walls of the buildings following an explosion can be obtained by outside glazing and by scoring the glass panes before they are installed.[115]

It is impossible to have too much ventilation around exceedingly hazardous operations. Whenever possible the operations should be carried out entirely in the open air, as is done in certain processes in the petroleum industry, with no closed structures, except those to house instruments and other equipment that must be protected from the weather.

G. RELEASE DIAPHRAGMS AND VENTS

Adequate release diaphragms should be provided on all equipment in which explosive mixtures may be present. The ideal release diaphragm is that having zero mass and infinite area. Although this cannot be realized in practice, the construction and size of release openings should approach the above ideal as closely as possible, yet be strong enough to sustain the operating pressure within the equipment without danger of rupture or leakage, except in case of an explosion within the equipment.

To protect properly a given installation containing explosive mixtures the following major factors must be known or determined experimentally: (*1*) the type and concentration of the combustible vapor or gas that may be present in the equipment; (*2*) the maximum pressure the equipment will safely stand; (*3*) the maximum pressure developed by the mixtures on explosion; (*4*) the area of release openings necessary to keep the pressures below the safe maximum pressure; (*5*) the kind, area, and thickness of the diaphragm material that will rupture at the desired pressure; (*6*) the proper location of the diaphragms to release the pressure developed before excessive pressures are reached. For specific information on this subject the reader is referred to published reports.[115–121] Release diaphragms are now available that will rupture at definite pressures ranging from less than 1 to more than 1000 p.s.i. Various types of materials are used, and they may be obtained with protective coatings where corrosive atmospheres are encountered.

One example of explosive mixtures of acetone and air will be discussed to show how the proper diaphragms may be determined. Figure 5 gives the pressures developed when the area of release opening is varied from no opening to 45 square inches per cubic foot of space in the equipment. These values were obtained experimentally in an 8-liter closed bomb with mixtures containing 5.50 per cent of acetone vapor, a concentration that gives the highest pressure on explosion.

[115] H. R. Brown and R. L. Hanson, *Chem. & Met. Eng.*, **40**, 1030 (1929).
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[121] T. S. Murphy, *Chem. & Met. Eng.*, **99**, 108 (1944).

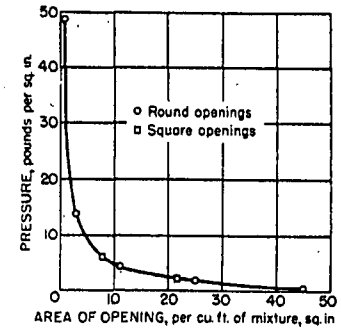

Figure 5. Relation of pressures produced to area of opening, 5.50 per cent acetone-air mixtures (8.05 liter bomb).

Let it be assumed that the equipment should not be subjected to a pressure greater than 10 p.s.i.; then from the results given in Figure 5 the area of release openings should be at least 5 square inches per cubic foot of space.

Next is determination of the proper size and thickness of the diaphragm material that will provide release of the gases from the equipment at a pressure of 10 p.s.i. or less. In general, lead, tin, aluminum, copper, gold, platinum, and special alloys have been found to be most suitable for release materials at low pressures. An example is shown of tests made on aluminum foil of 0.001-inch thickness in an 8-liter bomb using acetone-air mixtures. The rupturing pressures for openings of different sizes and for different concentrations of acetone in air on explosion are given in Figure 6. The rupturing pressures increase as the area

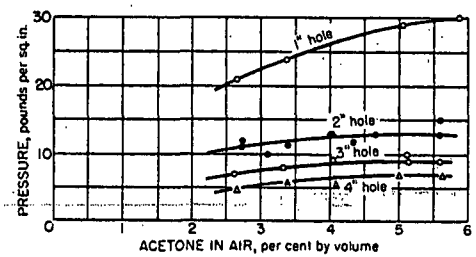

Figure 6. Aluminum diaphragm tests (0.001 inch thick).

of the opening is reduced. In this example, where the pressure must not exceed 10 p.s.i., the curves show that the diaphragms must be at least 3 inches in diameter for this particular aluminum foil; and, as previously determined, the number of release openings should be such as to give 5 square inches of diaphragm release opening per cubic foot of space in the equipment.