Evaluation of Wildland Fire Chemicals

STANDARD TEST PROCEDURES

STP-6.2 Accelerated Stability

Summary

The 2020 revision of the long-term retardant specification[1] allowed for a new optional course of testing to reduce the time it takes to reach the operational field evaluation (OFE). This testing is used to simulate outdoor conditions on an accelerated timeline. This testing is controlled in an environmental chamber, and run for approximately 60 days for the cold cycle and another 60 days for the hot cycle. These cycles simulate the outdoor conditions that would be observed in Missoula, MT and San Dimas, CA.

Apparatus and Equipment

The test equipment needed are as follows:

- Programmable Environmental chamber with minimum temperature range of -20°C to +60°C. Our laboratory uses the TEST EQUITY 1000H model chamber.
- 1 Liter glass containers with screw top lids
- Suspension line for suspending steel coupons
- 4130 Steel stability coupons (1/8” thick x ½” wide x 3” long, with a 0.187” hole ½” from one end
- Test Product

Temperature Profiles

A cold temperature profile is used to simulate the conditions in Missoula, MT over the course of one calendar year. This profile is outlined in Table 1. A hot temperature profile is used to simulate the conditions in San Dimas CA. This accelerated test profile is outlined in Table 2. Each profile provides the environmental chamber set points (in °C), duration (in hours), and number of cycles. Each cycle is run sequentially starting at the top of each table, and cycling to through all set points.

These profiles were developed using ASTM F1980[2] and MIL-STD-810G[3] for guidance.

Table 1-Cold Temperature Profile, Accelerated

Cold Temperature Cycle, Missoula					
	A2 Basic Hot Climatic design (°C)	**Set Point (°C)**	**Duration**	**Cycles**	**Time**
High Temperature	43	48	1 hr, ea	182	15.2 Days
Low Temperature	30	25			
High Temperature	*Freeze Thaw*	20	12 hrs, ea	5	2.5 Days
Low Temperature	*Freeze Thaw*	-20			
Acceleration, ASTM 1980	**Average Temp (°C)**	**Set Point (°C)**	**Duration**	**Cycles**	**Time**
Jan	-3.6	35.6	48 hrs	1	24 Days
Feb	-1.1	38.1	48 hrs	1	
Mar	3.9	43.1	48 hrs	1	
Apr	7.5	46.8	48 hrs	1	
May	11.9	51.2	48 hrs	1	
Jun	16.1	55.4	48 hrs	1	
Jul	20.3	59.5	48 hrs	1	
Aug	19.7	59.0	48 hrs	1	
Sep	14.2	53.4	48 hrs	1	
Oct	7.2	46.5	48 hrs	1	
Nov	0.8	40.1	48 hrs	1	
Dec	-4.4	34.8	48 hrs	1	
Total Time (days)	41.7				

Table 2-Hot Temperature Profile, Accelerated

Hot Temperature Cycle, San Dimas					
	A1 Hot Climatic design (°C)	**Set Point (°C)**	**Duration**	**Cycles**	**Total Time**
High Temperature	49	54	1 hr, ea	182	15.2 Days
Low Temperature	32	27			
Acceleration, ASTM 1980	**Average Temp (°C)**	**Set Point (°C)**	**Duration**	**Cycles**	**Total Time**
Jan	13.1	47.3	68 hrs	1	34 Days
Feb	13.9	48.1	68 hrs	1	
Mar	15.0	49.3	68 hrs	1	
Apr	16.9	51.2	68 hrs	1	
May	19.2	53.4	68 hrs	1	
Jun	21.7	55.9	68 hrs	1	
Jul	24.4	58.7	68 hrs	1	
Aug	25.0	59.3	68 hrs	1	
Sep	23.6	57.9	68 hrs	1	
Oct	19.7	54.0	68 hrs	1	
Nov	15.8	50.1	68 hrs	1	
Dec	12.8	47.0	68 hrs	1	
Total Time (days)	49.2				

Procedure

Products are tested based on the specification.

1. The 1-Liter container is filled with either the product concentrate or mixed product.
    a. If it is a powder or solid concentrate, the sample is tightly capped.
    b. If the product is a liquid, a steel coupon is suspended into the solution using the suspension line and fiber tape. Then the container is tightly capped.
2. All testing is prepared and performed in triplicate.
3. A 4th container is filled and set aside as a laboratory control for the duration of the experiment.
4. The testing samples are then placed in the environmental chamber for the duration of either the hot or cold cycle.
5. At the end of the cycle, the steel coupons are removed and the product is stirred to reincorporate any settling. The sample is then run through a 0.25” sieve and noted if particulates had formed over the course of testing.
6. Then the sample is then evaluated to its physical characteristics (density, refractometer, pH, and viscosity). These results are compared to the original data collected before the test began (i.e. LF-3.1.3, or other documentation).
7. The control sample is also evaluated after having been stored under a cabinet at laboratory conditions.

8. This testing is performed separately for the hot and cold cycles.

Results

The results of this testing are compared to the qualification criteria of the base specification. If products meet all qualification criteria, they may be considered for an interim qualification before the full 1-year stability testing has been completed.

> NOTE 1: If a product fails the outdoor testing later in the product test life cycle, the interim qualification status will be removed from the QPL. Also, if a product initially fails this testing but still passes the outdoor testing, it will be considered viable for use.

Validation

This testing was designed using references 2 and 3 to reduce the testing to under 60 days for each cycle. This testing has been shown to be more robust and harder (more extreme temperatures) on the developmental products than standard outdoor conditions. For this reason, products may fail this testing but still pass the outdoor storage test. Wildland Fire Chemicals evaluated several different historical products during this validation, most of which performed similarly to their 1-year outdoor results.

> NOTE 2: All accelerated testing must be validated by outdoor stability results, and this is noted in both reference standards. These temperature profiles may be adjusted as this method is developed and optimized to better represent real time results.

References

[1] FS 5100-304d – US Department of Agriculture Specification for Long-Term Retardant, Wildland Firefighting

[2] ASTM F1980 – Standard Guide for Accelerated Aging of Sterile Barrier Systems for Medical Devices

[3] MIL-STD-810G – Department of Defense Test Method Standard, Environmental Engineering Considerations and Laboratory Testing.