SNAPSHOT

SUITABILITY OF BELT MATERIALS FOR CO_2 PELLET CLEANING

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Project Description

The project was conducted to assess the suitability of dry-ice blasting for polymer-based conveyor belts used in the meat processing industry. Investigations were undertaken to determine the effects of thermal variations on material strength (impact resistance) of polypropylene, acetal, and high-density polyethylene.

Project Content

The project included a detailed literature review on low temperature effects on polymers (polypropylene, acetal, and high-density polyethylene), as well as experimental analysis of thermal exposure duration on internal temperature gradients, thermal exposure on impact resistance, and cyclic thermal loading on impact resistance.

Experiments were conducted using dry-ice powder applied to the various materials. Temperatures inside samples were measured using thermocouples imbedded at depths of 1 mm, 2.5 mm, and 5 mm. These were used to determine the internal thermal gradient from exposure to only one side of a sample. Material strength of each sample, after a varied period of cooling, was assessed by impact resistance and measured using an Izod impact tester. Finally, cyclic thermal loading was achieved by exposing samples to dry-ice for 60 seconds and then boiling water for 60 seconds, with impact testing conducted at room temperature.

Project Outcome

From the investigations conducted for the entire project, it is evident that dry ice blasting as a cleaning method of conveyor belts used in meat processing facilities may have some complications that render the process impractical. Polypropylene would have a high risk of material failure, as the glass transition temperature is high (0°C). Furthermore, there is a 10% reduction impact

resistance after one 60-second exposure to dry ice, even after subsequent heating to 100°C and temperature stabilisation to room temperature.

Acetal fairs better than polypropylene with impact resistance at cold temperature exposure, and thermal loading; and also has a much lower glass transition temperature. However, there is still sufficient evidence to indicate high risks of material failure of acetal when cleaned using dry ice blasting.

Experiments conducted on the HDPE samples indicate that variations in impact resistance from cooling, and cyclic thermal loading from dry-ice exposure, are minor and unlikely to cause material failure. This implies that dry-ice blasting on HDPE conveyor belts could be conducted. However, additional considerations could need to be made (such as other materials used on the belt construction, and operation of the cleaning equipment). Additionally, higher numbers of thermal loading cycles would need to be conducted to verify the impacts of thermal fatigue.

Overall, the results indicate that dry-ice blasting is not suitable for acetal or polypropylene, but could be suitable for HDPE. The impact resistance of acetal and polypropylene becomes unacceptably low, thus increasing the risk of material failure. However, the results from HDPE tests indicate that it is likely to be suitable for dry ice blasting as a cleaning process. The number of thermal loading cycles conducted on HDPE was inconclusive and further investigations would be warranted.

Benefit for Industry

Dry ice (solid CO_2) blasting provides an opportunity for an alternative cleaning process that can reduce energy costs associated with water boiling, reduce the quantities of cleaning chemicals, and potentially reduce labour time. However, for polymer-based conveyor belts, dry ice blasting should be limited to HDPE.