.0501	167.9673	168.9466	0.1556	0.8237	0.8738	0.1625	15.68	15.70
SUS no.1	Acetone+Hexane	116.2693	117.2640	0.9947	2.2744	118.5507	0.0070	164.0669	164.3718	0.1577	0.1472	0.1542	0.8405	84.50	84.52
SSI no.1	N-Hexane	116.3683	117.3867	1.0184	6.5209	123.8161	0.9269	0	0.1549	0.1524	0.0025	0.9294	0.089	8.74	8.60
TCRSS no.1	N-Hexane	116.3413	117.3689	1.0276	6.4787	123.7882	0.9682	0	0.1646	0.1602	0.0044	0.9726	0.055	5.35	5.22
SSM no.1	N-Hexane	116.6971	117.6392	0.9421	6.4286	123.3745	0.2488	161.1217	161.8543	0.1599	0.5727	0.8215	0.1206	12.80	12.65
SUS no.1	N-Hexane	116.2726	117.2386	0.9660	6.6559	122.9380	0.0095	158.6941	158.9932	0.1599	0.1392	0.1487	0.8173	84.61	84.46
SSI no.1	Petroleum ether	116.2148	117.2203	1.0055	6.3570	123.4773	0.9055	0	0.1688	0.1635	0.0053	0.9108	0.0947	9.42	10.41
TCRSS no.1	Petroleum ether	116.5944	117.5792	0.9848	6.4847	124.0184	0.9393	0	0.1723	0.1656	0.0067	0.946	0.0388	3.94	4.96
SSM no.1	Petroleum ether	116.5136	117.5324	1.0188	6.4882	123.8557	0.8539	0	0.1773	0.1539	0.0234	0.8773	0.1415	13.89	14.87
SUS no.1	Petroleum ether	116.5526	117.5681	1.0155	6.6496	123.3914	0.1892	0	0.4488	0.1613	0.2875	0.4767	0.5388	53.06	54.04
SSI no.2	Acetone	116.5114	117.5113	0.9999	2.2812	118.8868	0.0942	158.4358	159.4543	0.1639	0.8546	0.9488	0.0511	5.11	4.98
TCRSS no.2	Acetone	116.5880	117.5949	1.0069	2.2793	119.6104	0.7431	184.882	185.2464	0.1514	0.213	0.9561	0.0508	5.05	4.92
SSM no.2	Acetone	116.2675	117.2680	1.0005	2.2735	119.3866	0.8456	0	0.1931	0.1662	0.0269	0.8725	0.128	12.79	12.66
SUS no.2	Acetone	116.5517	117.5522	1.0005	2.2845	119.3971	0.5609	170.9956	171.1711	0.1492	0.0263	0.5872	0.4133	41.31	41.18
SSI no.2	Acetone+Hexane	116.2643	117.2634	0.9991	2.2781	119.4335	0.8911	0	0.1769	0.1548	0.0221	0.9132	0.0859	8.60	8.62
TCRSS no.2	Acetone+Hexane	116.5629	117.5867	1.0238	2.4067	119.5228	0.5532	184.8820	185.4214	0.1596	0.3798	0.933	0.0908	8.87	8.89
SSM no.2	Acetone+Hexane	116.6968	117.6883	0.9915	2.2807	119.7518	0.7743	0	0.2113	0.1602	0.0511	0.8254	0.1661	16.75	16.77
SUS no.2	Acetone+Hexane	116.9396	117.9159	0.9763	2.2845	119.2462	0.0221	158.4358	158.7234	0.1584	0.1292	0.1513	0.825	84.50	84.52
SSI no.2	Hexane	116.5421	117.5178	0.9757	6.5157	123.9416	0.8838	0	0.1627	0.1599	0.0028	0.8866	0.0891	9.13	8.99
TCRSS no.2	Hexane	116.6038	117.5609	0.9571	6.4187	123.9018	0.8793	0	0.1670	0.1599	0.0071	0.8864	0.0707	7.39	7.24
SSM no.2	Hexane	116.2745	117.2286	0.9541	6.3501	123.4098	0.7852	0	0.1870	0.1651	0.0219	0.8071	0.147	15.41	15.26
SUS no.2	Hexane	116.9392	117.9417	1.0025	6.5559	123.5823	0.0872	0	0.2497	0.1604	0.0893	0.1765	0.826	82.39	82.25
SSI no.2	Petroleum ether	116.3407	117.3373	0.9966	6.4331	123.6818	0.908	0	0.1691	0.1593	0.0098	0.9178	0.0788	7.91	8.91
TCRSS no.2	Petroleum ether	116.9401	117.9772	1.0371	6.4526	124.3882	0.9955	0	0.1694	0.1659	0.0035	0.999	0.0381	3.67	4.64
SSM no.2	Petroleum ether	116.4708	117.4456	0.9748	6.4073	123.7083	0.8302	0	0.2016	0.1702	0.0314	0.8616	0.1132	11.61	12.64
SUS no.2	Petroleum ether	116.258	117.2207	0.9627	6.3739	122.7953	0.1634	0	0.5025	0.1629	0.3396	0.503	0.4597	47.75	48.79

Sample	Solvent	Vessel W (g)	Vessel+ sample W (g)	Sample W (g)	Magnetic stirrer W (g)	vessel+ sample+ magnetic W (g)	residual sample W (g)	dish W (g)	dish+filter paper+ sample W (g)	filter paper W (g)	Remained sample W (g)	Total remained sample W (g)	Oil W (g)	% oil	% oil-blank
SSI no 1	Acetone	116.2033	117.2223	1.0190	24.7950	141.8851	0.8868	161.1217	161.3460	0.1679	0.0564	0.9432	0.0758	7.44	7.31

Extracted oil content (%w/w at Temp. program : 90 °c)

Sample	Solvent	Vessel W (g)	Vessel+sample W (g)	Sample W (g)	Magnetic stirrer W (g)	vessel+sample+ magnetic W (g)	residual sample W (g)	dish W (g)	dish+filter paper+ sample W (g)	filter paper W (g)	Remained sample W (g)	Total remained sample W (g)	Oil W (g)	% oil	% oil-blank
SSI no.3	Acetone	116.5262	117.5578	1.0316	2.2893	119.7406	0.9251	0	0.1827	0.167	0.0157	0.9408	0.0908	8.80	8.68
TCRSS no.3	Acetone	116.3333	117.3405	1.0072	2.3112	119.5331	0.8886	0	0.1939	0.1656	0.0283	0.9169	0.0903	8.97	8.84
SSM no.3	Acetone	116.4772	117.4893	1.0121	2.3996	119.7367	0.8599	0	0.1846	0.1592	0.0254	0.8853	0.1268	12.53	12.40
SUS no.3	Acetone	116.5613	117.5854	1.0241	2.2950	119.3926	0.5363	0	0.1751	0.1653	0.0098	0.5461	0.478	46.68	46.55
SSI no.3	Acetone+Hexane	116.3612	117.3126	0.9514	2.2600	118.7157	0.0945	170.9956	171.9263	0.1625	0.7682	0.8627	0.0887	9.32	9.34
TCRSS no.3	Acetone+Hexane	116.6028	117.597	0.9942	2.3082	119.7669	0.8559	0	0.1936	0.1581	0.0355	0.8914	0.1028	10.34	10.36
SSM no.3	Acetone+Hexane	116.3589	117.3855	1.0266	2.2800	119.4954	0.8565	0	0.1954	0.1664	0.029	0.8855	0.1411	13.74	13.76
SUS no.3	Acetone+Hexane	116.6769	117.6472	0.9703	2.2792	119.045	0.0889	0	0.2044	0.1558	0.0486	0.1375	0.8328	85.83	85.85
SSI no.3	Hexane	116.2164	117.2334	1.0170	6.3718	123.5305	0.9423	0	0.1654	0.1620	0.0034	0.9457	0.0713	7.01	6.87
TCRSS no.3	Hexane	116.5638	117.487	0.9232	6.4461	123.8710	0.8611	0	0.1738	0.1650	0.0088	0.8699	0.0533	5.77	5.62
SSM no.3	Hexane	116.2614	117.2714	1.0100	2.2759	119.3426	0.8053	0	0.2420	0.1659	0.0761	0.8814	0.1286	12.73	12.59
SUS no.3	Hexane	116.5990	117.6039	1.0049	2.3394	118.9550	0.0166	0	0.2932	0.1530	0.1402	0.1568	0.8481	84.40	84.26
SSI no.3	Petroleum ether	116.6720	117.6524	0.9804	6.5291	124.1005	0.8994	0	0.1685	0.1596	0.0089	0.9083	0.0721	7.35	8.37
TCRSS no.3	Petroleum ether	116.3204	117.3367	1.0163	6.5565	123.8302	0.9533	0	0.1722	0.1540	0.0182	0.9715	0.0448	4.41	5.39
SSM no.3	Petroleum ether	116.5265	117.4954	0.9689	2.2788	119.6243	0.8190	0	0.1738	0.1539	0.0199	0.8389	0.13	13.42	14.45
SUS no.3	Petroleum ether	116.2204	117.2573	1.0369	2.3392	118.9055	0.3459	0	0.3097	0.1613	0.1484	0.4943	0.5426	52.33	53.29
SSI no.4	Acetone	116.2275	117.2238	0.9963	2.2802	119.4216	0.9139	0	0.1742	0.1597	0.0145	0.9284	0.0679	6.82	6.68
TCRSS no.4	Acetone	116.609	117.6058	0.9968	2.3361	119.8556	0.9105	0	0.1885	0.1642	0.0243	0.9348	0.062	6.22	6.09
SSM no.4	Acetone	116.3537	117.3256	0.9719	2.2554	119.4245	0.8154	0	0.1845	0.1611	0.0234	0.8388	0.1331	13.69	13.56
SUS no.4	Acetone	116.2685	117.2688	1.0003	2.2796	118.9284	0.3803	0	0.3333	0.1663	0.167	0.5473	0.453	45.29	45.16
SSI no.4	Acetone+Hexane	116.4712	117.4825	1.0113	2.2790	119.6486	0.8984	0	0.1886	0.161	0.0276	0.926	0.0853	8.43	8.45
TCRSS no.4	Acetone+Hexane	116.3285	117.3413	1.0128	2.2571	119.2596	0.674	0	0.4273	0.1527	0.2746	0.9486	0.0642	6.34	6.36
SSM no.4	Acetone+Hexane	116.5177	117.4813	0.9636	2.4088	119.6517	0.7252	0	0.2658	0.1629	0.1029	0.8281	0.1355	14.06	14.08
SUS no.4	Acetone+Hexane	116.6720	117.6911	1.0191	2.2794	119.0740	0.1226	0	0.2428	0.1608	0.082	0.2046	0.8145	79.92	79.94
SSI no.4	Hexane	116.5678	117.5827	1.0149	2.2596	119.7315	0.9041	0	0.184	0.1577	0.0263	0.9304	0.0845	8.33	8.19
TCRSS no.4	Hexane	116.3526	117.3425	0.9899	2.3033	119.5827	0.9268	0	0.1668	0.1644	0.0024	0.9292	0.0607	6.13	5.99
SSM no.4	Hexane	116.2144	117.1948	0.9804	2.2816	119.2647	0.7687	0	0.2507	0.1704	0.0803	0.849	0.1314	13.40	13.26
SUS no.4	Hexane	116.2713	117.2514	0.9801	2.4025	118.7337	0.0599	0	0.2969	0.1664	0.1305	0.1904	0.7897	80.57	80.43
SSI no.4	Petroleum ether	116.268	117.2541	0.9861	2.2603	119.4334	0.9051	0	0.1695	0.1588	0.0107	0.9158	0.0703	7.1291	8.14
TCRSS no.4	Petroleum ether	116.4813	117.4514	0.9701	2.4087	119.8242	0.9342	0	0.1638	0.1591	0.0047	0.9389	0.0312	3.2162	4.25
SSM no.4	Petroleum ether	116.3331	117.3145	0.9814	2.2853	119.4405	0.8221	0	0.1857	0.1603	0.0254	0.8475	0.1339	13.6438	14.66
SUS no.4	Petroleum ether	116.6059	117.5916	0.9857	2.2548	119.2025	0.3418	0	0.321	0.1741	0.1469	0.4887	0.497	50.4210	51.44
Blank	Acetone	116.2549	116.2549	0	2.4090	118.6638	-0.0001	142.647	142.7969	0.1511	-0.0012	-0.0013	0.0013		
Blank	Acetone+Hexane	116.6436	116.6436	0	2.2845	118.9283	0.0002	0	0.1619	0.1619	0	0.0002	-0.0002		
Blank	Hexane	116.4848	116.4848	0	6.4829	122.9672	-0.0005	0	0.1603	0.1612	-0.0009	-0.0014	0.0014		
Blank	Petroleum ether	116.2571	116.2571	0	6.5171	122.7879	0.0137	0	0.1519	0.1556	-0.0037	0.01	-0.0100		

Note Condition (temperature program at 90 °c)

Extracted oil content (%w/w at Temp. program : 120 °c)

Sample	Solvent	Vessel W (g)	Vessel+ sample W (g)	Sample W (g)	Magnetic stirrer W (g)	vessel+ sample+ magnetic W (g)	residual sample W (g)	dish W (g)	dish+filter paper+ sample W (g)	filter paper W (g)	Remained sample W (g)	Total remained sample W (g)	Oil W (g)	% oil	% oil-blank
SSI no.1	Acetone	116.5717	117.5963	1.0246	2.2747	119.7707	0.9243	0	0.1749	0.1608	0.0141	0.9384	0.0862	8.41	8.32
TCRSS no.1	Acetone	116.6759	117.6173	0.9414	2.2797	119.7758	0.8202	0	0.1841	0.1507	0.0334	0.8536	0.0878	9.33	9.22
SSM no.1	Acetone	116.2226	117.2425	1.0199	2.2753	119.3132	0.8153	0	0.2454	0.1684	0.077	0.8923	0.1276	12.51	12.41
SUS no.1	Acetone	116.3353	117.3275	0.9922	2.3047	119.1143	0.4743	0	0.1721	0.1644	0.0077	0.482	0.5102	51.42	51.32
SSI no.1	A + H	116.2264	117.2585	1.0321	2.257	119.4179	0.9345	0	0.1963	0.1672	0.0291	0.9636	0.0685	6.64	6.28
TCRSS no.1	A + H	116.3380	117.3326	0.9946	2.4093	119.5731	0.8258	0	0.2590	0.1623	0.0967	0.9225	0.0721	7.25	6.88
SSM no.1	A + H	116.236	117.244	1.008	2.4405	119.4702	0.7937	0	0.2332	0.1615	0.0717	0.8654	0.1426	14.15	13.78
SUS no.1	A + H	116.4821	117.4593	0.9772	2.2749	118.8256	0.0686	0	0.2215	0.1584	0.0631	0.1317	0.8455	86.52	86.14
SSI no.1	Hexane	116.2721	117.2621	0.9900	6.6510	123.8206	0.8975	0	0.1658	0.1556	0.0102	0.9077	0.0823	8.31	6.48
TCRSS no.1	Hexane	116.6337	117.6753	1.0416	6.5467	124.1636	0.9832	0	0.178	0.1704	0.0076	0.9908	0.0508	4.88	3.14
SSM no.1	Hexane	116.4816	117.4516	0.97	6.4506	123.7403	0.8081	0	0.1885	0.1635	0.025	0.8331	0.1369	14.11	12.25
SUS no.1	Hexane	116.3628	117.3950	1.0322	6.6629	123.0485	0.0228	0	0.3159	0.162	0.1539	0.1767	0.8555	82.88	81.13
SSI no.1	P.E	116.2813	117.2598	0.9785	6.5567	123.7314	0.8934	0	0.1721	0.1676	0.0045	0.8979	0.0806	8.24	7.18
TCRSS no.1	P.E	116.3393	117.2963	0.957	6.5187	123.7296	0.8716	0	0.182	0.1702	0.0118	0.8834	0.0736	7.69	6.61
SSM no.1	P.E	116.271	117.2802	1.0092	6.5659	123.6985	0.8616	0	0.1774	0.1598	0.0176	0.8792	0.13	12.88	11.86
SUS no.1	P.E	116.4413	117.4495	1.0082	6.5352	123.3286	0.3521	0	0.202	0.1611	0.0409	0.393	0.6152	61.02	60.00
SSI no.2	Acetone	116.5326	117.7711	1.2385	2.4027	120.0616	1.1263	0	0.1798	0.1616	0.0182	1.1445	0.094	7.59	7.51
TCRSS no.2	Acetone	116.9412	117.9737	1.0325	2.3014	120.1519	0.9093	0	0.1889	0.1649	0.024	0.9333	0.0992	9.61	9.51
SSM no.2	Acetone	116.2708	117.2880	1.0172	2.4049	119.5080	0.8323	0	0.1992	0.1610	0.0382	0.8705	0.1467	14.42	14.32
SUS no.2	Acetone	116.3556	117.3943	1.0387	2.415	119.2239	0.4533	0	0.1775	0.1642	0.0133	0.4666	0.5721	55.08	54.98
SSI no.2	A + H	116.4790	117.4772	0.9982	2.2779	119.6637	0.9068	0	0.1908	0.1659	0.0249	0.9317	0.0665	6.66	6.29
TCRSS no.2	A + H	116.3638	117.3721	1.0083	2.2747	119.4756	0.8371	0	0.2545	0.1642	0.0903	0.9274	0.0809	8.02	7.66
SSM no.2	A + H	116.232	117.2341	1.0021	2.2644	119.285	0.7886	0	0.2298	0.1597	0.0701	0.8587	0.1434	14.31	13.94
SUS no.2	A + H	116.5423	117.5501	1.0078	2.2622	118.8825	0.078	0	0.2259	0.152	0.0739	0.1519	0.8559	84.93	84.56
SSI no.2	Hexane	116.3007	117.3396	1.0389	6.4618	123.6985	0.936	0	0.1792	0.1716	0.0076	0.9436	0.0953	9.17	7.43
TCRSS no.2	Hexane	116.3693	117.3234	0.9541	6.5098	123.7704	0.8913	0	0.1751	0.1527	0.0224	0.9137	0.0404	4.23	2.34
SSM no.2	Hexane	116.2323	117.2683	1.0360	6.3496	123.4403	0.8584	0	0.1778	0.1566	0.0212	0.8796	0.1564	15.10	13.35
SUS no.2	Hexane	116.3475	117.3279	0.9804	6.5218	122.9404	0.0711	0	0.2590	0.1689	0.0901	0.1612	0.8192	83.56	81.71
SSI no.2	P.E	116.2163	117.2138	0.9975	6.4752	123.6316	0.9401	0	0.176	0.1715	0.0045	0.9446	0.0529	5.30	4.27
TCRSS no.2	P.E	116.3517	117.3442	0.9925	6.3530	123.6006	0.8959	0	0.1974	0.1649	0.0325	0.9284	0.0641	6.46	5.42
SSM no.2	P.E	116.3253	117.332	1.0067	6.3575	123.5215	0.8387	0	0.1955	0.1602	0.0353	0.874	0.1327	13.18	12.16
SUS no.2	P.E	116.5882	117.5694	0.9812	6.3784	123.3569	0.3903	0	0.2125	0.1614	0.0511	0.4414	0.5398	55.01	53.96

Extracted oil content (%w/w at Temp. program : 120 °c)

Sample	Solvent	Vessel W (g)	Vessel+ sample W. (g)	Sample W. (g)	Magnetic stirrer W.(g)	vessel+ sample+ magnetic W (g)	residual sample W.(g)	dish W.(g)	dish+filter paper+ sample W (g)	filter paper W (g)	Remained sample W.(g)	Total remained sample W.(g)	Oil W.(g)	% oil	% oil-blank
SSI no.3	Acetone	116.2731	117.2336	0.9605	2.2788	119.4099	0.858	0	0.1810	0.1669	0.0141	0.8721	0.0884	9.20	9.10
TCRSS no.3	Acetone	116.3471	117.3813	1.0342	2.2520	119.4497	0.8506	0	0.2123	0.172	0.0403	0.8909	0.1433	13.86	13.76
SSM no.3	Acetone	116.5684	117.5794	1.011	2.2800	119.6799	0.8315	0	0.1971	0.1638	0.0333	0.8648	0.1462	14.46	14.36
SUS no.3	Acetone	116.9407	117.9898	1.0491	2.2619	119.6717	0.4691	0	0.1955	0.1668	0.0287	0.4978	0.5513	52.55	52.45
SSI no.3	A + H	116.5347	117.5713	1.0366	2.4101	119.8570	0.9122	0	0.1922	0.1643	0.0279	0.9401	0.0965	9.31	8.95
TCRSS no.3	A + H	116.6001	117.6120	1.0119	2.3126	119.6604	0.7477	0	0.3103	0.1674	0.1429	0.8906	0.1213	11.99	11.62
SSM no.3	A + H	116.346	117.3480	1.002	2.2505	119.3956	0.7991	0	0.224	0.1621	0.0619	0.861	0.141	14.07	13.70
SUS no.3	A + H	116.6021	117.5956	0.9935	2.3526	119.0333	0.0786	0	0.2439	0.1552	0.0887	0.1673	0.8262	83.16	82.79
SSI no.3	Hexane	116.5088	117.5299	1.0211	6.534	123.9572	0.9144	0	0.1832	0.1685	0.0147	0.9291	0.092	9.01	7.24
TCRSS no.3	Hexane	116.3763	117.3304	0.9541	6.437	123.6719	0.8586	0	0.2067	0.1658	0.0409	0.8995	0.0546	5.72	3.83
SSM no.3	Hexane	116.6012	117.6334	1.0322	6.5255	123.9912	0.8645	0	0.1871	0.1576	0.0295	0.894	0.1382	13.39	11.64
SUS no.3	Hexane	116.5766	117.5868	1.0102	6.4105	123.0386	0.0515	0	0.2175	0.1552	0.0623	0.1138	0.8964	88.73	86.94
SSI no.3	P.E	116.5636	117.5317	0.9681	6.4471	123.9026	0.8919	0	0.1608	0.1544	0.0064	0.8983	0.0698	7.21	6.15
TCRSS no.3	P.E	116.9455	117.9077	0.9622	6.6503	124.4521	0.8563	0	0.2187	0.1708	0.0479	0.9042	0.058	6.03	4.96
SSM no.3	P.E	116.4511	117.444	0.9929	6.5545	123.8565	0.8509	0	0.1799	0.1592	0.0207	0.8716	0.1213	12.22	11.18
SUS no.3	P.E	116.4752	117.4555	0.9803	6.4357	123.3098	0.3989	0	0.1989	0.1588	0.0401	0.439	0.5413	55.22	54.17
SSI no.4	Acetone	116.2200	117.2382	1.0182	2.2559	119.3916	0.9157	0	0.1927	0.1675	0.0252	0.9409	0.0773	7.59	7.49
TCRSS no.4	Acetone	116.3648	117.3427	0.9779	2.4131	119.6025	0.8246	0	0.2155	0.1661	0.0494	0.874	0.1039	10.62	10.52
SSM no.4	Acetone	116.5381	117.4910	0.9529	2.2535	119.5445	0.7529	0	0.1952	0.1613	0.0339	0.7868	0.1661	17.43	17.33
SUS no.4	Acetone	116.6716	117.6594	0.9878	2.2851	119.3562	0.3995	0	0.1697	0.1543	0.0154	0.4149	0.5729	58.00	57.90
SSI no.4	A + H	116.2824	117.2402	0.9578	2.2612	119.4033	0.8597	0	0.1796	0.1582	0.0214	0.8811	0.0767	8.01	7.62
TCRSS no.4	A + H	116.6739	117.6747	1.0008	2.2874	119.8629	0.9016	0	0.1950	0.1606	0.0344	0.936	0.0648	6.47	6.11
SSM no.4	A + H	116.4561	117.4265	0.9704	2.2390	119.5067	0.8116	0	0.2025	0.1629	0.0396	0.8512	0.1192	12.28	11.90
SUS no.4	A + H	116.3592	117.3701	1.0109	2.2897	118.7142	0.0653	0	0.2177	0.1596	0.0581	0.1234	0.8875	87.79	87.43
SSI no.4	Hexane	116.5674	117.5185	0.9511	6.3503	123.7767	0.859	0	0.1675	0.1562	0.0113	0.8703	0.0808	8.50	6.59
TCRSS no.4	Hexane	116.6883	117.6365	0.9482	6.4907	124.0705	0.8915	0	0.1803	0.1682	0.0121	0.9036	0.0446	4.70	2.79
SSM no.4	Hexane	116.5405	117.5887	1.0482	6.4339	123.8623	0.8879	0	0.1769	0.1589	0.018	0.9059	0.1423	13.58	11.85
SUS no.4	Hexane	116.2833	117.2534	0.9701	6.4797	122.8274	0.0644	0	0.2377	0.1681	0.0696	0.134	0.8361	86.19	84.32
SSI no.4	P.E	116.5296	117.5066	0.9770	6.5293	123.9642	0.9053	0	0.1527	0.1491	0.0036	0.9089	0.0681	6.97	5.92
TCRSS no.4	P.E	116.6753	117.6212	0.9459	6.4362	123.9911	0.8796	0	0.1750	0.1615	0.0135	0.8931	0.0528	5.58	4.49
SSM no.4	P.E	116.5678	117.5599	0.9921	6.4659	123.8845	0.8508	0	0.1885	0.1567	0.0318	0.8826	0.1095	11.04	10.00
SUS no.4	P.E	116.5445	117.5641	1.0196	6.4255	123.3552	0.3852	0	0.2163	0.1555	0.0608	0.446	0.5736	56.26	55.25
Blank	Acetone	116.2164	116.2164	0	2.2467	118.4618	-0.0013	0	0.1615	0.1612	0.0003	-0.001	0.0010		
Blank	A+H	116.9578	116.9578	0	2.2788	119.2311	-0.0055	0	0.1671	0.1653	0.0018	-0.0037	0.0037		
Blank	Hexane	116.9843	116.9843	0	6.4114	123.378	-0.0177	0	0.1593	0.1597	-0.0004	-0.0181	0.0181		
Blank	P.E	116.6857	116.6857	0	6.5444	123.2201	-0.01	0	0.1570	0.1573	-0.0003	-0.0103	0.0103		

Extracted oil content (%w/w at Temp. program : 150 °c)

Sample	Solvent	Vessel W.(g)	Vessel+ sample W. (g)	Sample W. (g)	Magnetic stirrer W.(g)	vessel+ sample+ magnetic W.(g)	residual sample W.(g)	dish W.(g)	dish+filter paper+ sample W.(g)	filter paper W.(g)	Remained sample W.(g)	Total remained sample W.(g)	Oil W.(g)	% oil	% oil-blank
SSI no.1	Acetone	116.2702	117.2795	1.0093	2.2771	119.4684	0.9211	0	0.1918	0.1665	0.0253	0.9464	0.0629	6.23	5.97
TCRSS no.1	Acetone	116.9368	117.8976	0.9608	2.4101	120.2143	0.8674	0	0.1965	0.1685	0.028	0.8954	0.0654	6.81	6.54
SSM no.1	Acetone	116.5658	117.5026	0.9368	2.2708	119.6007	0.7641	0	0.1913	0.1609	0.0304	0.7945	0.1423	15.19	14.91
SUS no.1	Acetone	116.3493	117.3137	0.9644	2.3082	119.0653	0.4078	0	0.1840	0.1616	0.0224	0.4302	0.5342	55.39	55.12
SSI no.1	A + H	116.4824	117.4517	0.9693	2.2557	119.6454	0.9073	0	0.1803	0.1647	0.0156	0.9229	0.0464	4.79	4.97
TCRSS no.1	A + H	116.6043	117.5949	0.9906	2.2766	119.7805	0.8996	0	0.1977	0.1658	0.0319	0.9315	0.0591	5.97	6.15
SSM no.1	A + H	116.4976	117.4955	0.9979	2.4147	119.6880	0.7757	0	0.2203	0.1565	0.0638	0.8395	0.1584	15.87	16.05
SUS no.1	A + H	116.3761	117.3907	1.0146	2.2783	118.7523	0.0979	0	0.2338	0.1563	0.0775	0.1754	0.8392	82.71	82.89
SSI no.1	Hexane	116.5176	117.4785	0.9609	6.5244	123.9147	0.8727	0	0.1690	0.1600	0.009	0.8817	0.0792	8.24	6.81
TCRSS no.1	Hexane	116.6468	117.6572	1.0104	6.3572	123.9016	0.8976	0	0.1811	0.1645	0.0166	0.9142	0.0962	9.52	8.16
SSM no.1	Hexane	116.5185	117.4980	0.9795	6.4770	123.8055	0.8100	0	0.1948	0.1681	0.0267	0.8367	0.1428	14.58	13.17
SUS no.1	Hexane	116.6416	117.6199	0.9783	6.4476	123.1496	0.0604	0	0.2079	0.1563	0.0516	0.112	0.8663	88.55	87.14
SSI no.2	Acetone	116.4876	117.5067	1.0191	2.2725	119.7048	0.9447	0	0.1828	0.1641	0.0187	0.9634	0.0557	5.47	5.21
TCRSS no.2	Acetone	116.3615	117.3385	0.977	2.2753	119.4982	0.8614	0	0.1930	0.1692	0.0238	0.8852	0.0918	9.40	9.13
SSM no.2	Acetone	116.2265	117.2689	1.0424	2.2796	119.3122	0.8061	0	0.1863	0.1602	0.0261	0.8322	0.2102	20.17	19.92
SUS no.2	Acetone	116.3430	117.3932	1.0502	2.2503	119.0433	0.4500	0	0.1707	0.1598	0.0109	0.4609	0.5893	56.11	55.87
SSI no.2	A + H	116.2304	117.2321	1.0017	2.4011	119.5762	0.9447	0	0.1802	0.1722	0.008	0.9527	0.049	4.89	5.07
TCRSS no.2	A + H	116.3461	117.3581	1.0120	2.2767	119.5047	0.8819	0	0.1928	0.1655	0.0273	0.9092	0.1028	10.16	10.34
SSM no.2	A + H	116.5463	117.5605	1.0142	2.2604	119.5787	0.772	0	0.234	0.164	0.07	0.842	0.1722	16.98	17.16
SUS no.2	A + H	116.6278	117.6038	0.9760	2.3083	119.0185	0.0824	0	0.2341	0.1674	0.0667	0.1491	0.8269	84.72	84.91
SSI no.2	Hexane	116.2658	117.2586	0.9928	6.4914	123.6570	0.8998	0	0.1659	0.1554	0.0105	0.9103	0.0825	8.31	6.92
TCRSS no.2	Hexane	116.3964	117.3864	0.99	6.5129	123.7980	0.8887	0	0.1903	0.1656	0.0247	0.9134	0.0766	7.74	6.34
SSM no.2	Hexane	116.9941	118.0182	1.0241	6.3581	124.1862	0.8340	0	0.1867	0.1645	0.0222	0.8562	0.1679	16.39	15.05
SUS no.2	Hexane	116.705	117.7119	1.0069	6.5597	123.2975	0.0328	0	0.2239	0.1656	0.0583	0.0911	0.9158	90.95	89.58

Extracted oil content (%w/w at Temp. program : 150 °c)

Sample	Solvent	Vessel W.(g)	Vessel+ sample W. (g)	Sample W. (g)	Magnetic stirrer W.(g)	vessel+ sample+ magnetic W.(g)	residual sample W.(g)	dish W.(g)	dish+filter paper+ sample W.(g)	filter paper W.(g)	Remained sample W.(g)	Total remained sample W.(g)	Oil W.(g)	% oil	% oil-blank
SSI no.3	Acetone	116.5594	117.5881	1.0287	2.2988	119.8111	0.9529	0	0.1721	0.1578	0.0143	0.9672	0.0615	5.98	5.73
TCRSS no.3	Acetone	116.6787	117.6219	0.9432	2.2577	119.7616	0.8252	0	0.1827	0.1588	0.0239	0.8491	0.0941	9.98	9.70
SSM no.3	Acetone	116.5281	117.5006	0.9725	2.2856	119.5925	0.7788	0	0.1939	0.1598	0.0341	0.8129	0.1596	16.41	16.14
SUS no.3	Acetone	116.9445	117.9322	0.9877	2.2588	119.6154	0.4121	0	0.1779	0.1630	0.0149	0.427	0.5607	56.77	56.51
SSI no.3	A + H	116.5354	117.5712	1.0358	2.2773	119.7440	0.9313	0	0.2096	0.1728	0.0368	0.9681	0.0677	6.54	6.71
TCRSS no.3	A + H	116.2813	117.2793	0.998	2.4051	119.5242	0.8378	0	0.2192	0.1745	0.0447	0.8825	0.1155	11.57	11.75
SSM no.3	A + H	116.2916	117.2597	0.9681	2.2788	119.3673	0.7969	0	0.1972	0.1674	0.0298	0.8267	0.1414	14.61	14.79
SUS no.3	A + H	116.3627	117.3240	0.9613	2.2894	118.7310	0.0789	0	0.2221	0.1670	0.0551	0.134	0.8273	86.06	86.25
SSI no.3	Hexane	116.3103	117.3284	1.0181	6.4528	123.6741	0.9110	0	0.1765	0.1624	0.0141	0.9251	0.093	9.13	7.78
TCRSS no.3	Hexane	116.3674	117.3536	0.9862	6.4492	123.6512	0.8346	0	0.2057	0.1554	0.0503	0.8849	0.1013	10.27	8.87
SSM no.3	Hexane	116.2655	117.227	0.9615	6.4492	123.5023	0.7876	0	0.2055	0.1680	0.0375	0.8251	0.1364	14.19	12.75
SUS no.3	Hexane	116.3773	117.4048	1.0275	6.4165	122.8369	0.0431	0	0.1869	0.1565	0.0304	0.0735	0.954	92.85	91.50
SSI no.4	Acetone	116.5228	117.5034	0.9806	2.2815	119.6937	0.8894	0	0.1815	0.1629	0.0186	0.908	0.0726	7.40	7.14
TCRSS no.4	Acetone	116.3688	117.3919	1.0231	2.2541	119.5432	0.9203	0	0.1939	0.1741	0.0198	0.9401	0.083	8.11	7.86
SSM no.4	Acetone	116.2743	117.3136	1.0393	2.3992	119.5285	0.855	0	0.1885	0.161	0.0275	0.8825	0.1568	15.09	14.84
SUS no.4	Acetone	116.6704	117.6437	0.9733	2.4093	119.5254	0.4457	0	0.1703	0.1647	0.0056	0.4513	0.522	53.63	53.36
SSI no.4	A + H	116.9606	117.957	0.9964	2.2824	120.149	0.906	0	0.2010	0.1704	0.0306	0.9366	0.0598	6.00	6.18
TCRSS no.4	A + H	116.3612	117.3767	1.0155	2.3053	119.5623	0.8958	0	0.2045	0.1704	0.0341	0.9299	0.0856	8.43	8.61
SSM no.4	A + H	116.969	117.9990	1.0300	2.4006	120.1876	0.8180	0	0.2085	0.1574	0.0511	0.8691	0.1609	15.62	15.80
SUS no.4	A + H	116.6881	117.6324	0.9443	2.2767	119.0567	0.0919	0	0.2326	0.1687	0.0639	0.1558	0.7885	83.50	83.69
SSI no.4	Hexane	116.5592	117.5803	1.0211	6.4114	123.9061	0.9355	0	0.1672	0.1601	0.0071	0.9426	0.0785	7.69	6.34
TCRSS no.4	Hexane	116.7066	117.6766	0.9700	6.6669	124.2336	0.8601	0	0.1706	0.1523	0.0183	0.8784	0.0916	9.44	8.02
SSM no.4	Hexane	116.3136	117.3617	1.0481	6.5318	123.7256	0.8802	0	0.1769	0.1583	0.0186	0.8988	0.1493	14.24	12.93
SUS no.4	Hexane	116.4023	117.3990	0.9967	6.5194	122.9488	0.0271	0	0.2034	0.1575	0.0459	0.073	0.9237	92.68	91.29
Blank	Acetone	116.678	116.678	0	2.2577	118.9345	-0.0012	0	0.1648	0.1662	-0.0014	-0.0026	0.0026		
Blank	A+H	116.2581	116.2581	0	2.2608	118.5212	0.0023	0	0.1639	0.1644	-0.0005	0.0018	-0.0018		
Blank	Hexane	116.9979	116.9979	0	6.5552	123.5391	-0.0140	0	0.1553	0.1551	0.0002	-0.0138	0.0138		

APPENDIX D

Chulalongkorn University

[c:\superq\data\453134a_.pks]

Concentrations of sample 453134A SSI No.1

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	1.062	SO3	0.238	CaO	0.45	Fe2O3	95.736
2	Na	<<	SiO2	1.669	Cl	<<	Cr2O3	<<	NiO	<<
3	MgO	0.214	P2O5	0.32	K	<<	MnO	0.311	CuO	<<

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162aa.pks]

Concentrations of sample 453162A SSI NO.2

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	0.947	SO3	0.241	CaO	0.439	Fe2O3	95.922
2	Na	<<	SiO2	1.614	Cl	<<	Cr2O3	<<	NiO	<<
3	MgO	0.223	P2O5	0.314	K	<<	MnO	0.301	CuO	<<

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162b_.pks]

Concentrations of sample 453162B SSI NO.3

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	0.928	SO3	0.263	CaO	0.461	Fe2O3	95.757
2	Na	<<	SiO2	1.678	Cl	<<	Cr2O3	0.108	NiO	<<
3	MgO	0.239	P2O5	0.267	K	<<	MnO	0.3	CuO	<<

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162c_.pks]

Concentrations of sample 453162C SSI NO.4

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	1.097	SO3	0.267	CaO	0.465	Fe2O3	95.508
2	Na	<<	SiO2	1.806	Cl	<<	Cr2O3	<<	NiO	<<
3	MgO	0.242	P2O5	0.322	K	<<	MnO	0.293	CuO	<<

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453134b_.pks]

Concentrations of sample 453134B SSM No.1

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	2.788	K	<<	Fe2O3	81.838	MoO3	<<
2	Na2O	0.939	P2O5	0.274	CaO	0.902	NiO	<<		
3	MgO	<<	SO3	0.555	Cr2O3	0.27	CuO	0.2		
4	Al2O3	11.758	Cl	0.178	MnO	0.297	ZnO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162g_.pks]

Concentrations of sample 453162G SSM NO.2

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	2.736	K	<<	Fe2O3	83.29	MoO3	<<
2	Na2O	1.066	P2O5	0.303	CaO	0.784	NiO	<<		
3	MgO	<<	SO3	0.542	Cr2O3	0.272	CuO	0.204		
4	Al2O3	10.268	Cl	0.214	MnO	0.321	ZnO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162h_.pks]

Concentrations of sample 453162H SSM NO.3

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	2.611	K	<<	Fe2O3	84.332	MoO3	<<
2	Na2O	1.062	P2O5	0.248	CaO	0.755	NiO	<<		
3	MgO	<<	SO3	0.492	Cr2O3	0.257	CuO	0.193		
4	Al2O3	9.593	Cl	0.18	MnO	0.277	ZnO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162i_.pks]

Concentrations of sample 453162I SSM NO.4

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	2.425	K	<<	Fe2O3	85.532	MoO3	<<
2	Na2O	0.809	P2O5	0.232	CaO	0.685	NiO	<<		
3	MgO	<<	SO3	0.487	Cr2O3	0.235	CuO	0.257		
4	Al2O3	8.915	Cl	0.167	MnO	0.256	ZnO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453134c_.pks]

Concentrations of sample 453134C TCR No.1

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	1.009	SO3	1.233	CaO	16.923	Fe2O3	57.835
2	Na2O	0.684	SiO2	19.321	Cl	0.39	Cr2O3	<<		
3	MgO	1.803	P2O5	0.803	K	<<	MnO2	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162d_.pks]

Concentrations of sample 453162D TCR NO.2

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	1.182	SO3	1.413	CaO	16.868	Fe2O3	58.221
2	Na2O	0.653	SiO2	18.356	Cl	0.469	Cr2O3	<<		
3	MgO	2.004	P2O5	0.834	K	<<	MnO2	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162e_.pks]

Concentrations of sample 453162E TCR NO.3

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	2.284	SO3	1.786	CaO	21.838	Fe2O3	51.617
2	Na2O	0.595	SiO2	17.676	Cl	0.302	Cr2O3	<<		
3	MgO	3.002	P2O5	0.899	K	<<	MnO2	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162f_.pks]

Concentrations of sample 453162F TCR NO.4

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	Al2O3	1.264	SO3	1.676	CaO	18.55	Fe2O3	55.778
2	Na2O	0.443	SiO2	18.852	Cl	0.291	Cr2O3	<<		
3	MgO	2.343	P2O5	0.802	K	<<	MnO2	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453134d_.pks]

Concentrations of sample 453134D SUS No.1

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	1.003	K	<<	MnO2	<<		
2	Na	<<	P2O5	1.314	CaO	4.935	Fe2O3	79.15		
3	MgO	1.157	SO3	2.533	TiO2	<<	NiO	<<		
4	Al2O3	9.908	Cl	<<	Cr2O3	<<	CuO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162j_.pks]

Concentrations of sample 453162J SUS NO.2

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	–	SiO2	1.822	K	<<	MnO2	<<		
2	Na2O	0.641	P2O5	1.563	CaO	5.838	Fe2O3	74.657		
3	MgO	0.616	SO3	2.74	TiO2	<<	NiO	<<		
4	Al2O3	12.123	Cl	<<	Cr2O3	<<	CuO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162k_.pks]

Concentrations of sample 453162K SUS NO.3

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	0.656	K	<<	MnO2	<<		
2	Na	<<	P2O5	1.28	CaO	5.234	Fe2O3	79.7		
3	MgO	0.542	SO3	2.189	TiO2	<<	NiO	<<		
4	Al2O3	10.399	Cl	<<	Cr2O3	<<	CuO	<<		

Normalised to: 100. %

Chulalongkorn University

[c:\superq\data\453162l_.pks]

Concentrations of sample 453162L SUS NO.4

	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)	Compound	Conc. (%)
1	O	--	SiO2	0.8	K	<<	MnO2	<<		
2	Na	<<	P2O5	1.257	CaO	4.779	Fe2O3	79.507		
3	MgO	0.433	SO3	2.137	TiO2	<<	NiO	<<		
4	Al2O3	11.087	Cl	<<	Cr2O3	<<	CuO	<<		

Normalised to: 100 %

APPENDIX E

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: ssi no.1

Sample weight (inclusive of binder): 1.0025 g

Binder weight: 0.9214 g (91.9 %)

Start temperature: 0.0000 C

Final temperature: 2.7170 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 346296 J/g (82711.442559 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 24373 J

Nitrogen Correction: 37 J (by titration)

Net CV of sample: 44441 J/g (10614.433881 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: ssi no.2

Sample weight (inclusive of binder): 1.0031 g

Binder weight: 0.8496 g (84.7 %)

Start temperature: 0.0000 C

Final temperature: 2.8450 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 191619 J/g (45767.318650 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 22475 J

Nitrogen Correction: 42 J (by titration)

Net CV of sample: 44441 J/g (10614.500379 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name:

Test description:

Test date & time: Thu, Aug 09, 2001, 14:28

Sample name: ssi 3

Sample weight (inclusive of binder): 1.0028 g

Binder weight: 0.8686 g (86.6 %)

Start temperature: 0.0000 C

Final temperature: 2.8050 C

Bomb heat capacity: 10342.6560 J/K (determined Wed, Aug 08, 2001, 13:58)

Gross CV of sample: 216219 J/g (51643.098525 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 22977 J

Nitrogen Correction: 39 J (by titration)

Net CV of sample: 44146 J/g (10544.030584 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: ssi no.4

Sample weight (inclusive of binder): 1.0127 g

Binder weight: 0.9618 g (95.0 %)

Start temperature: 0.0000 C

Final temperature: 2.6850 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 544862 J/g (130138.067953 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 25441 J

Nitrogen Correction: 39 J (by titration)

Net CV of sample: 43249 J/g (10329.783476 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: ptr .test

Test date & time: Thu, Aug 09, 2001, 14:28

Sample name: ssm no1

Sample weight (inclusive of binder): 1.0017 g

Binder weight: 0.9003 g (89.9 %)

Start temperature: 0.0000 C

Final temperature: 2.7440 C

Bomb heat capacity: 10342.6560 J/K (determined Wed, Aug 08, 2001, 13:58)

Gross CV of sample: 279961 J/g (66867.607630 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 23816 J

Nitrogen Correction: 33 J (by titration)

Net CV of sample: 44002 J/g (10509.765938 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: ssm no.2

Sample weight (inclusive of binder): 1.0036 g

Binder weight: 0.8586 g (85.5 %)

Start temperature: 0.0000 C

Final temperature: 2.8170 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 200793 J/g (47958.678443 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 22712 J

Nitrogen Correction: 41 J (by titration)

Net CV of sample: 43409 J/g (10367.966440 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: ssm no 3

Sample weight (inclusive of binder): 1.0052 g

Binder weight: 0.9075 g (90.3 %)

Start temperature: 0.0000 C

Final temperature: 2.7460 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 290518 J/g (69389.003069 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 24005 J

Nitrogen Correction: 41 J (by titration)

Net CV of sample: 43681 J/g (10433.056773 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: ssm no.4

Sample weight (inclusive of binder): 1.0035 g

Binder weight: 0.8867 g (88.4 %)

Start temperature: 0.0000 C

Final temperature: 2.7650 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 244690 J/g (58443.153045 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 23455 J

Nitrogen Correction: 42 J (by titration)

Net CV of sample: 42920 J/g (10251.222814 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name:

Test description:

Test date & time: Thu, Aug 09, 2001, 14:28

Sample name: tcr1

Sample weight (inclusive of binder): 1.0014 g

Binder weight: 0.9647 g (96.3 %)

Start temperature: 0.0000 C

Final temperature: 2.6380 C

Bomb heat capacity: 10342.6560 J/K (determined Wed, Aug 08, 2001, 13:58)

Gross CV of sample: 744420 J/g (177801.730449 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 25520 J

Nitrogen Correction: 36 J (by titration)

Net CV of sample: 45207 J/g (10797.554330 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name:

Test description:

Test date & time: Thu, Aug 09, 2001, 14:28

Sample name: tcr2

Sample weight (inclusive of binder): 1.0028 g

Binder weight: 0.9807 g (97.8 %)

Start temperature: 0.0000 C

Final temperature: 2.6140 C

Bomb heat capacity: 10342.6560 J/K (determined Wed, Aug 08, 2001, 13:58)

Gross CV of sample: 1225464 J/g (292697.115005 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 25943 J

Nitrogen Correction: 41 J (by titration)

Net CV of sample: 44436 J/g (10613.345441 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: tcr3

Sample weight (inclusive of binder): 1.0111 g

Binder weight: 0.9501 g (94.0 %)

Start temperature: 0.0000 C

Final temperature: 2.7070 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 458953 J/g (109618.963954 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 25133 J

Nitrogen Correction: 40 J (by titration)

Net CV of sample: 44895 J/g (10722.957846 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: tcr4

Sample weight (inclusive of binder): 1.0080 g

Binder weight: 0.9726 g (96.5 %)

Start temperature: 0.0000 C

Final temperature: 2.6740 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 781241 J/g (186596.122248 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 25728 J

Nitrogen Correction: 42 J (by titration)

Net CV of sample: 50876 J/g (12151.422783 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: sus 1

Sample weight (inclusive of binder): 1.0011 g

Binder weight: 0.8889 g (88.8 %)

Start temperature: 0.0000 C

Final temperature: 2.6530 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 244369 J/g (58366.417299 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 23513 J

Nitrogen Correction: 37 J (by titration)

Net CV of sample: 33882 J/g (8092.529608 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name:

Test description:

Test date & time: Thu, Aug 09, 2001, 14:28

Sample name: sus 2

Sample weight (inclusive of binder): 1.0026 g

Binder weight: 0.6851 g (68.3 %)

Start temperature: 0.0000 C

Final temperature: 2.8330 C

Bomb heat capacity: 10342.6560 J/K (determined Wed, Aug 08, 2001, 13:58)

Gross CV of sample: 92279 J/g (22040.461077 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 18122 J

Nitrogen Correction: 45 J (by titration)

Net CV of sample: 34839 J/g (8321.136987 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: sus no.3

Sample weight (inclusive of binder): 1.0021 g

Binder weight: 0.9218 g (92.0 %)

Start temperature: 0.0000 C

Final temperature: 2.6500 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 341266 J/g (81510.049255 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 24385 J

Nitrogen Correction: 42 J (by titration)

Net CV of sample: 36060 J/g (8612.836258 Cal/g)

<< TEST INCOMPLETE >>

AUTOCAL II TEST REPORT

Operator's name: siwadol

Test description: full test of sample with binder using titration

Test date & time: Thu, Aug 09, 2001, 15:10

Sample name: sus4

Sample weight (inclusive of binder): 1.0015 g

Binder weight: 0.6628 g (66.2 %)

Start temperature: 0.0000 C

Final temperature: 2.9020 C

Bomb heat capacity: 10336.9181 J/K (determined Thu, Aug 09, 2001, 15:09)

Gross CV of sample: 88565 J/g (21153.474489 Cal/g)

CV of Cotton: 59 J

CV of Wire: 13 J

CV of Binder: 17533 J

Nitrogen Correction: 43 J (by titration)

Net CV of sample: 36465 J/g (8709.561270 Cal/g)

<< TEST INCOMPLETE >>

APPENDIX F

Cost Estimation

1. Cost of Electricity

- Power of Microwave extraction equipment = 1600 Watt
- Extraction time = 30 Min.
- Amount of Sample = 12 Samples/ time
- Sample weight = 1 gram/sample
- Electricity price = 2.5 Baht/unit

- Cost calculation

  - KWH of microwave extraction $= \frac{1600 * 30}{1000*60}$ KWH
    $= 0.8$ KWH

  - KWH per sample $= \frac{0.8}{12}$ KWH/gram
    $= 0.67$ KWH/gram

  - **Cost of Electricity** **= 0.67*2.5** **B./g. of sample**

    = 0.167 **B./g. of sample**

2. Cost of Solvent

2.1 Acetone

- Acetone price = 380 B./2500 ml
- Solvent usage = 30 ml./g. of sample
- Cost of acetone $= \frac{380 * 30}{2500}$ B.
  $= 4.56$ B./gram of sample
- % recovery of solvent = 99 %
- **Total cost of acetone usage** **= 4.56 * 0.01**
  = 0.0456 **B./sample**

2.2 N-Hexane

- N-Hexane price = 630 B./2500 ml
- Solvent usage = 30 ml./g. of sample

- Cost of acetone = $\frac{630 * 30}{2500}$ B.
= 7.56 B./gram of sample
- % recovery of solvent = 99 %
- Total cost of acetone usage = 7.56 * 0.01
= 0.0756 B./sample

2.3 Petroleum Ether

- Petroleum Ether price = 400 B./1000 ml
- Solvent usage = 30 ml./g. of sample
- Cost of acetone = $\frac{400 * 30}{1000}$ B.
= 12 B./gram of sample
- % recovery of solvent = 99 %
- Total cost of acetone usage = 12 * 0.01
= 0.12 B./sample

2.4 Mixture of Acetone and N-Hexane

- Acetone price = 380 B./2500 ml
- N-Hexane price = 630 B./2500 ml
- Solvent usage (1:1 V/V) = 30 ml./g. of sample
- Cost of acetone = $\frac{(380+630)* 30}{2500 *2}$ B.
= 6.6 B./gram of sample
- % recovery of solvent = 99 %
- Total cost of acetone usage = 6.6 * 0.01
= 0.0606 B./sample

BIOGRAPHY

Ms. Jittiporn Kulpisitthicharoen was born on April 18, 1974 in Bangkok, Thailand. She attended Satrinonthaburi chool in Nonthauri. She received her Bachelor's Degree in Enviromental Science from Faculty o Science, Chulalongkorn Univerity in 1996. She had worked at Sahaviriya Steel Industry position there. She pursued her Master's Degree studies in the International Posttgraduate Programs in Environmental Management, Inter-Department of Environmental Management, Chulalongkorn University, Bangkok, Thailnad in May 2001.