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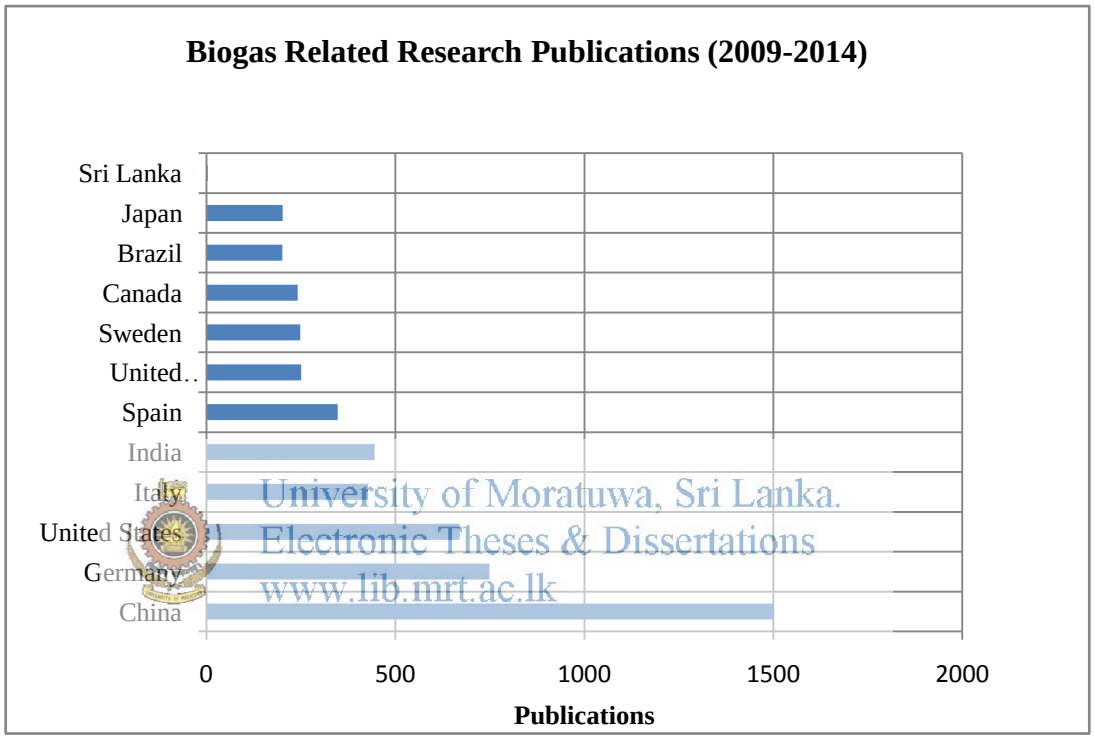
APPENDICES

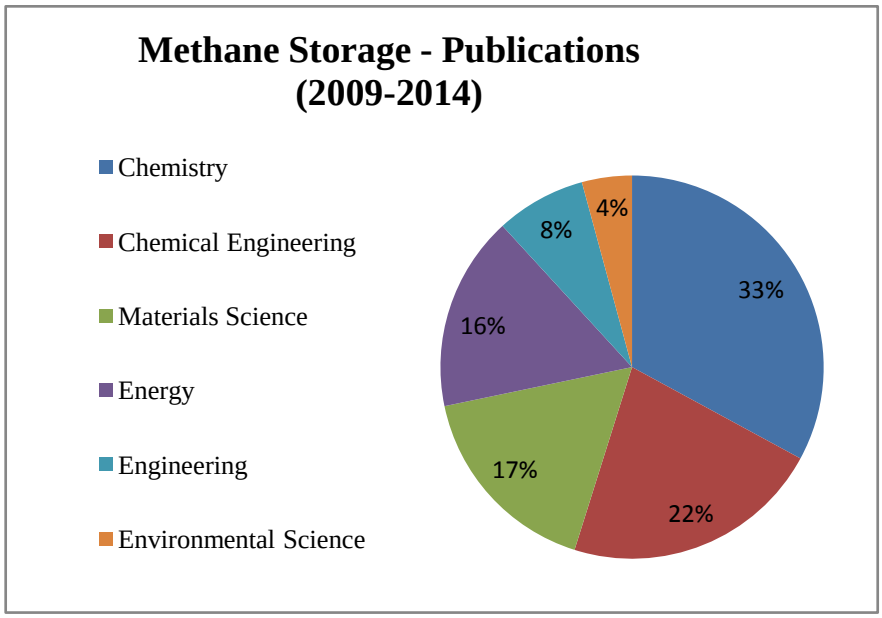
Appendix A

Scival Analysis on Bio-methane Storage on Activated Carbon

Country wise interests on biogas related research from 2009 to 2014 were analysed by using “biogas” as the keyword. Total 7804 publications were found, Sri Lanka only represents 3 among those. Country wise details are presented below.



Research interest on upgrading methane storage was analysed by using “methane storage” as the key word. Total 121 publications were found during the time period from 2009 to 2014 and categorized according to journal categories in a pie chart below.



Research interest on upgrading methane storage by activated carbon was analysed by using "methane storage" and "adsorption" and "activated carbon" as key words. Total 74 publications were found during the time period from 2009 to 2014 and categorized according to journal categories in a pie chart below

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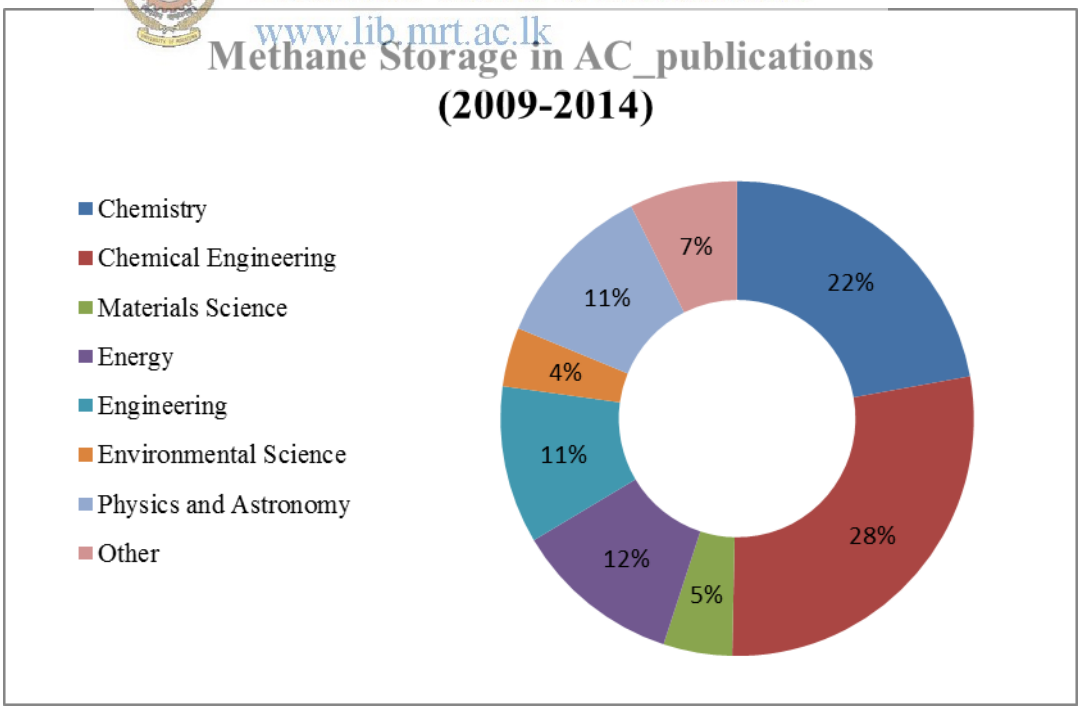

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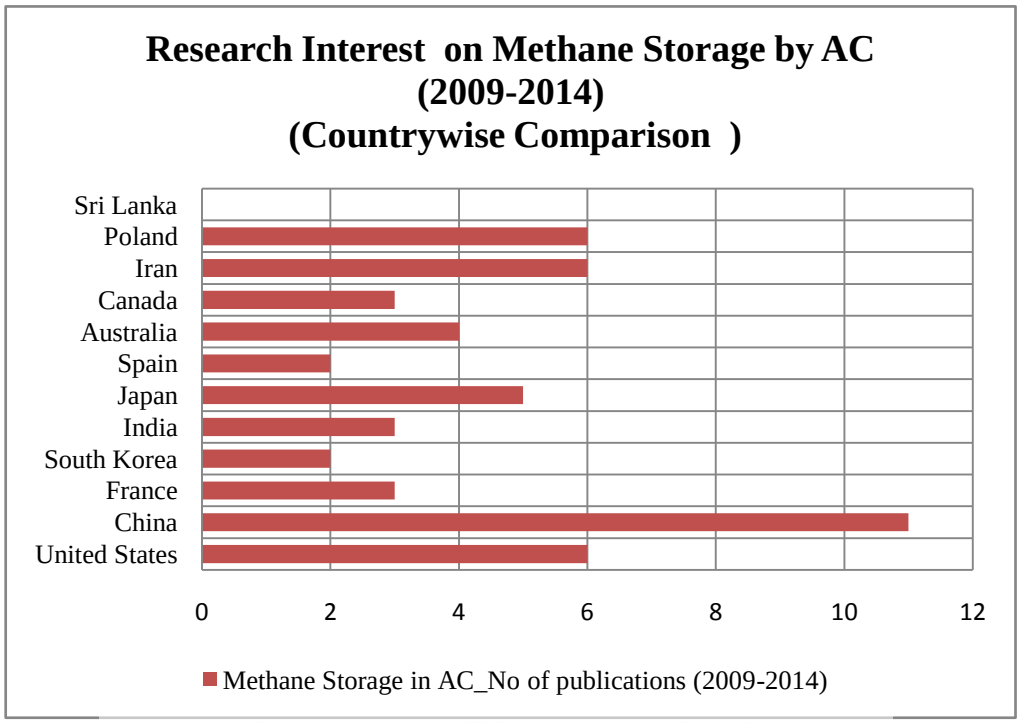
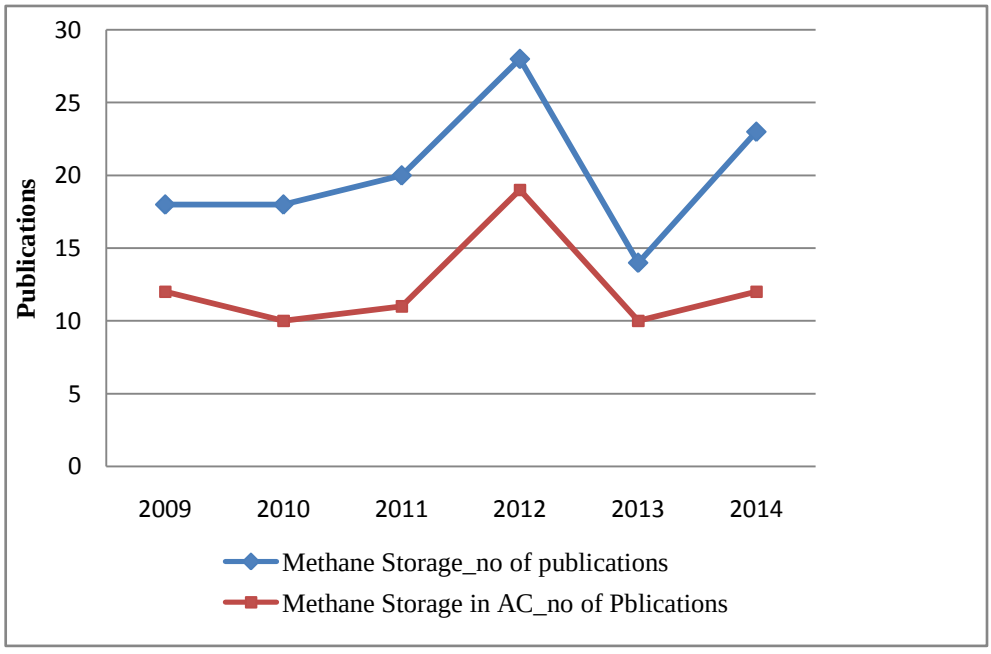
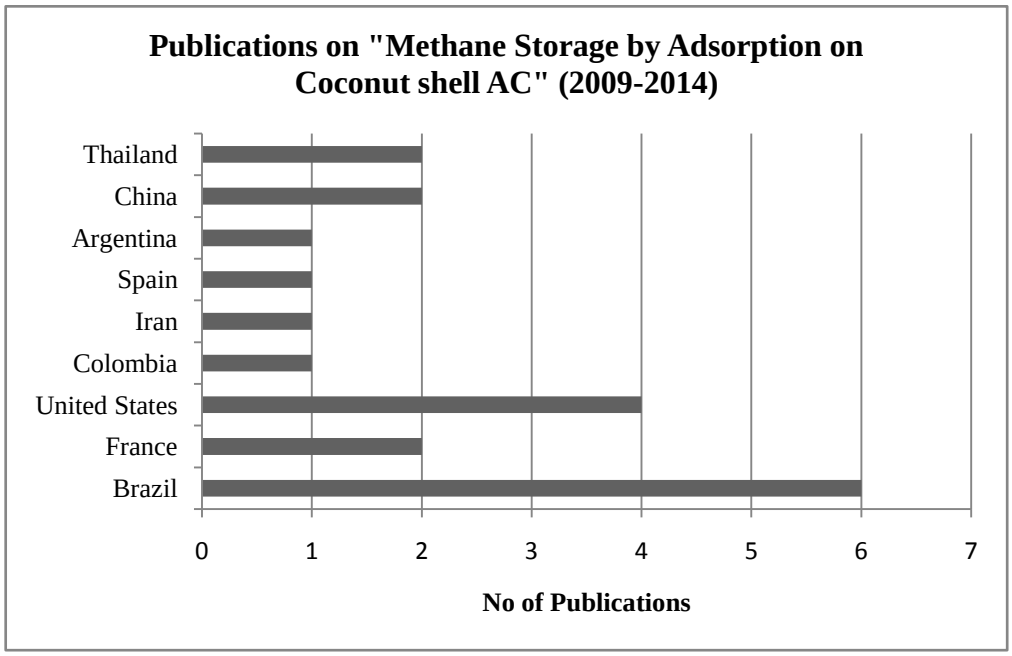
The below chart shows the country wise research interest on "methane storage by activated carbon" during 2009-2014



The yearly comparison of "methane storage" research area with "methane storage by activated carbon" is presented below. Most of the other methane storage publications are based on Metal Organic Frameworks (MOF) as the adsorbent.





The above chart shows the publication found from 2003 to 2014 period on methane adsorption on coconut shell activated carbon. All 15 publications were found are categorized according to the published country.

Appendix B

Activated Carbon Characterization Details found in Previous Publications

Raw Material	Activation Method	BET Surface Area (m^2/g)	Micropore Volume (cc/g)	Total Pore Volume (cc/g)	Apparent Density (g/cc)	Reference
Aeglemarmelos fruit shell	H_3PO_4	NG	0.56	0.58	NG	(Gottipati et al., 2012)
Coconut Shell	Steam, Burn off 58	1000	0.405	0.454	0.4	(Perrin et al., 2003)
	Steam, Burn off 86	1587	0.57	0.658	0.34	
	Steam, Burn off 120	2031	0.814	0.955	0.29	
Pinewood	H_3PO_4	1967	0.65	1.37	0.16	(Perrin et al., 2003)[17]
Coconut Shell	$ZnCl_2$	NG	0.268	NG	0.8	(Sapag et al., 2010)
	$ZnCl_2 + CO_2$, Burn off 20	NG	0.276	NG	0.65	
	$ZnCl_2 + CO_2$, Burn off 28	NG	0.34	NG	0.6	
NG	Commercial AC	899	0.48	0.5	0.48	(Siangsai et al., 2014)
	Commercial AC + KOH	935	0.5	0.52	0.48	
	Commercial AC + H_2SO_4	975	0.52	0.55	0.48	

Raw Material	Activation Method	BET Surface Area (m^2/g)	Micropore Volume (cc/g)	Total Pore Volume (cc/g)	Apparent Density (g/cc)	Reference
Coconut Shell	H_3PO_4 29%	520	0.3	0.34	0.32	(Rafael B. Rios et al., 2009)
	H_3PO_4 29%, H_2SO_4 washed	727	0.38	0.42	NG	
	H_3PO_4 36%	783	0.43	0.49	NG	
	H_3PO_4 36%, H_2SO_4 washed	844	0.5	0.55	0.45	
	H_3PO_4 44%	536	0.32	0.37	NG	
	H_3PO_4 44%, H_2SO_4 washed	767	0.44	0.51	0.33	
	H_3PO_4 53%	779	0.44	0.5	0.35	
	H_3PO_4 53%, H_2SO_4 washed	693	0.4	0.51	0.28	
	H_3PO_4 53%, H_2SO_4 washed+ carbonization	1441	0.73	0.86	0.26	
NG	Commercial	828	0.44	0.55	0.32	
	Commercial	1906	0.98	0.124	0.25	
Olive lexes	$ZnCl_2$	1291	0.54	0.91	0.38	(Solar et al., 2010)
	Steam	913	0.37	0.45	0.49	
	Steam	1015	0.42	0.47	0.5	

Raw Material	Activation Method	BET Surface Area (m^2/g)	Micropore Volume (cc/g)	Total Pore Volume (cc/g)	Apparent Density (g/cc)	Reference
Olive wood	$ZnCl_2$	2205	0.88	0.136	0.3	(Solar et al., 2010)
	Steam	1163	0.48	0.68	0.18	
	Steam	1117	0.46	0.75	0.21	
Graph Lex	$ZnCl_2$	1470	0.62	0.93	0.2	
Coconut Shell	$ZnCl_2 + CO_2$	2114	1.142	1.304	NG	(Bastos-Neto et al., 2005)
NG	Commercial	1967	0.945	0.957	NG	
Coconut Shell	$ZnCl_2$	1266	0.676	0.731	NG	(Cavalcante et al., 2007)
	$ZnCl_2$	1091	0.549	0.681	NG	
	$ZnCl_2 + CO_2$	1699	0.877	1.003	NG	
	$ZnCl_2 + CO_2$	2114	1.142	1.307	NG	
NG	Commercial AC (8 X 16)	1235	0.6	0.629	0.47	(Ercan et al., 2012)
	Commercial AC (30 X 70)	1589	0.706	0.747	0.39	
	Commercial AC (2 X 60)	1426	0.56	0.599	0.49	
	Commercial AC (12 X 40)	999	0.456	0.5	0.54	

Appendix C

Methane Adsorption Capacity on Activated Carbon found in Previous Publication

Raw Material	Activation Method	AC type	Methane Adsorption (V/V)	Pressure (MPa)	Temperature (K)	Reference
Coconut Shell	Steam, Burn off 58	PAC	107	8	275	(Perrin et al., 2003)
	Steam, Burn off 86		158	8	275	
	Steam, Burn off 120		121	8	275	
Pinewood	H_3PO_4	PAC	164	8	275	
Coconut Shell	$ZnCl_2$	Disc	30	3.5	298	(Solar et al., 2010)
	$ZnCl_2 + CO_2$, Burn off 20		42	3.5	298	
	$ZnCl_2 + CO_2$, Burn off 28		51	3.5	298	
Coconut Shell	$ZnCl_2 + CO_2$	NG	241	8	275	(Mahboub et al., 2012)
NG	Commercial AC	NG	44.1	3.5	303	(Siangsai et al., 2014)
	Commercial AC + KOH		52.1	3.5	303	
	Commercial AC + H_2SO_4		53	3.5	303	

Raw Material	Activation Method	AC type	Methane Adsorption (V/V)	Pressure (MPa)	Temperature (K)	Reference
Coconut Shell	H_3PO_4 29%	GAC	62	3.5	303	(Rafael B. Rios et al., 2009)
	H_3PO_4 36%, H_2SO_4 washed		95	3.5	303	
	H_3PO_4 44%, H_2SO_4 washed		67	3.5	303	
	H_3PO_4 53%		73	3.5	303	
	H_3PO_4 53%, H_2SO_4 washed		59	3.5	303	
	H_3PO_4 53%, H_2SO_4 washed+ carbonized		82	3.5	303	
NG	Commercial		59	3.5	303	
NG	Commercial		83	3.5	303	
Olive lexes	$ZnCl_2$	PAC	52	3.5	298	(Solar et al., 2010)
	Steam		28	3.5	298	
	Steam		57	3.5	298	
Olive wood	$ZnCl_2$		60	3.5	298	
	Steam		59	3.5	298	
	Steam		24	3.5	298	
Graph Lex	$ZnCl_2$		23	3.5	298	
Coconut Shell	$ZnCl_2$ + CO_2	PAC	80	4	298	(Cavalcante et al., 2007)

Appendix D

HAYCARB Characterization Report of Granular Activated Carbon

Appendix E

HAYCARB Characterization Report of Activated Carbon Pellets

Appendix F

Test Report of Biogas Chromatography Analysis

Appendix G

Calibration Certificate of Weighing Scale