Reference customer | Bio Bio refinery (formerly Petrox S. A.)
---|---
Location | South of Santiago de Chile, Chile
Introduction | Catalytic cracking is the most important and most widely used refinery process for converting heavy oils into more valuable gasoline and lighter products. This process has almost completely replaced thermal cracking. This is because with catalytic cracking, more gasoline with a higher octane level and less heavy fuel oils is produced. Moreover, light gases produced by catalytic cracking contain more olefins – a desirable feedstock for many petrochemical processes – than those produced by thermal cracking.

The cracking process produces carbon (coke), which remains on the catalyst particles and rapidly lowers the catalyst activity. To maintain the catalyst activity at a useful level, it is necessary to regenerate the catalyst by burning off the coke with the help of air. In a Fluid Catalytic Cracker (FCC), the catalyst is continuously circulated between the reaction zone (endothermic reaction) and the regeneration zone (exothermic reaction), and acts as a vehicle to transfer heat from the regenerator to the oil feed and the reactor.

Challenge | Refineries often require higher capacity and increased flexibility in their FCC plants. However, capacity is frequently constrained by velocity limitations in the regenerator, wet gas compressor capacity, velocity-induced erosion in the cyclones, lack of internal catalyst cooling capacity in the regenerator, CO boiler velocity limitations or air blower capacities (as in this case). By using oxygen enrichment, these limitations can be overcome. The amount of oxidant can be increased without increasing the load on the air blower and more coke is burned, with the result that the catalyst remains cleaner and its activity high.

Sometimes it is not only of interest to increase the feed capacity, but also to enhance conversion, i.e. the percentage of feed converted into different products with the same nominal feed capacity. This means that the number of light products is increased while the number of heavier products is reduced. In this plant, this too was effected by oxygen enrichment.
The Bio Bio refinery is a member of ENAP, the national petroleum and energy company in Chile. Due to capacity limitations in the air blower, the throughput of the FCC unit at this refinery could not be further increased. However, adding pure oxygen to the airflow solved the problem, so that more gasoline and olefins can now be produced while investment for new hardware was minimal.

Prior to the permanent installation of the oxygen enrichment system, a test programme was carried out at the Bio Bio refinery due to a temporary surplus of feedstock for the FCC unit. Its objective was to increase throughput while maintaining conversion. Thanks to oxygen enrichment, coke burning improved, which led to higher throughput and slightly enhanced conversion while the reactor outlet temperature was kept unchanged.

Tests were also performed with reduced air blower capacity. The lost air capacity was compensated by oxygen enrichment to a total oxygen content of 22% to 24% in the airflow to the regenerator. When the air blower operates below its maximum capacity, a much smoother operation with less vibration is achieved.

In some tests, the feed preheat was reduced, which allowed to keep the regenerator temperature below the maximum limit.

Three times per day, LOX container vehicles fill up the two on-site cryogenic tanks with a total capacity of 30 tons. The FLOWTRAIN® used to control the oxygen flow and pressure is operated from the control room. At the Bio Bio refinery, the air duct distance from the oxygen injection point to the bottom of the regenerator is longer than 30 m (including 90-deg bends, which improve the mixing). Therefore, no special oxygen nozzle was used in this case. Generally, however, the use of distribution nozzles is strongly recommended.

Capacity at Bio Bio increased by 15% without any problems. The gasoline production was enhanced by almost 20% and naphtha production by almost 30%. The Liquefied Petroleum Gas (LPG), which contains valuable olefins, was enhanced by approximately 7%. At the same time, the heavier fractions such as Light Cycle Oil (LCO) or decant oil, which is the heaviest lower-value product, were significantly reduced. With more gaseous oxygen available, the feed capacity can be extended by well above 15%.

By adding oxygen to the FCC regeneration air, the net profit of a typical refinery can be substantial. Additionally, it provides the flexibility to decide from day to day whether the oxygen application should be used or not. This substantially increases the flexibility with respect to the treated feed oils.