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Ammonium nitrate induced cracking of a dryer

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ABSTRACT

After less than 1 year of service, extensive cracking of two ammonium nitrate prill dryers was found. The cracking was found to be ammonium nitrate-induced stress corrosion cracking and the failure was attributed to a lack of post-weld stress relieving of the fabricated structures. It was considered likely that the SCC would occur more slowly once the cracks had progressed beyond the region of high residual stresses and that the design operating stresses in the dryer would be insufficient to cause rapid cracking in the dryers. It order to manage the dryers until new ones could be fabricated, the dryers were operated normally with regular inspections to monitor crack growth and to date, no significant addition crack growth of major cracks was observed.

1. Introduction

Ammonium nitrate (AN) is used as a fertilizer and as an oxidant for explosives. There is currently a high demand for AN, particular for use as an explosive in coal mines and plants in Australia have been running at capacity. As part of the process of producing AN, a prill, or small pellet of AN, is formed and then dried in a rotary dryer. This case study describes the cracking of a dryer in an AN plant by stress corrosion cracking. This dryer was one of two dryers that had been installed to dry AN from a moisture content of 5% to the final product value. It was found that both dryers were cracked, although one more severely than the other. This study represents the analysis of the more severely cracked dryer. The other dryer showed similar features, although to a lesser extent as it was younger. Failure of a key piece of equipment such as an AN dryer can lead to significant financial loss, particularly from the downtime associated with the failure. In this instance the dryer had been operating for only 1 year at the time the cracking was observed. The dryers had replaced an earlier dryer, but some significant design changes had been carried out, particularly with respect to the mounting of the bearings.

The rotary dryer consisted of a long horizontal tube that rotated about its axis and was mounted on two external bearings. The tube was approximately 3 m in diameter and AN was fed from one end and was removed from the other. The tube had been fabricated from boiler plate and had a number of longitudinal and transverse welds in the structure. The dryer received moist AN at one end and this was dried by a blast of warm air. The temperature of the AN as it entered the dryer was approximately 50 °C and the dry air was at about 70 °C. In the design of dryer used in this case, the dryer air came from both ends of dryer and was vented in the middle. On the inside of the dryer were a number of lifting lugs which were used to roll the prill in the drying air. The problem was first encountered when it was noticed that a number of the lifters had broken away from the shell of the dryer. The dryer was then inspected and it was found that a significant number of lugs were cracked and that the cracking extended into the shell.

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