World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:18, No:06, 2024

The Effect of Online Analyzer Malfunction on the Performance of Sulfur Recovery Unit and Providing a Temporary Solution to Reduce the Emission Rate

Authors : Hamid Reza Mahdipoor, Mehdi Bahrami, Mohammad Bodaghi, Seyed Ali Akbar Mansoori

Abstract : Nowadays, with stricter limitations to reduce emissions, considerable penalties are imposed if pollution limits are exceeded. Therefore, refineries, along with focusing on improving the quality of their products, are also focused on producing products with the least environmental impact. The duty of the sulfur recovery unit (SRU) is to convert H_2S gas coming from the upstream units to elemental sulfur and minimize the burning of sulfur compounds to SO_2. The Claus process is a common process for converting H_2S to sulfur, including a reaction furnace followed by catalytic reactors and sulfur condensers. In addition to a Claus section, SRUs usually consist of a tail gas treatment (TGT) section to decrease the concentration of SO_2 in the flue gas below the emission limits. To operate an SRU properly, the flow rate of combustion air to the reaction furnace must be adjusted so that the Claus reaction is performed according to stoichiometry. Accurate control of the air demand leads to an optimum recovery of sulfur during the flow and composition fluctuations in the acid gas feed. Therefore, the major control system in the SRU is the air demand control loop, which includes a feed-forward control system based on predetermined feed flow rates and a feed-back control system based on the signal from the tail gas online analyzer. The use of online analyzers requires compliance with the installation and operation instructions. Unfortunately, most of these analyzers in Iran are out of service for different reasons, like the low importance of environmental issues and a lack of access to after-sales services due to sanctions. In this paper, an SRU in Iran was simulated and calibrated using industrial experimental data. Afterward, the effect of the malfunction of the online analyzer on the performance of SRU was investigated using the calibrated simulation. The results showed that an increase in the SO_2 concentration in the tail gas led to an increase in the temperature of the reduction reactor in the TGT section. This increase in temperature caused the failure of TGT and increased the concentration of SO_2 from 750 ppm to 35,000 ppm. In addition, the lack of a control system for the adjustment of the combustion air caused further increases in SO_2 emissions. In some processes, the major variable cannot be controlled directly due to difficulty in measurement or a long delay in the sampling system. In these cases, a secondary variable, which can be measured more easily, is considered to be controlled. With the correct selection of this variable, the main variable is also controlled along with the secondary variable. This strategy for controlling a process system is referred to as inferential control" and is considered in this paper. Therefore, a sensitivity analysis was performed to investigate the sensitivity of other measurable parameters to input disturbances. The results revealed that the output temperature of the first Claus reactor could be used for inferential control of the combustion air. Applying this method to the operation led to maximizing the sulfur recovery in the Claus section.

Keywords : sulfur recovery, online analyzer, inferential control, SO_2 emission
Conference Title : ICCET 2024 : International Conference on Chemical Engineering and Technology
Conference Location : Montreal, Canada
Conference Dates : June 13-14, 2024