

IN TWO-STAGE REGENERATOR SYSTEMS, LOCATE THE MORE EFFICIENT CYCLONE FIRST

Traditional Systems

In most regenerator cyclone systems, the diameters of both stages of cyclones are the same and the first stage cyclone inlet area is greater than the second stage cyclone inlet area. The second stage cyclones are more efficient than the first stage because the ratio of the cylinder (barrel) cross-sectional area to the cyclone inlet area for the second stage cyclones is greater than the corresponding ratio for the first stage cyclones. Historically, it has been assumed that the more efficient cyclones should be in the second stage; however, when the negative effects of excessive mass flows through first stage cyclone cones were recognized, the assumption was questioned.

More Efficient First Stage

By using the more efficient second stage for the first stage cyclones, the diameter of the first stage cyclones increases in order to maintain the same inlet area; correspondingly, the diameter of the first stage cyclone cone outlets increases. This reduces the mass flow through the cyclone cones. The more efficient cyclones are longer, but this does not represent a problem; catalyst level in first stage diplegs is typically midway between the hopper dipleg weld line and the catalyst bed. Not only can the first stage diplegs be shortened to accommodate this additional cyclone height, but the diplegs can also be further shortened to accommodate an increase in the cyclone length-to-diameter ratio.

Alternate Second Stage Designs

Alternate cyclone designs were considered for the second stage. Using larger first stage cyclones reduced the plan area available for the second stage cyclones. This suggested that second stage cyclones should be the type traditionally used in the first stage. A comparison of performance calculations for traditional second stage cyclones and the alternate smaller second stage cyclones indicated a negligible difference in catalyst losses. The smaller cyclones were shorter, thus more dipleg length was available. If not required for cyclone operation, the cyclone length-to-diameter ration could be increased.

Results

When a system incorporating this reversed cyclone design was put into service, actual catalyst losses were 75% of estimated losses. (Estimated losses were based on empirical data from over 100 operating units.) Since, cyclone losses are primarily catalyst fines generated by catalyst attrition in the system, what caused this added benefit? It is believed that most catalyst attrition takes place in the second stage cyclones. By using more efficient first stage cyclones to reduce the catalyst loading to the second stage cyclones, catalyst attrition is significantly reduced. Inspection after 3 years of initial system operation revealed very little erosion in second stage cyclones and no measurable erosion in first stage cyclones.

Currently operating units, particularly regenerators with superficial velocities of 0.9 m/s (3.0 ft/s) or greater, have achieved significantly reduced cyclone losses and, correspondingly, reduced cyclone maintenance requirements.

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