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Cobalt bis(dicarbollide) ions with covalently bonded TODGA-like substituents for actinide and lanthanide extractions

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The partitioning and transmutation of long-lived nuclides such as minor actinides from high liquid waste (HLW) issued from nuclear fuel reprocessing is a method how to reduce the long-term environmental burden of HLW. In recent years, several HLW partitioning processes using different extractant agents have been developed. Among them, the tridentate ligands like N,N,N',N'-tetraoctyl diglycolamide (TODGA) are one of the most promising extractants for the recovery of actinides and lanthanides in the nuclear fuel treatment.

In this work, the recently developed extractants based on cobalt bis(dicarbollide) ion(1-), [(1,2-C₂B₉H₁₁)₂-3-Co)]- (COSAN) functionalized with TODGA like substituents were evaluated for extraction of trivalent actinides and lanthanides from acidic waste solutions. The extractants under study differed in substitution of the amide nitrogen (e.g. by butyl-, octyl-, terc-octyl-, dodecyl-, benzyl- groups) and the mode of attachment of two cobalt bis(dicarbollide) anions (with or without spacer) to diglycolyl acid platform by amidic bonds. It was found, the compounds with longer diethyleneglycol connectors between COSAN cage and diglycolamide group extracted trivalent lanthanides and actinides very effectively even from highly acidic nitric acid solutions. Additionally, the extraction efficiency of such derivatives was significantly higher than that of comparable organic TODGA molecules without COSANs. The most perspective compound from this series corresponds to the formula X-[(8-CH₂-CH₂O)₂-1,2-C₂B₉H₁₀](1',2'-C₂B₉H₁₁)-3,3'-Co)₂, where central amidic unit X corresponds to [(n-C₈H₁₇-NCOCH₂)₂O]. We will demonstrate here, this extractant enables good extraction of trivalent lanthanides and actinides from majority of fission products presented in the simulated PUREX feed. Trivalent radionuclides can be effectively stripped using complexants. This extractant will be further studied for possible technological applications.

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