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Editorial Note

It is clear that fossil fuels, such as petroleum, will continue to contribute a significant portion of the global energy portfolio in the coming decades. Global oil demand is expected to rise to 123 million barrels per day by 2025, according to the US Energy Information Administration. As a result, oil production and refining activities are constantly expanding to keep up with the rapid rise in global energy demand.

Unfortunately, petroleum recovery, storage, and refining are all linked to severe environmental pollution issues. Furthermore, these methods are energy-intensive, expensive, and, in some cases, inefficient. Furthermore, as demand for fossil fuels grows, the oil industry will be forced to develop and extract more unconventional resources, such as heavy and extra-heavy crudes, as well as bitumen. In addition to technological problems for the oil industry, this would result in even more environmental concerns.

The constant demand for cleaner fuels, combined with the depletion of light crude oil supplies and stringent environmental regulations, has prompted the development of alternative or complementary novel technologies for oil production and refining. Microorganisms and petroleum hydrocarbons have long been known to interact, and this close relationship begins in oil-bearing subsurface formations. This served as the base for the advancement of petroleum biotechnology. Petroleum biotechnology takes advantage of committed hydrocarbon-degrading/transforming microorganisms' incredible metabolic and adaptive abilities. Biotechnology-based methods are usually more environmentally friendly, cost-effective, and have high selectivity than traditional thermochemical and physical approaches.

Petroleum biotechnology has been used to clean up oil spills in the atmosphere and to handle refinery waste biologically (bioremediation). Oil discovery, microbial enhanced oil recovery (MEOR), biodesulfurization and biodenitrogenation of distillates, biodemetallation, bioupgrading of heavy crudes and refining residues, valorization of refining wastes, bioconversion of residual oil to methane, management of oil field souring and corrosion, formulation of petrochemicals, and other emerging applications are just a few examples.

Most of these applications are still in the research and development process in laboratories, with the exception of bioremediation and enhanced oil recovery. For commercial usage, further research and development is needed to fully comprehend the structure, function, and ecophysiology of microbial communities found in oilfields, refineries, and oil- and hydrocarbon-impoverished areas. Both culture-independent and traditional enrichment methods have made significant contributions to this field of study. Currently, the power of metagenomics, which is enabled by rapidly evolving advanced sequencing techniques, can be used to characterise the structure and function of microbial communities in order to learn more about the active microbial community members and

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functional genes expressed in subsurface ecosystems and other environments.

This research topic's selection of research findings is by no means comprehensive. Its sole purpose is to present current knowledge of certain petroleum biotechnology applications from active researchers all over the world. Though difficult, biotechnology's potential in the fossil fuel industry is enormous, and the sector will see significant progress in the coming decades. Advances in related disciplines such as metabolic engineering, bioprocess technology, biochemical engineering, and biocatalysis can drive this. Artificial metalloenzymes, in particular, have developed into a thriving research field that can be used to produce novel hydrocarbon biotransformations. Recent research, especially studies on specific biochemical processes and the underlying genes and microorganisms, has yielded new knowledge on hydrocarbon biodegradation and biotransformation. Recent metagenomics techniques, in combination with stable isotope probing, single cell sequencing, metaproteomics, and metabolomics, can shed new light on microbial ecophysiology in the subsurface. Simultaneously, synthetic biology will be critical in optimising the assembly of selected functions into engineered organisms or consortia in order to achieve purpose-directed production of effective biocatalysts. Parallel to scientific progress, comprehensive cooperation between academia and the fossil fuel industry is required for the effective creation and deployment of biotechnology applications that address specific technological, economic, and environmental issues. Overall, while petroleum has a long background in microbiology, it is clear that the topic is still vital to industry and the environment, and that fundamental and applied research on the subject will continue for decades.