We study exotic baryon systems composed of anticharmed mesons and strange baryons using the extended local hidden gauge approach. By solving the coupled-channel Bethe-Salpeter equation with interaction kernels from vector meson exchange, we explore the formation of hadronic molecular states in sectors with strangeness $S = -1, -2, -3$ and $-4$. We systematically consider all possible isospin configurations and include both octet and decuplet baryons in the coupled-channel systems. Our results indicate that attractive interactions in $S = -1, -2$ can dynamically generate bound states, while systems with $S = -3, -4$ have repulsive interactions and do not support molecular formation. We also investigate vector-baryon systems with $\bar{D}^*$ and $\bar{D}_s^*$ mesons, finding similar but more deeply bound states. The results show that bound exotic states are more likely when one or two strange quarks are present. To assess the robustness of our predictions, we perform an uncertainty analysis by varying the cutoff parameter $q_{\max}$, which affects the loop function regularization. The variations lead to moderate shifts in the pole positions, confirming the qualitative stability of the molecular states. These results highlight the strangeness dependence of the molecular formation mechanism and provide theoretical predictions that can guide future experimental searches for exotic multistrange-anticharm baryon systems.