



Caking Versus Packing of Dry Chemical Agents

Terms Defined

The terms “caking” and “packing” are frequently misused. Because of this, there is a great deal of confusion that exists regarding these phenomena.

The purpose of this bulletin is to place in proper perspective the two conditions, and to describe the impact that each has upon the operability of a dry chemical type fire extinguisher. Essential to our discussion is a definition of the two terms.

CAKING – Caking is a phenomenon that occurs when moisture chemically reacts with a dry chemical fire suppressing agent. The products of this reaction result in materials that are capable of being hydrated by moisture and, therefore, agglomerate; that is, individual particles stick together to form a large agglomerate, or what is more commonly referred to as lumps. This particular phenomenon, in general, is not dependent on the particle size of the suppressing agent.

PACKING – Packing is a phenomenon that occurs whenever you have a solid material composed of particles of different sizes which are stored in an upright or vertical container and subjected to any type of vibration. The worst vibration is in the vertical mode as opposed to the horizontal mode. This phenomenon does not involve any chemical reactions, and is distinctly dependent upon the particle size distribution of the suppressing agent.

Having defined these two terms, it is necessary to consider each one a little more in detail. These two phenomena refer to completely different interactions of the dry chemical with its particular environment. In the case of caking, we are referring to a chemical reaction which occurs between moisture and the dry chemical itself, resulting in the formation of agglomerates or aggregates. These consist of smaller particles of dry chemical which are reactive with the moisture and stick together, building up a large number of particles of the dry chemical into a lump. With packing, we are referring to the interaction of the dry chemical suppressing agent with a mechanical motion, usually vertical, when the dry chemical is stored in a vertical or upright container, as is the case most often in an extinguisher. In this case, a segregation of the particle sizes may occur. The degree of segregation depends upon the difference in particle sizes that are present in the chemical. The larger the difference in particle size in the chemical, the more severe will be the packing. Therefore, packing is something that is dependent upon particle size distribution, but is not dependent upon the presence or absence of moisture or elevated temperature.

Extinguisher Function

Having defined and discussed these two terms, we are able to explain what these two phenomena mean in terms of the use of a dry chemical fire suppressing agent in a typical extinguisher, of which there are two basic types. With the cartridge type, the dry chemical is stored in a pressure vessel in an upright or vertical cylinder configuration which is unpressurized. The expellant gas, usually carbon dioxide or nitrogen, is stored in a separate pressure vessel. When the extinguisher is actuated, the gas flows through an appropriate gas distribution system into the pressure vessel containing the dry chemical. The dry chemical is fluidized and flows through an outlet into the hose.

With the stored pressure type of extinguisher, the dry chemical is placed in an upright or vertical cylinder, which is pressurized after the dry chemical has been filled, with the mixture being maintained in a pressurized state until the device is to be used. Upon actuation the valve, which is located at the top of the pick-up tube, is opened and the dry chemical flows through the pick-up tube, up through the valve, and out to the nozzle.

Common Misconceptions

These are some common misconceptions with regard to these two types of extinguishers. It is always assumed that the dry chemical contained in the cartridge unit will pack when subjected to vertical motion, and this is true. This is because the dry chemical contains particles of different sizes and the smaller particles, as was previously pointed out, will migrate to the bottom of the cylinder and the larger particles will migrate to the top. However, the gas distribution system and the amount of gas necessary to overcome packing of a dry chemical having a particular size distribution are taken into consideration during the design of the extinguisher. Accordingly, it is extremely unlikely that the dry chemical in a properly designed cartridge unit can become so packed that the gas distribution system cannot overcome the packing resulting in an incomplete discharge of the dry chemical. This is providing, of course, that the dry chemical used is not contaminated by moisture.

Another misconception is that, with stored pressure units, because the dry chemical is pressurized with gas it cannot become packed. This is not true. Packing is a phenomenon, as we have pointed out, that occurs whenever you have a solid having different particle sizes in a vertical or upright cylinder that is subjected to vertical motion. In the case of a stored pressure unit, if one could section this while the unit was pressurized, one would see the following: at the top of the unit a very dilute gas solid mixture in which gas is the predominant species. In the middle of the unit, a less dilute gas solid mixture in which the solid is the more predominant species. At the bottom, a very dense gas solid mixture is present in which the solid is the predominant species. This solid could then, upon vertical motion, undergo segregation of the particle sizes resulting in the packing of the unit. So, it is entirely possible to have packing occur in a stored pressure extinguisher.

Causes of Caking

The situation with regard to caking is different. As discussed above, caking is a chemical reaction between moisture and the dry chemical. In the case of the cartridge unit, the seals in the unit must be moisture tight. In the case of a stored pressure unit, the major concern is the dryness of the gas in which the unit is pressurized. In most cases, the units are pressurized with the air or nitrogen and, unless the air or nitrogen is of a dry grade, problems can result due to a reaction between the moisture contained in the pressurizing gas and the dry chemical present in the extinguisher. The degree to which this reaction occurs and, therefore, the extent to which the gas contains moisture, will determine the severity of the problems that may arise during the operation of the unit. With both types of extinguishers, of course, it is essential that the dry chemical itself not be contaminated with moisture.

Summary

- Caking and packing are two totally different and completely independent conditions.
- Caking can occur only when moisture is present.
- Caking will not occur if quality hardware and agent are used, and proper recharge and maintenance procedures are followed, preventing moisture contact with agent.
- Packing can occur in both cartridge-operated and stored pressure type extinguishers, both portable and systems, when they are subjected to vibration.
- High quality extinguishers, of both cartridge-operated and stored pressure types, are designed to overcome packed dry chemical conditions.
- The best assurance against extinguisher failure due to either condition is to use quality equipment and to follow the manufacturer's recharge and maintenance instructions closely.