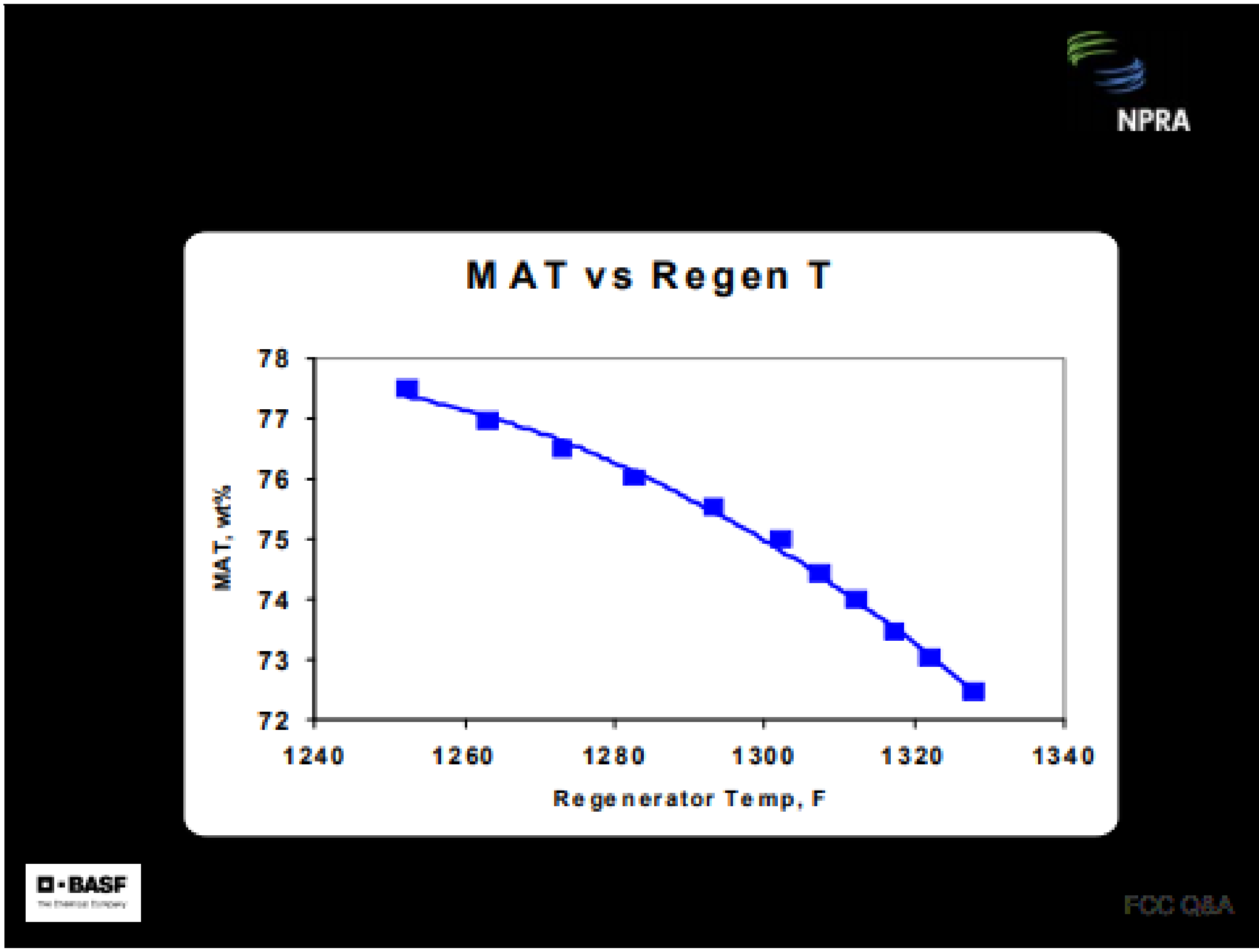
Question 9: Are there specific lab studies or commercial examples regarding the effect of regenerator temperature on catalyst deactivation and particle integrity, specifically attrition properties, apparent bulk density, and morphology?

HEATER (BASF Catalysts)

There is a very definite correlation between activity degradation and regenerative temperature. Some catalysts are more susceptible to thermal deactivation depending on the technology and the poor architecture used. The majority of the decline of particle integrity occurs as a result of inappropriate operating parameters and/or inadequate equipment performance; for example, excessive localized velocities or excessive steam injection. Above 1350°F catalyst zeolite deactivation accelerates rapidly. This is a key point for new process engineers. If you see a step change increase in your e-cat ABD, that is a good clue that there is excessive hydrothermal deactivation. So if you see your activity fall off, or your regenerator temperature increases, take a look at the ABD on your e-cat sheet and see if it is showing a step change increase. Also, with SOx additives, the SO_4 capture creates a popcorn effect, due to the larger crystal forms, with resulting negative impact on attrition.



Using data from our model, we created a graph of the activity of the e-cat versus regenerator temperature. As you can see, it is a rather steep slope and there is a decline of activity as you increase regenerator temperature.

WARDINSKY (ConocoPhillips)

ConocoPhillips has not conducted any studies looking into the effect of regenerator temperature on the properties and variables mentioned in the question. However, a review of FCC catalyst literature indicates that surface area retention of most catalysts utilizing rare earth exchanged zeolites is fairly linear with increase in temperature out to about 1400°F where the loss of catalyst surface area accelerates with increasing temperature.

Instances where we have experienced severe catalyst deactivation, loss of pore volume, and increased apparent bulk density have been associated with flow reversals and subsequent attempts to regenerate the oil-soaked catalyst too quickly. There has been some work done by one of the catalyst suppliers on the effect of temperature on catalyst attrition. They have developed an attrition test at elevated temperatures that they believe is more representative of catalyst attrition in FCC units.

We have performed attrition tests on FCC fresh catalysts without first subjecting the catalyst sample to a high temperature calcination step at 1100°F. The attrition index increases by roughly a factor of two without the calcination step, suggesting that the fresh catalyst is considerably more susceptible to attrition prior to its being exposed to regenerator temperatures.

We have also studied the effect of temperature shocks on the attrition properties of FCC catalysts. Fresh FCC catalysts were subjected to sudden changes in temperature, from ambient to up to 1100°F. Results so far have shown that sudden temperature changes do not appear to affect the attrition resistance of catalysts that have been exposed to a calcining step during their manufacturing process.

DOC KIRCHGESSNER (W.R. Grace Refining Technologies)

I think it is also important that we remember that particularly as regenerator temperature increases in resid processing-type units, the rate of deactivation of catalyst will change according to the oxidation state in the regenerator. Units that operate in partial CO combustion will tend to retain their activity at a better rate than units that operate in complete CO combustion. And for units that operate in both modes—that is, with a two-stage regenerator, I will leave that for Mr. Letzsch to comment.

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