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Small-Scale Incremental Pressing*

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REMOTE PLUNGER REMOVAL DEVICE FOR SMALL-SCALE INCREMENTAL PRESSING

by

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ABSTRACT

Small-scale pressing of high explosives (HE) at Los Alamos National Laboratory (LANL) and elsewhere is routinely performed using pneumatic presses. Blast shields provide protection to the operator during the pressing procedure, but safety of the operator is a concern during removal of the plunger, which is currently performed manually. To minimize this risk, very high tolerances between the plunger and the die are required. These tolerances are often very costly, especially in the case of long, relatively narrow dies. The safety issue is an even greater concern with incremental pressing in which cleaning the die between increments is difficult or impossible. To better protect press operators, a device has been designed and constructed to allow remote plunger removal in a standard HE press. In this report we describe this modified press that allows remote removal of the plunger.

STANDARD PRESSING PROCEDURES

High-density pressing of high explosives (HE) is often done with a standard two-surface press that inserts a high-strength steel plunger into a bed of HE contained in a die that is also made of high-strength steel. This setup is shown schematically in Fig. 1. Accurate densities are obtained by pressing a measured mass of HE to a specific volume, which is controlled by spacers. The assembly is placed in the press and rests in an upright position on the bottom pressing plate. The press has a blast shield that is lowered before the assembly is compressed. After the pressing plates have returned to their

Fig. 1. Standard HE pressing apparatus. resting position and the blast shield has

been raised, the assembly is removed from the press and the plunger is manually removed from the die by the operator. Any excess HE found on plungers, dies, and spacers is removed after each pressing.

SAFETY CONSIDERATIONS

Each press has an HE load limit and is robustly designed to contain a blast in excess of that limit. A blast shield is in place at all times during the pressing procedure, so if the load limits are not exceeded, the operator is protected.

Safety of the operator is a concern during the plunger removal, which is done by hand without a blast shield being in place. Pinching and shearing of HE particles between the plunger and the die create the potential hazard of unexpected initiation. To minimize this hazard and prevent failure and deformation during the pressing process, dies and plungers must be made of high-strength steel. In addition, a tight clearance (<0.005 in.) between the plunger and die must be held to prevent HE particles from being trapped between the plunger and die surfaces. And finally, dies and plungers are cleaned after each pressing. However, the potential hazards of manual plunger removal still remain, especially in the case of incremental pressings in a single die when the die cannot be easily cleaned between pressings.

A simple device has been designed and implemented in a standard HE press; this device allows for remote removal of the plunger from the die, thus reducing danger to the operator. In this report, we describe the design and operation of this modified press.

DESIGN CONSIDERATIONS

The distance between the pressing plates of a fully opened press is often only slightly greater than the combined length of a plunger and die set. For the plunger to remain fully extractable, then, the modifications made to the press must occupy a minimal amount of vertical space. Another requirement is that any device that is placed between the plunger/die assembly and the pressing plates must be able to withstand the high pressures experienced during the pressing procedure. Additionally, any upward forces exerted on the plunger to extract it from the die must be centered with, and parallel to, the plunger itself to prevent binding. Lifting of the die itself must be prevented either by a retention device or by the weight of the die itself (i.e., a large, heavy die with a small plunger). Because the blast shield cannot be lifted at any time during the pressing procedure, the task of removing the plunger must be fully automated. Use of the extraction apparatus, including its alignment with the plunger/die assembly, should be quick, easy, and fail-safe.

THE MODIFIED PRESS

The assembly designed and built to meet the requirements specified in the previous section consists of a hook fixture that is bolted to the top plate and that serves as a retainer for the four hooks (see Fig. 2) (The figure shows only two hooks.). For reference, mechanical drawings used are found in Appendix A of this document (see Figs. A-1 and A-2). The hooks slide unintrusively over the

redesigned, sloping face of the plunger as the assembly is compressed. As the pressing plates are opened, hooks catch on the plunger, retracting it from the die. A positioning block rests on the bottom pressing plate, and serves both to position the assembly underneath the hooks, and to hold the assembly in an upright position.

Hooks

The hooks are designed to be able to both apply an upward force on the plunger with no moments and slide freely along the plunger face. By positioning the pivot point, the point at which the upward force is exerted, in a position collinear with a line normal to the lifting face, the direct upward force applied on the hooks provides a direct upward force on the lifting face, with no moments. The profile of the bottom of each hook is rounded and slides freely along the sloped face of the top of the plunger. Each hook is balanced because of its shape, so that it will freely hang away from the plunger, tipped at an outward angle, preventing binding with the plunger face during compression. To facilitate machining of the parts and prevent corrosion, the hooks are made of aluminum.

Hook Fixture

The hook fixture is bolted to the top pressing plate and holds the free-hanging hooks. The pin joint of each hook is positioned directly over the lifting surface of the plunger. The fixture is made of mild steel and will withstand the pressures exerted on it by the press.

Fig. 2. Modified pressing and plunger removal apparatus.

Positioning Block

Good positioning of the plunger underneath the hook fixture is important to avoid binding between the hooks and plunger and to ensure that the upward force exerted on the plunger by the hooks is parallel to the axis of the die. This alignment is easily performed before pressing begins. The positioning block is made of mild steel and has a hole through it with the same diameter as the die body. The block rests on the bottom pressing plate and serves to hold the die in an upright position; it easily positions the plunger underneath the hooks between repeated removals of the die from the press. In the specific application discussed here, the die body is very large and heavy. Thus the weight of the die body exerts enough downward force to prevent it from lifting from the pressing plate during the extraction procedure. In other applications, however, a retention mechanism, such as

set screws in the positioning block, may be easily implemented.

Die and Fixture Modifications

As discussed earlier, proper positioning of the assembly is important to the functionality of the apparatus. The angle at which the hooks naturally hang allows for proper use of the extraction unit only if the assembly is aligned adequately under the hooks. A retention pin was placed in the hook fixture below the pivotal pin of each hook to prevent the hooks from swinging too far inward (see Fig. 2). Further, the hooks can potentially bind with the die as the pressing plates are closed together. This is avoided by machining a 0.5-in. chamfer on the top of the die, as shown in Fig. 2.

the cost is less because extremely high tolerances between the plunger and the die can be relaxed. This modification made to the press minimally affects the current pressing procedure.

OPERATION

The positioning block is placed on the bottom pressing plate and aligned with the hooks using an empty die. Once the positioning block is in place, pressing operations can continue following standard procedure. The normal pressing procedure is unmodified except for the remote removal of the plunger, which occurs when the pressing plates are extended from each other.

SUMMARY

In this report we describe a remote plunger removal device that improves the safety of small-scale HE pressing and decreases operational costs. The pressing procedure is safer because removal of the plunger is now performed remotely, and

Appendix A

Mechanical Drawings

Fig. A-1. Hook drawing.
(All lengths given in inches.)

Fig. A-2 Fixture and plunger drawing.
(All lengths given in inches.)