INTRODUCTION

It is important to look past the obvious when investigating and evaluating industrial machinery incidents. More often than not, it is obvious that the injured worker may bear some responsibility for his or her own injury because a procedure was not followed or a shortcut was taken. It also may appear obvious that the manufacturer of the machine involved in the incident could not be at fault because guarding existed or warning labels were present. Looking past the obvious means keeping options open and fully investigating each incident to obtain all available relevant facts and information before determining subrogation potential. In this article, I present information from a technical investigation of a granulator incident to show that, in industrial incidents, things are not always as they seem.

BACKGROUND

The subject incident occurred in a plastics plant and involved a machine called a granulator. A granulator is a machine using blades mounted to a rotor assembly to cut plastic into chips or granulates. The subject granulator, shown in Figure 1, was used to cut rejected plastic parts so that the plastic could be fed back into injection molding machines in the plant, thus reducing waste.

According to available information, the subject incident occurred when an operator was performing the routine task of emptying plastic chips from the granulator discharge bin and cleaning the granulator cutting chamber screen. After the machine was turned off, the operator opened the cutting chamber door to access the screen and was cut by one or more blades of the still spinning rotor assembly.

THE INVESTIGATION

When investigating this or any other industrial incident, it is important to collect as much information and evidence as possible. Identifying the machine is critical, including manufacturer, model, serial number and date made. Documentation for the machine is also needed, including manuals and service records. Getting information on how the incident occurred is a very important step in understanding the role machine design and safety may have played. Of equal interest are in-house investigations and OSHA findings, if available.

Physical inspection of the machine or machines involved in an incident is usually the cornerstone of a technical investigation. Information and evidence collected during a site visit can rarely be matched by reviewing similar information from another source. Another benefit of physically inspecting the machine is having the opportunity to operate the machine and perform relevant studies or tests.

In the subject investigation, I visited the insured’s facility and inspected the granulator involved. I also obtained identifying information and the manual supplied with the machine. The subject granulator's cutting chamber door, shown in the closed position in Figure 2, is secured with two toggle latches and has an electrical switch identified in the manual as a 'safety interlock.' The latches can be opened using a hand crank supplied with the granulator. No fasteners requiring tools are used to secure the door of the cutting chamber.

There are a number of generic warning labels on the subject granulator that speak of the moving blade hazard. One label, visible in Figure 2, located near the chamber door switch states:

"WARNING: WAIT 3 MINUTES AFTER SHUTTING OFF POWER BEFORE OPENING THE CUTTING CHAMBER."
During my inspection, I operated the subject granulator and opened the cutting chamber door. A view of the open cutting chamber is shown in Figure 3. I also repeatedly observed the time required for the rotor assembly to come to a complete stop. The average time measured was about 40 seconds. I was able to time the stopping of the rotor assembly by viewing a section of the rotor flywheel through a small hole on the left side of the machine. However, there was no obvious visible or audible indicator of rotor motion provided by the manufacturer for this purpose.

While at the insured's facility, I had the opportunity to inspect several other granulators of the same model, made by the same manufacturer. All of those machines were similar to the subject machine in design and function. I also inspected a granulator made by another manufacturer. This other machine incorporated a cutting chamber door that was securely fastened with hex head bolts requiring the use of tools for opening. This alternate cutting chamber door system is shown in Figure 4. It is often interesting to see similar machines made by another manufacturer during a site visit. This can provide valuable information on what the state-of-the-art may be in the design of a given type of equipment.

THE OBVIOUS

What is obvious is that the operator opened the cutting chamber door before the rotor assembly had stopped, thus exposing herself to the cutting hazard presented by the moving blades. This fact, in and of itself, may seem daunting. Since the operator did something 'wrong,' it is easy to overlook the contribution of other parties and their potential responsibility.

It may initially appear obvious that the design of the subject granulator was adequate and that proper safeguards were employed. The cutting chamber door has latches that must be released. The chamber door has an electrical switch that cuts off electrical power to the machine if the door is opened. Furthermore, there are half a dozen or more warning labels on the machine addressing the blade issue and warning of the injury that could occur.

PAST THE OBVIOUS

The safety design principle known as the Safety Hierarchy, which has taken different forms over the past 50 years, provides guidelines for the design of any type of equipment that presents a hazard. The Safety Hierarchy simply states that first, one must evaluate a given machine to identify hazards that may be present under reasonably foreseeable use conditions. After hazards are identified, then they must be controlled. The three main control methods available are listed in priority order as follows: eliminate the hazard by design, provide appropriate guarding and provide warning labels or signs.

The moving blade hazard in the cutting chamber of the subject granulator is the primary hazard to be addressed in evaluating granulator safety. It is apparent that the manufacturer recognized this fact by their use of warning labels and their incorporation of a 'safety interlock' switch into the design of the subject cutting chamber door system. Certainly, good design intent would dictate that when the cutting chamber door is opened, the rotor assembly should be stopped, eliminating the moving blade hazard.

The cutting chamber door supplied by the manufacturer is a barrier guard to prevent contact with the blades inside while the door is closed. Since the door must be opened for maintenance and service functions, an interlock of some type is useful to ensure safety with respect to the moving blades. Interlocking guards can be mechanical, electrical, pneumatic or some combination.

As stated in the National Safety Council's Accident Prevention Manual (1), an effective interlocking guard must satisfy three requirements; it must:

1. Guard the dangerous part before the machine can be operated;
2. Stay closed until the dangerous part is at rest; and,

3. Prevent operation of the machine if the interlocking device fails.

Elaborating on point 2, it is further stated that:

"When the machine is in motion, the guard cannot be opened. It can be opened only when the machine has come to rest or has reached a fixed position in its travel."

Based on inspection of the subject granulator and review of the granulator manual supplied, the safety provided by the chamber door system relies on the door's electrical 'safety interlock' switch. When the toggle latches are opened, the chamber door is released, which deactivates the electrical switch, thus cutting off electrical power to the machine. If that is the case, the time required to open the toggle latches and drop the chamber door should exceed the stopping time of the rotor assembly.

Unfortunately, this arrangement does not comply with accepted interlock theory. Based on testing of the subject machine, the potential of opening the chamber door while the rotor assembly is coasting to a stop still exists, in violation of the second requirement listed above. Although the switch ensures that the door must be closed before the granulator can operate, it does not ensure that the blades are stationary before the chamber door can open. In this way, the design fails to provide the safety needed. In fact, the presence of a switch that cannot render the machine safe during opening of the chamber door may be detrimental to user safety, in that it can provide a false sense of security.

Standard tools are not required for chamber access in the subject granulator design. Flipping the latches does require use of the granulator's own hand crank, but the hand crank is kept with the machine and is readily available for use. The presence of the electrical switch does not ensure that the rotor assembly has stopped when the door is opened; i.e. contact with blades on the spinning rotor assembly can occur, as did occur at the time of the subject incident.

The review of standards and regulations is very useful when evaluating the safety provided by the design of a given machine. Many industrial machines are covered by voluntary standards promulgated by the American National Standards Institute (ANSI). ANSI standards are written by committees that consist of interested parties from industry, government and private concerns. Sometimes the manufacturer of the machine in question will even be listed as a committee member.

Review of available ANSI standards in this investigation revealed that ANSI B151.11 covers plastics machinery used for the size reduction of plastics, including granulators. The ANSI standard for granulators (2) is clear in stating that fasteners requiring tools should be used to secure the cutting chamber and that some type of interlock is required. Specifically, the standard states that during granulator screen removal or cleaning:

"The discharge area shall be guarded by fasteners requiring the use of hand tools for removal plus either an electrical safety interlock or mechanical safety interlock."

If a waiting time of three minutes is necessary, as is stated by the warning label on the subject granulator, the chamber door design and access procedure should be such that at least three minutes are required to open the chamber door. However, inspection of the subject granulator and review of the granulator manual, show that easy access is an inherent feature of the as-designed and manufactured granulator cutting chamber door system.

SUMMARY
Thorough investigation of the subject granulator incident leads to the technical conclusion that the design of the machine was inadequate from a safety perspective. Even though, on the surface, it appeared that sufficient guarding and warnings were provided, further analysis uncovered a significant design flaw. The electrical 'safety interlock' switch on the chamber door does not meet the requirements of an interlock, thus the chamber door system does not provide the safety required during chamber access operations. It is unsafe to allow the door to be opened while the rotor assembly is still spinning and that is exactly what can occur given the subject chamber door system design.

References:


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