Contribution ID: **173** Type: **ORAL**

Development of Alkali leaching technology: Key to Self Sufficiency in Uranium Production in India

Wednesday, 27 June 2018 11:20 (20 minutes)

INTRODUCTION

Geological investigations for uranium deposits initiated in India during 1949-50 have led to the discovery of a number of favourable geological basins in the country. First uranium deposit located at Jaduguda in Singhbhum Shear Zone in the eastern state of Jharkhand continued to attract investments in exploration and mining of uranium for over five decades. However, extensive exploration in other parts of the country has brought to light more uranium deposits / occurrences in South Cuddapah basin (Andhra Pradesh), North Cuddapah Basin (Telangana), Mahadek basin (Meghalaya), Bhima basin (Karnataka) and Delhi Supergroup of rocks (Rajasthan) in addition to Singhbhum Shear Zone (Jharkhand).

Uranium mining in India, the front end activity of the Indian nuclear power programme, has always been challenging considering the uranium deposit characteristics in the country. Indian uranium deposits in general are of medium-tonnage and low-grade. Detailed studies of geological characteristics of these deposits are undertaken for selection of proper mining method and technology. Ore processing technology is subjective to mineralogical and metallurgical characteristics of the ore and hence determination of suitable technology and process parameters is crucial for successful operations of these deposits. Of all the above areas, South Cuddapah basin in Andhra Pradesh accounts for about 49% of Indian uranium resources, occurring in carbonate hosted rock which calls for development of alkali leaching process route. Part of this resource extending over a strike length of 6.6 km is under development at Tummalapalle. An underground mine with a capacity to produce 3000 tonnes of ore per day with a plant of matching capacity based on alkali leaching has been set-up.

ALKALI LEACHING TECHNOLOGY AT TUMMALAPALLE

The ore zones at Tummalapalle are confined two thin distinct bands within a thick pile of carbonate rocks - massive limestone, intra-formational conglomerate, dolostone, shale and cherty limestone. The mined out ore, after conventional crushing and grinding (80% passing 74 micron) are thickened, re-pulped and subsequently subjected to alkali leaching by sodium carbonate and sodium bicarbonate solution. Leaching is carried out under high pressure and temperature conditions in autoclaves in series with a nominal residence time of 6.5 hrs. The leached slurry is then filtered in Horizontal Belt Filter (HBF) and the desired concentration leached liquor is achieved through repeated recirculation and washing. The washed cake in the form of slurry is disposed in tailings impoundment facility. The leached filtrate, after clarification and pre-coat filtration is subjected to precipitation with the addition of sodium hydroxide. The final product, at a pH of 12 or above is precipitated as sodium di-uranate (SDU). Extensive laboratory and pilot plant studies have been undertaken to develop this process parameters and flow sheet. The process has undergone several up-gradations in different areas for better leaching and precipitation efficiency. A major breakthrough has been recently achieved for settling and complete recovery of precipitated product by commissioning the Re-dissolution System facility wherein part of the product is sent to precipitation tanks. Regeneration of sodium carbonate and sodium hydroxide treating barren liquor before recycling has been taken up. The plant will also produce sodium sulphate as by-product.

Uranium tailings management is an integral part of the uranium mining industry. In view of effective utilization of available and acquired land and ease of handling and monitoring of tailings, UCIL has recently proposed the concept of Near Surface Trench disposal of uranium tailings which consists of an earthen Construction with the use of impervious & geo-synthetic liners along with arrangements for withdrawal of excess water and temporary coverage of top surface during heavy rain. This method will lower the transportation cost as well as increase the stability and life of the structure. Successful implementation of this concept will benefit new uranium mining projects in the country in terms of time and cost. A further detailed study on the concept and its implementation is currently being undertaken.

CONCLUSION

India has had a long commitment to nuclear energy since the establishment of the Atomic Energy Commission in 1948 and the Department of Atomic Energy in 1954. Nuclear energy plays a critical role in addressing energy challenges, meeting massive energy demand potentials, mitigating carbon emissions and enhancing energy security. The three-stage nuclear power programme being pursued to develop nuclear power in India is consistent with India's unique resource position of limited uranium and large thorium reserves and hence, uranium production plays a vital role in this growing indigenous nuclear power program of the country. The alkali leaching technology adopted for processing of low grade ore at Tummalapalle is the result of extensive research work of the Department of Atomic Energy. Carbonate hosted uranium mineralization accounts for lion's share of the Indian uranium inventory, therefore, successful operations and extraction of uranium at Tummalapalle shall enable to develop more uranium deposits in this area (South Cuddapah basin in Andhra Pradesh). Newer areas in other geological basins amenable to acid leaching have also been taken for development to meet the requirement of uranium in coming decades.

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Country or International Organization

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Session Classification: Underground and Open Pit Uranium Mining and Milling

Track Classification: Track 6. Underground and open pit uranium mining and milling