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Pillow Burning Rates*

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SUMMARY

Burning rates have been determined for four common pillow types and one of newer design, intended to be especially fire resistive. One replicate test was run and showed satisfactory reproducibility. The order of performance, best to worst, was: fiberfill (protected with fiberglass cover); feathers; fiberfill (ordinary construction); polyurethane foam; latex foam.

Key words: beds, burning rate, heat release rate, pillows.

INTRODUCTION

In full-scale room fires on mattresses, tested with bedding, it was noted that with the best-performing mattresses the polyurethane foam pillow, used as part of the bedding, was the dominant fire vector [1]. While it can be expected that pillow performance would follow the same trends as similar fabric/filling combinations in mattresses or upholstered furniture, nonetheless, quantitative heat release data have been lacking. Furthermore, some pillow materials, such as feathers, are not commonly used in other furnishings. Thus, it became desirable to measure the burning behavior of a range of common pillow types.

TESTS PROCEDURE

Quantitative rate of heat release testing could be readily done with the recent availability of the furniture calorimeter [2], an apparatus where oxygen consumption measurements are used to determine the rate of

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heat release. For testing, all pillows were covered with standard percale pillowcases, 0.50 m × 0.66 m. Pillowcase fiber content was 65% polyester/35% cotton, with each pillowcase weighing 0.112 kg. Prior to the start of the test series some preliminary experiments were made on ignition. Pillowcases could be readily ignited with a match or with a torch. When ignited at one top corner, near the open flap, flame spread progressed very slowly and only a strip about 40 mm × 150 mm was burned prior to the fire going out — it appeared difficult, if not impossible, to ignite the pillow itself that way. At this point a larger ignition source was tried. Six full-size newspaper sheets were balled up and placed in a row just inside the open flap of the pillowcase and ignited with a match. This arrangement led to a successful pillow ignition in all cases.

Figure 1 shows the polyurethane foam pillow at about the halfway point of its burning. Table 1 lists the measurement results; the rate of heat release curves are shown in Fig. 2. The worst performance was seen with the latex foam pillow, with a peak heat release rate of 117 kW. Shredded polyurethane foam pillows

Fig. 1. Shredded polyurethane foam pillow near peak heat release rate at about the halfway point of its burning.

TABLE 1

Pillow fire results

Filling material	Case material	Pillow mass (kg)	Total[a] mass (kg)	Peak heat release rate (kW)	Total heat released (MJ)	Average heat of combustion (MJ/kg)		Unburnt mass at end of test (kg)	
Latex foam (single piece)	50% polyester/ 50% cotton	1.003	1.238	117	27.5	27.6		0.2	
Polyurethane foam, shredded, #1	non-woven	0.650	0.885	43	18.4	22.0		0.00	
Polyurethane foam, shredded, #2	non-woven	0.628	0.863	35	18.9	23.7		0.0	
Fiberfill (polyester)	80% polyester/ 20% cotton	0.602	0.837	33	10.2	20.0		0.3	
Feathers	cotton	0.966	1.201	16[b]	8.9	18.3		0.8	
Fiberfill (polyester)	fiberglass	0.687	0.922	22	3.1	17.4		0.71	

[a]Includes pillowcase (65% polyester/35% cotton percale) weighing 0.112 kg, and newspaper (6 balled-up full sheets) weighing 0.123 kg.

[b]Reading low due to slow ignition; otherwise expect $\simeq 20$ kW peak.
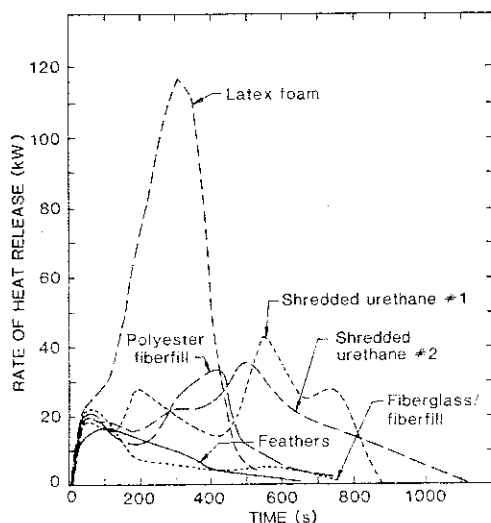

Fig. 2. Rate of heat release curves, measured in the furniture calorimeter.

showed peak rates of about 40 kW. The polyurethane pillows were essentially totally consumed, while the latex foam specimen, which was the heaviest one, was largely but not totally consumed. A conventional fiberfill pillow showed a peak of 33 kW but released only about half the total heat of the polyurethane ones, partly because a large fraction of the melted filling did not burn up. The feather pillow burned much more slowly and was only about half-consumed at the end of the fire. The fiberfill pillow with a protective fiberglass covering was essentially unburned — only the pillowcase burned off. From Fig. 2

it can be seen that all tests showed an initial peak of about 20 kW, due to the newspaper and pillowcase alone. In the case of the feather pillow, it appears that the ignition sequence was slightly delayed.

Finally, an observation first made in connection with mattress testing [1] bears repeating. It was found there that the assembly of bedding plus the best performing mattress resulted in slower burning than the bedding burning alone (using an organic-free fiberglass batt in place of a mattress). This suggests that simple addition of the rate of heat release curves for various bed items may often be misleading.

ACKNOWLEDGEMENTS

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