

Pyrotechnic Fuse Burn Rates

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Over the years, we have had occasion to work with a fairly large number of different fuse products. One of the more important characteristics of a pyrotechnic fuse is its burn rate, but often that is not specified by the supplier. Thus, when we have had a large enough supply of a type of fuse to make an accurate determination, we measured its burn rate. To do this, three pieces of fuse, 36 inches in length were prepared. Then, using a stopwatch, the time taken to burn each piece of fuse was measured, and the average determined. For future reference, these values were recorded, along with burn times (in seconds per inch) and burn rates (in inches per second). We had not given the matter much further thought, until, following a lecture on the "Identification of Pyrotechnic Devices," we received a number of requests for that information. Unfortunately, the data was scattered throughout several notebooks, and not in a form ready for distribution. In order to fulfill our promise for the data, we compiled the table following. With the thought that there might be others wishing the same data, this brief article was prepared.

Most pyrotechnic materials have a pressure dependent burn rate, and burn rates in the table were determined in Whitewater Colorado at about 4600 feet above sea level. Thus, it is likely that somewhat different values would have resulted had they been determined at another elevation. It is possible that this is the reason we observed burn

times for Ensign-Bickford's Orange Sword and Explo Industrias Quimicas Explosivos' safety fuse that were 22% and 14% (respectively) longer than specified for them.

Most fuse products experience end-effects when burned, wherein the first and last small portion of fuse burns at a different rate than that in between. Thus the length of fuse segment used makes a difference in the average burn rate measured. For example, the fireworks time fuse distributed by Fire Art, displayed a burn rate of 0.33 inch per second when burned in 36-inch lengths, and only 0.27 inch per second when burned in $\frac{3}{4}$ -inch lengths. The burn rates reported here were generally for 36-inch lengths. However, because of its high rate of burn, that for the fireworks quick match was determined using lengths ranging from 35 to 50-feet. Further, the burn rate for Chinese (firecracker) fuse was determined using many lengths of fuse, each only about 2-inches long. This was because that was the longest length available for measurement.

From time to time, whether intentional or not, manufacturing methods or fuse powder formulations can vary for a specific fuse product. Thus, even under identical conditions, it is not possible to be certain that all fuse of a specific type will exhibit the same burn rate as reported here. One example of this can be seen for the CXA slow Thermalite, where two values differing by 16% are reported.

Table of Pyrotechnic Fuse Burn Rates.

Description	36" Burn Time (sec.)	Burn Time (sec./in.)	Burn Rate (in./sec.)
Visco (Cannon) Fuse:			
American Safety Fuse (≡" Green)	102	2.8	0.36
American Visco Fuse (≡" Green)	92	2.6	0.39
Ensign-Bickford (≡" Red)	94	2.6	0.38
Dist. by Fire Art (1/8" Green)	84	2.3	0.43
Hobby Fuse:			
Dist. by Midwest Fwks. (≡" Pink & White Braid)	77	2.1	0.47
Fireworks Time Fuse:			
Japanese Time Fuse (Paper, 2-White & 2-Red Threads)	106	2.9	0.34
Dist. by Fire Art, China (Paper, 10-White Threads)	109	3.0	0.33
Dist. by Advanced Imp., China (Paper, 9-White & 1-Pink Threads)	72	2.0	0.50
Rozzi ≡", United States (White Gauze over Asphalt)	112	3.1	0.32
Ruggeri, France (Paint, White Crossed Threads)	84	2.3	0.43
Ruggeri, France (Black Plastic)	126	3.5	0.29
Blasting Safety Fuse:			
Ensign-Bickford (Orange Sword, Waxed Threads)	147	4.1	0.24
Explo Ind. Qui., Brazil (White Plastic)	146	4.1	0.25
Igniter Cord:			
CXA (Canadian Safety Fuse) Thermalite			
(Fast, White)	16	0.44	2.2
(Medium, Green)	30	0.83	1.2
(Slow, Red, Non-Std.)	54	1.5	0.67
(Slow, Red, Std. Prod.)	64	1.8	0.56
Imperial Chemical Ind., Scotland			
(Fast, Brown)	2.9	0.08	12.
(Slow, Green)	42	1.2	0.86
Explo Indus. Qui., Brazil (Silver)	45	1.2	0.80
Fireworks Match:			
Black Match (Average of Various Mfg.)	30	0.83	1.2
Quick Match (Average of Various Mfg.)	--	0.008	120
Chinese (Firecracker) Fuse:			
Average of Various Mfg.	--	1.9	0.53