FEATURES

IGNITION HAZARD

From internally-generated H_2 in sealed mining equipment

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A number of ignition incidents involving mining and farm equipment have illustrated the surprising danger of drilling, cutting, or otherwise penetrating sealed compartments or frames that are filled with metal scrap for ballast. The presence of chemically-reactive metals (or electrochemically-active pairs), such as zinc in galvanized steel, can produce hydrogen from moisture in the steel scrap, and the resulting pressure, due to the internally-generated hydrogen, can produce an easily-ignited gas jet when the sealed component is penetrated. Hydrogen or methane production is also possible in contaminated steel scrap by microbial action. Thus, the simple act of drilling a hole in such equipment can have disastrous consequences to the operator behind the drill.

NIOSH, the U.S. government agency charged with conducting research aimed at preventing work-related injury and illness, investigated two such incidents that occurred in the state of New York in 1995 and 1996. Workers were drilling into sealed frame members that were filled with metal scrap (Fig. 1). They were thrown back for some distance by the force of the ignited jet and suffered burns. Both equipment frames had been filled with sundry metal scrap, including galvanized steel, that were generated by punching operations in machine shops. Hydrogen gas was found to accumulate in the resealed sections of both frames, and a rough linear increase of pressure with time was noted in the one frame that had been supplied to us for a detailed study. An absolute pressure of 185 lb/in.^{2}, predominantly from hydrogen gas, was found when the remaining sealed section of this frame was penetrated using a drill designed for the safe penetration of pressurized gas lines.

Fig. 1. The cut end of a filled plow frame section (4x4x142 in.) and the contained metal scrap.

Another incident is the electrical cable fire in 1998 that resulted from the liberation and ignition of a flammable jet of internally-generated gas by drilling into a bulging ballast compartment in a dragline that was operating at a surface coal mine in NSW, Australia (Fig. 2). This fire resulted in the idling of the equipment with a substantial cost in lost production. The walls of the ballast compartments were made of 1/2-in.-thick steel, but with a large unsupported area. Pressure readings of up to 91 lb/in.^{2} were found in the remaining intact compartments. The compartments with higher pressures were found to contain some galvanized steel scrap and substantial concentrations of hydrogen gas. The Deptartment of Mineral Resources, NSW, Australia, concluded that the ignited gas was hydrogen.

Hydrogen is not the only flammable gas that can be internally generated from scrap used as a ballast. The presence of anaerobic bacteria together with a food source, such as oils, can produce methane once the oxygen from the air is largely removed by reaction with the metal scrap. Appreciable amounts of methane were found in some of the dragline ballast compartments, and evidence of some methane was found in one of the plow-frame sections that were investigated.

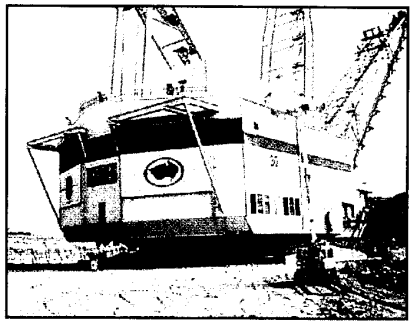

Fig. 2. A view of the dragline showing the ventilation window in the center rear (below the sign). The top of the ballast compartments forms the floor at the base of this window.

The lesson learned from these incidents is that sealed and filled equipment components must be treated as if they contained a flammable gas at considerable pressure. Penetration of such equipment should be done remotely, in a safe area, or with a drill used to penetrate high-pressure natural gas lines safely (the method that both NIOSH and the Australian investigators used). The above potential hazard can be minimized by providing a vent hole or valve in such sealed systems, or insuring that only clean and dry-carbon steel scrap is used. EMJ