With the depletion of conventional light crude oil, heavy crude oil will occupy an increasing share of the energy structure in the 21st century. Heavy crude oil is characterized by an API gravity of 10 to 22.3 or a viscosity of 0.09 to 10 Pa·s. The flow of heavy crude oil in the pipeline is laminar in the higher viscosity range and turbulent in the lower viscosity range, and its flow resistance comes from the viscous force between the oil and the wall or the additional stress of turbulent flow. Hence, pipeline transportation of heavy crude oil is faced with a huge loss of frictional resistance, which means a reduction of the transportation efficiency. To decrease pump power consumption, improving the transportation efficiency of heavy crude oil pipelines is a key factor. In recent years, some biomimetic technologies that reduce the flow resistance of viscous oils have made new progress in improving their fluidity and have not yet been put into use in commercial pipelines. Therefore, it is important and appropriate to discuss the breakthrough achievements and progress made by researchers in the drag reduction (DR) of heavy crude oil and to summarize its advantages, disadvantages, and potential problems. This review discusses boundary layer control methods for heavy crude oil drag reduction. First, conventional DR technologies, such as polymers, surfactants, fiber suspensions, oil–water core annular flow (CAF) and oil–aqueous foam CAF, and potential DR technologies, including oleophobic surfaces, flexible walls, biomimetic microgrooves, and ferrofluid annular DR under magnetic confinement, are presented. Second, the mechanism of DR is investigated and summarized; the highlights and progress of the technology are reviewed, and new ideas to improve the existing DR technology are proposed. Finally, .the challenges and prospects of DR are presented