

An Investigation of the Flammability of Carpet Under Various Conditions

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Introduction

Under the broad realm of fire debris analysis, the effects of accelerants on flooring materials is a complex and yet understudied area. The results produced from such research is useful in the fire investigation field, as investigators can be educated on the potential trends and patterns related to the correlation between flooring substrate and accelerant. This can then be put to use when responding to suspected arson scenes and in predicting what type of accelerant was used. We conducted analyses to determine if varying burn conditions affects the flammability of carpet in terms of area burned and burn rate. The results give insight as to how carpet behaves under each condition and the corresponding trends.

Methodology

Liquid accelerants were poured onto pre-cut squares of carpet and fire was subsequently initiated. Each fire was allowed to reach combustion and self-extinguish. For each burn, one independent variable was changed with the intent of evaluating its effect, or lack thereof, on the dependent variables. High-speed and real-time video as well as photography was used to document each burn.

Controlled variables:

- Carpet (4"x4" squares)
- Accelerants – turpentine and lighter fluid
- Ignition source – gas grill lighter

Independent variables:

- Volume of accelerant (1mL & 2mL portions)
- Accelerant position on carpet (corner, middle, or dispersed continuously from corner to middle)
- Ignition position (corner or middle, depending on accelerant position)

Dependent variables:

- Percentage of carpet burned
- Burn rate of the carpet

Results and Conclusions

Once the burns were completed, the percentage of carpet burned and burn rate of the carpet was calculated for each combination of accelerant volume, position, and ignition site. Calculations were executed using the photographs of the burned carpet, image processing software ImageJ, and the frame per second (fps) speed of the recording cameras. Trends resulting from the data for each accelerant are shown below.

Percentage Carpet Burned			
Volume (mL)	Position/Ignition	Percent Burned – Turpentine (%)	Percent Burned – Lighter Fluid (%)
1	corner	34	11
1	middle	42	29
2	corner	45	39
2	middle	63	46
2	dispersed, corner ignition	72	59
2	dispersed, middle ignition	61	38

Carpet Burn Rate			
Volume (mL)	Position/Ignition	Burn Rate – Turpentine (cm ² /s)	Burn Rate – Lighter Fluid (cm ² /s)
1	corner	5	2
1	middle	6	4
2	corner	9	8
2	middle	11	9
2	dispersed, corner ignition	20	12
2	dispersed, middle ignition	6	8

Trends are apparent for both the percentage of carpet burned and the carpet burn rate and are present for each accelerant individually and when compared to each other. Factors that appeared to influence these trends include all the three of the independent variables: accelerant volume, accelerant position, and the ignition position. This confirms that the flammability of carpet is dependent in nature.

Trends:

- Turpentine resulted in a higher percentage burned and burn rate than did lighter fluid for the majority of the data in each set
- Percentage burned and burn rate were directly proportional to accelerant volume for localized accelerant position
- Middle placement/ignition resulted in a greater percentage burned and burn rate when accelerants were placed in only one position
- Corner ignition resulted in a greater percentage burned and burn rate when accelerants were dispersed



Fig. 1: 2mL Turpentine dispersed, corner ignition



Fig. 2: 2mL Turpentine dispersed, middle ignition

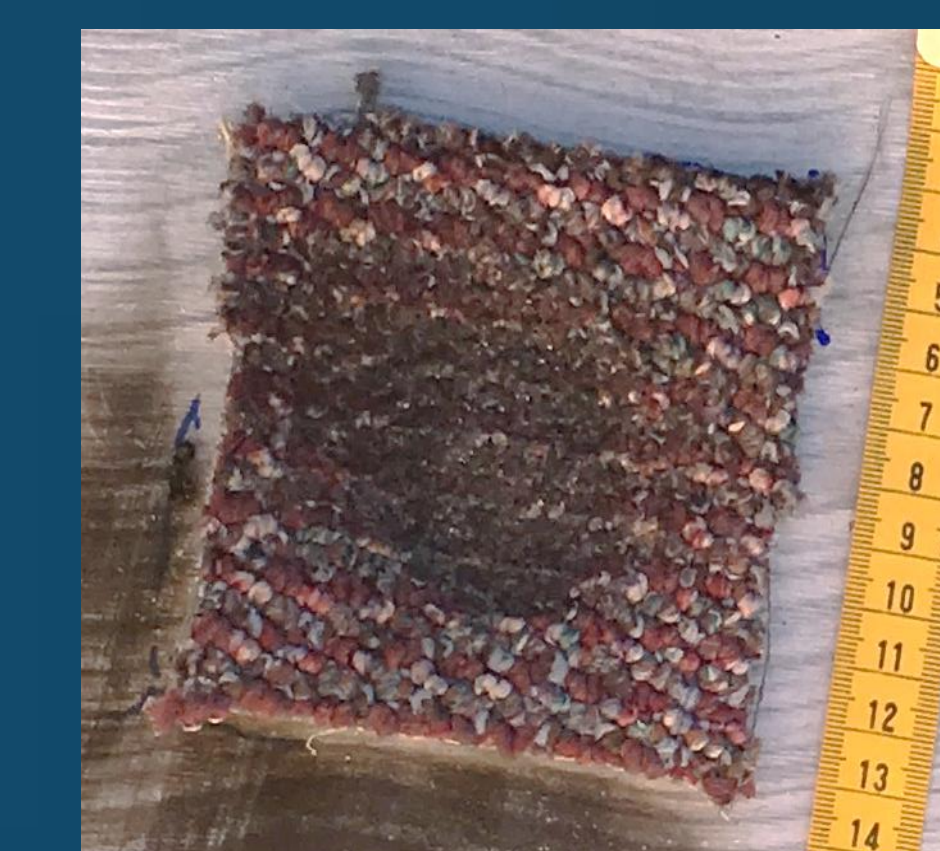
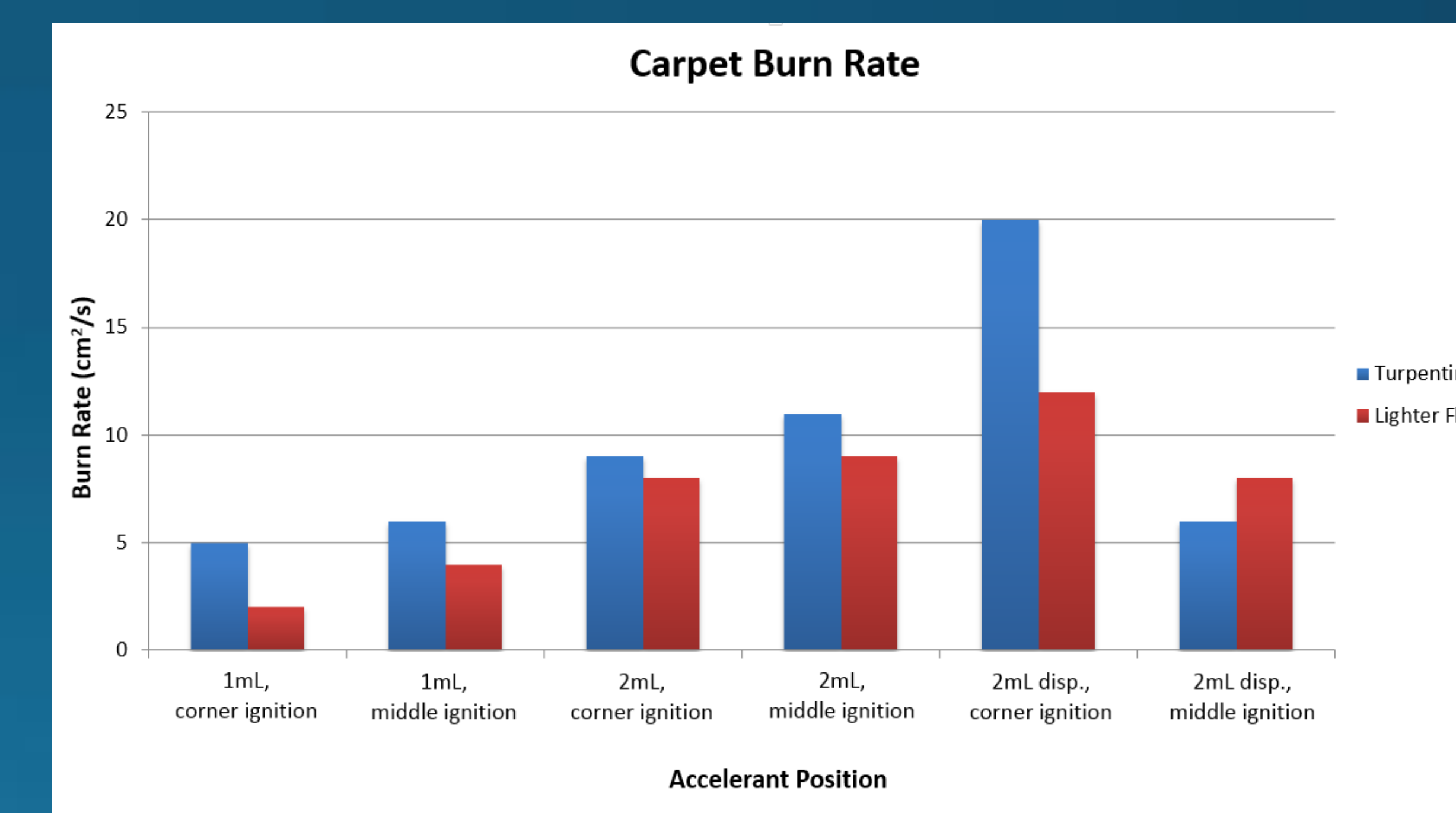
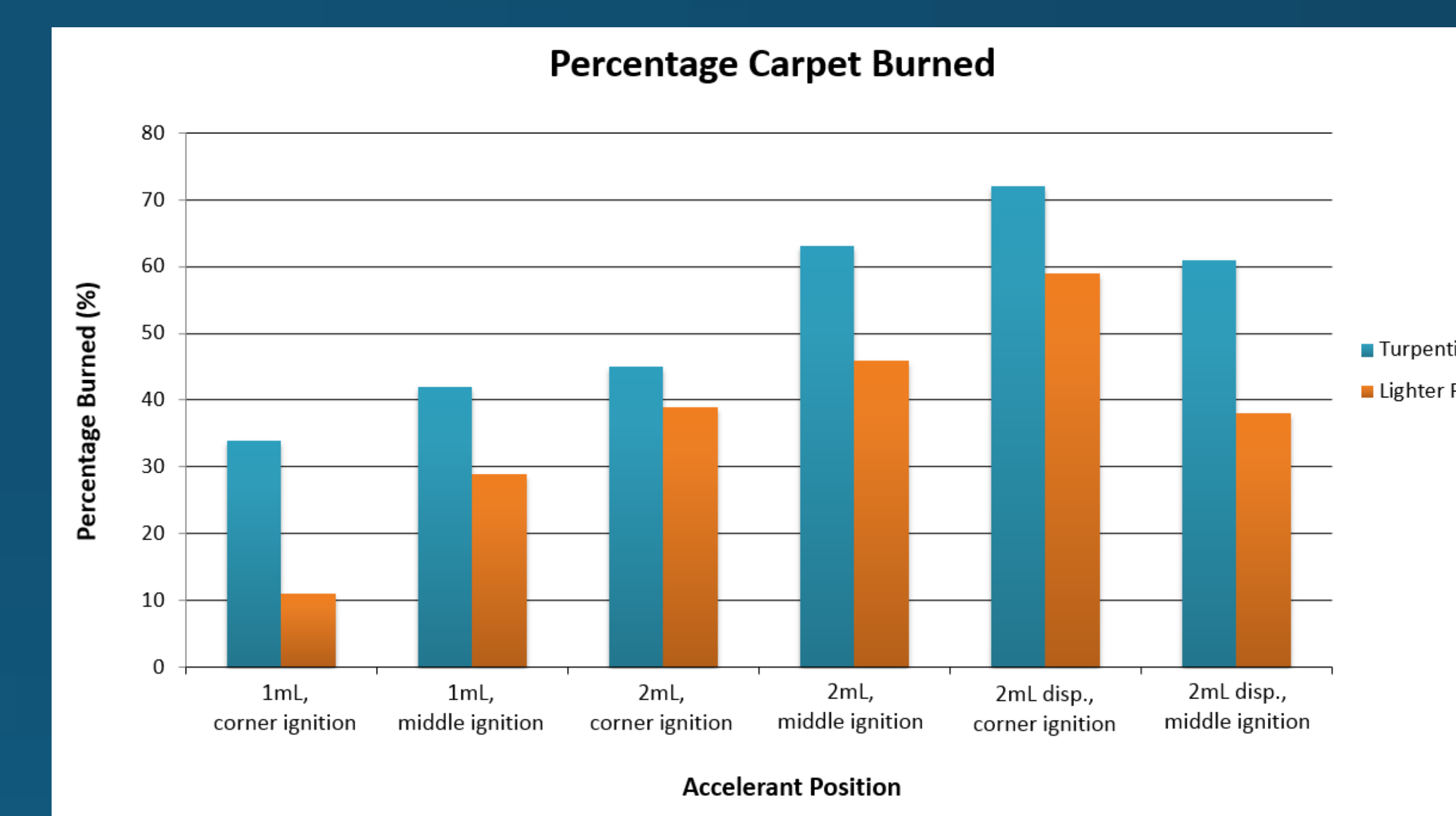


Fig. 3: 2mL Lighter Fluid, middle ignition



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