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Overview of Indian Uranium Production Scenario in Coming Decades

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Abstract

India's atomic energy programme, in spite of opportunities for import of fuel shall continue to prefer the ideal path of generating power using indigenous uranium. In the last four decades, the Indian uranium industry has established mining and processing capacity of 5,500 tpd ore which is likely to go up to 12,000 tpd by 2015. The grade of uranium ore in India being low, inevitable efforts to mine and process progressive lower grade ore does not record matching rise in uranium production capacity. The SE part of Cuddapah basin is likely to draw greater attention for mining of carbonate hosted rock in coming decade. Successful implementation of indigenously developed processing technology at Tummalapalle holds the key for larger expansion programme of uranium production capability in this area. Further expansion of uranium production capacity shall greatly depend on the progress made on mining and processing of ore reserves in Northern part of Cuddapah basin (Andhra Pradesh) lying in environmentally sensitive regions and sandstone hosted deposits of Meghalaya around Kyelleng Pyndengsohiong. The technologies to mine thin and low grade ore, benchmark of zero discharge, higher and purer product recovery, disposal and management of large tailings, public perception on uranium mining, availability of skilled manpower etc are expected to be the major challenges for indigenous uranium production scenario in coming decades.

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Keywords: In-situ resources, uranium production, depletion, progressive low-grade reserves, environmentally sensitive, public opinion

1. Introduction

The outstanding growth of Indian economy during last one decade has led to significant rise in use of commercial energy sources. Of all the available options to use possible energy sources for meeting the need of a secure and robust energy supply, nuclear power now occupies a special eminence [1]. India's three-stage atomic energy programme is based on a robust and commercially successful first stage (PHWRs operated by indigenous natural uranium). The recent developments in international civil nuclear co-operation has provided opportunities for enhancing nuclear power capacity through the import of fuel (safeguarded atomic energy programme), the ideal path of generating power using indigenous uranium shall continue to be the impending paradigm for the nation.

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Uranium Corporation of India Ltd, a front-end unit in the nuclear cycle of the country has the mandate to mine and process uranium ore in India to meet the fuel requirement of Pressurized Heavy Water Reactors. Over the years, the company has marched forward towards maximizing the production of uranium. Many operating units have been expanded and new facilities have been built maintaining an uninterrupted supply of fuel in line with the requirement. The organic growth of such magnitude has heralded a new era of uranium production capability of the country. A few more projects of critical importance towards uranium production augmentation are already in different stages of implementation whose successful completion shall create newer benchmark in uranium industry of the country and go a long way in easing the uranium supply situation.

However, some of the resources already identified and under development (in Jharkhand) for the last four decades are on continuous process of depletion, thereby generating concern on future sources of supply and plan for sustained production.

2. Present uranium resources and production scenario

Last six decades of extensive search (since 1950) by Atomic Minerals Directorate for Exploration and Research has brought to light many uranium deposits / occurrences in different geological environments of the country. Major areas of uranium finds in different geological basins are Singhbhum shear zone (Jharkhand), Cuddapah basin (Andhra Pradesh), Mahadek basin (Meghalaya), Bhima basin (Karnataka) and Delhi Supergroup of rocks (Rajasthan). Jaduguda, in the state of Jharkhand (formerly in Bihar) is the first uranium deposit to be located in the country [2].

Indian uranium deposits are of medium size and the country has a modest uranium resource. Only a small part of the land mass of the total of 3.28 million sq km of Indian sub-continent is assumed to be geologically favourable for hosting uranium deposits. Of the total uranium resources identified so far, Jharkhand accounts for about 45%, Andhra Pradesh 26%, Meghalaya 16%, Rajasthan and Karnataka 4% each and remaining in other states [3].

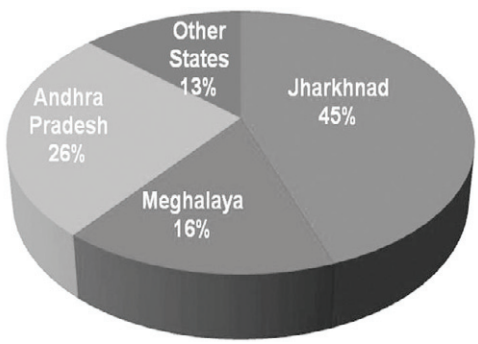

Fig. 1. Distribution of uranium resources in India

The geological in-situ resources so identified / established are sometimes never available for commercial mining operations. Several techno-economic factors need to be looked into on regular basis for evaluating the exploitable in-situ reserves. Some reserves are also lost as in-situ pillars in underground mining practices and some part of the uranium also remains unrecoverable during processing influenced by properties of the host rock. The resources established in some areas are sometimes not accessible for uranium mining due to environmental considerations, adverse public perception on uranium mining and sensitive administrative / political issues. The reserves identified in these areas are required to be re-looked / reassessed with every change in above scenarios as the above factors are of dynamic nature [4]

Uranium production in India, started with the formation of UCIL in 1967 met the requirement of fuel with 1000 tpd mining and ore processing capacity at Jaduguda. The ore mining capacity was progressively expanded with the opening of new mines at Bhatin (1987) and Narwapahar (1995) and accordingly, augmenting the ore processing capacity of Jaduguda plant.

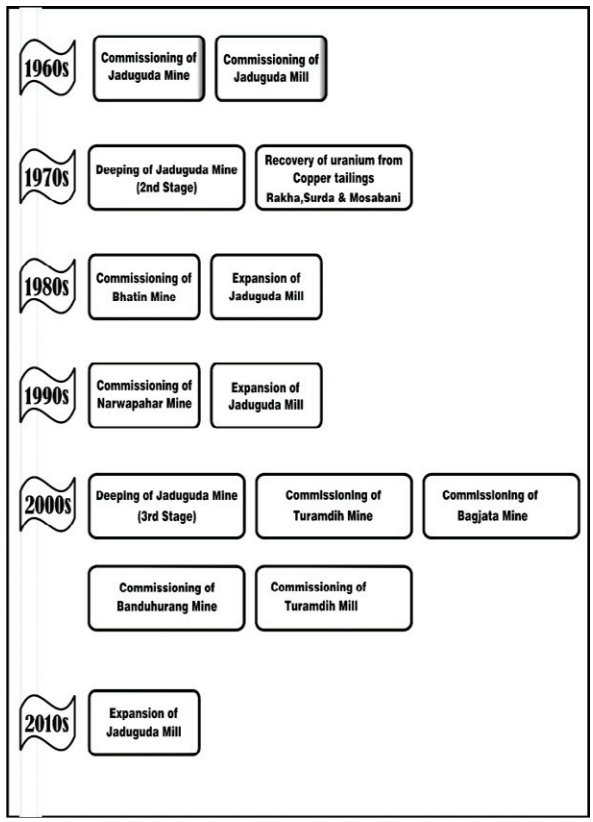

Fig. 2. Growth story of UCIL

The uranium bearing copper concentrates of Singhbhum shear zone were also treated in the expanded plant at Jaduguda recovering the uranium as by-products which were suspended later on due to untimely closure of copper mines of the region. With mammoth expansion of nuclear power programme during late 90s, construction of production facilities (mines and mill) were speeded up in Jharkhand and other parts of the country [5]. New facilities like Turamdih underground mine (2003), Bagjata underground mine (2008), Banduhurang openpit mine (2009) and Turamdih processing plant (2009) have already been made operational in addition to capacity expansion of existing facilities like Narwapahar underground mine and Jaduguda processing plant. Present uranium ore mining and processing capacity of all the above units is about 5,500 tpd and all these facilities are located in the state of Jharkhand.

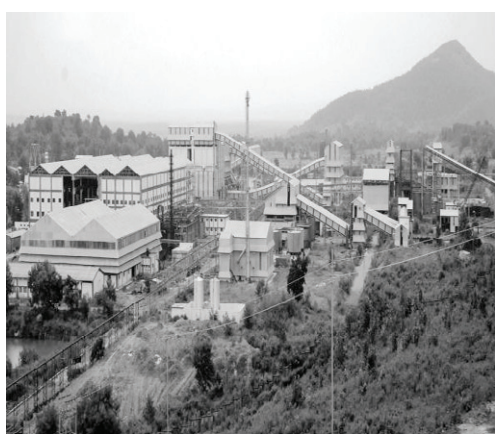

Fig. 3. Newly commissioned Turamdih plant

Fig. 4. Newly commissioned Bagjata mine

The uranium production of India has maintained a steady progressive trend with timely opening of mines and expansion of processing capacity. This steady up-trend in production was briefly affected during mid 90s due to the closure of copper mines in Singhbhum region leading to termination of supply of uranium concentrate from copper tailing to Jaduguda plant. The inherent uranium content of Indian uranium ore being low, UCIL's inevitable efforts to maximize the processing capacity with progressive lower grade of ores does not record matching rise in uranium production. The requirement of fuel for indigenous nuclear power programme therefore continues to remain exigent calling for exciting efforts.

2.1. Uranium resources and production scenario during 2010s

The expansion programme presently undertaken in Jharkhand includes augmentation of processing capacity of Turamdih plant and construction of Mohuldih underground mine. With successful commissioning of the above, a total of 7,000 tpd ore processing capacity is expected to be in place during 2011. Towards the later part 2010s, the uranium production from two plants (Jaduguda and Turamdih) in Singhbhum shear zone in Jharkhand are expected to be influenced by changing pattern of supply of ore due to depletion of reserves and opening of new mines. Deepening of Jaduguda mine and consequent depletion of reserves, diminution of exploitable reserve in Narwapahar mine and upper levels of Bagjata mine are expected to have adverse effects on feed to Jaduguda plant which may partly be compensated by expansion of production capacity of Bagjata mine after sufficient underground developments. With the commissioning of Mohuldih mine, the ore processing scenario may undergo adjustment to enable sustained supply of ore to Turamdih plant. However, the recent renewed exploration activities by AMD in Singhbhum region may add to the depleted reserve base of the operating mines and likely to be beneficial in extending the sustained production from the operating units of this region for about two more decades (say till 2030). However, the uranium production from Jharkhand may show a gradual fall towards the later part of 2030s.

The large limestone hosted uranium mineralisation under development at Tummalapalle in south-eastern part of Cuddapah basin in YSR (formerly in Kadapa) district of Andhra Pradesh holds the promise for multifold increase in uranium production in future. The area is likely to draw greater attention for expanding the production capacity during 2010s and beyond. The present mine and plant are under advanced stage of completion and the expansion of this project has already been planned for augmentation of production

Fig. 5. Mine and mill under construction at Tummalapalle, Andhra Pradesh

With completion of ongoing project at Tummalapalle, mining and processing capacity of 4,500 tpd in this area is likely to be in place by 2015. The uranium reserve base around Tummalapalle is quite extensive and exploration activities in this region have already been stepped up multiplying the known reserve with extension of lodes along strike and dip. With the successful implementation of process technology (indigenous developed, being implemented first time in the country), efforts for capacity enhancement and setting-up of new centers in this area shall be stepped up. Present exploration findings provide potential for additional 6,000 tpd uranium ore mining and processing capacity. The mining and processing facilities towards the above are being envisaged, which needs to be implemented in stages. Thus, a total of about 10,000 tpd mining and processing capacity is expected around Tummalapalle towards the end of 2010s. This is likely to maintain a sustained supply of uranium beyond 2030. Capacity addition with additional mines and plants, subject to successful exploration in the area needs to be looked into at appropriate time.

High grade uranium mineralisation hosted in granite and limestone rock at Gogi in Yadgir (formerly in Gulbarga) district of Karnataka has already been planned for development.

Fig. 6. Site for new mine at Gogi, Karnataka

The limited reserve of this deposit, as estimated now may not continue to contribute for a long period. But the better uranium concentration in this deposit is expected to result in higher production. Mining and processing capacity of 500 tpd in this area is expected to be on stream by 2015 which is likely to last for a little more than a decade. However, the mining in this deposit may pose a challenge because of highly irregular nature of ore body. The uranium production from this deposit lasting up to say towards the end of 2020s may provide a cushion moderating the otherwise demanding uranium requirement scenario from Singhbhum (Jharkhand) and Tummalapalle (Andhra Pradesh).

2.2. Uranium resources and production scenario beyond 2020

Production from Singhbhum, as discussed above is expected to show down-turn towards later part of 2030s with the depletion of reserves from most of the major mines. Jaduguda plant along with its captive mines (Jaduguda, Bhatin,

Narwapahar and Bagjata) would near the phase of decommissioning. Production from Turamdih mine shall also drop with depletion of reserves.

Production from Tummalapalle region in SE part of Cuddapah basin is expected to remain steady beyond 2020. Additional findings with favorable ore geometry may even encourage expanding the uranium mining and processing capacity in this region.

Uranium resources already identified around Lambapur-Peddagattu region (NW part of Cuddapah basin) in Nalgonda district of Andhra Pradesh may deserve serious consideration at appropriate time for compensating the gradual fall in production from Singhbhum. Proximity of this deposit to environmentally sensitive sites (Nagarjunasagar reservoir and the Rajiv Gandhi Tiger Sanctuary) is a hindrance for timely implementation of this project. The resources already identified in the vicinity at Chitrial and Kuppunur and additional resources at Peddagattu near Lambapur project (planned) also hold the promise for the future. Commissioning of Lambapur project may pave the way for development of large reserve identified within and around Rajiv Gandhi Tiger Sanctuary. Appropriate measures need to be initiated for de-notification of this area by competent authority to enable uranium mining in this region.

The sandstone hosted uranium mineralisation at Kyelleng-Pyndengsohiong Mawthabah (Domiasiat) and its adjoining areas is the promise for another large uranium production center of the country. However, the problems of inaccessibility, poor infrastructure, negative public perception etc need to be addressed in different fronts. Wahkyn and other small to medium deposits in this region deserve to be re-looked for development along with Kyelleng-Pyndengsohiong with a common plant at Mawthabah. Starting of uranium production from this region shall be a great boost to the indigenous nuclear power programme of the country.

3. The challenges and strategy for the future

With the anticipated growth of nuclear power programme of the country, maintaining a sustainable supply of uranium in line with the requirement needs to be met with alacrity and enthusiasm. Technology towards uranium exploration needs to be improved / upgraded for locating better grade, large buried deposits. Already known uranium bearing areas are to be assessed with greater intensity and new areas are to be covered on the basis of concept based approaches.

Processing of progressively low grade reserves shall lead to production and processing of large volume of solid waste and effluent. With greater public awareness of health hazards and stringent environmental guidelines, the generation and management of tailings (solid and liquid waste) shall become a crucial part of uranium mining sector. With rise in production of low grade ore, the need for innovations in mineral beneficiation will greatly be felt in order to eliminate transportation of entire ore from mine sites to the far-off mother plant and also reduce volume of processing. A benchmark for zero discharge may pose a serious challenge for future uranium production facilities. Mining of the low grade ore within economically workable ranges may also cause greater challenges for the future.

As more and more low grade of ore are required to be processed in future to recover uranium, the technological breakthrough through unconventional way of extraction should gradually be put into practice. Possibility of adopting low-cost, large-volume uranium ore processing through heap leaching in low grade ore of Singhbhum and Tummalapalle may be looked into at appropriate time. Cluster of small tonnage deposits also need to be considered for commercial exploitation, though production of uranium in small scale does not in any way reduce the inherent problems of uranium mining and processing.

Uranium tailings management system needs to be strengthened demonstrating the best practices, which warrants wide ranging research and development. Newer technologies to bring in sound design features of embankment system and impermeability of the pond surface need to be developed.

Multifold increase in uranium production capability of the country as already envisaged, needs intensive mobilisation of manpower. Many vital operations of uranium industry are of specialised nature, which demand on-site training of newly recruited workforce apart from skill up-gradation of existing employees. A dedicated training centre at one of the operating units or one attached to any academic institute of national repute may help inculcating professionalism within the work force.

Adverse public perception on uranium mining needs to be cautiously dealt through many socio-economic programmes in different platforms involving community and civic society.

4. Conclusion

Nuclear power in India shall continue to draw greater attention in view of demand for clean and secured energy in coming decades. Therefore, uranium production, the front end activity of nuclear programme of the country shall continue to face the uphill task of meeting the increasing need. The uranium concentrations in Indian uranium deposits are admittedly lower than the average world grade. The identified resources need to be evaluated with respect to several techno-economic factors. It has been seen that it takes about 15 years to start the production on regular basis from the date of discovery of a deposit. Sometimes, the deposits in environmentally sensitive areas remain under the consideration of regulatory agencies

for decades as have been experienced in many uranium mining countries of the world including India. Public opinion towards uranium mining greatly influences such decision making processes.

The recent developments in international nuclear co-operation provide opportunity for meeting the energy situation through import of fuel from favourable countries. Acquiring stakes in uranium properties abroad shall also ease the situation to a large extent. However, the preferred path of pursuing the three stage nuclear power programme of the country shall continue to require more indigenous fuel in future. Advantages of global co-operation should be fully exploited by assimilating the global technology and adopting the best practices in uranium production sector.

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