FIRE SAFETY OF HANDHELD PLASTIC CONTAINERS

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I. Assessing the Fire Safety of Reusable Plastic Containers

Reusable plastic containers, or ***RPC's***, typically made of polypropylene (PP)[1], are the subject of this article, more specifically, the many RPC's that are increasingly replacing corrugated cardboard containers in the storage and distribution of foodstuffs in warehouses and stores.

A. Background

In early 2007, on behalf of a major foodservice retail organization, the ***Reusable Pallet and Container Coalition*** and its member companies engaged the consulting group CE Tech, LLC[2] to perform a detailed, independent assessment of any possible fire safety consequences that could result from the complete replacement of corrugated cardboard containers with handheld reusable plastic containers (RPC's) in the retailer's large, automated distribution centers. As it does for all such studies, CE Tech employed the widely recognized resources of the Department of Fire Technology at San Antonio's Southwest Research Institute (SwRI).

B. Objective and Summary Result

The present objective was to accurately assess the flammability characteristics of the reusable plastic containers loaded with the desired commodities and to ascertain whether they fell within the present fire safety capabilities of the client retailer's fire suppression systems, or whether added protection would be necessary. As will be seen in this article, ***the loaded plastic containers did exhibit a highly constrained burn behavior that was well within the client company's existing fire suppression systems.*** The following discussion describes how this was accomplished.

II. Measuring Potential Fire Risks against the Adequacy of Existing Fire Safety Systems

Over the last half-century, as commercial and retail food product distribution has grown in size and complexity, and distribution centers (DC's) have become larger, automated, and increasingly fire-safe, an important fire safety design consideration has been the proper match between the assessed burn characteristics of the stored commodities in any warehouse, store or DC and the capabilities of the fire-suppressing sprinkler system.

A. Factory Mutual (FM Global) 4995 Commodity Fire Classification Ratings

About fifteen years ago, in order to facilitate and quantify such fire safety assessments, the research arm of Factory Mutual Underwriters, FM Global Research, developed and published a set of fire safety classifications for a series of standardized palletized commodities[3]. With these classifications[4], FM Global Research also provided a detailed burn test procedure, designated FM4995, to assess the burning characteristics of a contained commodity desired to be stored in a given container against the standard classifications. The measured FM4995 Commodity Classification ratings so obtained can then either be compared to the FM classification rating of an existing fire suppression system, or the ratings can be used in new system designs.

Basically, non-combustible meat and produce in the typical handheld corrugated cartons used to date in wholesale food storage and distribution most likely fall into FM4995 Class II: "Class I (non-combustible) products in wood or multiple thickness corrugated cartons or

equivalent", and that indeed is where many large modern DC sprinkler systems are targeted, for example, in cold storage areas where instant-response sprinklers cannot be used because their constant water charge would freeze up. Given the Class II rating for the conventional fire suppression systems in place in the client retailer's DC's, the present test effort was directed at determining whether representative produce and case-ready meats would exhibit Class II burn behavior or better when stored in plastic RPC's instead of in corrugated cartons.

B. The FM 4995 Classification Test Procedure

The test comprises a specified apparatus and procedure for the burning of a standard array of test packaged commodities under controlled, standard conditions in a rack simulating commercial storage conditions. The system includes a standardized sprinkler system of specified response time and adjustable water flow rate. Three tests are run, each at a different standard water flow rate. The array is ignited in a specified fashion, and the rate of heat radiation in all directions (total heat) is measured as the well as the rate of hot air conveyed upward towards the sprinkler nozzles (convective heat). At the prescribed heat release rate, the sprinkler nozzles come on and begin to suppress the test fire. The suppression system is designed not to quench the fire outright but to allow it to burn out gradually while measurements go on until the required heat and energy generation values have been collected for each water flow rate. Each value is compared to the permissible ranges for that value at a given water flow rate and a unit rating assigned. The unit ratings are totaled for each water flow rate, and the average of these three totals gives the overall Commodity Classification rating. One can see how it quantitatively ties to sprinkler capability.

III. Results of the Reusable Plastic Container (RPC) FM Global 4995 Testing

Using the standardized FM4995 apparatus installed at SwRI, we tested industry-standard RPC's loaded with lemons and tomatoes on the produce side, as well as case ready meat grinds. The high combustible fat content of the meat grinds, the high known citrus oil content in the lemons, and the plastic clamshell-packed, high water content tomatoes were chosen to span the most representative range of combustibility risk.

In addition to producing the mildest set of burns ever seen for such arrays in the observers' collective experience, the results were very revealing in a number of respects:

- The ability of any significant fire to build appeared to be restrained by the high volume of the food commodities with their high water content, regardless of fat content, compared to the relatively small volume of thin, typically perforated polypropylene plastic container walls and bottoms.
- In some tests, numerous small "satellite" fires erupted but failed to unite into the cohesive full-scale burn that one normally sees in a typical FM4995 test. In one such test, even thin polyethylene stretch wrap around one of the sidewalls of an array failed to ignite.
- ***As a result of the failure of a significant fire to get going, in half of the tests the water system failed to actuate at all.*** While this in itself suggests an extremely low level of fire hazard, strictly speaking a true numerical FM4995 rating cannot even be obtained because the corresponding water flow rate tables cannot be consulted to assign a unit rating to the measured heat and energy values. When this happened, the lowest water flow table was used as an expedient to assign an estimated unit rating.
- In the case of the ***tomato*** containers, the walls were particularly thin and lacey, contributing very little combustible plastic to the overall water-laden tomato array. Burns were so weak and sporadic that water did not actuate either at the low or intermediate flow rate settings, giving unit ratings as estimated above under 1.00 for both. ***This system appears to be below measurable FM4995 limits.***

- For the ***lemons***, using estimated unit values where water failed to actuate and actual re-ference tables where it did, the ***overall Commodity Classification was measured at 1.60 or Class II.***
- For the ***case–ready meats***, again using estimated unit values where water failed to actuate and actual reference tables where it did, ***the overall Commodity Classification was measured at 1.46 or Class I.***

IV. Conclusion

These results are quite striking and they confirm that when these commodities and their equi-valents are stored in standard reusable plastic containers in the typical arrays used in warehouses, stores and DC's equipped with fire suppression systems rated for Class II commodities, the RPC-stored commodities will be well within the capabilities of the installed system and there will be no measurable risk entailed as compared with the same products stored in corrugated containers.

Please do not hesitate to contact us for any additional information.

Notes:

1) P***olypropylene*** (PP) is among the highest-volume commodity plastics today. It is widely seen in disposable and durable consumer products and appliances and also in a very large number of durable commercial goods. Included in the durable goods category are many types of material handling containers, ranging from mechanically handled crates holding 60 cu.ft. or more, down to the handheld RPC's discussed here, a cubic foot or so in volume and reused many times because of their durability and cleanability.
2) CE Tech is an independent consulting group specializing in plastics technology and manufacture, cost improvement, new product development, competitive analysis, failure analysis, and product risk assessment. The latter includes fire safety and testing for both commercial and legal clientele.
3) "Approval Standard for Commodity Classification of Idle Plastic Pallets; Class No. 4955" FMRC; (May, 1992)
4) A brief summary of the FM4995 Commodity Classifications, in order of decreasing safety:
   - Class I: Noncombustible products on wood pallets, in plain corrugated cartons or unpacked.
   - Class II: Class I products in wood or multiple thickness corrugated cartons or equivalent.
   - Class III: Packaged or unpackaged wood, paper, cloth, etc. products on wood pallets.
   - Class IV: Class I, II or III products containing no more than 15% by wt. (solid) or 25% by volume (foamed) plastic in ordinary corrugated cartons on wood plastic pallets.

   There are several additional classes of higher burn characteristics, but the above are the four main categories around which most common sprinkler systems are designed.