Indian Minerals Yearbook 2021

(Part- III : MINERAL REVIEWS)

60th Edition

ILMENITE AND RUTILE

(ADVANCE RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX: (0712) 2562649, 2560544, 2560648
E-MAIL: cme@ibm.gov.in
Website: www.ibm.gov.in

March, 2023

15 Ilmenite & Rutile

India is endowed with large resources of heavy minerals which occur mainly along coastal stretches of the country and also in inland placers. Heavy mineral sands comprise a group of seven minerals, viz, ilmenite, leucoxene (brown ilmenite), rutile, zircon, sillimanite, garnet and monazite. Ilmenite ($FeO.TiO_2$) and rutile (TiO_2) are the two chief minerals of titanium. Titanium dioxide occurs in polymorphic forms as rutile, anatase (octahedrite) and brookite. Though brookite is not found on a large-scale in nature, it is an alteration product of other titanium minerals. Leucoxene is an alteration product of ilmenite and is usually found associated with ilmenite.

RESERVES/RESOURCES

Ilmenite and rutile along with other heavy minerals are important constituents of beach sand deposits found right from Saurashtra coast (Gujarat) in the west to Digha coast, West Bengal in the east. These minerals are concentrated in five well-defined zones:

* Over a stretch of 22 km between Neendakara and Kayamkulam, Kollam district, Kerala (known as 'Chavara' deposit after the main mining centre).
* Over a stretch of 6 km from the mouth of River Valliyar to Colachal, Manavalakurichi and little beyond in Kanyakumari district, Tamil Nadu (known as MK deposit).
* On Chatrapur coast stretching to about 18 km between Rushikulya river mouth and Gopalpur lighthouse with an average width of 1.4 km in Ganjam district, Odisha (known as 'OSCOM' deposit after IREL's Orissa Sands Complex).
* Brahmagiri deposit stretches for 30 km from Girala nala to Village Bhabunia with an average width of 1.91 km in Puri district, Odisha.
* Bhavanapadu coast between Nilarevu and Sandipeta with 25 km length and 700 m average width in Srikakulam district, Andhra Pradesh.

The AMD of the Department of Atomic Energy has been carrying out exploration of these mineral deposits. Of the total, coastal length of 5,921 km spread in Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa, Gujarat and West Bengal about 451 km, 1,873 km, and 112 km have been covered by detailed exploration, general exploration and preliminary exploration respectively. A coastal length of 2,272 km have not been covered due to various reasons viz., mangrove, port activity etc., leaving an unexplored coastal length of 1,214 km. The distribution of area coverage (sq km) in different geological domains are Beach & Dune (1845), Inland Sand Body (180), Terrace sediments (368), River Channel (32), Inland alluvium (646) and Lake & Sea Beds (38). The ilmenite resource estimation for the areas explored up to March, 2020 has been completed and the resources are up from 629.57 million tonnes (including leucoxene) in the year 2016 to 687.57 million tonnes in the year 2020. The resources include Measured, Indicated and Inferred categories. Though, the latest state-wise / deposit-wise details are not available, the state-wise/ deposit-wise details as received from DAE vide letter dated 26.07.2018 are furnished in Tables-1 & 1A.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration and Development" under "General Reviews".

PRODUCTION AND PRICES

Ilmenite

The production of ilmenite was 351 thousand tonnes in 2020-21 increased by 0.24% as compared to that in the preceding year. Odisha was the leading producer of ilmenite during the year under review, contriubuting 65% of the total production followed by Kerala (25%) and Tamil Nadu (9%).

Table – 1 : Ilmenite Reserves, Resources/Deposits in India

State/Deposit	Ilmenite reserves (In million tonnes)
Andhra Pradesh	
1. Bhavanapadu	10.18
2. Kakinada (Phase I-VIII)	13.81
3. Kalingapatnam	7.03
4. Narasapur	2.92
5. Nizampatnam	19.26
6. Srikurman (South)	8.60
7. Visakhapatnam (Bhimunipatnam)	2.88
8. Amalapuram (Phase I-IV)	4.72
9. Pandurangapuram-Voderevu (Bapatla-Chirala coast)	10.38
10. Vetapalem Coast (Chirala coast)	5.31
Kerala	
1. Chavara Barrier beach	13.17
2. Chavara Eastern Extension (Phase-I)	17.02
3. Chavara Eastern Extension (Phase-II)	49.26
4. Trikkunnapuzha-Thotapally Beach & Eastern Extension	9.50
5. Alapuzha-Kochi	5.88
Maharashtra	
Ratnagiri	3.68
Munge-Achra-Malvan	1.12
Vijayadura-Mithbav	0.70
Gujarat	
Moti Daman-Umbrat coast	2.77
Odisha	
1. Brahmagiri (Phase I-V and NW extension)	86.04
2. Chatrapur	26.72
3. Gopalpur	6.42
Tamil Nadu	
1. Kudiraimozhi	22.86
2. Ovari-Periyatalai-Manapadu (Teri)	24.01
3. Sattankulam Teris	41.26
4. Cuddalore-Pudupattuchavadi (beach sand)	4.67
5. Vayakallur (beach sand)	4.52
6. Manavalakurichi (beach sand)	3.07
7. Midalam	1.64

Source: *As per letter received from Department of Atomic Energy, Mumbai dated 26/07/2018*

Table – 1 A : Reserves/Resources of Ilmenite and Rutile

(In million tonnes)

State	Total in situ #
Ilmenite* : Total	**629.57**
Andhra Pradesh	156.17
Jharkhand	0.73
Gujarat	2.77
Kerala	144.02
Maharashtra	5.50
Odisha	150.62
Tamil Nadu	167.70
West Bengal	2.06
Rutile : Total	**33.95**
Andhra Pradesh	10.55
Jharkhand	0.01
Gujarat	0.02
Kerala	8.74
Maharashtra	0.01
Odisha	6.58
Tamil Nadu	7.85
West Bengal	0.19

Source: *As per letter received from Department of Atomic Energy, Mumbai dated 26/07/2018. The resources of beach sand minerals (BSM) viz. Ilmenite, Rutile, Zircon, Garnet, leucoxene, monazite and Sillimanite were last updated in the year 2016 by AMD. # Inclusive of Indicated, Inferred and Speculative categories. * Including leucoxene.*

Rutile

The production of rutile at 13 thousand tonnes in 2020-21 decreased by 2% as compared to that in the previous year. Kerala was the leading producer of rutile accounting for 73% of the total production followed by Kerala (17%) and Tamil Nadu (10%).

Production and prices of ilmenite and rutile are furnished in Tables -2 to 4.

Table – 2 : Production of Ilmenite and Rutile (By States)

(In tonnes)

State	2018-19	2019-20	2020-21* (P)
ILMENITE			
India : Total	**292226**	**350535**	**351387**
Kerala	74834	75593	88110
Odisha	191492	241009	230040
Tamil Nadu	25900	33933	33237
RUTILE			
India : Total	**12593**	**13102**	12845
Kerala	8384	8669	2197
Odisha	3270	3257	9409
Tamil Nadu	939	1176	1239

Table – 3 : Prices of Rutile 2017-18 to 2019-20

(₹ per tonne)

Year	Grade	Price	Remarks
IREL			
2017-18**	Q	60748	Ex-works, Bagged
	MK	-	Ex-works, Bagged
	OR	61070	Ex-works, Bagged
2018-19	Q	76995	Ex-works, Bagged
	MK	79627	Ex-works, Bagged
	OR	76798	Ex-works, Bagged
2019-20	Q	92138	Ex-works, Bagged
	MK	93052	Ex-works, Bagged
	OR	92788	Ex-works, Bagged
KMML			
2017-18	-	52083	Average
2018-19	-	66916	Average
2019-20	-	NA	-
V.V. Mineral			
2017-18	-	NA	Average
2018-19	-	NA	-
2019-20	-	-	-

Source: *Department of Atomic Energy, Mumbai*
Note*: Q: Quilon; MK: Manavalakurichi; OR: Odisha*
***During the financial year 2017-18 MK unit not despatches any material due to non- availability of transport permit.*

Table – 4: Prices of Ilmenite 2017-18 to 2019-20

(₹ per tonne)

Period	Grade	Price	Remarks
IREL			
2017-18**			
	Q*	11922	Ex-works, loose
	MK*	-	Ex-works, loose
	OR*	11618	Ex-works, loose
2018-19			
	Q*	12978	Ex-works, loose
	MK*	12667	Ex-works, loose
	OR*	12512	Ex-works, loose
2019-20			
	Q*	14618	Ex-works, loose
	MK*	14235	Ex-works, loose
	OR*	13167	Ex-works, loose
KMML			
2017-18		NA	
2018-19		NA	
2019-20		NA	
V.V. Mineral			
2017-18	-	-	-
2018-19	-	-	-
2019-20	-	-	-
BMC			
2017-18		NA	
2018-19		NA	
2019-20		NA	
DCW Ltd			
2017-18	-	8423	
2018-19	-	14489	
2019-20	-	15265	

Source: *Department of Atomic Energy, Mumbai.*
Note*: Q: Quilon; MK: Manavalakurichi; OR: Odisha*
Ilmenite is usually sold on NAW (naked at works) basis from all production center
**: Regular Price*

MINING & PROCESSING

A notification dated 27.07.2019, was issued for reserving the prospecting and mining rights of offshore minerals under Offshore Areas Minerals (Development and Regulation) Act, 2002 exclusively to Government and Government owned companies for curbing illegal mining of atomic minerals by private parties. Mining and processing of beach sand is carried out by the IREL, a Government of India Undertaking and KMML, a Kerala State Government Undertaking. Exploitation work of beach sand deposits located at Chavara in Kerala, Gopalpur in Odisha and Manavalakurichi in Tamil Nadu by IREL is under progress.

At IREL, Chavara, Beach Sand was collected over a stretch of 22 km between Neendakara and Kayamkulam in Kerala and was transported to plant site. The unit has adopted wet mining operations involving use of two Dredge and Wet Concentrator (DWC) of 100 tph capacity each to exploit the inland deposits away from the beaches. Chavara ilmenite is the richest in TiO_2 content (75.8% TiO_2) and has great demand in India and abroad for manufacture of pigments.

At Manavalakurichi, the deposit is spread over 300 hectares at Thuthoor-Ezudesam villages, Vilavancode tehsil, district Kanyakumari, Tamil Nadu. All the raw sand required for the mineral separation plant to operate to its full capacity is collected from nearby beaches. Deposits are also exploited by DWC of 100 tph capacity. Manavalakurichi is next to Chavara in terms of TiO_2 content which is more than 55%.

The sand deposits of OSCOM at Chatrapur in district Ganjam extend along the coast of Bay of Bengal with an average width of 1.4 km and average depth of 7.5 m. Mining operations involve suction dredging to 6 m depth below water level on a much larger scale (500 tph) augmented by a smaller sized (100 tph) supplementary. The ilmenite from OSCOM is inferior in grade in terms of TiO_2 content (50%) in comparison to Chavara and Manavalakurichi. The Synthetic Rutile Plant of OSCOM is presently not working. As a result, the majority of OSCOM ilmenite produced of late is routed to the international market as feedstock for production of both slag grade and anatase grade pigment.

In dry mining, beach washings laden with 40-70% Heavy Minerals (HM) are collected through front-end loaders and bulldozers for further concentration to 90% HM at land-based concentrators. Though dry mining is very simple and economic, there is considerable opposition by local people for this form of mining for reasons that removal of sand would expose the land area to sea erosion. Therefore, collection of beach washings has reduced significantly in recent past.

As an alternate approach, IREL has adopted wet mining involving dredging and wet concentration (DWC) from inland areas away from the beach lines. In this mode, an artificial pond is created, the sand bed is cut and the slurry is pumped to spiral concentrator for removal of quartz. Manavalakurichi was the first plant to install a DWC (100 tph) followed by one (500 tph) at OSCOM and two (each 100 tph) at Chavara. The concentrate (90% HM) of beach washing plant from DWC is further upgraded to 97% HM grade at a Concentrate Upgradation Plant (CUP) before sending it to Mineral Separation Plant (MSP).

Execution of Supplimentary Mining Lease deed for OSCOM Mines till a period up to the year 2047 has been completed under the provision of AMCR 2016. Communication on precious area of the Bramhagiri Mineral Sands Deposit in Puri District under AMCR 2016 is in the final stages of issuance by Government of Odisha.

After much persuasion, the precise area communication over an extent of 855 ha out of the identified area of 1,817 ha in Kanyakumari district is also expected to be issued by Government of Tamil Nadu. The Government is showing keen interest in exploiting the resources through a joint venture between IREL and TAMIN, a State PSU. This initiative would be a breather for MK operations as the mineable land within the mining leasehold areas are on the verge of exhaustion. Further, it will also pave way for formation of a new subsidiary of IREL in the same line as that of IREL and IDCOL.

KMML collects seasonal accretions of heavy mineral sand from the beach front. The pit so formed gets filled by fresh accretions of heavy mineral sand. The mineral sand is collected using bulldozers and wheel loaders and transported in tippers to Mineral Separation Plant.

The mineral separation plants use variety of equipment, such as, gravity concentrators, high tension electrostatic separators and magnetic separators. Making use of difference in physical properties like electrical conductivity, magnetic susceptibility and difference in specific gravity, etc., individual minerals like ilmenite, rutile, zircon, sillimanite and garnet are separated. The mined beach sands are pre-concentrated and dried after sieving (30-mesh) to separate the heavies from rejects. The heavy minerals are passed through electrostatic separators where conducting minerals – ilmenite and rutile – are separated from other non-conducting minerals. Ilmenite and rutile are further subjected to low-intensity magnetic separators where magnetic fraction - ilmenite is separated from rutile. Similarly, non-conducting fractions are subjected to high-intensity magnetic separators where weak magnetic fraction (monazite and garnet) is separated from non-magnetic fraction (zircon and sillimanite). The fractions are further processed on wind tables to separate garnet from monazite and sillimanite from zircon.

Installed capacity and production of ilmenite, rutile and other associated heavy minerals by various separation plants are furnished in Table-5.

Table – 5 : Installed Capacity & Production of Ilmenite, Rutile and Other Heavy Minerals, 2017-18 to 2019-20

(In tonnes)

Company/ Location	Mineral/ Product	Installed capacity (tpy)	Production		
			2017-18	2018-19	2019-20
Indian Rare Earths Ltd					
Manavalakurichi,#	Ilmenite	90000	-	25745	320485
Distt Kanyakumari,	Rutile	3500	-	938	11674
Tamil Nadu.	Zircon	10000	-	2190	11490
	Sillimanite	8778	-	-	26052
	Monazite	6000	-	-	69748
	Garnet	10000	-	7425	5034
Chavara,	Ilmenite	200000	43253	48694	
Distt Kollam,	Rutile	11400	1515	1723	
Kerala.	Zircon	17500	2649	3072	
	Rare Earths	4500*	-	-	
	Sillimanite	10000	6826	7953	
Orissa Sands Complex,	Ilmenite	220000	184657	191492	
Distt Ganjam,	Rutile	7400	7860	8384	
Odisha.	Zircon	5000	5696	6694	
	Sillimanite	13000	16698	17930	
	Garnet	20000	34170	31332	
Kerala Minerals & Metals Ltd					
Chavara,	Ilmenite	61600	56757	26140	30009
Distt Kollam.	Rutile	4400	2454	1548	1428
Kerala.	Zircon	6500	4844	4762	4110
	Sillimanite	3600	701	271	1329
V.V. Mineral					
Distt Thoothukudi,	Ilmenite	450000	-	-	
Tamil Nadu.	Rutile	12000	-	-	NA
	Zircon	18000	-	-	
	Zircon-sillimanite	24000	-	-	
Beach Minerals Co. Pvt. Ltd					
Kuttam, Distt Tirunelveli, Tamil Nadu.	Ilmenite	150000	-	-	
V.V. Titanium Pigments Pvt. Ltd Distt Thoothukudi Tamil Nadu.	Titanium Dioxide	18000	13801	11902	9419

Source: *Department of Atomic Energy, Mumbai and IREL.*

** In terms of rare earths chloride. '-' Not Available # During the year 2017-18, Manavalkurichi Plant was non-operating from Jan 2017 because of non-availability of environmental clearence (EC). V.V.Mineral mine is not in operation since 2017-18*

INDUSTRY

For manufacturing titanium dioxide pigment, ilmenite is first treated chemically to obtain upgraded ilmenite, commonly called as synthetic rutile. There are two major pigment production processes, namely, chloride process and sulphate process depending on different operating characteristics and feedstock requirements. Plants employing chloride process consume high TiO_2 content feedstocks like synthetic rutile and chloride slag. On the other hand, plants employing the sulphate process use lower-grade ilmenite and sulphate slags.

Ilmenite obtained from Mineral Separation Plant (MSP) is chemically treated to remove impurities, such as, iron to obtain synthetic rutile (90% TiO_2) in Synthetic Rutile Plant (SRP). Indian SRP are based on reduction roasting followed by acid leaching with or without generation of hydrochloric acid. Plants of IREL (OSCOM) and KMML depend on acid regeneration from the leach liquor while those of Cochin Minerals & Rutile Ltd (CMRL) and DCW use fresh acid and recover ferric chloride from the leach liquor for its use in water purification.

At OSCOM plant of IREL, reduction-roasting of ilmenite with coal is followed by leaching with HCL to separate iron as soluble ferrous chloride. The leached ilmenite is calcined to yield synthetic rutile and the acidic leach liquor is treated in an acid regeneration plant to recover HCL for recycling with iron oxide as waste. The unit stopped production in 1997, as it was not viable economically. Against the Request for Proposal floated to set up titanium slag plant under Build-Own-Operate (BOO) model, a CPSE has shown keen interest and based on their request, the due date of submission has been extended. Considering the formidable investment and difficulties in sourcing technology in the field, the progress, though slow is in the right direction.

Environment Clearence for setting up nano titania/zirconia facilities have been received. However, in consideration of the stringent norms of Zero Effluent Discharge, work has been taken up to use alternate feed material to meet the stipulations. The KMML is manufacturing rutile grade titanium dioxide pigment by chloride route at its Sankaramangalam plant near Chavara in Kerala. The project for the production of one lakh tonnes of TiO_2 in a phased manner is under implementation. The Company also has plans to enhance pigment capacity to 60,000 tpy for which detailed project report is under preparation. In 2009, the Company had developed Nano Titanium Dioxide particles on laboratory scale and in July 2011, India's first commercial plant for synthesis of Nano titanium Dioxide was commissioned.

The DCW Ltd procures ilmenite from Manavalakurichi which is then roasted with coke fines to convert Fe_2O_3 into FeO. The reduced ore is leached with concentrated hydrochloric acid to remove oxides of iron and other metals. The leached ore is washed and calcined to get upgraded ilmenite which contains more than 95% TiO_2. The upgraded ilmenite is micronised to 2 microns by using high-pressure steam. This is marketed as Titox. The liquor from ilmenite leaching process contains fine TiO_2 particles and chlorides. The TiO_2 recovered by filtration & washing in filter process is marketed as Utox. The Company has plans to increase the plant capacity to 48,000 tpy and also to install facilities for the manufacture of ferrite grade iron oxide from the effluent of the ilmenite plant.

Cochin Minerals and Rutile Ltd (CMRL), which began production at its 10,000 tpy synthetic rutile plant in Kerala in 1990 as a 100% EOU, has gradually raised the production capacity to around 45,000 tpy since 2008-09 for exports. It also has ferric chloride & ferrous chloride plants having capacities of 24,000 tpy & 72,000 tpy, respectively.

The Travancore Titanium Products Ltd (TTPL), a Kerala State Government Undertaking, manufactures titanium dioxide pigment by sulphate process at its plant at Kochuveli, Thiruvananthapuram. Ilmenite is reacted with sulphuric acid in digesters and a porous cake is formed. The mass in the solid form is dissolved in dilute sulphuric acid to get titanium in solution as titanium oxysulphate along with other metallic ingredients in ilmenite as their sulphate. The liquor is reduced using scrap iron, when ferric iron gets completely reduced to the ferrous state. The liquor is clarified, concentrated and boiled to precipitate the titanium content as hydrated titania which is then filtered by vacuum filters and calcined. Sulphuric acid required for captive consumption is produced at site using elemental sulphur. Till recently, TTPL was the only unit producing anatase grade titanium dioxide pigment in India. TTPL has capacity to produce 17,000 tpy of titanium dioxide, and with plans to modernise and diversify in stages, the Company has chalked out targets to produce both anatase and rutile grades titanium dioxide pigment.

Tata Steel has proposed a project to produce 1,00,000 tonnes per year titanium dioxide from ilmenite mined from beach sands of Tirunelveli and Thoothukudi districts in southern Tamil Nadu.

Present domestic titanium metal production is negligible. KMML has setup a 500 tpy titanium sponge plant with Defence Metallurgical Research Laboratory (DMRL) technology and first batch of titanium was delivered in September 2011. The plant will be further expanded to 1,000 tpy. IREL is to setup a 10,000 tpy titanium sponge plant at OSCOM for which proposals have been invited on "build, operate and own" basis. Two forward looking MoUs have been entered by IREL, one with UKTMP, Kazakhstan for setting up of facility for production of titanium slag using ilmenite produced from OSCOM mines, while the other one is with Sultanate of Oman for Co-operation in the field of rare earths. Depending upon feasibility, further value addition to TiO_2 pigment and titanium sponge will be taken up, subsequently. Titanium sponge is imported by Mishra Dhatu Nigam Ltd (MIDHANI) for further processing in the country.

The available data on plantwise installed capacities of synthetic rutile and TiO_2 pigment are furnished in Table-6.

USES

About 90% of the world's titanium mineral production is used in the manufacturing of white titanium dioxide pigment. The unique combination of superior properties of high refractive index, low specific gravity, high hiding power and opacity and non-toxicity enable titanium dioxide in its application in the manufacture of all types of white and pastle shades of paints, white-walled tyres, glazed papers, plastics, printed fabrics, flooring materials like linoleum, pharmaceuticals, soaps, face powders and other cosmetic products. Besides, its non-toxic nature facilitate its use in cosmetics, pharmaceuticals, and even in foodstuffs as well as in toothpastes. Titanium dioxide is used in the manufacture of many sunscreen lotions and creams because of its non-toxicity and ultraviolet absorption properties. Synthetic rutile is used for coating welding electrodes as flux component and for manufacture of titanium tetrachloride which in turn is used in making titanium sponge. Synthetic rutile is also used as ingredient of special abrasives. Titanium metal is a versatile material with exceptional characteristics. The lightness, strength and durability of the metal make it an essential metal for the Aerospace Industry. It is also used in desalination and power generation plants and corrosive chemical industries because of its inertness and resistance to corrosion and high thermal conductivity. Its non-reactive property makes titanium metal one of the few materials that can be used in the human body for orthopaedic use and in pacemakers.

Table –6 : Installed Capacity of Synthetic Rutile/Titanium dioxide Pigment,

(In tonnes)

Plant	Location	Specification	Installed capacity (tpy)
IREL	Orissa Sands Complex, Distt Ganjam, Odisha.	90.5% TiO_2 (min.)	100000 (Synthetic rutile)
KMML Kerala	Chavara, Distt Kollam,	92-93% TiO_2	55000 (Synthetic rutile) 60000 (TiO_2 - Chloride Process)
DCW Ltd	Sahupuram, Distt Thoothukudi, Tamil Nadu.	95% TiO_2	42000 (Synthetic rutile)
CMRL	Edayar, Distt Ernakulam, Kerala.	96.5% TiO_2	50000 (Synthetic rutile)
TTPL	Kochuveli, Distt Thiruvananthapuram, Kerala.	97.5% TiO_2	17000 (TiO_2-Sulphate Process)
VVTi Pigments Pvt. Ltd* (formerly Kilburn Chemicals)	Thoothukudi, Tamil Nadu.	98% TiO_2 (min.)	18000 (TiO_2- Sulphate Process)
Kolmark Chemicals Ltd	Kalyani, Distt Nadia, West Bengal.	NA	4800 (TiO_2- Sulphate Process)

Source: *Department of Atomic Energy, Mumbai and individual companies*

Note: *KMML captively consumes synthetic rutile while CMRL and DCW export synthetic rutile*

** Including Kilburn Chemicals*

CONSUMPTION

The ilmenite consumption is placed at 2,25,100 tonnes in 2019-20 which is lower as compared to the previous year. The bulk of ilmenite is consumed by the Chemical Industry (99 %). Moderate proportions are consumed by Welding Electrode Industry. The consumption of rutile in 2018-19 was 10,500 tonnes as compared to 9,700 tonnes in 2017-18. The entire consumption was reported from Electrode Industry since last two years (Table-7).

Table – 7 : Consumption* of Ilmenite and Rutile 2017-18 to 2019-20 (By Industries)

(In tonnes)

Industry	2017-18	2018-19 (R)	2019-20 (P)
Ilmenite			
All Industries	**295000 (36)**	**222900 (36)**	**164800 (26)**
Chemicals	294100	222000	163900
Electrode	800	800	900
Others (Ceramic, Ferroalloys)	100	100	-
Rutile			
All Industries	**9700**	**10500**	**NA**
Electrode	9700	10500	NA
Paint	-	-	NA

Figures rounded off
** Includes actual reported consumption and/or estimates made wherever required.Paucity of data, hence, the coverage may not be complete.*
():Number of plants reported/estimated.

POLICY

A notification dated 27.07.2019, was issued for reserving the prospecting and mining rights of offshore minerals under Offshore Areas Minerals (Development and Regulation) Act, 2002 exclusively to Government and Government owned companies for curbing illegal mining of atomic minerals by private parties. The Government of India had notified in October 1998, a policy on exploitation of beach sand minerals in the country, which inter alia allows participation of the Private Sector with or without foreign companies subject to conditions stipulated. This will encourage further exploitation of mineral deposits through a judicious mix of Public & Private Sector participation including foreign collaboration. The ceiling on FDI on mining of titanium minerals has been raised to 100 per cent.

Joint ventures with foreign participation were being pursued by IREL for production of value-added products, keeping in view the Beach Sand Mineral Policy of the Government.

The minerals, ilmenite and rutile, were grouped as 'prescribed substances' as per notifications issued under the Atomic Energy Act, 1962. However, as per the revised list of Prescribed Substances, Prescribed Equipment and Technology notified by Department of Atomic Energy vide S.O.No.61(E), dated 20.1.2006, the titanium ore minerals like ilmenite, rutile and leucoxene have been delisted as prescribed substances by the Department of Atomic Energy subject to the note as below:

"These minerals shall remain prescribed substances only till such time the policy on Exploration of Beach Sand Minerals notified vide Resolution No.8/1(1)/97-PSU/1422, dated 6.10.1998, is adopted/revised/modified by the Ministry of Mines or till 1.1.2007, whichever occurs earlier and shall cease to be so thereafter".

As per notification No 26/2015-2020, the export of Beach Sand Minerals have been brought under State Trading Enterprise (STE) and shall be canalised through Indian Rare Earths Limited (IREL). Beach Sand Minerals, permitted anywhere in the export policy under Sl. No. 98A of Chapter 26 of schedule 2 Export Policy.

As per Gazette Notification No : GSR.134 (E) dated 20.2.2019, the particulars of threshold values for atomic minerals in respect of Beach Sand Minerals (BSM) shall be regulated as Schedule A [Rule 2(1)(m) and Rule 36] (Table-7A).

SUBSTITUTES

There are no cost-effective substitutes for titanium dioxide pigments. Synthetic rutile made from ilmenite can be substituted for natural rutile. Nickel steels, stainless steels and some non-ferrous metal alloys can sometimes replace titanium alloys in industrial uses although at the expense of performance or economics. Tungsten carbide competes with titanium carbide for surface cutting machine tools. Titanium slag competes with ilmenite and rutile.

Environmental awareness indicates that titanium dioxide plants are likely to use chloride technology in future as it produces much less quantity of waste products. Synthetic rutile or slag (made from ilmenite) is likely to be used as feed in increasing amount. There is also a strong pressure to reduce the radioactive content of feedstocks because it affects the marketability of beach sand ilmenite. Titanium alloys could be replaced in aerospace applications by lithium-aluminium alloys or carbon-epoxy composites.

Table - 7 A : Particulars of Threshold Value for Atomic Minerals
[See Rule 2 (1)(m) and Rule 36]

Uranium-bearing tailings left over from ores after extraction of copper and gold, ilmenite and other titanium ores.	60 ppm U_3O_8 and/or 250 ppm ThO_2.
Zirconium-bearing minerals and ores including zircon.	All cases of zirconium-bearing minerals occurring in Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e. the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade. In other cases, zircon containing less than 2,000 ppm of Hafnium.
Beach Sand Minerals, i.e., economic heavy minerals found in the teri or beach sand, which include ilmenite, rutile, leucoxene, garnet, monazite, zircon and sillimanite.	All cases of Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade.

WORLD REVIEW

World resources of anatase, ilmenite and rutile are more than 2 billion tonnes. World reserves of ilmenite are estimated at 700 million tonnes in terms of TiO_2 content. Major reserves are in China with 230 million tonnes (33%) followed by Australia with 160 million tonnes (22%), India with 85 million tonnes (12%), Brazil with 43 million tonnes (6%), Norway with 37 million tonnes & South Africa with 35 million tonnes (5% each), Canada with 31 million tonnes & Mozambique with 26 million tonnes (4% each) and Madagascar with 22 million tonnes (3%). The world reserves of rutile are 49 million tonnes in terms of TiO_2 content. Major rutile reserves are located in Australia with 31 million tonnes (63%), followed by India with 7.4 million tonnes (15%), South Africa with 6.5 million tonnes (13%) and Ukraine with 2.5 million tonnes (5%).

World production of ilmenite and rutile concentrates was 12 million tonnes and 0.58 million tonnes, respectively, in 2020. China and Canada contributed 4.2 million tonnes (35%) and 2.1 million tonnes (17%) of ilmenite production, followed by South Africa with 1 million tonnes (8%), Ukraine with 0.77 million tonnes and Mozmbique with 0.75 million tonnes (6%).

Australia produced 0.15 million tonnes of rutile, contributing 26% of world rutile output, followed by Sierra Leone with 0.11 million tonnes (19%), Ukraine with 0.11 million tonnes (18%), South Africa with 0.10 million tonnes (17%) and Kenya with 0.07 million tonnes (12%). World reserves and production of ilmenite and rutile are furnished in Tables-8 to10.

Table – 8 : World Reserves of Ilmenite and Rutile (By Principal Countries)

(In '000 tonnes of contained TiO_2)

Country	Reserves	
	Ilmenite	Rutile
World: Total (Rounded)	**700000**	**49000**
China	230000	-
Australia[a]	160000	31000
India	85000	7400
Brazil	43000	-
Norway	37000	-
South Africa[d]	35000	6500
Canada[d]	31000	-
Mozambique	26000	890
Madagascar[d]	22000	400
Ukraine	5900	2500
USA[b][c]	2000	-
Kenya	390	170
Senegal	NA	NA
Sierra Leone	-	490
Vietnam	1600	-
Other countries	26000	NA

Source: USGS, Mineral Commodity Summaries, 2022
a:Joint Ore Reserves Committee- compliant reserves for ilmenite and rutile were estimated to be 38 million and 9.4 million tonnes respectively
b:Rounded to nearest 1,00,000 tonnes to avoid disclosing company proprietary data
c:US rutile reserves data are included with ilmenite.
d: Mine production is primarily used to produce titaniferous slag

Table – 9 : World Production of Ilmenite (By Principal Countries)

(In '000 tonnes)

Country	2018	2019	2020
World: Total (Wt of Conc.)	**12242**	**12722**	**12193**
China	4200	4200	4200
Canada	2000	2100	1900
South Africa	765	1100	1000
Ukraine	745	818	773
Mozambique	958	892	756
Australia	569	596	634
Norway	630	630	630
Senegal	506	491	505
Madagascar	381	461	424
Kenya	463	352	334
Other countries	1021	1079	1036

***Source**: BGS, World Mineral Production,2016-2020.*

**:Estimate*

a:Canada produces some ilmenite which is sold as such and not processed into slag, but tonnages are small

b:It is believed that the majority of this is processed in to slag

c:Years ended 30 June of that stated

d:Years ended 31 March following that stated

m:Including natural rutile

Metal

Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), which is reduced with magnesium (Kroll process) or sodium (Hunter process) to produce a commercially pure form of titanium metal. The metal formed has a porous appearance and is referred to as sponge. Titanium ingot and slab are produced by melting titanium sponge or scrap or a combination of both, usually with various other alloying elements.

Pigment

Global TiO_2 pigment production capacity was estimated to be 5.7 million tonnes per year. TiO_2 pigment produced is categorised by crystal form as either anatase or rutile. Rutile pigment is less reactive with the binders in paint when exposed to sunlight than the anatase pigment and is preferred substance in outdoor paints. Anatase pigment has a bluer tone than rutile, is somewhat softer and is used mainly in indoor paints and in paper manufacturing. Depending on the manner in which it is produced and subsequently finished, TiO_2 pigment can exhibit a wide range of functional properties, including dispersion, durability, opacity and tinting.

Table – 10 : World Production of Rutile (By Principal Countries)

(In '000 tonnes)

Country	2018	2019	2020
World: Total (wt of conc)	**657**	**635**	**585**
Australia[c]	209	154	156
Sierra Leone	108	136	116
Ukraine	106	115	110
South Africa	103	110	100
Kenya	98	85	72
India	11	11	11
Madagascar	5	6	6
Mozambique	8	8	5
Malaysia	5	5	5
Sri Lanka	2	1	1

***Source :** BGS, World Mineral Production,2016-2020.*

c: Years ended 30 June of that stated.

d: Years ended 31 March following that stated

** : Estimated*

FOREIGN TRADE

Exports

Exports of titanium ores & conc. increased to 0.24 million tonnes during 2020-21 from 0.24 million tonnes in the preceding year. Exports were mainly to China (38%), Japan (26%), Republic of Korea (13%), Belgium (12%) and Malaysia (9%).

Exports of titanium and alloys (including waste & scrap) were at 253 tonnes, registering an decrease of 52% from 486 tonnes in the previous year. Exports were mainly to Russia (20%), USA (19%) and Republic of Korea (9%). Exports of titanium oxide and dioxide (total) decreased by 27% to 28,419 tonnes in 2020-21 from 38,506 tonnes in the preceding year. Out of the total exports in 2020-21, those of titanium dioxide were 6481 tonnes and exports of titanium oxides (other than titanium dioxides) were 21,938 tonnes (Tables-11 to 18).

Imports

Imports of titanium ores & conc. decreased drastically by 43% to 78,747 tonnes in 2020-21 from 1,38,042 tonnes in the preceding year. Imports were mainly from Mozambique (53%), Norway (9%), Australia (3%) and Thailand (5%).

Imports of titanium and alloys (including waste & scrap) were 8,875 tonnes in 2020-21 as compared to 8,347 tonnes in the previous year. Imports were mainly from USA (30%), China (15%), Japan (9%) and Singapore (8%). Imports of titanium oxide and dioxide (total) were 13,514 tonnes in 2020-21 as compared to 16,591 tonnes in the preceding year. Imports were mainly from Republic of Korea (42%), China (32%), and Japan (6%). Bulk of these imports were of titanium dioxide (13,389 tonnes) and titanium oxides (other than titanium oxides) were 125 tonnes in 2020-21 (Tables - 19 to 26).

Table – 11 : Exports of Titanium Ores & Conc. (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**246203**	**4995763**	**246534**	**5348323**
Japan	71337	2407794	65624	2134372
China	87300	1166713	95596	1767412
Malaysia	3484	311364	22314	504675
Korea Rep. of	44000	579319	33000	489294
Belguim	40000	525768	30000	452568
UAE	9	408	++	2
Bangladesh	24	1041	-	-
UK	7	829	-	-
Brazil	7	812	-	-
Cyprus	5	610	-	-
Other countries	30	1105	-	-

Figures rounded off

Table – 12 : Exports of Titanium Ores & Conc. (Ilmenite) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**246179**	**4992946**	**246534**	**5348321**
Japan	71337	2407794	65624	2134372
China	87300	1166713	95596	1767412
Malaysia	3484	311364	22314	504675
Korea Rep. of	44000	579319	33000	489294
Belgium	40000	525768	30000	452568
Bangladesh	24	1041	-	-
Kenya	14	323	-	-
Qatar	7	186	-	-
UAE	7	166	-	-
Taiwan	5	141	-	-
Other countries	1	131	-	-

Figures rounded off

Table – 13 : Exports of Titanium Ores & Conc. (Rutile) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**16**	**2000**	**++**	**2**
UAE	2	242	++	2
UK	7	829	-	-
Cyprus	5	610	-	-
Pakistan	2	296	-	-
Egypt	++	23	-	-
Nepal	++	++	-	-

Figures rounded off

Table – 14 : Exports of Titanium Ores & Conc. (Others) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**8**	**817**	**-**	**-**
Brazil	7	812	-	-
Sri Lanka	1	5	-	-

Figures rounded off

Table – 15 : Exports of Titanium & Alloys (Incl. Waste & Scrap) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**486**	**546039**	**253**	**443579**
Turkey	4	16499	7	124135
Russia	128	204663	50	77552
Israel	1	44101	4	44775
Indonesia	++	486	31	33614
USA	116	29684	49	24311
Korea Rep. of	98	86285	24	17920
UK	14	12934	8	14795
Finland	1	10598	3	13780
France	3	17285	1	13156
Japan	-	-	25	12748
Other countries	121	123504	51	66793

Figures rounded off

Table – 16 : Exports of Titanium Oxide & Dioxide : Total (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**38506**	**3779067**	**28419**	**2990597**
Japan	30544	2612449	16183	1513268
USA	2270	377398	2518	438301
China	++	82	5078	352282
Italy	1032	186369	1220	241144
Malaysia	2268	181340	1517	101894
Egypt	186	56135	178	38318
Nepal	125	25000	152	31846
Sri Lanka	160	26763	157	25509
Spain	420	73139	140	25477
Baharain	40	7537	120	24440
Other countries	1465	232855	1156	198118

Figures rounded off

Table – 17 : Exports of Titanium Dioxide (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**6231**	**1065352**	**6481**	**1152120**
USA	2250	375637	2464	432755
Italy	1032	186369	1220	241144
Japan	1122	161844	1135	158562
Nepal	123	24631	125	27309
Sri Lanka	121	20909	148	25070
Baharain	40	7537	120	24440
Spain	420	73139	120	24101
Egypt	96	15661	142	22752
UAE	178	27619	113	22252
Iran	138	37777	102	21620
Other countries	711	134229	792	152115

Figures rounded off

Table – 18 : Exports of Titanium Oxide (Other than Titanium Dioxide) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**32275**	**2713715**	**21938**	**1838477**
Japan	29418	2450605	15048	1354706
China	++	17	5026	332038
Malaysia	2268	181335	1515	101371
Egypt	90	40474	36	15566
Mexico	20	3638	40	7691
USA	20	1761	54	5546
Brazil	146	9673	85	5315
Nepal	2	369	27	4537
Turkey	74	5968	29	3462
Tanzania	31	2228	38	2986
Other countries	206	17647	40	5259

Figures rounded off

Table – 19 : Imports of Titanium Ores & Conc. : Total (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**138042**	**3965292**	**78747**	**3440562**
Mozambique	91132	1614268	42300	855800
USA	725	27509	4452	363880
Thailand	3483	237875	4537	331018
China	4155	350068	3188	295112
Australia	4844	422285	2966	252003
UAE	46	3372	2440	204925
Netherlands	2533	88994	6977	204437
Sri Lanka	4781	330561	2335	189085
Brazil	++	6	2160	183593
Ukraine	1680	155318	1714	164630
Other countries	24663	735036	5678	396079

Figures rounded off

Table – 20 : Imports of Titanium Ores & Conc. (Ilmenite) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**109771**	**1963147**	**43894**	**907344**
Mozambique	91132	1614268	41624	796023
Sri Lanka	1294	94928	898	69473
Vietnam	25	1874	250	20703
Malaysia	1710	20130	946	12893
China	20	1063	120	6904
Ukraine	-	-	56	1348
Norway	15538	229440	-	-
Sierra Leone	26	727	-	-
Netherlands	26	711	-	-
Brazil	++	6	-	-
Other countries	-	-	-	-

Figures rounded off

Table – 21 : Imports of Titanium Ores & Conc. (Rutile)
(By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**20589**	**1689194**	**29562**	**2224774**
USA	234	18905	4212	347314
Thailand	3483	237875	4537	331018
China	3199	275464	2392	225104
UAE	46	3319	2440	204925
Brazil	-	-	2160	183593
Australia	4224	372804	1856	164402
Netherlands	646	56191	5333	163365
Ukraine	1652	152615	1602	157659
South Africa	2212	199534	1636	150260
Sri Lanka	2435	220131	1124	114540
Other Contries	2458	152356	2270	182594

Figures rounded off

Table – 22 : Imports of Titanium Ores & Conc. (Others)
(By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**7682**	**312951**	**5291**	**308444**
Australia	620	49481	1110	87601
Senegal	980	67577	1080	81475
China	936	73541	676	63104
Netherlands	1861	32092	1644	41072
USA	491	8604	240	16566
UK	-	-	88	6801
Ukraine	28	2703	56	5623
Sri Lanka	1052	15502	313	5072

Figures rounded off

Table – 23 : Imports of Titanium & Alloys (Incl. Waste & Scrap) (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**8347**	**7448533**	**8875**	**5480218**
China	1445	2130090	1349	1603114
USA	2448	1479858	2683	1077148
Japan	1051	1119974	877	454878
UK	240	569578	224	347683
Germany	225	526619	259	332159
Italy	365	304899	554	302330
Belgium	18	8917	242	193844
Singapore	742	177512	769	180260
Netherlands	110	92193	149	154954
France	75	264565	69	154026
Other countries	1628	774328	1700	679822

Figures rounded off

Table – 24 : Imports of Titanium Oxide & Dioxide : Total (By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**16591**	**3164190**	**13514**	**2579284**
Korea, Rep. of	6350	991895	5678	939060
China	5521	928826	4359	727242
Germany	571	161576	720	217144
Japan	838	252812	862	215069
Belgium	566	139462	484	128415
Netherlands	1780	443328	393	114442
Hong Kong	66	8679	452	80621
Canada	129	42684	176	63772
Taiwan	200	49685	107	29672
Russia	120	18027	140	19631
Other countries	450	127216	143	44216

Figures rounded off

Table – 25 : Imports of Titanium Dioxide
(By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**16416**	**3082535**	**13389**	**2510726**
Korea, Rep. of	6350	991895	5678	938957
China	5464	916752	4322	720044
Germany	570	148788	719	202767
Japan	773	218707	796	177150
Belgium	526	130055	464	123286
Netherlands	1780	443324	393	114442
Hong Kong	66	8679	452	80621
Canada	129	42684	176	63772
Taiwan	200	49685	107	29672
Russia	120	18027	140	19631
Other countries	438	114539	142	40384

Figures rounded off

Table – 26 : Imports of Titanium Oxide
(Other than Titanium Dioxide)
(By Countries)

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**175**	**81655**	**125**	**68558**
Japan	65	34705	66	37919
Germany	1	12788	1	14377
China	57	12074	37	7198
Belgium	40	9407	20	5129
France	1	3558	++	1687
UK	++	751	1	1542
Sweden	-	-	++	226
USA	10	7772	++	190
Poland	++	108	++	119
Korea Rep. of	-	-	++	103
Other countries	1	492	++	68

Figures rounded off

FUTURE OUTLOOK

As per Technology Vision Document 2035, the demand for titanium in India would be approximately 1,000 tonnes by 2035. The contribution to the demand would be from Space Sector (100 tonnes), General Engineering (50 tonnes), Atomic Energy (125 tonnes), Aeronautical (50 tonnes), Power Generation (150 tonnes), Petroleum Refinery (50 tonnes) and Chemical Industry (475 tonnes).

As per data available, the defence, atomic energy and space research which are critical sectors have been assigned targets to increase communication set-up, safeguard India's security with modern arms, ammunitions & control and to increase power generation by three-fold. For meeting these targets, Indian Engineering Industry will dependent on input materials like titanium sponge. Titanium sponge was not available in India till 2012, the first ever commercially indigenously made Ti-sponge was released as late as 2013 at KMML, Kerala, with the support of ISRO. However, with the successful commissioning of the titanium sponge plant, India has joined the elite club of seven countries capable of producing aerospace-grade titanium sponge. The plant has the basic infrastructure for increasing the capacity to 1,000 tpa in future with sponge to metal yield at 35%, the requirement of titanium sponge on a conservative estimate would be 2,500 tpa for India. The gap, therefore, will remain and would have to be met by import. The plant capacity now will be just sufficient to serve Strategic Industry like the indigenous space & defence programmes.

Titanium Sponge Industry is get to come out of the input of the pandemic as its demand is mainly depend on the aviation sector which is badly affected due to the pendemic restrictions.Global demand growth for TiO_2 is expected to trend with the prospects of economic growth and production of paint, paper and plastics.

Aerospace, defence and industrial uses are expected to strongly influence the consumption of titanium metal in the near future.

The impetus by the Government for renewal energy and infrastructure, however, augurs well for demand for steel and that for IREL's rutile which finds application in production of welding electrodes.