NITROGEN VERSUS STEAM REGENERATION IN ACTIVATED CARBON ADSORPTION SYSTEMS

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The Imation Plant (formerly 3M) is in a rather unique position because it has had both types of carbon adsorption systems. Because of its location in Camarillo, California (a non-attainment area for air quality) a steam regenerated activated carbon adsorption system was started up very soon after the plant was built back in 1996. This system was operated successfully for many years and continuously met all the current Emission Control Efficiency requirements.

When the company management (then 3M) decided to reduce air emissions from all its plants by 85%, the Camarillo plant began a study to determine the best way to do this. The result of which was the replacement of the steam system with a hot nitrogen regenerated activated carbon adsorption system in 1992.

Because there is more equipment necessary for Nitrogen regeneration and the operation requires more complex controls, it is no surprise that the capital cost for a Nitrogen regeneration system is about 40 to 50% higher than a Steam regeneration system handling the same volume of Solvent Laden Air.

More equipment also usually means more maintenance cost. However, in our case the maintenance cost is only slightly higher due to the various maintenance-friendly features which were designed into the plant based on our experience; better quality valves and sealless, close-coupled pumps being good examples. Fixing nitrogen leaks is the biggest continuous maintenance problem with the nitrogen desorb system. Overall however, maintenance costs are quite small compared to the desorption and carbon replacement cost involved.

The desorption cost of a steam plant consisted mostly (about 65 to 70%) of the steam requirements, the rest being the electrical costs. With a nitrogen desorb plant the cost of steam drops to about 30% of the total while the electrical increases to about 50%. The remaining 20% is in the nitrogen replacement costs. In our present operation, there is no significant difference in the cost per pound of solvent recovered to desorb the nitrogen system when compared to the steam system. This is due mainly to the much higher solvent recovery efficiencies demanded of our nitrogen desorb plant.

The reason that we chose the nitrogen desorb system in the first place was because of its improved solvent recovery efficiency. Because the carbon remains dry, it has a higher affinity for solvent and shows almost 100% efficiency throughout the adsorption cycle until just before solvent breakthrough. In addition, the solvent

concentration increase after breakthrough is much more rapid than with steam desorb. In practical terms, this phenomena results in much improved adsorption efficiencies. In our case the breakthrough concentration set point for desorption in the nitrogen system is very nearly the average concentration of old steam desorb system. In terms of efficiency, we went from around 96% to greater than 99%. More importantly, our total emissions went from about 175 tons per year to 21 tons per year.

Another improvement over a steam desorb system is the way bed fires are handled. Even though one of the many solvents adsorbed is Cyclohexanone, the nitrogen system seems to be more forgiving about bed fires than the steam system. Although we have had a few incidences of what appeared to be bed fires with the nitrogen system, they were all extinguished using nitrogen purge and cooling. This meant that the beds could be very quickly put back in service with no damage or loss of adsorption efficiency. This was not the case with the steam system which used water to cool down the hot carbon and hurt our recovery efficiencies because of wet carbon.

A bit negative to nitrogen desorb is its sensitivity to carbon properties. While the steam desorb system seemed to operate well using a wide range of carbon densities and pore sizes, not so with nitrogen desorb. The carbon has to be very microporous. So microporous that, as of now, none of the domestic manufacturers have been able to supply it on a regular basis. Probably as a result of this microporosity, carbon life suffers. We get about third to half the life that we were getting with the steam desorb carbon.

Despite claims of the nitrogen desorb system manufacturer, the recovered solvent was just as acidic, if not more so, than the steam desorb solvent. It had to be neutralized before it could be reused the same as the steam desorbed solvent.

Another claim the manufacturer made was for dry solvent. Apparently dryness is a relative thing as we found about 0.5% water in the recovered solvent which is much higher than our specification requirements. This water content, however, does not matter to us as our neutralization process is a wet one anyway.

Despite the higher total operating costs mainly due to the carbon replacement costs, the nitrogen desorb plant was a good overall investment for us because of the tremendous improvement in the recovery efficiency. This improvement made it possible for our plant to be one of only a very few plants in the US chosen to participate in Project XL. Implementation of this new concept in environmental regulation will enable us to respond quickly to the changing demands of the marketplace. This ability will save us both time and money and is a matter of survival in the modern high-tech world.