Actual Power Consumption Values Of Alloy Steels – Experimental Results

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Abstract:

In this paper experimental heats were conducted for ascertaining actual energy required to produce one ton of liquid alloy steels. For this purpose 3.0T and 0.5 T Furnaces were selected in a foundry and experimental heats were conducted in a equi-uniform conditions. The furnaces were started from cold conditions, heated and metal was tapped till 3 rd heat. The charge consisted of scrap, foundry returns and additives on the basis of required chemistry of the client. The liquid metal was heated to the superheat and required quantity was tapped in to the ladles and poured in to the moulds. Energy readings were taken from the energy meter. Total liquid metal poured in the moulds is calculated.. Thus power consumption per one ton of liquid metal was arrived. As per the experiments 825 KWH energy was consumed for melting one Ton of Mn Steel , 886 KWH consumed for melting one ton of Carbon Steel. The power consumption was higher when the furnace was started from a Cold start(1 st heat) and decreased by 100-120 KWH to the 2nd heat and further reduced by 30-50 to the third heat giving an indication that, if the process is continuous, there will be a saving of 100-150KWH per one ton of liquid metal for a 3.0 Ton Induction Furnace. The actual power consumption values are compared with the theoretical values. It is observed that the practical values are almost double the theoretical, giving a suggestion that the foundry under study has to apply efficient measure to save power.

Key words : liquid metal, melting point, super heat, alloy steels ,actual power consumption, energy efficiency.

Introduction:

The growth and prosperity of any nation depends up on the effective utilization of its natural resources and implementation of energy efficient technologies. India is no exception to this. It has large reserves of Iron ore and a tradition of making Iron and steel for many decades. The annual production of Iron and steel in India is around 80 million tones and it consumes over 46 Mtoe of energy contributing about 6 percent of the National Greenhouse Gas emission [1]. Globally, this industry is an efficient one and in a few stages of Iron making , efficiency touches almost theoretical levels [1]. But in most of the cases, Indian plants are 50 percent higher than the global best practice with respect to practical energy consumption. There can be a number of options for improving energy efficiency. Many number of experiments were conducted to study the actual power consumption in many foundries . The present study is one such attempt to find out the actual amount of energy required for melting one ton of liquid metal in 3.0 Ton and 0.5 T induction Furnace and caution the industry.

Methodology of Experimental Heats to measure Actual Energy Consumption:

The Foundry and its Infrastructure *:* The foundry under the experimental study is part of a Billion $ Limited Company, in South India having capacity of 4000 MT and is having good foundry equipment. It is manufacturing Alloy Steels like Stainless Steels, Heat resistance Steels, Ni-Hard, Hi-Cr Carbon Steels, Mn Steels as per Indian and International Standards in the weight range of 10 kg to 3 MT single casting. The company is well supported by experienced Engineers in the field of Electrical, Mechanical and Metallurgical Engineering. The production facilities include: a) Medium Frequency Induction Furnaces, 550KW/ 3 MT /50 HZ, One no, 250 KW / 1 MT and 0.5 MT each, b**)** Hand Moulding facilities using Sand, Quartz sand, Zircon, Olivine, c**)** CO_2 Cores and Shell Cores in no bake condition ,d**)** Batch type Shot Blasting Machines, Swing Frame Grinders, Pedestal Grinders, Pneumatic fettling tools, e) Gas Fired Heat Treatment Furnace with recording and water quenching Facilities, f) EOT Crane 10 ton and Geared ladles, g**)** Air compressors, Diesel Generator, Lathe, Welding machines, and Drilling machines, h**)** Spectro Meter and other Quality Control lab equipment. **Mn Steel and C Steel making** : Experimental heats were conducted in actual conditions for Mn Steels and C Steel casting in a 0.5 T and 3.0 Ton Induction Furnace. The refractory lining consists of thermal shock resistance silica rammed along the refractory bricks resulting longer life to the refractory lining. The charge is loaded in batches after

Table -1: Melting Log Sheet showing detailed values of Mn Steel and C Steels in 0.5 Ton MFI Furnace

weighing manually. Additives were added as per the requirement of the chemistry of the client.The charge is melted to the melting point. For Mn Steels :The charge consists of – MS scrap, Mn Steel scrap, Mn Steel foundry returns and rejected castings .High Carbon Fe Mn and MC Fe Mn are added as additives.. For Carbon Steels: Thee charge consists of —MS Scrap, Foundry Returns and rejected castings , MC.Fe.Mn and Fe Si is added as per the qualitative requirement as additives.

The temperature and chemistry of the bath are controlled and measured regularly. The molten metal is tapped in ladles and poured in the moulds. The log sheet parameters of sample heats of 9 nos for Mn Steels and C Steels in 0.5 T furnace are tabled in Table-1 and similar readings of 10 nos are tabled in Table 2 for furnace 3.0 Ton .The actual energy consumed for one Ton of liquid metal is derived and tabulated in the last Row of the Tables-1 and 2. Similarly, another 54 sets of experimental heats were conducted for Mn Steels and C Steels and results were Tabulated in Tables—3 to Table --6 . The actual power consumption patterns are shown in the Fig 1 to Fig -4

Table -2 : Melting Log Sheet showing detailed values of Mn Steel and C Steels in 3.0 Ton MFI Furnace

Experiment	day 1-1	day 1-2	day 1-3	day 2-1	day 2-2	day 2	day 3-1	day 3-2	day 3-3
Particulars	**C.Steel**	**Mn.Steel**	**Mn.Steel**	**Mn.Steel**	**C.Steel**	**C.Steel**	**C.Steel**	**C.Steel**	**C.Steel**
Specification	**19511**	**Gr-3**	**Gr-3**	**Gr-3**	**19569**	**Is 1030**	**19569**	**19569**	**19569**
Heat No	Q-383	Q-384	Q-385	Q-386	Q-387	Q-388	Q-387A	Q-387B	Q-387C
Furnace	0.5T	0.5T	0.5T	0.5T	0.5T	0.5T	0.5T	0.5T	0.5T
Furnace On at Hrs	11.50	14.10	15.50	11.00	14.15	16.20	9.00	11.30	13.50
Tapped at Hrs	14.00	15.40	17.30	14.00	16.10	17.55	11.20	13.40	16.40
Time Taken in hr	2.10	1.30	1.40	3.00	1.55	1.35	2.20	2.10	2.50
Tapping Temp C	1600	1493	1486	1487	1603	1610	1610	1610	1620
Lining Heat No	24/57	24/58	24/59	24/60	24/61	24/62	24/63	24/64	24/65
Liquid Metal kg		210	20			50		30	50
MS Scrap	634	100	94	250	655	606	690	676	998
Mn.S.Scrap		150	100						
Foundry Returns		38	300	547					
HC.Fe.Mn		30	20	15					
MC.Fe.Mn	2	40		20	1			2.5	2
Fe.Si	3.5				4	4	1	3	7

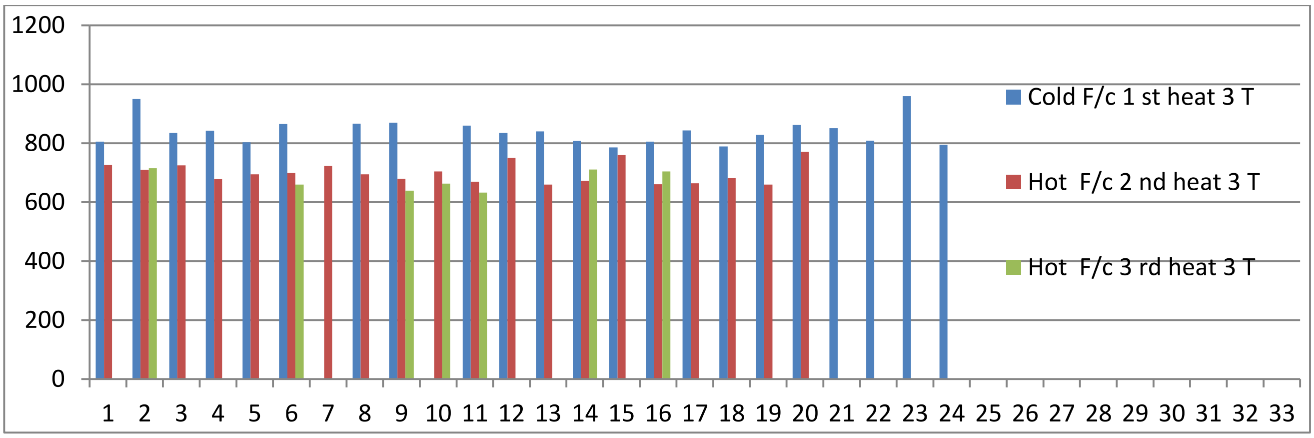
HC.Fe.Cr		12	6	5					
Foundry Rejected	30	90	120	90	30	30	30	30	30
Solid Charge kg	669.5	460	640	927	690	640	721	711.5	1037
Total Charge kgs	669.5	670	660	927	690	690	721	741.5	1087
Graphite Powder				2					
Al/Fe.Ti	0.6	1	1	1	0.6	0.7	1	0.8	1
Calcium Silicide	0.6				0.6	0.7	1	0.8	1
Slag Coagulant	10	10	10	10	10	10	10	10	10
Gross Wt Kgs	440	630	630	900	620	630	640	640	967
Test Bars							30	30	
Metal Returned	210	20			50	40	30	50	
Pig—2			10						90
Total Misc	210	20	10	0	50	40	60	80	90
Total LM Kgs	650	650	640	900	670	670	700	720	1057
Power Consumed Units KW	640	320	460	720	520	420	600	440	740
Power consumed per Ton of Liquid Metal KWH	985	727	742	800	776	677	857	638	735

Table –3: Showing the power consumption KWH/Ton of Liquid Metal for Mn Steel in 3T Furnace

Number of experimental heats

Status of Furnace	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cold F/c 1 st heat	805	950	834	842	803	865	--	866	869		859	835	840	807	786	805	843
Hot F/c 2 nd heat	726	710	725	678	694	699	722	694	679	704	669	750	659	672	759	661	664
Hot F/c 3 rd heat	--	715	--	--	--	659	--	--	639	663	632	--	--	711	--	704	--
	18	19	20	21	22	23	24	5	266	27	28	28	30	31	31	33	
Cold F/c 1 st heat	789	828	862	851	808	960	794	750	821	821	799	837	--	783	778	--	
Hot F/c 2 nd heat	681	659	770	--	--	--	--	--	713	711	761	731	694	628	776	667	

Fig—1: Figure showing the values of actual power consumption against number of experiments in a 3T furnace for Mn Steel



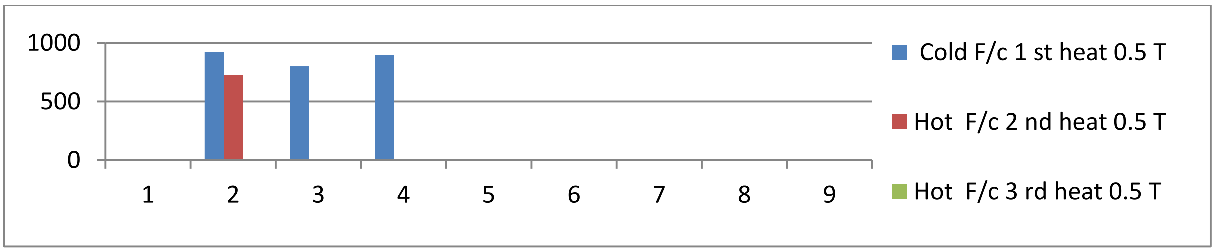
Observations : It is observed from the above results that the average requirement of energy for melting one ton of Mn Steel metal from a 3 T furnace is

1) Cold start or Start up 1 st Heat 820 KWH
2) 2nd heat 700 KWH
3) 3rd heat 675 KWH

Table—4. Showing the power consumption KWH/Ton of Liquid Metal for Mn Steel in 0.5 T Furnace

Status of Furnace	Number of experiments		
	1	2	3
Cold F/c 1 st heats	923	800	897
Hot F/c 2 nd heat	725	--	--

Fig—2: Figure showing the values of actual power consumption against number of experiments in 0.5T Furnace for Mn Steels



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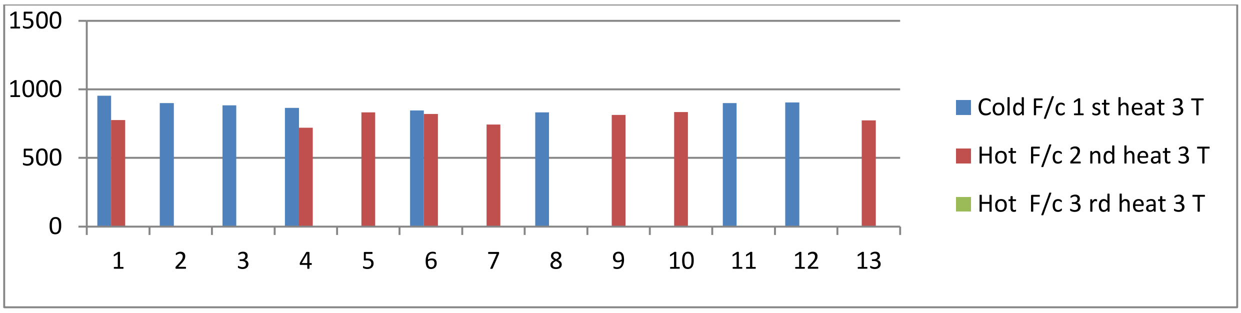
Observations : It is observed from the above results that the average requirement of energy for melting one ton of Mn Steel metal from a 0.5T furnace is

1) Cold start or Start up 1 st Heat 873 KWH
2) 2nd heat 725 KWH

Table—5. Showing the power consumption KWH/Ton of Liquid Metal for C Steel in 3T Furnace

Status of Furnace	number of experiments												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Cold F/c 1 st heat 3 T	953	900	885	866	--	847	--	833	--	--	900	905	-
Hot F/c 2 nd heat 3 T	777	--	--	721	833	822	745	--	814	835		--	774

Fig—3: Figure showing the values of actual power consumption against number of experiments.



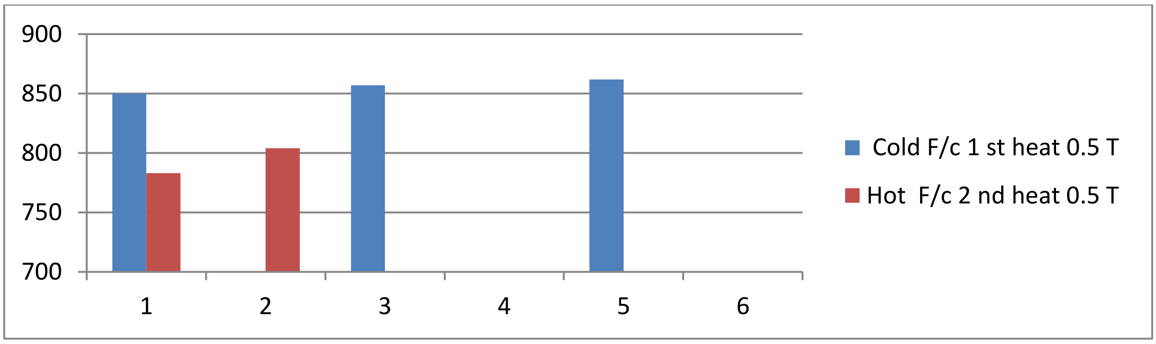
Observations : It is observed from the above results that the average requirement of energy for melting one ton of Mn Steel metal from a 3.0T furnace is

1) Cold start or Start up 1 st Heat 886 KWH
2) 2nd heat 790 KWH

Table—6. Showing the power consumption KWH/Ton of Liquid Metal for C Steel in 0.5T Furnace

Status Furnace	Number of experiments				
	1	2	3	4	5
Cold F/c 1 st heat	850	--	857		862
Hot F/c 2 nd heat	783	804	--		---
Hot F/c 3 rd heat	--	830	--		---

Fig—4: Figure showing the values of actual power consumption against number of experiments.



Observations: It is derived from the above results that the average requirement of energy for melting one ton of C Steel metal from a 0.5 T furnace is

1) Cold start or Start up 1 st Heat 856 KWH
2) 2nd heat 793 KWH

Results and discussions:

The experimental heats were conducted in 3.0 T and 0.5 T Furnace for Mn Steels and C Steels. The furnace was started from cold state for the first heat and second heat was also taken and some times third heat was also taken. The values of KWH were carefully drawn.. The energy required in 0.5 T furnace is more than that of 3.0T furnace for melting Mn Steels . But the same is not true for C steel. The energy required in 0.5 Ton furnace is less than that of 3 T furnace for C steels. The theoretical energy required for medium frequency is 383--406 KWH/ Ton of liquid metal.[2]

Mn Steel 3.0 T MFI		0.5 T MFI	Industry average	Theoretical Energy
1) Cold start or Start up 1 st Hea	820 KWH	873KWH	628	383--406
2) 2nd heat	700 KWH	725KWH	628	383-- 406
3) 3rd heat	675 KWH	-----		
C Steel 3.0 T MFI				
1) Cold start or Start up 1 st Heat	886 KWH	856KWH	628	383--406
2) 2nd heat	790 KWH	793KWH	628	383--406

Conclusions : The present experiments are done with an aim to know the actual energy required to melt one ton of steel alloy. The results varied from 675 to 820 KWH for a 3 Ton furnace. The theoretical requirement of the energy is 383-406. Thus, the foundry under study is consuming double energy than the theoretical energy which is required. The industrial average is 628 KWH . Thus Precious energy is lost by the SME because of inefficient methods |The foundry was suitably advised . As energy efficient methods are key words for innovation, foundries are to adopt innovative technologies for a better 'save energy complain '.

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