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Website: www.iim-india.net Fax: (033) 2367 5335

Editor: Dr. Sukomal Ghosh

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EDITORIAL

Industry 4.0: A perception

The digitization of manufacturing represent the fourth revolution (Industry 4.0) that has occurred in manufacturing. From the first industrial revolution (mechanization through water and steam power) to the mass production and assembly lines using electricity in the second, the fourth industrial revolution will take what was started in the third with the adoption of computers and automation and enhance it with smart and autonomous systems fuelled by data and machine learning.

As Industry 4.0 unfolds, computers are connected and communicate with one another to ultimately make decisions without human involvement. A combination of cyber-physical systems, the Internet of Things and the Internet of Systems make Industry 4.0 possible and the smart factory a reality. As a result of the support of smart machines that keep getting smarter as they get access to more data, factories will become more efficient and productive and less wasteful. Ultimately, it's the network of these machines that are digitally connected with one another and create and share information that results in the true power of Industry 4.0.

While many organizations might still be struggling to find the talent or knowledge to know how to best adopt it for their unique use cases, several others are implementing changes and preparing for a future where smart machines improve their business. Here are just a few of the possible applications:

Identify opportunities: Since connected machines collect a tremendous volume of data that can inform maintenance, performance and other issues, as well as analyse that data to identify patterns and insights that would be impossible for a human to do in a reasonable timeframe, Industry 4.0 offers the opportunity for manufacturers to optimize their operations quickly and efficiently by knowing what needs attention.

Optimize logistics and supply chains: A connected supply chain can adjust and accommodate when new information is presented. If a weather delay ties up a shipment, a connected system can proactively adjust to that reality and modify manufacturing priorities.

Robots: Once only possible for large enterprises with equally large budgets, robotics are now more affordable and available to organizations of every size. From picking products at a warehouse to getting them ready to ship, autonomous robots can quickly and safely support manufacturers.

Additive manufacturing (3D printing): This technology has improved tremendously in the last decade and has progressed from primarily being used for prototyping to actual production. Advances in the use of metal additive manufacturing have opened up a lot of possibilities for production.

Internet of Things and the cloud: A key component of Industry 4.0 is the Internet of Things that is characterized by connected devices. Not only does this help internal operations, but through the use of the cloud environment where data is stored, equipment and operations can be optimized by leveraging the insights of others using the same equipment or to allow smaller enterprises access to technology they wouldn't be able to on their own.

While Industry 4.0 is still evolving, companies who are adopting the technologies realize Industry 4.0's potential. These same companies are also grappling with how to upskill their current workforce to take on new work responsibilities made possible by Industry 4.0.

Source: Excerpts from of Article of Bernard Marr
https://www.forbes.com/sites/bernardmarr/#5c82e0b730c8

Hot Rolling of Maraging Steel at Plate Mill

K L Balasubramaniam, Vinita Verma, Desaraju Swetha, Himani Thakur

Abstract

Mishra Dhatu Nigam Limited (MIDHANI), Hyderabad is the only organization in India producing different alloy steel components for Defense and Space research applications. Maraging steel is one of such special steel produced by MIDHANI for manufacture of the outer casing of PSLV, GSLV space flights. The major alloying elements specified for Maraging steel are Ni: 17.5% - 18.5%, Mo: 4.6% - 5.2%, Co: 7.5%-8.5% & Ti: 0.4%-0.6%[1]. At MIDHANI the steel is produced and refined in vacuum induction furnaces and the ingot cast is forged into slabs. These slabs of 165 mm thickness, designated as MDN 250, are to be hot rolled into plates of thinner sections for manufacturing outer casing of space flights. For developing the rolling at BSP, several rounds of discussions took place between MIDHANI and Vikram Sarabhai Space Centre at Bhilai. The plates were rolled successfully in Bhilai Steel plant and were further machined and heat treated to obtain the desired dimensional and mechanical properties for the intended purpose. The salient features of rolling MDN250 grade steel from the input size of 165 mm slabs to 9.5 mm plates at Bhilai Steel Plant are:

The Sulphur content of the fuel in the reheating furnace was controlled within 400 ppm and the Oxygen in the furnace atmosphere was controlled within 2%.

Very stringent thermal regimes were maintained while heating the slabs of Maraging steel at pre-heating, heating and soaking zones of the reheating furnace.

Soaking of the slabs were controlled within a narrow range to avoid excess heating and formation of undesired phases. The soaking temperature and duration is the most critical factor which determines the final properties of the plate rolled after heat treatment at MIDHANI.

De scaling of each slab was done at hydraulic descaler and salt spray was carried out at roughing stand for all the slabs to eliminate the sticky scales.

The pass schedule at roughing and finishing stand was worked out carefully considering the alloy content of slabs and the faster cooling rate of the stock during rolling. Further the maximum load was contained within 4500 Ton the maximum roll separating force the mill is designed[2].

The technological norms designed were strictly adhered to resulting in all the plates rolled and supplied passed at MIDHANI after heat treatment.

Introduction

Maraging steels (a portmanteau of "martensitic" and "aging") are steels (iron-alloys) which are known for possessing superior strength and toughness without losing malleability, although they cannot hold a good cutting edge. Aging refers to the extended heat-treatment process. These steels are a special class of low-carbon ultra-high-strength steels which derive their strength not from carbon, but from precipitation of inter-metallic compounds. The principal alloying element is 15 to 25% nickel[3].

Secondary alloying elements are added to produce intermetallic precipitates, which include cobalt, molybdenum, and titanium. Due to the low carbon content maraging steels have good machinability[4]. Maraging steels offer good weldability, but must be aged afterward to restore the properties of heat affected zone[3]. When heat-treated, the alloy has very little dimensional change, so it is often machined to its final dimensions. Due to the high alloy content maraging steels have a high hardenability [5]. M/s MIDHANI have developed MDN 250 Grade Maraging steel with guaranteed mechanical properties of YS 1725 MPa min, UTS: 1765MPa min and Fracture Toughness (KiC) 90 MPa $\sqrt{}$m minimum. The steel made through vacuum induction furnaces was cast into ingots and forged into slabs at MIDHANI and further hot rolled at Bhilai Steel Plant into plates. Use of carefully controlled reheating regimes and rolling parameters at plate mill of Bhilai Steel Plant coupled with unique two / three stage Solution Treatment at MIDHANI[6,7], helped in meeting customer needs and the final results of the product surpassed various international standards. Table 1 shows the comparable properties of International Standards with MIDHANI MDN 250 grade:

The mentioned properties made MDN 250 grade most suitable for forming the outer cases of space flights which require

(a) Sufficient static strength to withstand high stresses
(b) Very high fracture toughness to withstand shock loads
(c) Retention of strength upto moderately high temperature
(d) High stress corrosion resistance
(e) High stiffness and adequate fatigue resistance to resist dynamic stresses

Rolling of Maraging steel slabs

BSP does not have the facility to cast the slabs of Maraging steel. However, the maraging steel made through a series of vacuum induction process cast into ingots and forged into slabs was converted into plates at Bhilai Steel Plant. These plates will be further processed, heat treated and used in the areas of satellite launching. The parameters followed in rolling of this grade slab are as detailed below:

Ten slabs were taken up for rolling into plates in a lot/campaign:

Nominal Slab Size T x W x L (mm)	Nominal Plate size to be rolled T X W X L (mm)	Weight (kg)
165 x 1300 x 2400	9.5 x 2400 x 10000	4252

Table 1

Specification	Guaranteed Minimum Properties		
	0.2% Proof Stress (MPa)	UTS(MPa)	KiC MPa √m
	INTERNATIONAL		
AICMA-FE-PA95	1620	1720	-
W.Nr.1.6359.4	1620	1720	-
AMS6520C	1690	1758	-
Mil-S-46850D	1650	-	83
	MIDHANI		
MDN250	1725	1765	90

SAIL, Bhilai Steel Plant
E-mail: *klbalasubramanian@sail-bhilaisteel.com*

At the start of each campaign of rolling MDN 250, it is customary to have a kick off meeting between BSP, M/s MIDHANI and M/s VSSC where all the activities relating to process parameters to be followed from charging of slabs to rolling, finishing and inspection of plates are discussed and finalized.

Preparatory activities

The furnace temperature measuring instruments were calibrated.

To ensure close control of thermal regimes the status of furnace temperature vis-à-vis the slab temperature was checked with job thermocouples provided by M/s MIDHANI.

The sulphur in flue gas and oxygen in furnace atmosphere were analyzed and recorded. The limiting parameter for sulphur is 400 ppm and for oxygen is around 2%.

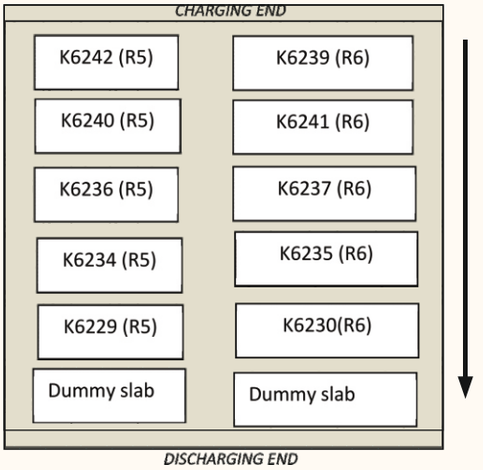
Charging and furnace regime

All the 10 slabs, taken in one lot, were placed on charging table in such a way that the top location of the slabs (hard punched on the slab) faces the discharging end of the furnace. The top location indicates the top portion of the ingot cast and forged into slabs at MIDHANI. This will be used for traceability of properties after post rolling heat treatment at MIDHANI.

All the ten Slabs were charged in the same furnace in both the rows. One mild steel slab (dummy slab) of 200 mm thickness was charged and kept in each row in front of MDN-250 slab at furnace 2. The purpose of charging the mild steel slab of 200 mm is to avoid climbing of MDN 250 slabs which are of 160 mm thickness. These mild steel slabs were subsequently discharged and rolled and taken out off-line. One pilot heat of 10 mm thickness in high tensile grades was charged in furnace and rolled before MDN-250 slabs for setting the mill.

The preheating zone temperature[2] was aimed around 1180^{0}C and the heating Zone temperature at 1280^{0}C max. The slabs were soaked at 1250^{0}C for initial 3 hours and then increased to 1280^{0}C for minimum 1 hour. Residence time from charging to end of heating zone: 3h minimum (Preheating zone around 2h and heating zone around 1h minimum) and the residence time at soaking Zone: 4h Minimum.

The actual charging scheme and the residence time recorded for one of the lots is given :



- Charging started at - 10:45 h
- Charging completed at - 11:25 h
- Discharging started at - 19:25 h
- Discharging completed at - 21:20 h
- Temperature at soaking zone up to 18:00 h : 1260-1280 °C
- Temperature increased to 1290-1305 °C from 18:00 h to 21:20 h
- Slabs in Preheating zone: 11:25 h to 13:25 h
- Slabs in Heating zone : 13:25 h to 14:25 h
- Slabs in Soaking zone : 14:25 h to 19:25 h
- Total residence time in the furnace : 8h 40 minutes (First slab) to 9h 55 minutes (Last slab)
- Residence time in the soaking zone : 5 h

Sample for sulphur and oxygen analysis taken once after charging of slabs and the other during soaking of slabs. Further, samples were taken for oxygen analysis during soaking at an interval of one hour. Oxygen in the furnace atmosphere was controlled within 2%. Actual furnace temperature, zone wise, is recorded and the slabs were discharged in planned sequence. Data recorded for one of the campaign is given below:

Actual Zonal temperature (in Deg C)

TIME	TPHZ Y/S	TPHZ M/S	BPHZ Y/S	BPHZ M/S	THZ Y/S	THZ M/S	BHZ Y/S	BHZ M/S	SZ Y/S	SZ M/S
11:00	1163	1138	1177	1171	1194	1269	1242	1260	1269	1290
12:00	1180	1165	1174	1166	1260	1278	1264	1276	1276	1270
13:00	1183	1161	1161	1168	1258	1260	1261	1273	1263	1270
14:00	1173	1179	1173	1168	1268	1255	1273	1264	1253	1257
15:00	1168	1155	1160	1159	1268	1273	1280	1278	1268	1267
16:00	1139	1117	1118	1124	1256	1252	1263	1264	1259	1264
17:00	1168	1147	1121	1125	1263	1260	1266	1272	1263	1262
18:00	1201	1184	1145	1156	1276	1275	1280	1281	1283	1281
19:00	1195	1166	1175	1179	1266	1275	1280	1289	1303	1307
20:00	1169	1139	1182	1205	1290	1299	1298	1270	1320	1309
20:40	1148	1119	1170	1175	1288	1300	1298	1273	1320	1305
21:00	1192	1172	1164	1178	1296	1279	1280	1265	1324	1308
21:30	1176	1165	1159	1182	1287	1274	1285	1281	1331	1312

Note: Slab surface temperature at soaking zone was measured at different interval by using contact "K" range thermocouple brought by MIDHANI and inserting it in the hole made by removing side wall brick at yard side.

Time (hour)	Soaking zone Temp.- Set Point (°C)	Yard side slab temp (°C)
16:00	1260	1224
16:15	1260	1243
16:30	1260	1245
17:00	1260	1260
17:30	1270	1265
18:00	1290	1270
18:30	1300	1285
19:00	1300	1285
19:50	1300	1300
20:30	1305	1305
21:00	1305	1304

Flue gas analysis

Time (hour)	Oxygen	Sulphur
11:00	0.4 % (PRE HEATING ZONE)	16 ppm
16:00	0.5 % (SOAKING ZONE)	In traces
17:30	0.5 % (SOAKING ZONE)	-

Discharge sequence

Discharging Sequence	Heat No . (Midhani)	Plate No. (BSP)	Furnace Number	Row Number
1	K6229	2275925	3	5
2	K6230	2275930	3	6
3	K6234	2275926	3	5
4	K6235	2275931	3	6
5	K6236	2275927	3	5
6	K6237	2275932	3	6
7	K6240	2275928	3	5
8	K6241	2275933	3	6
9	K6242	2275929	3	5
10	K6239	2275934	3	6

Slab Charging / Discharging Time and Receiving Temperature at Roughening Stand

Slab No	Charging Time (hour)	Discharging Time (hour)	Slab Receiving Temp.(°C)
K6229	10:45	19:25	1072
K6230	10:50	19:45	1053
K6234	10:55	20:05	1072
K6235	11:00	20:20	1080
K6236	11:05	20:30	1066
K6237	11:10	20:43	1051
K6240	11:15	20:55	1094
K6241	11:25	21:05	1078
K6242	11:30	21:15	1068
K6239	11:45	21:20	1083

- De-scaling of each slab was done at hydraulic descaler.
- Salt spray carried out at roughing stand for all the slabs.

Rolling of slabs

As a precautionary measure, in the event of any delay or breakdown in the mill, when slabs are inside the furnace, and if delay is likely to exceed 4 hours, it was planned that the furnace temperature shall be brought down below 1000°C to avoid excessive oxidation of the slab surface. However such incident never happened during rolling of MDN 250 slabs.

Only after finish-rolling the previous slab, next slab was discharged. Slab temperature after discharging was recorded. De-scaling of slabs was done at hydraulic descaler with pressure set at 170 bars. In addition to this, salt spray was carried out at roughing stand for effective removal of scales formed in the top surface of the slabs. This has ensured the surface of plates rolled free of rolled- in scale pits.

During rolling at roughing stand, each slab discharged was turned 90 Deg clockwise and rolled. Rolling continued in the same direction. The indicative draft schedule at roughing stand was 17.5-14.4-13.2-12.4-11.4-10.3-9.8-9.6 mm. Draft schedule was altered at finishing stand also as per the condition at the time of rolling. Actual draft (each pass) and rolling load was recorded. The finish rolling temperature was aimed above 800°C. Finishing temperature recorded for all the plates. The typical pass schedule and finishing temperatures achieved are as given below:

Rolling at Roughing Stand

Slab No		PASS										Exit Temp. (°C)
		1	2	3	4	5	6	7	8	9	10	
K6229	Draft	147	127	107	86	66	50	35	28	21	16	1011
	Load	2700	2900	3500	3600	3500	3900	3894	3210	3500	3600	
K6230	Draft	145	125	106	83	66	51	36	28	20	16	1038
	Load	2900	3700	3600	4100	4200	4300	4800	4340	4300	3765	
K6234	Draft	145	125	106	86	66	50	36	26	19	16	1040
	Load	2495	3000	3100	3500	3300	3591	3800	3800	4000	3100	
K6235	Draft	145	125	105	83	66	50	36	26	19	16	1048
	Load	2390	2900	3300	3700	3800	3900	4900	4100	4173	3400	
K6236	Draft	145	125	107	84	66	50	36	26	19	16	1035
	Load	2600	2900	3200	3300	3800	3600	3900	3800	4200	3022	
K6237	Draft	145	125	105	84	66	50	36	26	19	16	1020
	Load	2400	3200	3100	3600	3700	4000	4000	4100	4100	3300	
K6240	Draft	145	125	105	84	66	50	36	26	19	16	1071
	Load	2300	2900	2900	3200	3200	3600	3800	3700	3800	3400	
K6241	Draft	145	125	105	84	66	50	36	26	19	16	1068
	Load	2391	3100	3100	3500	3600	3800	3900	3900	4000	3100	
K6242	Draft	145	125	105	84	66	50	36	26	19	16	1070
	Load	2200	2800	2890	3260	3200	3300	3500	3600	3800	3000	
K6239	Draft	*	*	*	*	*	*	*	*	*	*	910
	Load	*	*	*	*	*	*	*	*	*	*	

** No data available*

Rolling at Finishing Stand

Slab No		Rec. Temp (°C)	PASS										Fin. Temp. (°C)
			1	2	3	4	5	6	7	8	9	10	
K6229	Draft	960	16.8	14.0	14	13.5	12.9	12.5	-	-	-	-	763
	Load		3600	3700	3850	3600	3754	4100	-	-	-	-	
K6230	Draft	952	16.7	14.1	12.3	12.0	10.7	10.3	9.5	9.5	-	-	746
	Load		3600	3680	3750	4200	4100	4000	3800	3700	-	-	
K6234	Draft	971	16.8	14.0	13.0	11.8	10.5	10.1	9.6	9.7	-	-	761
	Load		3750	3680	3800	3750	3648	3652	3700	3800	-	-	
K6235	Draft	961	17.2	13.2	12.9	11.6	10.7	10.1	9.6	9.6	-	-	707
	Load		3620	3654	3720	4000	3900	3820	3650	3700	-	-	
K6236	Draft	974	16.9	14.1	12.8	11.6	10.6	10.2	9.6	9.7	-	-	714
	Load		3750	3800	3900	3752	3860	3400	3460	3700	-	-	
K6237	Draft	964	16.9	14.1	12.8	11.7	10.6	10.1	9.8	9.8	-	-	764
	Load		3900	3560	3800	4100	3700	3890	3970	3840	-	-	
K6240	Draft	982	16.9	14.1	13.0	11.7	10.6	10.1	9.7	9.7	-	-	761
	Load		3780	3640	3895	3966	3846	4000	3800	3600	-	-	
K6241	Draft	967	17.0	14.1	12.7	11.8	10.7	10.0	9.6	9.7	-	-	765
	Load		3900	3650	3860	3870	4100	3870	3560	3750	-	-	
K6242	Draft	960	17.1	14.1	12.8	11.6	10.5	10.1	9.6	9.7	-	-	749
	Load		3866	3865	3460	3900	3870	4000	3600	3700	-	-	
K6239	Draft	847	17.6	18.0	16.0	14.5	13.1	12.1	11.1	10.5	10.1	9.6	714
	Load		3560	3750	3600	3870	4600	3465	3865	4100	3800	3900	

All the slabs were finally aimed to be rolled to 9.2 mm thickness. Due to the sensitive requirement of the surface, no hot stamping was carried out. Plates were identified with Hot Chalk only. No hot cropping of ends was carried out to ensure the entire slab rolled into plate is utilized by M/s MIDHANI. Plates were leveled at Leveler 1.

The top surface of the plates was initially inspected for surface quality. The entire plate was tilted to inspect the bottom surface also. After the inspection of top and bottom surface, the plate was again tilted to maintain the as supplied surface identity for MIDHANI. Thickness measurement recorded at 3 places both the edges (front, middle and back). The rolled length and width of plates were also measured and recorded. Plates were paint marked to indicate the plate number/piece number, heat number, grade, size(mm), Top/bottom reference marks. The plates were shifted to heavy plate area for dispatch. Wooden dunnages were placed in between the plates while loading. Joint report indicating the details of heating, rolling and inspection results were prepared and signed.

Conclusion

In the initial stages, due to high strain rate sensitivity as well as high flow stress of Maraging steel at low rolling temperatures resulted in mill over loading & consequently stalling of the mill. Improper hot working results in undesirable microstructural features & low unacceptable fracture toughness in MDN 250 steel. The Problem has been resolved by carrying out strictly maintaining the regimes at reheating furnace and closely controlling the temperatures at various zones and total residence time. The draft at roughing and finishing stands was worked out and stabilized in all the subsequent rolling of MDN 250 slabs. This has ensured consistent and desired microstructure after post rolling heat treatment at Midhani.

MDN 250 steel plates rolled at SAIL-BSP subsequently subjected to solution treatment at MIDHANI

a) Optical Micrograph

b) Fractrograph

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Recovery of Quality Sinter Grade Fines from Reject Slime by Appropriate Beneficiation

**Abhijit Das*, M. Roy*, S.K. Pan*, K. Prakash*,
P.K. Thakur*, R.P. Singh*,P.K. Singh*,
T. Sutradhar#, V.B. Singh# & S. Mondal#**

Abstract

A vibrant steel industry has historically been the foundation of a nation's rapid industrial development. India's competitive advantage in steel production is driven, to a large extent, from the indigenous availability of high grade iron ore and non coking coal – the two critical inputs of steel production. National Steel Policy 2017 of India envisages the ambitious goal of the nation to reach a production capacity of 300 MTPA of crude steel by 2030-31 and the corresponding demand of iron ore would be around 437 MTPA. To cope up with increasing global and domestic market demand and to achieve the goals of National Steel Policy, our steel industry is in need of large quantity of quality iron ore.

With depletion of high grade iron ore deposits and stringent mining, environment and forest conservation acts/rules, the importance of using medium and low grade iron ore is getting emphasis eventually. Run-of-Mine (R.O.M) ore is put through wet beneficiation system to remove the clayey matter due to the presence of alumina and silica in iron ore leading to slime (process rejects) generation (of 45-55% Fe) which are disposed off in tailing ponds. Since utilization of iron ore at 45% Fe as cut-off grade has been fixed by Indian Bureau of Mines (IBM), appropriate beneficiation process has to be explored to effectively beneficiate the rejected slimes and reduce the waste generation in mines as well as recovery of valuable minerals from the slime.

This paper deals with the appropriate methodologies for beneficiation of iron ore in given mineralogical context. RDCIS had installed a slime beneficiation system in Dalli Mines, BSP which takes input as slimes from the ore processing plant. With the cumulative effect of fluidized bed classifier, hydro-cyclones and spiral classifier, the quality of reject slime has been enriched from 49% Fe to 62.5% Fe. The system not only helps in recovery of sinter grade fines but also effectively reduces the waste generation and help mines in maintaining environmental standards.

1. Introduction

The consumption of iron ore has increased rapidly over the past decade due to the tremendous growth of iron and steel industry. The blast furnace route of iron making is predominant in India. The raw materials used in the blast furnace for hot metal are lumpy iron ore, agglomerates (sinter and pellet), metallurgical coke and fluxes (limestone and dolomite). It has been established over the years that the productivity of the blast furnace increases and energy consumption decreases by using superior quality of raw material, particularly of iron inputs. Thus, higher the iron content in feed material, lower is the slag volume generated in blast furnace, which automatically increases the productivity and reduces the coke rate. 1% increase in Fe improves the Blast Furnace productivity by 2% and reduces the coke consumption by 1% [1]. National Steel Policy 2017 of India envisages the ambitious goal of the nation to reach a production capacity of 300 MTPA of crude steel by 2030-31 and the corresponding demand of iron ore would be around 437 MTPA [2]. To cope up with increasing global and domestic market demand and to achieve the goals of National Steel Policy, our steel industry is in need of large quantity of quality iron ore.

Bhilai Steel Plant (BSP) is undergoing expansion to increase hot metal production to 7.6 Mtpa. With envisaged burden ratio of 80% sinter and 20% lump ore and pellet in large blast furnaces, esp. in BF8 (useful volume 4060 m^3), iron ore requirement for BSP will be around 12 Mtpa. The target grade of iron ore fines for sinter making is minimum 62.5% Fe. Dalli-Rajhara Iron Ore Complex is the existing captive iron ore mines of BSP. There are two nos. of ore processing plants (one located at Rajhara & other at Dalli) which receive Run of Mines (ROM) ore from the mines. The combined capacity of the plants is 9.5 Mtpa (Rajhara – 4.0, Dalli – 5.5). Thus, there will be a shortfall of about 2.5 Mtpa of iron ore at 7.6 Mtpa hot metal stage at BSP. In the wake of lowering of mining cut-off grade from 55% to 45% by IBM, works are underway to recover about 9.47 Mt of Generated Fines (in course of manual mining in the past) and about 14.5 Mt of slimes accumulated in the Hitkasa tailing dam [3] so as to attend the shortfall.

2. Necessity for Slime Beneficiation

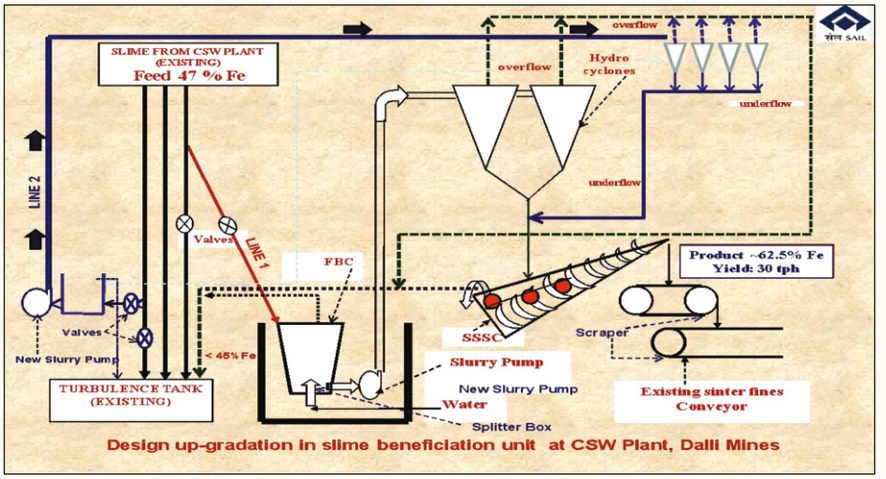
Dalli ore processing plant comprises of 2-stage crushers, wet screens, 4-twin set screw classifiers. The final products are lump (-40+8 mm) for feeding to blast furnace and sinter fines (-8 mm) for sinter plants of the BSP. To achieve the quality of fines, the ROM fines are processed in the plant. The screw classifiers reject particles less than 0.2 mm through its overflow as slime. Dalli processing plant has been rejecting about 14-16% of the total ROM feed to the plant as slime loss for over a long period of time. Although the overall quality of slime is poor but it contains a significant quantity of iron mineral particles especially in the finer size range and that too in liberated form. The slime is finally disposed off in the tailing dam through thickeners which causes siltation, handling as well as environmental issues.

The management of tailings from iron ore mines is an important issue not only from an environmental point of view but also from resource conservation perspective. It has been reported in the literature that by enriching the slimes using appropriate beneficiation techniques and utilizing this fraction in the sinter feed through proper mixing and balling, the waste can become an asset in enhancing hot metal production. Due to the depletion of high-grade ore at the mines and increased loss of mineral values during processing, along with the lack of space to store these rejects, it has become essential to develop efficient and cost-effective methods to recover iron values from ore fines. Conversely, it is not easy to process the slime fraction mainly because of the micron size range typically present in a finely disseminated form [4]. Hence, the present work assumes importance for the development of scheme to recover the iron values from the mine ore fines or slime fraction.

3. System Description

The slime beneficiation unit at Dalli Mines was installed by RDCIS to recover quality iron ore fines concentrate from outgoing reject slime, which otherwise gets directed to tailing dam. The average quality of slime is 54.6% Fe, 10% SiO_2, 6.4% Al_2O_3, the silica and alumina mineral particles are mostly in Free State. In the present work, the untreated slime, emanating from the ore processing plant of Dalli Mines, is tapped and pumped to two circuits: one with Fluidised Bed Classifier (FBC), cluster of 14" hydro-cyclones followed by Slow Speed Spiral Classifier (SSSC) in series and the other circuit having cluster of 5" hydro-cyclones and then feeding the underflow to SSSC. The final sinter grade fines product obtained in SSSC is fed to fines conveyor of the mines. The complete system is automated and operated from a PLC control panel. In this process waste generated from the mines process system is getting qualitatively enriched and extracting useful sinter grade fines which cumulatively support the production requirement of the plant.

* R & D Centre for Iron and Steel, SAIL, Bhilai Centre
# Dalli mines, BSP
Email: *abhijit625@sail-rdcis.com*



4. Experimental

4.1 Process Flow Elucidation

The aim of the innovative work is to recover iron mineral particles with minimum 62.5% Fe grade from slime of ~55% Fe. The principle of beneficiation techniques applied in the system are: (i) size separation using centrifugal action in hydro-cyclones, (ii) density separation in FBC and (iii) size cum density separation through hindered settling process in SSSC. In the process, the untreated slime flowing at a rate of about 1200 m^3 per hour, is tapped and pumped to the circuits. In the first circuit, slime is treated in the FBC. This system consists of a cylindrical vessel with conical bottom, where the slime (classifier overflow) enters tangentially, like hydro cyclone, and splits into two parts, the overflow (o/f) and the underflow (u/f). From bottom of the vessel, an upward stream of water is being injected to make the particles in fluidized state. A teeter bed thus formed which allows only heavier particles to pierce through and rejects all the slimy and lighter particles through its o/f. The u/f particles are further processed in a cluster of 14" hydro-cyclones to get rid of finer gangue mineral particles. The u/f of hydro-cyclones is then passed through a specially designed SSSC, which consists three feed entry points, takes advantage of the hindered settling action of the incoming pulp, and discards the lighter gangue particles as o/f. In the second circuit, slime is fed to the cluster of 5" hydro-cyclones. Upon classification, the u/f is passed through the SSSC. The SSSC is thus made to maintain high pulp density in its pool. The u/f extracted from SSSC is the final product in the form of sinter grade fines. The o/f coming out from FBC, hydro-cyclones and SSSC together contains the reject of the slime beneficiation system and is mixed with the slime line going to the thickener.

4.2 Sampling & Testing

The ore processing plant of Dalli mines was studied in detail and performance data collected. The representative sample of slime was collected for in-depth investigation at RDCIS laboratory. Observations were noted of the particles segregation from the pool area of the SSSC, and settling characteristics of the particles. Product samples were drawn from both the hydro-cyclones and the SSSC. The samples were tested and analyzed for granulometric and chemical composition.

5. Results and Discussion

Table-1 shows the fraction-wise granulometric and chemical analysis of input slime. Slime sample was collected from the classifier sump pit location at the ore processing plant of Dalli mines. It is quite clear from the analysis that the majority of the particles in the slime are smaller than 400 mesh i.e. less than 38 microns. In this fraction, most of the silica and alumina particles are concentrated, apart from the above figure, there is +100 mesh size fractions in slime but whose percentage is negligible. So, efforts were made to reduce the gangue from the smallest fraction in the installed beneficiation system.

Table–1: Granulometry and Chemical analysis of input slime

Size fraction in mesh	% Wt	% Fe	% SiO_2	% Al_2O_3	% LOI
+30	0.26	58.30	7.21	4.03	4.91
-30+60	0.55				
-60+100	2.54				
-100+200	9.53	61.56	5.0	3.30	3.18
-200+300	16.87	62.07	4.56	3.35	2.84
-300+350	2.68	61.54	4.90	3.24	3.37
-350+400	5.21	61.77	4.63	3.30	3.24
-400	62.36	53.83	9.06	7.14	6.36

Table-2 indicates the fraction-wise granulometric and chemical analysis of the underflow of SSSC, which is the main focus of the entire investigation activities. It clearly shows that the particles smaller than 300 mesh size are very less in the SSSC product, which has decreased from 70.25% to 6.87%. The concentration of particles with high iron content and low gangue content are in the 30-200 mesh size range and have increased from 12.62% in slime to 79.54% in the product sinter grade fines.

Table – 2: Granulometry and Chemical analysis of SSSC Product

Size fraction in mesh	% Wt	% Fe	% SiO_2	% Al_2O_3	% LOI
+30	3.26	59.71	7.39	3.72	3.26
-30+60	27.06	62.02	4.50	3.18	2.19
-60+100	26.02	63.79	2.97	2.10	1.43
-100+200	26.46	64.42	2.53	1.62	1.33
-200+300	10.33	64.06	2.94	1.71	1.56
-300+350	0.54				
-350+400	0.75				
-400	5.58	57.85	7.66	5.92	6.07

Table-3 records the granulometric analysis of the final reject of the system. It contains the o/f of FBC, hydro -cyclones and SSSC. By

analyzing the data, it can be concluded that the amount of -400 mesh size fraction is the highest in the system rejects. This shows significant rejection of particles in the smallest size fraction. As this fraction contains significant amount of gangue particles, it highlights the successful implementation of the beneficiation techniques to enrich the slimes getting rejected from the processing plant.

Table-3: Granulometric analysis of Final Reject

Size (mesh)	Sample 1	Sample 2
	% wt	% wt
+30	0.25	NIL
-30+60	1.50	2.80
-60+100	3.54	5.13
-100+200	24.46	19.63
-200+300	27.24	17.70
-300+350	2.85	3.52
-350+400	4.65	2.29
-400	35.51	48.93

Table-4 indicates qualitative and quantitative analysis of the constituents of the upgraded slime beneficiation unit. The investigative study was conducted when only one circuit was in operation, which resulted in reduced product rate as envisaged but with improved quality. With a consistent level of pulp of around 20% and flow of 1200 m^3/hr be maintained at the plant end, significant results would emerge from the operation of this innovative combination of beneficiation system.

Table–4: Qualitative and quantitative analysis of the constituents of the slime beneficiation system (one circuit in operation)

Sample Number	Sample Details	Fe%	SiO_2%	Al_2O_3%	LOI%	Remarks/ production rate of conc.
1	Feed slime	54.32	11.08	6.56	4.23	
	SSSC Product	**61.71**	**7.52**	**2.00**	**1.77**	**16.8 tph**
2	Feed slime	55.03	10.62	5.86	4.34	
	SSSC Product	**60.33**	**9.16**	**1.94**	**1.73**	**17 tph**
3	Feed slime	54.50	8.59	6.80	6.24	
	SSSC Product	**63.38**	**4.12**	**2.99**	**1.78**	**16.5 tph**

The following are the analysis of the trials/treatment after implementing the slime beneficiation system at Dalli mines:

- During treatment of slime assaying ~54.6% Fe, 10% SiO_2 and 6.40% Al_2O_3 through series of 24 nos. cluster hydro-cyclone (5"), the quality of the concentrate obtained is ~58.30% Fe, 8.9% SiO_2 and 4.1% Al_2O_3.
- During treatment of underflow of the conventional cyclone assaying above mentioned composition through SSSC, the quality of the concentrate obtained is ~63.38% Fe, 4.12% SiO_2 and 2.99% Al_2O_3.
- With this addition of concentrate, the overall sinter fines quantity has also increased.

6. Conclusions

Design and installation of an innovative slime beneficiation system has resulted in qualitative enrichment of reject slime to product sinter grade fines. This system has been designed to recover iron ore fines of sinter grade from incoming slimes at the rate of 1200 m^3/hr. By implementation of this technology, alumina in recovered fines gets reduced from 6.8% to 3% and silica from approx. 8.6% to 4.1%. Iron ore particles with 63.4% Fe are being recovered from slime having 54.5% Fe. This slime beneficiation system has a positive impact on mineral conservation and reduction in waste generation thereby helping in abatement of environmental pollution. The annual benefit to the plant includes additional fines generation as well as cost savings in handling, de-silting and storage. The application of this system has augmented the production capacity of the plant through smart waste management, hence converting an adversity into an opportunity.

7. Acknowledgement

Authors are very much thankful to the management of BSP for allowing us to pursue the project. We also thank the concerned personnel of Dalli Mines, BSP for co-operation and continuous support provided throughout the execution of this project. We do acknowledge with thanks for all the support and facilities provided by RDCIS management.

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Failure Analysis of Bottom Roll of 1150 Stand In Blooming & Billet Mill

D Sathya Devi, S Mukhopadhyaya, Satya Prakash

Introduction

Rolls are tools used in rolling mills to reduce the cross section of the metal stock. Rolls do the most important work in a rolling mill. They constitute a very important component of the running cost of the mill. Despite careful attention from the roll supplier and the user, roll failures happen in service which lead to partial or total loss of the rolls and may even cause subsequent damage to rolling equipment. Failures of roll occur due to improper manufacturing and operational parameters.

Blooming Mill is having a Two High Reversing Horizontal Stand equipped with individually driven bottom and top rolls. The imported bottom roll of 1150 stand in Blooming & Billet Mill had broken while rolling bloom 325x325 mm section, as reported by the shop, abruptly resulting in major break down & severe production loss. The roll was stipulated to be made of 60XH USSR grade (Alloy Forged Steel) and had broken after rolling 4,20,242 ton, as against the certified life of 6,00,000 ton, thereby giving a life of 70.04% only. Sample of prematurely failed roll was collected from the shop and was examined for its chemistry, macro-structural examination, micro-structural characteristics and hardness. Dye penetrant test was also conducted on the roll.

On-Site Visual Examination

One of the fork located on the drive end collar of bottom roll of 1150 stand had broken off along vertical plane (Figure 1&2). Examination of the fracture face had revealed the presence of two distinct zones, i) a quadrant shaped dark zone covering about a cross sectional area of around 20%, located near one of the inner corner of Fork wherein the zone was found to be extending to a maximum length and depth of 210mm & 175mm respectively from the outer surface (size of the fork as per drawing-530x290mm), and ii) a bright zone containing fine crystalline features & river line pattern of crack propagation lines covering rest of the cross sectional area, as shown in Figure 3.

Fig. 1: Bottom Roll

Fig. 2: Broken fork

Fig. 3: Fracture face of broken fork

Further closer examination of the quadrant shaped dark zone revealed the presence of three sub-zones, i) a small smooth zone containing ratchet marks & extending to a maximum depth of ~40mm from the outer surface located near inner corner of fork, ii) an intermittent zone containing few pin holes and crack propagation lines resembling the appearance of hydrogen flakes and iii) a dark coloured smooth layer having a width of ~ 20 mm encircling the intermittent zone, as shown in Figure 4 & 5. Both the outer surfaces of rectangular fork adjacent to inner corner revealed the presence of shiny appearance, as shown in Figure 2&6. Sample containing dark fatigue zone was marked and cut from the broken piece of the fork. Sample from the broken roll was collected in BSP RCL laboratory for metallurgical investigation.

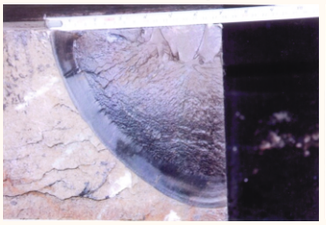


Fig. 4

Fig. 5

Fig. 4 & 5: closer examination of fracture face of Broken fork

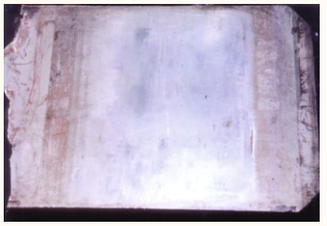


Fig. 6: showing shiny appearance

Chemical Composition

The chemical composition of the roll sample, weld deposition and the specified grade were as depicted in the Table.

	C	Mn	P	S	Si	Cr	Ni	Mo
Sample	0.53	0.52	0.005	0.008	0.29	0.56	1.26	0.10
Weld deposition	0.09	1.86	0.019	0.011	0.68	0.10	0.08	1.04
60XH	0.55 0.65	0.50 0.80	0.040 Max.	0.040 Max.	0.17 0.37	0.60 0.90	1.00 1.50	*

* Not specified.

Hardness

The hardness of the roll sample along the parent metal was found to be 217 BHN (33 ShC) as against the specified range of 32 to 36 ShC. However, the same was found to be 269 BHN (41 ShC) along the weld deposition zone.

Macro Examination

The fork sample cut adjacent to fracture area was macro-etched with hot HCl (1:1) solution. Macro-etching of the transverse section of the sample had revealed the presence of prominent region of weld deposition extending to a maximum length and depth of around 130mm & 90mm respectively from the inner corner of Fork located near fracture surface, as shown in Figures 7 to 9. Fine cracks were present along the heat affected zone as shown in Figure 10.

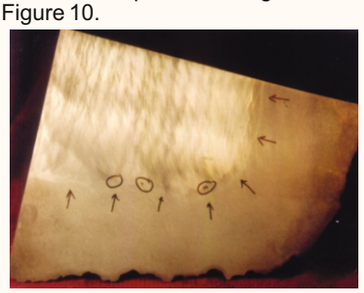


Fig. 7

Fig. 8

R & C Laboratory, BSP, Bhilai
E-mail: *sathyadevi@sail-bhilaisteel.com*

Fig. 9

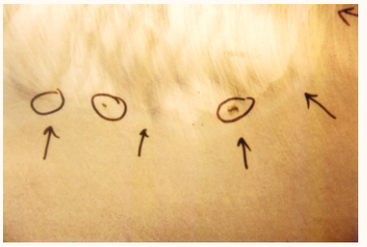


Fig. 10

Dye Penetration Test

Dye penetration test was carried out on the unbroken fork. It did not reveal any surface cracks, as shown in Figure 11.

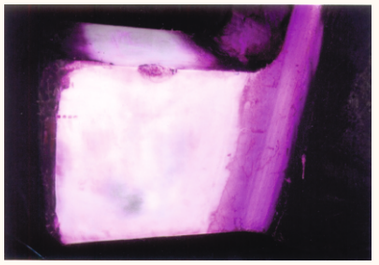


Fig. 11: dye penetrant testing of fork

Microstructural Analysis

The fork sample confirmed the presence of surface weld deposition, as evident from different micro-structures along the weldment, junction of weldment & heat affected zone & parent metal. Weldment was found to have micro cavities. Micro-structure of the roll sample taken along the parent metal had revealed the presence of pearlite (Figure 12). However at some locations structure was found to be pearlite colonies surrounded by ferrite network. Acicular structure was present along the localised area at heat affected zone. The extent of heat affected zone was found to be around 11mm, as shown in Figure 13.

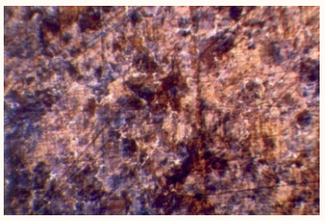


Fig. 12

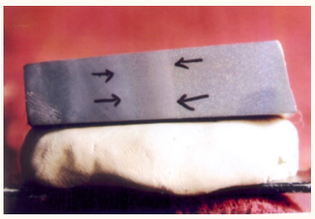


Fig. 13

Conclusions

The chemical composition of the sample taken along the parent metal of the Fork of roll is considered to be satisfactory except slightly lower Cr content and an additional Mo content, as compared to the specified grade.

1. The hardness of the sample taken along the parent metal of the Fork of roll (33 ShC) was found to be within the specified range (32-36Sh C). However, the same measured along the weld deposition zone (41 ShC) was found to be significantly higher than the specified range.
2. Visual examination revealed that one of the fork located near the drive end collar of bottom roll of 1150 stand had broken off along vertical plane. Examination of the fracture face had revealed the presence of a quadrant shaped dark fatigue zone covering about a cross sectional area of around 20% located near one of the inner corner of fork. The maximum length & depth of fatigue zone was measured to be 210x175mm respectively from the outer surface. The fatigue zone was containing crack propagation lines resembling the appearance of hydrogen flakes, ratchet marks & pin holes. Both the outer surfaces of rectangular fork adjacent to inner corner revealed the presence of shiny appearance.
3. Macro-etching of transverse section of the Fork sample taken adjacent to the fracture surface had revealed the presence of prominent region of weld deposition extending to a maximum length and depth of around 130mm & 90mm respectively. Fine cracks were present along the heat affected zone.
4. Micro-structure of the roll sample taken from the fatigue initiation zone had confirmed the presence of localised weld deposition. Acicular structure & cracks present along the 11mm thick, HAZ and micro cavities observed in the weldment area had increased the inherent brittleness of the roll.

As evident from the features of fracture face, the bottom roll of 1150 stand had broken along transverse plane, after giving a life of 70.04% by fatigue mode of failure. Metallurgical investigation revealed that the Fork of the Roll had been reclaimed by metal deposition, probably, to remove surface defects developed during forging/ machining. Further, fine cracks and cavities generated along the weldment & HAZ of metal deposition during weld repair had acted as mechanical notches from where fatigue cracks were initiated. In addition to that, hydrogen flakes were also present along the sub surface located near inner corner. Fatigue cracks together with hydrogen embrittlement, which, had penetrated up to a depth of about 210x175mm from the outer surface, had drastically reduced the effective cross sectional area of the roll, thereby reducing the load bearing capacity of the roll. Finally the roll had further broken in a brittle manner, apparently under the action of working loads in service. Weld repair along the inner corner of the Fork, which is a region of severe stress concentration, is highly unusual and unacceptable. Added to it, inferior quality of weld deposition containing hydrogen embrittlement, fine cracks and micro cavities present along the weldment & HAZ and high hardness could be attributed to the subject failure.

Steel to be carbon-neutral by 2040

The UK steel industry has gained a huge vote of confidence, winning £35m of funding to establish a research network for long-term improvements.

Called SUSTAIN, the initiative will see industry leaders, steelmakers, trade bodies and manufacturers team up with universities to overhaul the production methods of steel and create new steel products to serve the material's major markets. And according to SUSTAIN, it is projected to boost jobs, increase productivity in the sector by 15%, and double steel's gross value added.

Led by Swansea University, UK, alongside the universities of Warwick and Sheffield, SUSTAIN will run for seven years with two specific goals – aiming for zero waste and making steel carbon-neutral by 2040, and introducing smarter processes.

The former will focus on production, lowering carbon emissions and addressing material waste streams to increase efficiency. Meanwhile, the latter will aim to embrace Big Data, making better use of the smart technologies available to refine processes.

SUSTAIN Deputy Director at Swansea University, Dr Cameron Pleydell-Pearce, said, 'We are already on the road to clean, green and smart steelmaking, but this is another giant step forward. Research and innovation are the bedrock of a modern steel industry. This network represents almost the whole UK steel sector, with researchers and companies working together on an unprecedented scale.'

Echoing the sentiments, UK Steel Director General, Gareth Stace said, 'The future success of our sector rests on our ability to remain at the forefront of product and process innovation, delivering the new steel products demanded by our customers and society. This new hub will enable us to do just that.'

£10m of the total amount has been contributed by EPSRC, as part of its Future Manufacturing Research Hub programme. The remaining £25m was funded by steel industry members, universities, research and technical organisations, trade bodies, and the Higher Education Funding Council for Wales.

Ceri Jones in Materials World

Microscopy technique sheds light on hydrogen's effects in metal

Hydrogen, the second-tiniest of all atoms, can penetrate right into the crystal structure of a solid metal. That's good news for efforts to store hydrogen fuel safely within the metal itself, but it is bad news for structures such as the pressure vessels in nuclear plants, where hydrogen uptake eventually makes the vessel's metal walls more brittle, which can lead to failure. But this embrittlement process is difficult to observe because hydrogen atoms diffuse very fast, even inside the solid metal.

Now, researchers at MIT have figured out a way around that problem, creating a new technique that allows the observation of a metal surface during hydrogen penetration. Their findings are described in a recent paper in the International Journal of Hydrogen Energy, by MIT postdoc Jinwoo Kim and Thomas B. King Assistant Professor of Metallurgy C. Cem Tasan.

The new way of observing the embrittlement process as it happens may help to reveal how the embrittlement gets triggered, and it may suggest ways of slowing the process—or of avoiding it by designing alloys that are less vulnerable to embrittlement.

The key to the new monitoring process was devising a way of exposing metal surfaces to a hydrogen environment while inside the vacuum chamber of a scanning electron microscope (SEM). Because the SEM requires a vacuum for its operation, hydrogen gas cannot be charged into the metal inside the instrument, and if precharged, the gas diffuses out quickly. Instead, the researchers used a liquid electrolyte that could be contained in a well-sealed chamber, where it is exposed to the underside of a thin sheet of metal. The top of the metal is exposed to the SEM electron beam, which can then probe the structure of the metal and observe the effects of the hydrogen atoms migrating into it. The hydrogen from the electrolyte "diffuses all the way through to the top" of the metal , where its effects can be seen, Tasan says. The basic design of this contained system could also be used in other kinds of vacuum-based instruments to detect other properties. "It's a unique setup. As far as we know, the only one in the world that can realize something like this, he says.

In their initial tests of three different metals—two different kinds of stainless steel and a titanium alloy—the researchers have already made some new findings. For example, they observed the formation and growth process of a nanoscale hydride phase in the most commonly used titanium alloy, at room temperature and in real time.

Devising a leakproof system was crucial to making the process work. The electrolyte needed to charge the metal with hydrogen, "is a bit dangerous for the microscope," Tasan says. "If the sample fails and the electrolyte is released into the microscope chamber," it could penetrate far into every nook and cranny of the device and be difficult to clean out. When the time came to carry out their first experiment in the specialized and expensive equipment, he says, "We were excited, but also really nervous. It was unlikely that failure was going to take place, but there's always that fear."

Tsuzaki adds that "once it is accomplished, outputs by this method would be super. It has very high spatial resolution due to SEM; it gives in-situ observations under a well-controlled hydrogen atmosphere." As a result, he says, he believes that Tasan and Kim "will obtain new findings of hydrogen-assisted dislocation motion by this new method, solve the mechanism of hydrogen-induced mechanical degradation, and develop new hydrogen-resistant materials."

The work was supported by the Exelon Corp through the MIT Energy Initiative's Low-Carbon Energy Center for Advanced Nuclear Energy Systems.

Source: ASM International

Nickel sheet with nanoscale pores weighs less than titanium but is just as strong

In a new study published in Nature Scientific Reports, university researchers announce that they have fabricated a sheet of nickel with nanoscale pores that make it as strong as titanium but four to five times lighter. The scientists are from the University of Pennsylvania's School of Engineering and Applied Science, the University of Illinois at Urbana-Champaign, and the University of Cambridge.

The study was led by James Pikul, Assistant Professor in the Department of Mechanical Engineering and Applied Mechanics at Penn Engineering in Philadelphia. Bill King and Paul Braun at the University of Illinois at Urbana-Champaign, along with Vikram Deshpande at the University of Cambridge, contributed to the study.

Dr. Pikul's method starts with tiny plastic spheres, a few hundred nanometers in diameter, suspended in water. As the water is slowly evaporated, the spheres settle and stack like cannonballs, providing an orderly, crystalline framework. Using electroplating, the researchers then infiltrate the plastic spheres with nickel. Once the nickel is in place, the plastic spheres are dissolved with a solvent, leaving an open network of metallic struts. The empty space of the pores, and the self-assembly process in which they are made, make the porous metal akin to a natural material such as wood.

"We've made foils of this metallic wood that are on the order of a square centimeter," Dr. Pikul says. "To give you a sense of scale, there are about a billion nickel struts in a piece of that size." Because roughly 70 percent of the resulting material is empty space, its density is extremely low in relation to its strength. With a density on par with water, a brick of the material would float.

Just as the porosity of wood grain serves the biological function of transporting energy, the empty space in this "metallic wood" could be infused with other materials. For example, infusing the scaffolding with anode and cathode materials could enable this metallic wood to serve double duty as both a structure and a battery.

Source: ASM International

Australian scientists develop molten metal catalyst to change carbon dioxide into coal

RMIT University in Melbourne, Australia, announces that its researchers have developed a molten metal catalyst technique that can efficiently convert carbon dioxide from a gas into solid particles of carbon. Published in the journal Nature Communications, the research offers an alternative pathway for safely and permanently removing the greenhouse gas from our atmosphere.

RMIT researcher Dr. Torben Daeneke, an Australian Research Council DECRA Fellow, says that converting CO_2 into a solid could be a more sustainable approach. "While we can't literally turn back time, turning carbon dioxide back into coal and burying it back in the ground is a bit like rewinding the emissions clock," says Dr. Daeneke "By using liquid metals as a catalyst, we've shown it is possible to turn the gas back into carbon at room temperature, in a process that's efficient and scalable. While more research needs to be done, it's a crucial first step to delivering storage of solid carbon."

Lead author Dr. Dorna Esrafilzadeh, a Vice-Chancellor's Research Fellow in RMIT's School of Engineering, developed the electrochemical technique. The researchers designed a liquid metal catalyst with specific surface properties that made it extremely efficient at conducting electricity, while chemically activating the surface. The carbon dioxide is dissolved in a beaker filled with a liquid electrolyte and a small amount of the liquid metal, which is then charged with an electrical current. The CO_2 slowly converts into solid flakes of carbon, which are naturally detached from the liquid metal surface, allowing the continuous production of carbonaceous solid.

Dr. Esrafilzadeh says the carbon produced could also be used as an electrode. "A side benefit of the process is that the carbon can hold electrical charge, becoming a supercapacitor, so it could potentially be used as a component in future vehicles. The process also produces synthetic fuel as a by-product, which could also have industrial applications."

Source: ASM International

Printing metals with crystal formations

The robust crystal structures of metals can be mimicked in 3D-printed lattices for added strength, says a team of researchers. Through imitating the hardening mechanism of crystals, scientists at Imperial College London and the University of Sheffield, UK, have found they can significantly boost the strength and reduce the weight of lattice materials. This advance could accelerate the use of 3D-printed metal parts in engineering projects.

The fabrication method produces lattices in grid-like formations. Researchers believe that varying the patterns in the lattice micro-scale structures and building the materials in layers could substantially add to its durability. This would help reduce the frailties found in current 2D lattices, which tend to follow the same structural pattern and are prone to fracturing. Due to the atomic alignment of the 3D-printed lattices resembling that of crystalline materials, any crack should either stop or ease when coming into contact with a 'crystal' that follows a different structural pattern.

According to Imperial, 'When loaded with weight, the new material — dubbed "meta-crystal" — is far stronger and more damage-tolerant than conventional lattice materials.' They also found that the strength of the meta-crystals can be increased by reducing the size of each grain-like lattice region within the structure, therefore, these engineering materials have the potential to benefit any number of industries, including construction, automotive, aviation and medical devices.

'We bring what we learn in metal science to guide our design in architectured materials,' explains Dr Minh-Son Pham, from Imperial's Department of Materials. 'Everything is inspired by nature with what we found in crystal. In that understanding of the science of nature, we guide our design and solve the problem while maintaining the low weight and high specific strength.'

Reinforced strength, reduced weight

The technique, developed for 3D printing, allows lattice materials to be designed with specific structural properties on an atomic level to meet the exact demands of their intended application. 3D - printed lattices are designed to reinforce material strength during fabrication, removing any potentially defective areas. This technique can ensure that any structural weaknesses are lessened so that weight is distributed more evenly, prolonging the material's life. The long-term plan is to be able to achieve this on an industrial scale.

So far, the majority of data from 3D printed lattices has been gathered using polymers, as they are cheaper to produce and experiment with. Yet it is applying this approach to metals that offers the greatest industrial potential. Pham explains how the team is investigating different combinations of materials to assess their structural performance. Provided funding is secured to continue the research, Pham aims to apply the 3D-printed lattice method to metal alloys. This would

not only make the materials tougher, but also increase their resilience

to high temperatures.

'It's very exciting if you can combine this approach with shape memory alloys, because you can not only make them robust, but also make them smart,' he says. 'It can open up a wide space of opportunities to design smarter and higher performing metals. The benefit of metals is not only about strength, but also resilience to damage and they can also bear the load of very high temperatures.'

Applications aplenty

3D printing is currently being used by a number of industries, but the technology is still relatively new and unrefined in certain applications. Nevertheless, the growth of additive manufacturing is evident and, according to Pham, 'its potential is almost limitless and will only

become more widespread'. While it is unlikely that an entire aeroplane will be made from 3D-printed architectured lattices any time soon, these materials could be used to create individual segments and components onboard, to reduce the overall weight.

Beyond the aero sector, these high-strength lattices could have applications in protective equipment, being used to produce outerwear for the military, or even sports gear, such as American football helmets. 3D lattices also present a wide range of possibilities for medical devices and orthopaedics such as hip replacements, given their lightweight structure and durability.

'A lot of people want to use 3D printing to fabricate an artificial hip,' Pham says. 'Because with this, we can increase the integration between the hip and the tissue in the human body, and also reduce the weight as well, to make it more compliant. One problem with orthopaedic application is stress shearing. That means the artificial hip becomes stiffer than nature would want. That carries the load and the bone doesn't carry the load anymore. So, the bone will degrade over time.

'If you can make the artificial hip have the same stiffness as natural bone and become lighter, that means we have much more benefit, increasing the integration between the artificial hip and the bones enables the re-healing of the bones and make the patient feel more comfortable. There's quite a range of opportunities and applications for this approach.'

James Fernandes in Materials World

Budget 2019 a positive for steel sector, although certain key assumptions a cause of concern: Seshagiri Rao

Enhancing liquidity in the hands of the rural consumers as well as the middle-income earning group is likely to have a positive ripple effect on the demand for steel, Seshagiri Rao, joint MD of JSW Steel said, adding however that there is a mismatch in the government's assumption of GDP growth rate vis-a-vis the tax buoyancy, which could be a point of concern. "The three schemes (Pradhan Mantri Kisan Samman Nidhi, Mega Pension Scheme and direct tax benefits) have left more than Rs 1 lakh crore in the hands of rural India and also the middle income group which will stimulate consumption and be good for the steel industry," Rao told ET. Among other announcements, finance minister Piyush Goyal announced the introduction of the Pradhan Mantri Kisan Samman Nidhi, under which marginal and vulnerable farmers with cultivable land of up to 2 hectares will be given Rs 6,000 per year; a scheme that will touch about 12 crore farmers and cost the state exchequer Rs75,000 crore. Another scheme that the government launched was the Pradhan Mantri Shram-Yogi Maandhan Yojana under which both organised and unorganised sector with monthly income of up to Rs 15,000 are entitled to a pension of Rs 3,000 per month once they retire at the age of 60. The above two along with direct tax benefits equaling Rs 23,200 crore that entails full tax rebate for individual tax payers with taxable income of less than Rs 5 lakh as well as the raising of standard deductions from Rs 40,000 to Rs 50,000, will together lead to a rise in consumption of refrigerators, air conditioners, passenger cars and tractors, fuelling the demand for steel, said Rao. However, he observed that the government's assumption that overall tax base growth at 13.5% while estimated GDP growth for FY20 is kept at 11.5% shows a mismatch. Similarly, the assumption of CGST growing at 21% while 18% in the overall GST growth rate is an aggressive assumption. "This inconsistency in the assumption of GDP vis-a-vis the tax buoyancy is not matching which is a point of concern. It will have to be seen whether they are able to manage to maintain the growth in the tax collections and then restrict the fiscal deficit," Rao said.

The Economic Times

India overtakes Japan, becomes world's second latest crude steel producer

World Steel Association (worldsteel) has said in its latest report that India has jumped ahead of Japan to become world's second largest steel producing country in the world. The report added that crude steel production of India in 2018 stood at 106.5 MT, an increase of 4.9 percent from 101.5 MT in 2017. On the other hand, Japan produced 104.3 MT in 2018, down 0.3 percent compared to 2017. China is still on top with its crude steel production in 2018 reaching 928.3 Mt, up by 6.6% on 2017. According to the report, the crude steel output of China increased 6.6 percent to 928.3 million tonnes (MT) in 2018 from 870.9 MT in 2017. The share of China in global crude steel production jumped from 50.3 percent in 2017 to 51.3 percent in 2018. Global crude steel production in 2018 stood at 1,808.6 MT from 1,729.8 MT in 2017, a jump of 4.6 percent, said the report. The US was at the 4th position as it produced 86.7 MT of crude steel in 2018. The other nations in the Top 10 are South Korea (72.5 MT, 5th place), Russia (71.7 MT, 6th), Germany (42.4 MT, 7th), Turkey (37.3 MT, 8th), Brazil (34.7 MT, 9th) and Iran (25 MT, 10th). The report showed that Italy produced 24.5 MT of crude steel in 2018, while France's output was 15.4 MT. In 2018, annual crude steel production for South America was 44.3 Mt, which is 1.3% more than 2017. Brazil produced 34.7 Mt in 2018, a jump of 1.1% compared to 2017.

https://zeenews.india.com/economy

Tata Steel subsidiary signs pacts with China's HBIS Group

Tata Steel said its step-down subsidiary, T.S. Global Holdings Pte Ltd (TSGH), has signed definitive agreements with China's HBIS Group to divest a majority stake in its South East Asia (SEA) business. "TSGH has executed definitive agreements with HBIS Group Co Ltd controlled entity to divest its entire equity stake in NatSteel Holdings Pte Ltd (NSH) and Tata Steel (Thailand) Public Co Ltd. (TSTH)," the steel maker said in a regulatory filing. As per the agreements signed in Beijing, the divestment will be made to a company in which 70 per cent equity shares will be held by an entity controlled by the HBIS and 30 per cent by the TSGH. Both Tata Steel and HBIS Group have been in discussions in relation to the future of the SEA business. "The definitive agreement signed between the two companies is a significant milestone in our strategic relationship, offering the SEA business robust growth opportunities, given the access to resources, technical expertise and regional understanding of HBIS," Tata Steel CEO and Managing Director T.V. Narendran said. According to the filing, the sale is expected to be completed in at least four months, subject to regulatory approvals. Tata Steel also said the consideration received from such sale would be "$327 million and equity stake of 30 per cent in the entity held by HBIS Group and TSGH on 70-30 basis". The Chinese group was established on June 30, 2008, by the merger of Tangshan Iron and Steel Group and Handan Iron and Steel Group of Hebei province. It is amongst the largest steel makers in the world and a state-owned enterprise in China. HBIS is a leading player in China's home appliance, automotive steel and supplies steel for nuclear power, marine engineering, bridges and construction with revenue in excess of $40 billion and total assets exceeding $50 billion.

The Economic Times

Synergy between steel, refractory industry need of the hour: IRMA

The refractory and steel sectors need to work closely with each other to reduce dependence on imports and cut production costs, a top official of the Indian Refractory Makers Association (IRMA) said. If India wants to achieve its ambitious target of 300 million tonne of steel production by 2030, the only way forward is synergy between the two sectors, said Sameer Nagpal, Head, Advocacy of IRMA. Though the Indian refractory industry was minuscule compared to its steel counterpart, it is critical in the production of the metal, he said, adding, the steel sector consumes about 65 to 70 per cent of refractories. "Unless the issues related to the refractory industry are addressed, the government's steel production target might get hampered," Nagpal, who is also the CEO (Refractory Business) of the Dalmia Bharat Group, told to PTI. At present, the refractory sector is largely dependent on China for raw-material procurement, much like the steel industry that imports around 40 per cent of low-cost finished products from that country. Nagpal, however, said following the implementation of new environmental rules in China, the inflow of raw materials has been disrupted, affecting the refractory companies. Batting for zero per cent duty on raw materials, he said domestic refractory companies are on expansion mode through the inorganic route, and the industry is expected to garner an investment of USD 100-150 million, mainly in the eastern part of the country in the next three to five years. The IRMA functionary said most of the acquisitions are likely to be in Europe, which will also help in latest technology transfers. Nagpal said that India can become a refractory hub if the right steps in favour of the sector are initiated, such as making it a part of the Steel Research and Technology Mission of India (SRTMI), which has already attracted an initial corpus of Rs 200 crore. He also said that a proposal has been mooted to set up a refractory centre of excellence. On Dalmia Bharat Group's expansion plans for the refractory business, Nagpal said it is eyeing overseas acquisitions, too, particularly in Europe and Egypt. "Our negotiations are underway with three companies in Europe and Egypt. At least one of them will be finalised by the next quarter," he said. India's current refractory capacity stands at 1.5 million tonne per annum.

The Economic Times

RINL achieves many heights in 2018 - Mr PK Rath, CMD

Mr PK Rath, CMD, RINL said that Vizag Steel achieved many heights and significant performance during the year 2018 by

recording around 20% growth across its operations while addressing the senior officers of RINL-VSP on the occasion of New Year 2019 in Ukkunagaram. Mr Rath also observed that notable achievements were made in high end value added steel production, increase in capacity utilization in the new mills, improvement in power generation and handling of raw materials. He called upon the employees to primarily focus on increase in Pulverized Coal Injection (PCI) usage in Blast Furnaces to reduce cost of Hot Metal production and added that a PCI rate of 100 kg/ton hot metal brings in a savings of INR 1500 crores per year. He exhorted the employees to achieve the targets during the 4th Quarter by improving the volumes, production more from the Blast Furnaces and Steel Melt Shops and finishing mills.

Mr Rath congratulated the RINL collective for the achievements and said that challenges are many but expressed the confidence in the capabilities and commitment of RINL collective to propel the Company on a continuous growth path.

Performance during April-December'18 - RINL-VSP registered a growth of 18%, 16% and 15% in Hot Metal, Liquid Steel and Saleable Steel production respectively during April-December'18. All the steel mills also recorded notable performance during the period. On Sales front, RINL recorded 29% growth at INR 14,687 crores compared to the CPLY of INR 11,395 crores during the period. Sales volume achieved a growth of 8% and Value Added Steel recorded a growth of 25%.

Strategic Research Institute, Steel Guru

NINL Registers Highest Single-day Sinter Production

Odisha's Kalinga Nagar-based Neelachal Ispat Nigam Limited (NINL) set another benchmark in production with highest ever single-day Sinter output of 5,680 ton on 28th December, 2018 surpassing the previous best of 5640 ton recorded in 2013.

Earlier, Brahmani, the Blast Furnace of the company, registered 110 per cent of the rated capacity on 15th December, 2018 with highest single-day Hot Metal output of 3412 ton. For this achievement, Vice-Chairman & MD of NINL S. S. Mohanty congratulated the entire team.

NINL resumed billet production earlier this month by restarting its state-of-the-art Steel Melting Shop which is the second milestone, the company has planned for the turnaround of the plant. NINL had achieved the first milestone with the completion of the Blast Furnace and expects to achieve the third milestone with operation of its captive iron ore mines towards the end of the present Financial Year. The company has also plans to produce TMT Bars and Wire Rods soon.

www.steel-360.com

NINL scripts best ever quarterly, half-yearly, monthly hot metal production

Neelachal Ispat Nigam Limited (NINL) said it has stepped closer to its turnaround plan by achieving all time high production in 2018 at its integrated iron and steel plant in Odisha's Kalinga Nagar.

With further growth in production, value added billets, iron ore from the captive mines in its basket and converting part of the billets into TMT, wire rod - the company aims to make net profit in next financial year, NINL said in a statement.

Riding on the capital repair of its blast furnace - NINL witnessed all time best calendar year with highest ever third quarterly (Q3) hot metal production of 537,720 tonne, best ever first half-yearly (H1) hot metal production of 367,735 tonne and best ever monthly hot metal production of 85,090 in December, it said.

The company also achieved 110 per cent of the rated capacity of the blast furnace on a daily basis with 3,412-tonne hot metal output on December 15. However, as the NINL's blast furnace resumed production in May last year after the capital repair, it achieved the production only in eight months.

S S Mohanty, Vice-Chairman & MD, NINL, said, "The production growth is most significant for the turnaround of the company. The next target is production of value added billets, conversion of part of the billets into TMT, wire rod and operation of the captive mines towards the start of the next fiscal which will strengthen the company's bottom-line."

The last calendar year was also most significant as NINL achieved two of the three milestones planned for the turnaround of the company with completion of the capital repair of the blast furnace and resuming of billet production by restarting of the steel melting shop (SMS).

The third milestone of operation of the captive mines is expected in early next fiscal.

Business Standard

Crude steel output falls 1.4% to 8.936 mt in Dec

The crude steel production fell by 1.4 per cent to 8.936 million tonnes (MT) in December 2018, according to official data. The country had produced 9.067 MT crude steel in December 2017.

"Crude steel production stood at 8.936 MT in December 2018, down by 1.4 per cent over December 2017 and was down by 0.3 per cent over November 2018." the Joint Plant Committee (JPC) said in its latest report. State-run SAIL, Rashtriya Ispat Nigam, Tata Steel, Essar Steel, JSW Steel and Jindal Steel and Power together produced 47.462 MT, the report said, adding that the rest 31.522 MT came from other producers.

In December 2018, hot metal output stood at 6.158 MT, 2.6 per cent higher over 6.001 MT in the same month in 2017, the JPC said. The country's pig iron production fell by 5.5 per cent to 0.530 MT in December 2018 from 0.561 MT in December 2017. India has set an ambitious target of increasing its capacity to 300 MT by 2030-31. The JPC, under the Ministry of Steel, is the only institution in the country that collects data on the iron and steel industry.

The Hindu

IIT Roorkee to include elective course on stainless steel, advanced carbon special steel

IIT Roorkee and Jindal Stainless have entered into a long-term association that would lead the institute to include an elective course on stainless steel and advanced carbon special steel.

The course is expected to commence from July 2019. It will include the study of these metals in detail, including the uniqueness of various grades, behavioural and forming characteristics, determination of life cycle cost benefit analysis, and an understanding of the entire gamut of their applications across the globe.

Commenting on the initiative, Director, IIT Roorkee, Prof Ajit Kumar Chaturvedi, said: "IIT Roorkee is pleased to enter into a long-term association with Jindal Stainless Ltd on institutionalising a course on stainless steel, whereby, various aspects of the material would be covered in depth in architecture, metallurgy, and materials engineering course curricula."

On the occasion, Managing Director, Jindal Stainless, Abhyuday Jindal said: "This initiative hits two targets at once. One, it prepares students to deal with the metal of tomorrow. Two, it ensures that future decision makers choose the best suited material while building infrastructure. As a result, this course will positively affect public safety, environment sustainability, and economic costs in the long run."

Director, Jindal Stainless, S Bhattacharya added, "Stainless steel is a young and green metal with ample potential for growth. In India, it is still at a nascent stage, with a per capita consumption of 2 kg, as compared to the global average of 6 kg. Here, it is synonymous with cookware and kitchenware, while in more developed economies, the metal is widely used in segments such as architecture-building-construction, automobile-railway-transport, and process industries, among others. By collaborating with the academia, our intent is to drive awareness among the future engineers and architects of the country."

As a part of this association, IIT Roorkee has decided to institutionalise a 3 credit elective course on stainless steel and advanced carbon special steel for the 4th year B. Tech and PG students of the Department of Metallurgical & Materials Engineering. The primary objective of the programme is to create awareness about stainless steel and advanced carbon special steel among the graduating students.

The Economic Times

Vedanta Zinc International opens Gamsberg mine in South Africa

Vedanta Zinc International announced the opening of the first phase of Gamsberg mine, having reserves and resource of more than 214 million tonnes (MT), in South Africa.

"Phase 1 of Gamsberg represents a USD 400 million investment by Vedanta in South Africa," the company said in a statement.

The life of mine (LoM) of Gamsberg is of 13 years and will see four million tonnes per annum (MTPA) of ore produced from the open pit and 2,50,000 tonnes per annum (TPA) of concentrate from its concentrator plant.

Investigations into phase two and three are underway and will see increase in ore mining to 8 MTPA and production of zinc-in-concentrate to 4,50,000 TPA, and in a modular fashion ultimately to 6,00,000 MTPA.

"It will reflect an additional investment of USD 350 to USD 400 million," the company said.

Vedanta is simultaneously pursuing a feasibility study into the development and construction of a smelter-refinery complex, which speaks to both Vedanta and government's commitment to local metal beneficiation, it added.

Vedanta Chairman Anil Agarwal emphasised "his commitment to South Africa, and his belief in the future of the South African mining industry".

"For us at Vedanta, Gamsberg is so much more than a mine. It is an employer and job creator, an enabler of development and growth, a good neighbour and citizen, and a fervent supported of the Northern Cape and South Africa," VZI's CEO Deshnee Naidoo said, adding that the opening of the first phase of Gamsberg was the result of the combined efforts of several thousand people.

Business Standard

ArcelorMittal plans Rs 18,697-crore capex for debt-laden Essar Steel

ArcelorMittal's resolution plan for Essar Steel, which is awaiting approval from the National Company Law Tribunal (NCLT), includes a capital expenditure plan of Rs 18,697 crore to take the finished steel goods capacity of the plant to 8.5 million tonnes by 2024.

In its annual report, ArcelorMittal has said the capital expenditure plan of Rs 18,697 crore (about $2.8 billion) will be implemented over six years.

The first stage will involve investments to increase production of finished steel goods sustainably to 6.5 million tonnes per annum and completion of ongoing capital expenditure projects. It will also include implementation of ArcelorMittal's best practices.

The second stage will involve investments to increase the production of finished steel goods from 6.5 million tonnes per annum to 8.5 million tonnes per annum by the end of 2024, including asset reconfiguration and the addition of coke oven, blast furnace and basic oven furnace.

The long-term aspiration, however, was to increase finished steel shipments between 12 and 15 million tonnes through the addition of new iron and steel-making assets so that ESIL (Essar Steel India Limited) can play an active role and fully benefit from the anticipated growth in the Indian industry, ArcelorMittal said.

Arcelor has offered an upfront payment of Rs 42,000 crore ($5.7 billion) towards debt resolution of Essar with a further Rs 8,000 crore ($1.1 billion) of capital injection into the company to support operational improvement, increase production levels and deliver enhanced levels of profitability.

In October 2018, the committee of creditors (CoC) of Essar Steel had voted to approve ArcelorMittal's plan and a letter of intent was issued.

In November, ArcelorMittal entered into a $7 billion term, facilities agreement with a group of lenders in connection with the acquisition of ESIL. The agreement has a term of one year (i.e. until November 20, 2019) subject to ArcelorMittal's option to extend the term by six months. The facility may be used for certain payments by ArcelorMittal as well as by the joint venture, the annual report mentioned.

ArcelorMittal expects to jointly own and operate ESIL in partnership with Nippon Steel & Sumitomo Metal Corporation (NSSMC), Japan's largest steel producer and the third largest steel producer in the world, as per the joint venture agreement.

Arcelor and NSSMC are expected to finance the joint venture through a combination of partnership equity (one-third) and debt (two-thirds), and ArcelorMittal anticipates that its investment in the joint venture will be equity accounted.

However, the report mentioned, that the resolution plan if implemented, it would subject the company to various risks.

On the financial front, the uncertainties and risks related to ArcelorMittal's exposure (via equity investment in the joint venture and possible guarantee of the joint venture's debt). The exact ratio had yet been determined and the nature of long-term debt financing of the joint venture had not been defined.

Pending the implementation of long-term financing, ArcelorMittal would guarantee any amounts drawn by the joint venture under the bridge financing.

On the operational front, the industrial project to turnaround ESIL and further improve operational profitability was large-scale and ambitious.

"While ArcelorMittal has substantial experience in turnaround situations, the scale of this one is particularly large and it is the company's inaugural large-scale acquisition in India, an emerging market. Capital expenditure in excess of budgeted amounts, delays and difficulties in achieving commercial objectives therefore cannot be ruled out," the company mentioned.

Business Standard

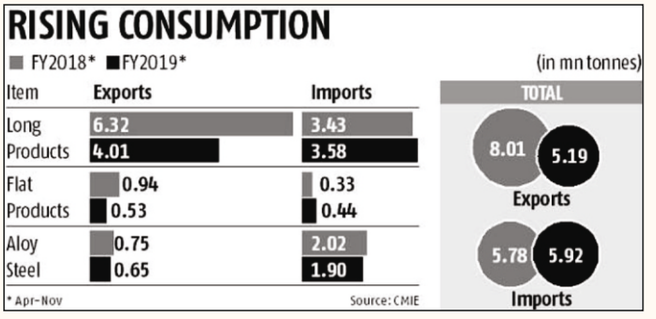
Demand for higher steel grades to fuel imports in 2019

The country's import of steel is expected to rise by 2.5 to 3-5 per cent in 2019-20, fuelled by demand for special and higher grades, says CARE Ratings.

Its report says domestic consumption of steel is projected to rise between 5.5 and 7.5 per cent. "We believe consumption of long steel products will grow at a faster pace, compared to flat steel products, mainly on account of the government's focus on infrastructure. For FY19, the government's revised capital expenditure was higher by 20.3 per cent to Rs 3.2 trillion on a year-on-year basis and funds of Rs 3.4 trillion have been allocated for FY20," it adds.

Finished steel production is tipped to grow by 6-8 per cent during FY20, backed by demand from user industries such as construction and infrastructure, automobiles and consumer durables.

In FY17 and FY18, India was a net exporter of steel. This had altered in the April-November period of FY19 (first eight months of the financial year), with finished steel import toppling export by 0.7 million tonnes.



According to data from the Centre for Monitoring Indian Economy, the former rose 2.2 per cent to 5.9 mt, while the latter fell 35 per cent to 5.2 mt.

Higher import from South Korea was one reason. In March 2018, the American government imposed protectionist levies of 25 per cent and 10 per cent on steel import; this led to diversion here of Korean shipments.

Hot Rolled coil, galvanised sheets and some grades of alloy steel are the bulk of our export. On an average, nine per cent of the country's production is exported, while 11 per cent of the demand was met from import in the past five years.
The CARE report says domestic prices of steel products have been firm. Between April and December 2018, these rose by 18-33 per cent over a year before, on the back of a robust demand.
Consumption in the comparable period grew 7.9 per cent to 71.6 mt. Prices are expected to weaken by five per cent in FY20, taking cues from those in China. A rise in domestic consumption will arrest any sharper fall, the report believes.

Business Standard

Better days ahead for steelmakers

Tata Steel and JSW Steel are up 4-6 per cent in the last three trading sessions on improving realisations, expectations of higher demand and upgrades by rating agencies. Moody's Investor Service has changed JSW's outlook to positive; Tata Steel's corporate family moved a notch up (Ba2 from Ba3).
There are more reasons for investors to cheer. Reports indicate that domestic steel prices are going up for a second time in February. Major hot rolled coil steel producers have taken a price hike of Rs 500-Rs 1,000 per tonne after the Rs 750-Rs 1,000 per tonne rise at the beginning of the month. These price hikes in the domestic market arena are coming after a gap of three to four months and should lift investor sentiment.
This should be a relief for the listed steel stocks, which have been trading at their 52-week lows in recent weeks. The Street was worried about a correction in domestic steel prices on the back of a further slowdown in China and trade war uncertainties.
Among the reasons for the bearish outlook on steel stocks were volume concerns. While JSW Steel saw its consolidated sales volumes decline by 10 per cent year-on-year, Tata Steel witnessed a 9.04 per cent decline in the December quarter. Analysts at ICICI Securities had revised marginally downward their sales volume estimates for JSW Steel.
The positive, going ahead, is strong demand expectation. Moody's expects India's steel consumption to grow at 5.5-6.0 per cent annually over the next one-two years, supported by domestic demand. Growth is expected to be led by the government's spending on infrastructure projects and revival in demand from the automotive industry.
Despite volume pressures, companies continued to report strong profitability.
The other trigger could be the acquisitions made by these companies. The confidence in JSW Steel, which had been acquiring both domestic and international companies, is because of control on costs. Kaustubh Chaubal, Moody's vice president and senior credit officer, is positive given the improving trajectory of JSW's credit metrics principally due to its competitive and efficient production costs, solid domestic demand conditions and expectation for a supportive ongoing price environment.
JSW's standalone operations during the December quarter posted a steady Ebitda/tonne of Rs 12,060 versus Rs 9,000 seen in the year-ago quarter and Rs 12,126 in the previous quarter. Consolidated Ebitda, too, rose 16.9 per cent year-on-year to Rs 4,501 crore.
Tata Steel, on the other hand, had reported better profitability (Ebitda/tonne at Rs 16,400) being an integrated player. The company has turned around acquired Bhushan Steel's operations as Tata Steel BSL (formerly Bhushan Steel) and delivered a strong Ebitda/tonne of Rs 11,000. The acquisitions are driving domestic performance. Analysts at Prabhudas Lilladher said that exit from loss-making European (TSE) and southeast Asian (SEAN) operations would significantly improve the quality of earnings and balance sheet (would reduce debt by 23 per cent or Rs 2,400 crore).
Moody also expects that Tata Steel will remain selective in its acquisitions, funding them with a prudent mix of debt and equity and allowing only a temporary spike in adjusted debt/Ebitda leverage.
The stable demand and price conditions in its domestic market coupled with Tata Steel's strong operating efficiencies and vertical integration were cited as main reasons by Moody's for the upgrade of Tata Steel's corporate family rating.
For JSW Steel, Moody's expects adjusted debt/Ebitda in March 2019 to remain flat at 2.6 as in March 2018. Based on sustainable Ebitda/ton of Rs 9,500, Moody's estimates the company's leverage will reach around 2.8- 3.2 times in the financial year ending March 2020.
Meanwhile, the rise in international iron ore prices due to disruption in supplies from Vales will help domestic manufacturers. Rising international steel prices cushion fall in domestic steel prices, as well as, help reduce cheap imports.
India Ratings and Research believes that an increase in the iron ore import price for China would translate to a $25-30/metric tonne rise in steel price, thereby rendering Chinese steel imports expensive.

Business Standard

Tata Steel bets big on downstream products

Buoyed by the recent acquisitions of Bhushan Steel and Usha Martin, Tata Steel has set targets to achieve at least 30 per cent volume sales from downstream products by 2025. Stepping up downstream sales is part of Tata Steel's deft strategy to counter the vagaries of a cyclical steel business.
By 2025, Tata Steel is looking to ramp up its India crude steel capacity to 30 million tonnes per annum (mtpa), from 18.6 mtpa currently. The steel maker has been diversifying its portfolio with differentiated product and service offerings. Close to 70 per cent of its product mix (as on September 30, 2018) was made up of enriched and value added products.
Besides Bhushan Steel and Usha Martin's speciality steel plants, Tata Steel's brownfield expansion at Kalinganagar will see the commissioning of a cold-rolled complex with a thrust on servicing downstream industries, especially automotive. In the second phase, the rated capacity of the Kalinganagar mill in Odisha is being scaled up to eight mtpa with an investment of Rs 23,500 crore.
"One of our focus areas is capital deployment in value-added downstream assets and ventures. The takeover of Bhushan Steel plant has brought in downstream integration and value addition with a complementary product mix", said a source in the know.
Tata Steel has presence in 85 per cent of the carbon steel market. Nearly half of its domestic sales comes from the construction sector.

Business Standard

Surge in iron ore prices cheers local miners

A 30% surge in global iron ore prices to $90 a tonne this month following disruption in supply at top producer Vale's mines in Brazil, is expected to benefit Indian miners, according to industry analysts. With steel demand estimated to grow at a robust rate of 5.5-6.5%, domestic miners are poised to maintain strong prices through the first half of 2019, a recent Crisil Research report said.
India Ratings & Research (Ind-Ra) also said revocation of the licence at the Brazilian mine would be favourable for Indian miners and steel producers in the short term.
Local miners have announced price hikes of Rs 600-700 per tonne for 62% Fe fines and Rs 800-900 per tonne for pellets in February. "We foresee domestic iron ore prices rising 3-4% during calendar year 2019. This would have a direct bearing on 62% of the steel production that is based on supply from merchant (non-captive) miners," said Prasad Koparkar, senior director of CRISIL Research.

The Economic Times

Mr. R N Parbat, Former President (1995-96) of IIM, delivered a Key Note Address to INCAL 2019, held at Bhubaneswar from 31st January to 2nd February, 2019 where all the national and international Aluminium Companies participated showcasing their Technological Achievements, and having participation of more than 850 delegates.

Mr. Parbat was invited as a Veteran of Indian Aluminium Industry with total knowledge of Mining, Alumina Refining, Aluminium Smelting, Captive Thermal Power Plant, Direct Chill Casting/Continuous Casting, Sheet Rolling, Foil Rolling & Conversion, Wire drawing, Extrusion and Down Stream Product Manufacturing.

The IIM Metal News conveys 'ovation'.

Dr. U. Kamachi Mudali, Vice President, IIM, Distinguished Scientist & Chairman and Chief Executive, Heavy Water Board, DAE received Frank Newman Speller Award from NACE International, USA and Distinguished Alumnus Award of IIT Bombay. He is elected as Fellow of National Academy of Sciences India (NASI), Allahabad and Fellow of Indian Institute of Chemical Engineers (IIChE), Kolkata. Dr. Mudali is appointed as Adjunct Faculty of Institute of Chemical Technology (ICT) (University), Mumbai, and elected as President of Electrochemical Society of India, IISc., Bengaluru. He has delivered Inventa Prof. CK Murty Memorial Award and Lecture of IIChE, during CHEMCON 2018 at NIT, Jalandhar, December 2018 and Prof. GRD Endowment Lecture, at PSG Institutions, Coimbatore, February 2019.

The IIM Metal News conveys 'Heartiest Congratulation'.

INFORMATION

The 7th International Conference on Aluminium (INCAL-2019) has been organized between 31st January and 3rd February 2019 at Bhubaneswar where in +850 delegates attended the Conference.

It has been informed that for downloading 'Presentation materials' (under the Heading PAPER) and Photos one may visit INCAL-2019 website and follow the link https://www.incal2019.com/index.php/gallery-2/ .

Hard copy of the INCAL-2019 Proceedings (Volume 1&2) comprising of about 600 pages in multi-colour print can be availed from Aluminium Association of India (AAI), Bangalore office* for INR 3,500 / USD 50 per set (Vol-1 &2) with a complimentary copy of Participants Directory comprising of details about company, address, email id, business areas etc.

*Dr. Pratapaditya Mishra; Addl. Director General
Aluminium Association of India
Ramanashree Arcade, #118, First Floor ; 18, M.G. Road, Bangalore - 560 001
Tel: 080 25582757 E-mail: aluminiumaai@gmail.com, aai@aluminium-india.org
Website: www.aluminium-india.org

Visakhapatnam Chapter

1) One day Workshop on "Industry 4.0 and Smart Iron Making" was jointly organised by the Indian Institute of Metals, Visakhapatnam Chapter & Vizag Steel on 17th January, 2019. Shri P. K. Rath, CMD, Vizag Steel was the chief guest at the workshop. Shri R N Bhattacharya, GM (T&R) and Dr. D Bandyopadhay, Head of Metal Extraction and Recycling and Chief Scientist of CSIR-NML shared their experiences on digitisation of iron making processes and research works. A total of six papers were presented in three technical sessions. Mechanisation of tapping technology, digitisation, cloud technology, level-2 automation for higher productivity for large capacity blast furnaces were discussed. A total of 70 participants from different iron making & related industries were present.

2) The Indian Institute of Metals, Visakhapatnam Chapter & Vizag Steel - RINL jointly organized a two day seminar on "Global Trends in NH-RH Coke Making Technologies" on February 8 & 9, 2019. A total of 70 participants from technology supplier, consultants and coke/steel making industries participated in the seminar. Fifteen technical papers were presented in five technical sessions. The use of indigenous coal and viability of NH-RH coke making technologies towards steel production were discussed.

Hyderabad Chapter

1) The Indian Institute of Metals Hyderabad Chapter organized a Distinguished Lecture by Dr. Sudhir Kumar Mishra, Chairman and MD (Brahmos) & Director General (Brahmos) DRDO, New Delhi on “Inside Story: India’s Most Credible Missile”. The lecture was held on January 18, 2019 at Tamhankar Auditorium, DMRL, Hyderabad.

Dr. Mishra explained about the various stages in the evolution & development of BRAHMOS missile system and its achievements. He stated that BrahMos Missile is working dedicatedly in the service of the Nation strengthening our Defence. It is heartening to note that India, in the recent times, has enhanced its capabilities and geared up for greater production, meeting the production orders ahead of schedule.

BRAHMOS, world's fastest and deadliest supersonic cruise missile, has created history on 22nd November, 2017 after being successfully test fired from the Indian Air Force's frontline Sukhoi-30 MKI fighter aircraft against a sea-based target in the Bay of Bengal.

DRDO is making all efforts to ensure on-time delivery of different versions of BRAHMOS missiles to meet the aspirations and requirements of the Defense force including Army, Navy & Air Force.

NMD-IIM Award Winners of Hyderabad Chapter were honoured on this occasion by the Chief Guest. More than 200 Scientists & Engineers from various organizations in Hyderabad attended the lecture.

2) The IIM Hyderabad Chapter celebrated IIM Foundation Day on February 23, 2019 at Gurukul – NFC, by initiation of IIM FOUNDATION DAY LECTURE from this year. The maiden foundation day lecture was delivered by Dr. U. Kamachi Mudali, Vice-President-IIM and Chairman & Chief Executive, Heavy Water

Board, DAE, Mumbai on the subject “Ageing Management, Life Assessment & Extension of Structural Materials in Heavy Water Plants”.

Dr. Mudali expressed that the Physical characteristics of Structures, Systems and Components (SSCs) of Fuel Cycle Facilities may change due to ageing process. This may reduce the safety margin provided in the design during course of service life. Most of these facilities operates under varying temperature, pressure and handles large inventory of corrosive, toxic & flammable fluids and having single line of pressure boundary between hazardous fluid & that of environment. He also mentioned that understanding and detecting ageing effects is one of the most important element for implementing an effective life management programme in any facility. Non–Destructive testing is one of the detection techniques that are being used immensely for reliable inspection and interpretations of ageing effects in the SSCs over a period of service.

Dr. Dinesh Srivastava, Chairman, IIM Hyderabad Chapter and Chairman & CE, NFC, welcomed the gathering. Prof. Bhanu Shanker Rao, UoH; and Dy. CEs & GMs of NFC graced the occasion.

Dr. Kamachi Mudali was honoured on this occasion.

Sri M.N.V. Viswanath, Secretary-IIM Hyderabad Chapter, introduced the guest speaker. Dr. Y. Purushottam, Treasurer-IIM Hyderabad Chapter, proposed vote of thanks. Sri V. Vijaya Kumar anchored the programme.

More than 150 Scientists from various organizations attended this lecture. This was followed by a Special EC Meeting which was addressed by Dr. U K Mudali.

Report by Hon. Sec., Hyderabad Chapter

Mumbai Chapter

1) The Indian Institute of Metals, Mumbai Chapter was one of the organisers of the International Conference and Exhibition on Zinc . Coated Steels in Infrastructure, Construction and Automobiles from 4-5 February, 2019. The conference was held in Orchid Hotel, Mumbai.

2) The IIM-Mumbai Chapter arranged an industrial tour to Bharat Forge on 9th February, 2019. Nearly 40 participants visited various hot forging facilities in Bharat Forge.

Durgapur Chapter

The IIM-Durgapur Chapter organized a technical talk on "Making of new generation wheels to fulfil Railways' increasing requirements". The talk was delivered by Shri S K Behera, AGM, Wheel and Axle plant, Durgapur Steel Plant. The talk was held at Dhatu bhawan on 8th February, 2019.

HQ visit to Jaipur Chapter

A meeting of IIM Jaipur with the HQ team was held on Feb. 13, 2019 at 11.00 A.M at Department of Metallurgical & Materials Engineering, MNIT, Jaipur. The HQ- team comprised of Mr. Kushal Saha, Sec. Gen., Mr. Chiradeep Majumdar, Head- Finance, and Mr. Tamal Goswami, Manager- Membership. At the outset, Chapter Chairman, Prof. M. K. Bhargava extended a warm welcome to the HQ team. Mr. Kushal Saha presented general updates on IIM covering various types of memberships, eligibility criteria, fee structure etc., and mentioning that now online membership portal is also available. Mr. Tamal Goswami’s presentation was on membership of IIM, especially comparing with membership status of Jaipur Chapter. Mr. Chiradeep Majumdar presented in regard to GST registration, mentioning that it is imperative when we are going to organize conference/ seminar etc.

Meeting ended with vote of thanks, delivered by Prof. P. R. Soni, Hon. Sec., IIM Jaipur Chapter, to the HQ team, IIM members, faculty members and the research students of the department attending the meeting, ensuring the HQ team that their visit will boost the membership drive and re-active the Chapter.

-Report by Hon. Sec., Jaipur Chapter

Delhi Chapter

IIM Delhi Chapter celebrated the 74th foundation day of IIM on 24th February, 2019 at chapter premises. All the IIM Delhi Chapter members were invited along with their family members to celebrate this occasion.

At the outset, Shri B D Jethra, Chairman, Delhi Chapter, gave an overview of the IIM. He also spoke about the technical activities of the Delhi Chapter. Chairman shared with the members about the MMMM 2018 event which was successfully held at Pragati Maidan, New Delhi, during 29-31 August 2018.

Shri S C Suri narrated some of the long experiences of his working in steel sector and also about the Indian Institute of Metals.

Shri P K Bajaj, Vice Chairman, IIM Delhi Chapter, also shared his thoughts with the audience about technical activities of the Chapter.

After that, Shri K L Mehrotra, immediate Former Chairman of IIM Delhi Chapter, took over the stage and administered the entertainment activities in terms of Quiz relating to old songs. A number of audio visuals of old songs were played on the screen and questions were asked from the audience about names of some of the singers, actors, actresses, music directors, names of the movies etc. The winners were awarded. The IIM-Members and their family members appreciated the endeavour of Delhi Chapter and enjoyed their participation in the function. About 50 people participated in the Foundation Day. The celebration concluded with lunch.

Report from IIM-Delhi Chapter

Kolkata Chapter

IIM Kolkata Chapter celebrated the IIM-Foundation Day by organizing a get together on February 24, 2019 on the Vessel (MV SUMANGAL, WBTDC) on river Ganges. Participated by IIM members and their families, over 35 in number, the river cruise for 6 hours including welcome coffee, followed by breakfast, a snacks, a sumptuous lunch and a farewell tea.

Kudos to Sri T K Chakravarty, Vice-Chairman, IIM, Kolkata chapter and Sri S K Basu, Secretary IIM, Kolkata Chapter for organizing such a wonderful event.

IIM-Head Office

The Indian Institute of Metals reached yet one more milepost as it celebrated the 74th Foundation Day on Sunday, 24th February 2019 with significant fervour. Celebrating and embracing the success has been an important agenda to add value to the accomplishments of the employees and the members of this august body. This year's Foundation Day Celebration at IIM Head Office has been one of such instances where the stakeholder's intense participation brought in much enthusiasm and vigour.

The Foundation Day at IIM Head Office witnessed the presence of Office Bearers, Council Members, Chapter representatives and IIM Head Office employees who all assembled in the Auditorium at Metal House at 10 am sharp. The celebration commenced with the gratifying performance of one of the IIM Head Office employees, Ms. Nabatara Goswami. Her welcome songs traversed through various facets of one's journey, emulating the roadmap of our Institute.

Soon after the welcome song, Mr. Kushal Saha, Secretary General, IIM invited dignitaries on the dais. The event was taken over by Mr. Anand Sen, President, IIM followed by Vice Presidents, M/s U Kamachi Mudali and Amol A Gokhale, Former Presidents, Mr. RN Parbat and Dr. RN Patra , delivering inspiring speeches that highlighted the glorious past of the Institute. They took us through their reminiscences on IIM's journey so far; and also suggested the way forward, keeping our Institute's flag soaring high. IIM was founded by a few visionary Metallurgists and professionals in 1946 with a vision to outshine in the metallurgical and materials science fraternity.

Mr. Anand Sen, President, IIM gave us an insight into some of the last year's pivotal initiatives taken and also emphasized on the collaborative approach which is a crucial component for success of the Institute.

- Mr. Kushal Saha , Former Director, HEC succeeded Mr. S K Roy , Former Adviser to MD, Tata Steel Ltd , as the Secretary General of the Institute wef April 1st , 2018
- New Chapters Inducted in the fraternity:
  Regular Chapters: Bharuch, Sambalpur, Mathura
  New Enrolment: 1st April 2018 to date: 410 [182 Ordinary Members ;85 Life Members; 130 Student Members; 7 Associate Members; 1 Fellow; 1 Hon Member; Sustaining Members : 4 [3 Large Scale & 1 Small Scale].
  The enrolment has been adversely affected due to the below mentioned factors :
  a) Amendment in Membership Fees by more than 60% wef 2018 April
  b) Pending recent recognition of AMIIM examination by AICTE, new enrolments has ceased effective Dec'17.

- IIM Metal News [Semi Technical monthly journal] got digitized wef April 2018 ; 500 Hardcopies are available in print edition

- NMD Portal has been designed, developed and introduced in March 2018. All NMD Awards Applications and assessment process with respect to various NMD Award categories has been initiated through the portal. We received 58 duly filled applications in the maiden portal. The cumbersome process of inviting & sending hardcopies of nominations ceased effective from 2018.

The event ended with a thank you speech by Mr. SN Guha, Treasurer, followed by a cake cutting ceremony embodying mutual commitment and zeal to uplift the Institute's brand value. On this auspicious day, during his Thank you Speech, Mr. SN Guha urged the members to rededicate our commitment to strive for oneness – one vision, one direction, one Organisation.

The coming year is defining and significant, and we are prepared to take on the challenges of the metallurgy world.

Mr. Anand Sen, President-IIM, delivering his speech

Cake cutting ceremony

International Women's Day Celebrations by IIM Mumbai Chapter

The Indian Institute of Metals, Mumbai Chapter in association with Materials Group, Bhabha Atomic Research Centre organized a half day program for celebrating the International Women's day on 8th March, 2019. About 100 delegates from DAE and IIM Mumbai Chapter attended the program which was held at the DAE Convention Centre, Anushaktinagar, and Mumbai. The program constituted of talks from women achievers from various fields including science and technology. Senior members of IIM including the Chairman, Dr. V. Kain, former president, Dr. (Smt.) S. B. Roy gave introductory speeches on the occasion of the first Women's day program, organized by the Institute. Ms. Chintha Issac (Additional Commissioner, Directorate General of Vigilance, Department of Revenue, WZU, Mumbai) graced the occasion as the chief guest.

Glimpses of Women's day Celebrations

EVENTS CALENDAR 2019

March
25-29
National Workshop on "Non-Destructive Testing Methods and Their Applications" at AERB Auditorium, Niyamak Bhavan, Anushaktinagar, Mumbai organized by Indian Nuclear Society. E-mail: indiannuclearsociety@gmail.com
April
15-16
IIM Mumbai Chapter in association of Indian Institute of Technology, Bombay, organizing a Symposium on "Critical Non-Ferrous Metals: Establishing the value chain".
Convener: Dr Vilas Tathavadkar, Aditya Birla Science & Technology Co Pvt Ltd.
17-21
Five days short term course on "Advanced Materials, Processing & their Future Prospects" (AMPFP-2019), organized by GLA University, Dept. of Mechanical Engineering, in association with IIM Mathura Chapter.
Co-ordinators: Prof. Piyush Singhal & Dr. Kuldeep Kumar Saxena
November
14-16
57th National Metallurgists' Day (Under the aegis of Government of India, Ministry of Steel) and 73rd Annual Technical Meeting of IIM, organized by IIM Trivandrum Chapter.
Convener: Dr P Ramesh Narayanan, ramesh_narayanan@vssc.gov.in

SEMINARS & CONFERENCES

Past Events

Conference on "Augmenting Coal Production through Commercial Mining"
Assocham organised a Conference on India Coal Sector on February 14, 2019 at Hotel Le Meridian, New Delhi. The theme of the Conference was "Augmenting Coal Production through Commercial Mining". Shri Haribhai Parthibhal Chaudhary, Hon'ble Minister of State for Mines and Coal, Govt. of India, was the Chief Guest of the Conference.

Report from IIM Delhi Chapter

India Corporate Governance and Sustainability Vision Summit and Awards
The Indian Chamber of Commerce (ICC) organised India Corporate Governance and Sustainability Vision Summit and Awards at New Delhi on February 21, 2019.
At the outset, Shri Anil Razdan, Chairman-ICC National Expert Committee Energy and Former Secretary, Dept. of Power, Govt. of India, delivered the welcome address. In his address Shri Razdan stated that sustainability is very vital to mankind. He informed that a few companies have been chosen by them for giving the awards. These companies have done commendable work in the corporate governance area. Mr. Saunak Saha Associate Partner, Ernst and Young, stated that there is a resource constraint in India. There is sea change in India on sustainable issue. A number of regulations have been introduced in energy sector to improve energy efficiency. He also talked about renewable energy and enhancement of energy productivity. Dr. Bhaskar Chatterjee, Former Secretary, Dept. of Heavy Industries and Public Enterprises, Government of India and Sr. Director, Indian Institute of Learning and Management , stated that he was part of the jury which have chosen the awardees in the area of Corporate Governance and Sustainability Vision Awards.
The Summit was attended by about 150 delegates from various organisations and media. Some members of Executive Committee of Delhi Chapter of IIM also attended the Conference. The Summit concluded with lunch.

- Report from IIM Delhi Chapter

Seminar on "Prospects and Challenges in Metallurgical and Allied Industries with Special Emphasis on Quality, Safety and Environment"
The IIM Kolkata Chapter organized this International seminar on February 22, 2019 at Hotel Floatel on Ganges, Kolkata. About 80 delegates, invitees and IIM Members attended the one day programme, which included a panel discussion on the topic "Thrust on Environment, Safety and Quality Management are essential for sustainability of Metallurgical and Allied Industries" besides the usual inaugural and technical sessions .

Upcoming Events

Symposium on "Critical Non-Ferrous Metals: Establishing the value chain"
The Mumbai Chapter of the Indian Institute of Metals is organising a two-days symposium on "Critical Non-Ferrous Metals: Establishing

the Value Chain" during 15-16 April, 2019 at Indian Institute of Technology Bombay, Powai, Mumbai, with the following themes (dealing specifically with metals like titanium, zirconium, lithium, niobium, rare earths, tungsten and hafnium among others):

- Advances in mining, mineral beneficiation and extractive metallurgy
- Alloy development, physical metallurgy, product design, manufacturing and applications
- Mineralogical, chemical and metallurgical characterization
- Key infrastructure developments and shortcomings
- Sustainability challenges – raw materials, energy, waste & effluent treatment

The purpose of holding the two-days symposium is to bring together as many stakeholders as possible to deliberate on the subject and reach a common understanding, so that suitable future plans can be proposed to fill gaps in technologies, investments and policies.
The symposium provides a platform to participate and interact with individuals and organisations involved in research, production, downstream processing and applications of nonferrous metals and alloys or related engineering.
Registration details and the list of invited speakers can be found at : IIM Website and
https://www.me.iitb.ac.in/~cnfm2019/

Short term course on "Advanced Materials, Processing & their Future Prospects" (AMPFP-2019)
GLA University, Dept. of Mechanical Engineering, Mathura, in association with IIM Mathura Chapter is organizing a Five days Short term course on "Advanced Materials, Processing & their Future Prospects" during 17-21 April, 2019.

ABOUT UNIVERSITY

GLA University is one of the Premier Universities in India, situated in Northern India. The university was established by the present Chancellor, Shri Narayan Das Agrawal in 1998. The chancellor envisioned GLA as a quality educational institution to serve the higher education needs of the youth of the region and beyond. The institute was accorded the status of university under the U.P. State Legislative Act of 2009 (UP Act 21 of 2010). Recently the University was accredited with 'A' grade by NAAC. It spread across 110 acres of land and is home to more than 12,000 students, enrolled in a variety of professional courses. It boasts of well-designed and maintained buildings, contemporary laboratories, spacious residential complexes and recreational facilities. The facilities of such kind and grandeur make the GLA campus one of the best in the region, providing its students an ideal environment to hone their skills in an increasingly competitive and demanding world.

ABOUT DEPARTMENT

Under the banner of GLA University, Department of Mechanical Engineering is consistently working to achieve core objectives of the University. Department facilitates, state of art laboratories and research centers where students can realize their ideas into tangible objects in terms of new technologies and engineering products. Department has Solar Energy Research Centre (SERC), Micro Nano Development and Research Centre (MNDRC), Center of Automotive Research (CAR) and well established workshops and other laboratories. Department is consistently delivering high quality research. The Faculty of the department are highly qualified and extending their expertise in academic and research.

COURSE CONTENT

*** Overview of advanced materials**
- Types of Materials (Ferrous Alloys ,Non –Ferrous Alloys, Super Alloys, Nano Materials, Smart Materials, Shape memory Alloys
- Basic of Physical Metallurgy
- Phase Diagram of Specific Materials
- TTT and CCT Diagrams of Specific Materials

*** Processing of Materials**
- Forming
- Heat treatment
- Welding

*** Microstructural Characterization (Techniques and Advantages)**
- Optical, SEM/EBSD, TEM, XRD

*** Properties and Application**
*** Industry 4.0**
*** Future Prospects and Career Opportunity**
*** Local Visit of Mathura /Agra (Last Day)**

IMPORTANT DATES

Registration Deadline : 5 April , 2019
Program Schedule : 17-21 April, 2019
Complete registration form with payment receipt or demand draft required to send at the following address:
Head, Department of Mechanical Engineering.
Institute of Engineering & Technology.
GLA University, 17 Km Stone, NH#2, Delhi-Agra NH.
PO: Chaumuhan, Mathura- 281406 (U.P.) India

REGISTRATION FEE:

Participant Type	Amount (Rs.)
Faculty Members/ PhD Scholar/Industry Person	**3000/-**
For IIM Members	**2000/-**
For Students	**750/-**

* Accommodation for out station candidates may be provided in the University Guest houses/ Hostels on prior request and nominal payment basis.
The registration fee payment can be made by following modes:

Demand Draft:
In favor of "The Indian Institute of Metals Mathura Chapter", payable at SBI Vrindavan.

Online Transfer:
Beneficiary Name - "The Indian Institute of Metals Mathura Chapter",
Current A/C No.-38291357717, IFSC Code- SBIN0002502,
Branch Name- SBI Vrindvan Main Branch

CO-ORDINATORS

Prof. Piyush Singhal
Dr. Kuldeep Kumar Saxena

ANY QUERY, PLEASE CONTACT

Registration:
Mr. Bharat Singh :
8630539401 (bharat.singh@gla.ac.in)
Mr. Pankaj Sonia :
7534088705 (pankaj.sonia@gla.ac.in)

Sponsorship:
Ms. Soni Kumari :
8168698706 (soni.kumari@gla.ac.in)
Mr. Prashant Dixit :
9450421101 (prashant.dixit@gla.ac.in)

METAL STATISTICS

	2015 -16	2016 -17	2017 -18	2018			
				Aug'18	Sept'18	Oct'18	Nov'18
ALUMINIUM							
National Aluminium Co Ltd	3,72,184	3,87,423	4,25,513	37,518	36,051	36,898	34,897
	13.8%	4.1%	9.8%	4.9%	2.0%	0.6%	-2.9%
Hindalco Industries Ltd	4,09,376	4,05,354	4,08,904	34,972	33,946	34,998	33,984
	-0.1%	-1.0%	0.9%	1.5%	1.4%	0.3%	0.0%
Bharat Aluminium Co. Ltd	3,31,324	4,26,140	5,68,932	48,336	46,852	48,402	46,987
	1.5%	28.6%	33.5%	-0.4%	-0.2%	1.9%	0.4%
Vedanta Ltd	5,15,398	5,26,932	4,08,904	43,064	44,997	47,024	44,681
	-4.1%	2.2%	-22.4%	28.3%	33.1%	22.8%	17.7%
Total	**16,28,282**	**17,45,849**	**18,43,416**	**1,63,890**	**1,61,846**	**1,67,322**	**1,60,549**
	1.7%	**7.2%**	**5.6%**	**7.6%**	**6.8%**	**6.3%**	**-2.5%**
ZINC							
Hindustan Zinc Ltd	7,58,939	6,71,993	7,91,427	58,483	58,040	59,461	62,519
	3.4	-11.5%	17.8%	-13.4%	-3.9%	-15.0%	-3.2%
Total	**7,58,939**	**6,71,993**	**7,91,427**	**58,483**	**58,040**	**59,461**	**62,519**
	3.4%	**-11.5%**	**17.8%**	**-13.4%**	**-3.9%**	**-15.0%**	**-3.2%**
COPPER (Cathodes)							
Hindustan Copper Ltd	17,015	16,448	25,949	1,840	2,082	1,909	1,756
	11.6%	-3.3%	57.8%	-27.4%	-9.8%	12.1%	-12.0%
Hindalco (Unit. Birla Copper)	3,89,301	3,77,381	4,13,807	22,103	34,284	35,224	35,984
	0.3%	-3.1%	9.7%	-33.9%	11.3%	-3.8%	6.8%
Vedanta Ltd	3,84,069	4,02,372	4,03,208	3,836	7,787	6,567	7,504
	6.0%	4.8%	0.2%	-89.6%	-77.8%	-80.1%	-75.9%
Total	**7,90,385**	**7,96,201**	**8,42,964**	**27,779**	**44,153**	**43,700**	**45,244**
	3.2%	**-0.7%**	**5.9%**	**-61.9%**	**-35.2%**	**-38.7%**	**-32.3%**
LEAD							
Hindustan Zinc Ltd	1,44,918	1,39,010	1,71,345	18,056	18,909	19,187	18,036
	14.0%	-4.1%	23.3%	35.2%	58.6%	40.2%	24.8%

Source : MMR – February 2019

Non – Ferrous Metal Prices in India (March, 2019)

Source : http://www.mtlexs.com/todays-metal-prices

Rs./kg (Mumbai Local Prices)

Product	11-Mar-2019
Rs./kg (Mumbai Local Prices)	
Copper Armature	*431*
Copper cathod LME ++	*479*
CC Rod LME ++	*483*
Copper Cable scrap	*444*
Copper shell 40mm	*472*
Electrolytic Copper strip 25mm	*467*
ACR Copper Coil 3/8	*531*
Brass Sheet scrap	*345*
Brass Pales scrap	*353*
Brass Pallu scrap	*355*
Brass Honey scrap	*325*
Brass Shell 40mm	*393.96*
Aluminium 6063 scrap	*128*
Aluminium scrap Taint/Tabor	*115*
Aluminium Cable scrap	*138*
Aluminium Ingot	*149*
Aluminium utensil scrap	*122*
Zinc Slab	*217*
Lead ingot	*156*
Tin Slab	*1670*
Nickel Cathod	*955*

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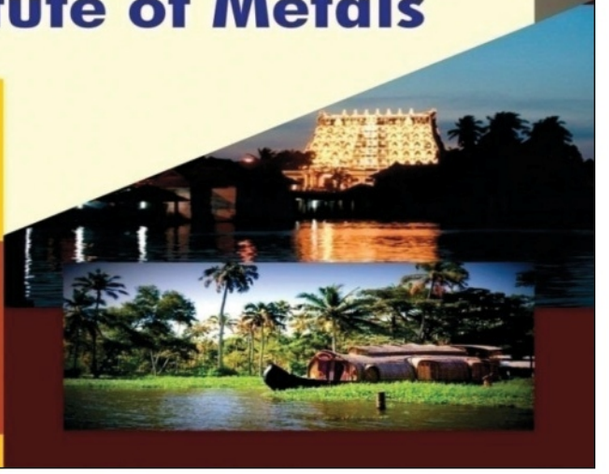

Central Secretariat:
Dr. P. Ramesh Narayanan
Convener, NMD-ATM 2019
Scientist and Head, MCD/MMG, VSSC, ISRO (PO),
Trivandrum 695022, Kerala, INDIA
Tel: 0091 471 2563748; Fax: 0091 471 270 5048
Mail: ramesh_narayanan@vssc.gov.in

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www.chromatographyinst.com
info@chromatographyinst.com ; cicpltd@gmail.com