Optimizing Catalyst Regeneration With An In Situ Oxygen Probe

INTRODUCTION

BACKGROUND

Catalytic crackers have long been utilized to extract additional gasoline from heavier components resulting from the distillation process. The distillation process is the physical separation of a MIXTURE of different molecules, based upon the different boiling points of these molecules. The catalytic cracking process splits larger hydrocarbon molecules into lighter components using a catalyst, which aids the reaction or "cracking" process. The cracking process produces carbon, or coke, which remains on the catalyst particle, reducing its effectiveness over time.

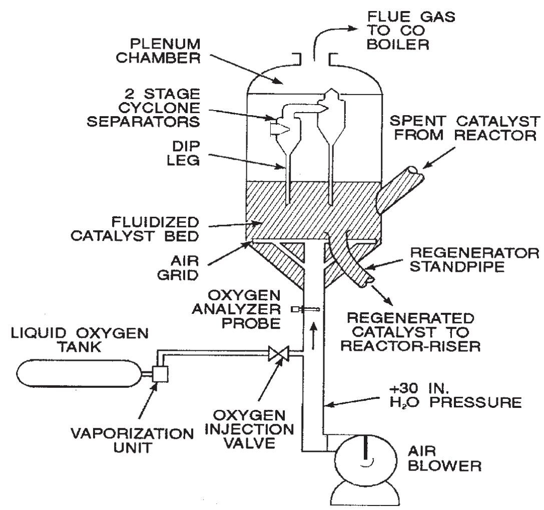

Figure 1 - Typical regenerator with separate CO boiler (not shown)

CATALYST REGENERATION

Spent catalyst is continuously routed from the reactor to a "regenerator". Oil remaining on the surface of the catalyst is stripped off with steam or solvent. The catalyst is then sent to the regenerator, where air is introduced to burn the coke off the catalyst.

There are many different variations in the regeneration process, and there are several applications where the in situ zirconium oxide probe works well.

TRADITIONAL COMBUSTION FLUE GAS APPLICATIONS

Oxygen is measured in the flue gas resulting from the coke burn-off to assist in maintaining the most efficient fuel/air ratios. Some catalytic regenerators generate CO gas, and route this to a separate CO boiler (figure 1), while other units complete the combustion process within the regenerator (figure 2). In either case, the O_2 analyzer is placed in the flue gas ductwork exiting the unit, or in the stack.

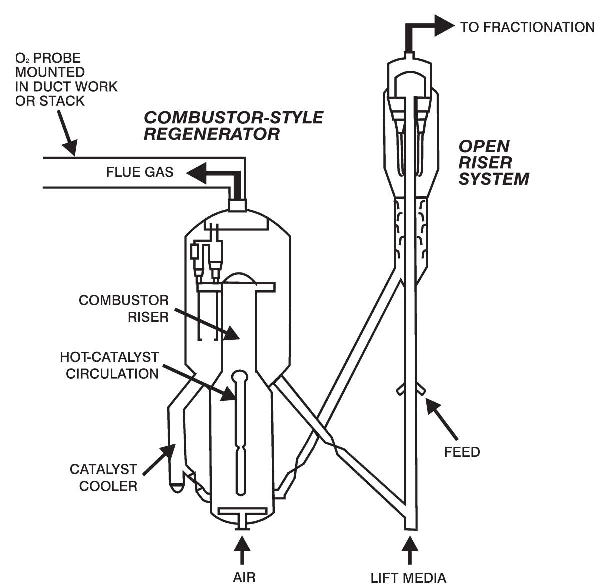

Figure 2 - Typical reactor with integral combustor section

OXYGEN ENRICHMENT IMPROVES THROUGHPUT (see figure 1)

Enriching the air used in the regeneration process can increase the coke burn-off rate. Many refineries will mix pure oxygen with the air used for regeneration, resulting in a mixture of 21 to 25% O_2, which increases the efficiency of the regeneration process. This oxygen measurement can be used for operator information, alarming, or automatic control of the oxygen injection valve (see figure1).

Pressures are normally 35PSI, so the probe must be pressure-balanced with reference air (see reverse side).

ROSEMOUNT® Analytical

EMERSON™ Process Management

CONTINUOUS CATALYTIC REGENERATOR (CCR)

Utilized with a "moving bed" process, the CCR utilizes a regeneration gas loop to control temperature and O_2 levels in the regenerator "burn zone". This recirculation loop heats or cools the combustion flue gas resulting from the regeneration process to control temperature, and air is also controlled to an optimum point (see figure 3). The O_2 measurement is critical to maintaining optimum rate of regeneration, and for preventing thermal damage inside the burn zone.

Process pressures may be close to atmospheric, or pressurized to app. 35 PSI. Pressure balancing may be required, and an isolation valving system may be needed if probe insertion or withdrawal is required with the process on-line. Pressure balancing will adjust to pressure variations, while traditional O_2 systems place a fixed compensation into the electronics.

Chlorine is injected into this unit, and a special HCL-resistant cell is required.

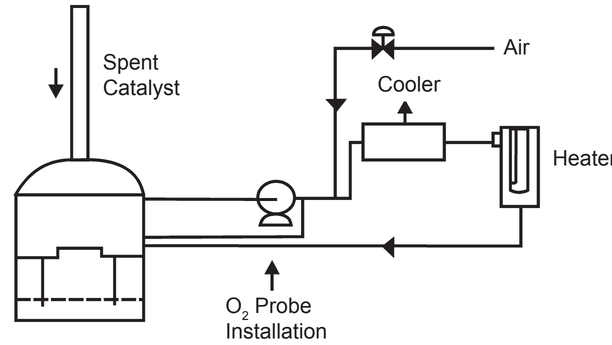

Figure 3 - CCR Regenerator

PRESSURE BALANCED O_2 PROBE

Most in situ oxygen analyzers utilize zirconium oxide sensing technology, which is sensitive to pressure variations in the process. An output change of approximately 1% of reading (not 1% FS, or 1% O_2) can be expected for every 4 in. of H_2O pressure in the process. Special accommodation must be made to balance the process pressure with the inside of the oxygen probe. Rosemount Analytical has a special probe design that balances the inside of the probe to the same pressure as the process. A sealed probe is used along with a "booster relay" which duplicates the pressure of the process with the instrument air being used as a reference gas (see figure 4).

For accurate, reliable oxygen analysis, Rosemount Analytical offers the Oxymitter 4000 with integral electronics. The user-friendly design of the probe allows convenient access to internal probe components for in-house service. In addition, Rosemount Analytical's patented electronic cell protection automatically protects the sensor cell's electrodes from harmful corrosive gases. And, the HART® Field Communications Protocol permits all operator functions to be performed from the control room.

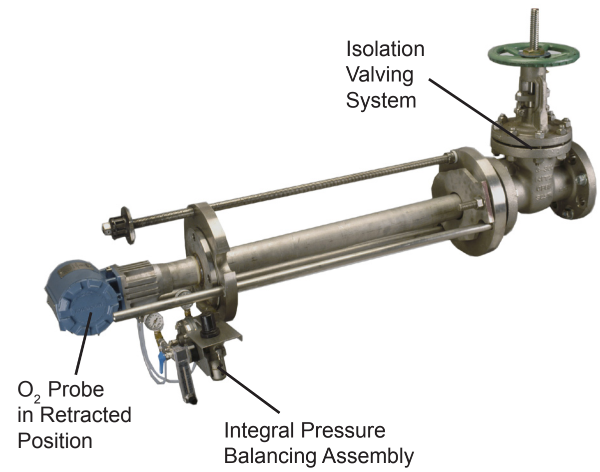

Figure 4 - Pressure balanced in situ O_2 probe with optional isolation valving system (probe withdrawn)

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