

GraphICE - Thermal Energy Storage Balls

PCM-embedded solid graphite balls within water tanks, enabling the efficient storage of both heat and cold energy Thermal Energy Storage for both new installations and retrofitting projects.

Graphite formed into spherical balls within a diameter range of 10mm to 100mm and later they are impregnate with Bio based organic or hydrated salt-based Phase Change Materials (PCMs).



By nature, whether organic or hydrated salt based PCM materials are very poor for heat transfer due to very low thermal conductivity. Using plastic encapsulation, it makes it worse for heat transfer point of view and although this can be improved by using metal encapsulation but that increases the cost 10-fold and makes them uneconomical.

Our graphite based formed shaped PCM provides a highly conductive TES option with superior heat transfer performance. As these formed shaped PCM materials can be manufactured in shape and size it offers not only for a wide range of new products / application options but also a significant opportunity for any existing retrofit applications for wide range of heating and cooling TES applications.

GraphICE balls can be produced a temperature range between **+2°C** and **+95°C** and at present standard size is 32mm diameter and based one can fits balls /m³ tank volume and depending on PCM used offers 40-45 kWh/m³ thermal energy storage density. Other ball diameter tank loading;

Tank Volume (Lt.)	No of Balls	kWh
50	2,158	2
100	4,315	4
150	6,473	6
200	8,630	8
250	10,788	9
300	12,946	11
350	15,103	13
400	17,261	15
450	19,419	17
500	21,576	19
550	23,734	21
600	25,891	23
650	28,049	24
700	30,207	26
750	32,364	28
800	34,522	30
850	36,679	32
900	38,837	34
950	40,995	36
1000	43,152	38

Patent Pending: GB2315438.8



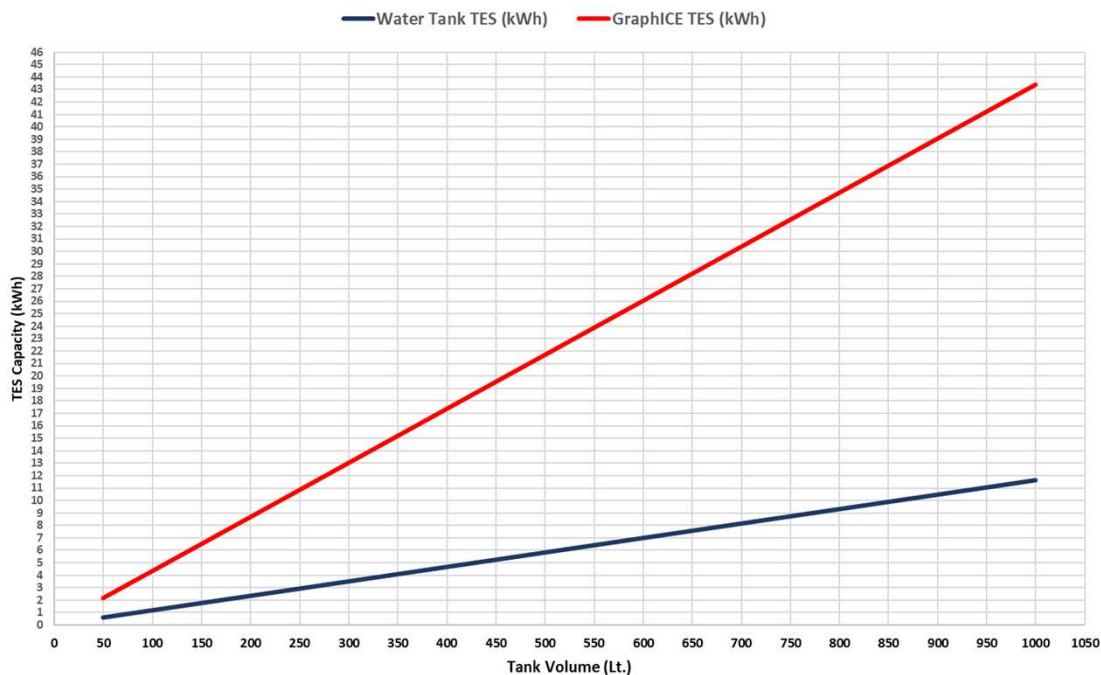
*Note;
Only latent
heat capacity
of the balls*

As GraphICE can be applied to both new and retrofit hot water and heat pump buffer tanks. Although by simply adding these balls into existing hot water may increase the capacity 2-3 times but the main benefits can be achieved for heat pump buffer application whereby the tank volume can reduced as much as by 1:4 ratios due to lower temperature difference for the design.

GraphICE Ball TES Design Data

PCM Type	Phase Change Temperature		GraphICE Ball Density		Latent Heat Capacity / 32mm ball		1m ³ = 43,152 Balls TES Capacity (kWh/m ³)			Specific Heat		Thermal Conductivity		Maximum Operating Temperature	
	(°C)	(°F)	(kg/m ³)	(lb/ft ³)	(kJ/kg)	(Btu/lb)	kWh	MBtu	RT-h	(kJ/kgK)	(Btu/lb°F)	(W/mK)	(Btu/Hr ft ² °F)	(°C)	(°F)
A2	2	36	765	48	175	75	27	0.093	8	1.93	0.46	8.77	5.07	150	302
A3	3	37	765	48	170	73	26	0.090	8	1.93	0.46	8.77	5.07	150	302
A4	4	39	766	48	235	101	37	0.125	10	1.91	0.46	8.77	5.07	150	302
A5	5	41	768	48	200	86	31	0.106	9	1.91	0.46	9.19	5.31	150	302
A6	6	43	768	48	180	77	28	0.096	8	1.90	0.45	8.77	5.07	150	302
A6.5	6.5	44	770	48	150	64	23	0.080	7	1.91	0.46	9.19	5.31	150	302
A7	7	45	770	48	180	77	28	0.096	8	1.91	0.46	9.19	5.31	150	302
A8	8	46	770	48	165	71	26	0.088	7	1.89	0.45	8.77	5.07	150	302
A9	9	48	770	48	175	75	27	0.093	8	1.89	0.45	8.77	5.07	150	302
A10	10	50	770	48	175	75	27	0.093	8	1.89	0.45	9.19	5.31	150	302
A11	11	52	775	48	200	86	31	0.106	9	1.89	0.45	9.19	5.31	150	302
A12	12	54	775	48	200	86	31	0.106	9	1.89	0.45	9.19	5.31	150	302
A13	13	55	775	48	200	86	31	0.106	9	1.89	0.45	9.19	5.31	150	302
A14	14	57	775	48	200	86	31	0.106	9	1.89	0.45	9.19	5.31	150	302
A15	15	59	780	49	205	88	32	0.109	9	1.89	0.45	7.52	4.34	150	302
A16	16	61	780	49	225	97	35	0.120	10	1.89	0.45	7.52	4.34	150	302
A17	17	63	780	49	235	101	37	0.125	10	1.91	0.46	7.52	4.34	200	392
A18	18	64	765	48	175	75	27	0.093	8	1.91	0.46	9.19	5.31	200	392
A19	19	66	765	48	140	60	22	0.074	6	1.91	0.46	9.19	5.31	200	392
A20	20	68	770	48	165	71	26	0.088	7	1.93	0.46	9.19	5.31	200	392
A21	21	70	770	48	150	64	23	0.080	7	1.93	0.46	9.19	5.31	200	392
A22	22	72	785	49	160	69	25	0.085	7	1.93	0.46	7.52	4.34	200	392
A23	23	73	785	49	170	73	26	0.090	8	1.93	0.46	7.52	4.34	200	392
A24	24	75	790	49	160	69	25	0.085	7	1.95	0.47	7.52	4.34	200	392
A25	25	77	785	49	210	90	33	0.112	9	1.95	0.47	7.52	4.34	200	392
A26	26	79	790	49	230	99	36	0.122	10	1.95	0.47	8.77	5.07	200	392
A27	27	81	768	48	180	77	28	0.096	8	1.95	0.47	9.19	5.31	200	392
A28	28	82	789	49	260	112	41	0.138	12	1.95	0.47	8.77	5.07	200	392
A29	29	84	785	49	175	75	27	0.093	8	1.95	0.47	8.77	5.07	200	392
A30	30	86	790	49	155	67	24	0.082	7	1.95	0.47	8.77	5.07	200	392
A31	31	88	790	49	155	67	24	0.082	7	1.95	0.47	8.77	5.07	200	392
A32	32	90	790	53	160	69	25	0.085	7	1.95	0.47	8.77	5.07	200	392
A33	33	91	790	49	165	71	26	0.088	7	1.95	0.47	8.77	5.07	200	392
A34	34	93	790	49	190	82	30	0.101	8	1.95	0.47	8.77	5.07	200	392
A36	36	97	776	48	250	108	39	0.133	11	2.02	0.48	9.19	5.31	250	482
A39	39	102	900	56	155	67	24	0.082	7	1.95	0.47	9.19	5.31	250	482
A42	42	108	905	57	150	64	23	0.080	7	1.95	0.47	8.77	5.07	250	482
A43	43	109	780	49	280	120	44	0.149	12	2.08	0.50	7.52	4.34	250	482
A46	46	115	910	57	140	60	22	0.074	6	1.95	0.47	9.19	5.31	250	482
A48	48	118	810	51	230	99	36	0.122	10	2.50	0.60	7.52	4.34	250	482
A53	53	127	910	57	150	64	23	0.080	7	1.95	0.47	9.19	5.31	250	482
A57	57	136	910	57	150	64	23	0.080	7	1.95	0.47	9.19	5.31	250	482
A58	58	136	820	51	240	103	37	0.128	11	2.50	0.60	7.52	4.34	200	392
A59	59	138	890	56	140	60	22	0.074	6	1.93	0.46	9.19	5.31	200	392
A62	62	144	910	57	190	82	30	0.101	8	1.93	0.46	9.19	5.31	250	482
A65	65	149	890	56	180	77	28	0.096	8	1.93	0.46	9.19	5.31	250	482
A70	70	158	890	56	200	86	31	0.106	9	1.93	0.46	9.60	5.55	250	482
A73	73	163	890	56	210	90	33	0.112	9	1.93	0.46	9.60	5.55	250	482
A78	78	172	890	56	210	90	33	0.112	9	1.93	0.46	9.60	5.55	250	482
A79	79	174	980	61	125	54	19	0.066	6	1.93	0.46	9.60	5.55	250	482
A82	82	180	930	58	210	90	33	0.112	9	1.93	0.46	9.60	5.55	250	482
A84	84	183	900	56	220	95	34	0.117	10	1.93	0.46	9.60	5.55	250	482
A88	88	190	900	56	220	95	34	0.117	10	1.93	0.46	9.60	5.55	250	482
A92	92	198	920	57	220	95	34	0.117	10	1.93	0.46	9.60	5.55	250	482
A95	95	203	900	56	230	99	36	0.122	10	1.93	0.46	9.19	5.31	300	572

Water Tank vs. GraphICE TES Capacity Comparison



Note; Capacities are based 32mm dia. Balls loaded with 48C PCM