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PRELIMINARY EVALUATION OF TX-350 -- A NEW LONG-TERM FIRE RETARDANT

by

J. E. Grigel

FOREST RESEARCH LABORATORY
EDMONTON, ALBERTA
INTERNAL REPORT A-20

FORESTRY BRANCH
DEPARTMENT OF FISHERIES AND FORESTRY
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J. E. Grigel[1]

INTRODUCTION

The use of long-term fire retardants is an established practice in aerial fire suppression operations in the western United States and British Columbia. In the United States Forest Service Northern Region, 2,435,000 gallons of long-term retardants were applied during 1967 (Hardy, 1967). The effectiveness of these materials in retarding and/or extinguishing wildfires in this region will undoubtedly lead to their introduction and widespread use in other areas.

During the fall of 1968 a number of tests were conducted, in co-operation with the Alberta Forest Service, to obtain a preliminary evaluation of a new long-term fire retardant, TX-350. Although circumstances of the tests precluded investigations in depth the observations made on mixing, handling, storage, fire retardant and air drop characteristics are interesting enough to bring them to the attention of potential users at this time.

METHODS AND RESULTS

Physical Properties of TX-350

TX-350 is a clear powder which hydrates rapidly when mixed with

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water. In appearance, the mixture is similar to an industrial gum solution. The various salts present in water have no effect on the characteristics of TX-350 Solution. The solution cannot be overmixed to the point where viscosity is lost, i.e. it is not thixotropic. The composition can be adjusted to permit the mixture to reach a desired viscosity (Anon. 1968).

The retardant mixture is both non-toxic and non-corrosive. It is subject to spoilage but can be made more stable and given a longer life with various preservatives (Anon. 1968). The TX-350 composition tested contained 0.25% Paraformaldehyde to prevent spoilage. Pink dye is added to improve its visibility.

Data presented on the effects of time and water temperature on viscosity[1] (Figures 1 and 2) and shear stress/rate of shear (Figure 3) were provided by the manufacturer. For the composition tested, sixty per cent of the maximum viscosity is attained twenty minutes after mixing, when the rate of application is 15 pounds per 100 gallons of water. Water temperature at the time of application has an effect on solution viscosity.

Comparison of the flow curve (shear stress/shear rate), shown in Figure 3, with that of different types of fluids indicates that the composition may contain dissolved high polymers (Anon. 1967).

The retardant mixture is very slippery and can create serious hazards both at the airtanker base and in the field if precautions are not taken.

Mixing Tests

A series of laboratory tests was carried out to determine the

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[1] Viscosity is the thickness of a solution or suspension. A measure of the relative ability of a fluid to resist flow. Viscosity is usually measured in centipoise units.

FIGURE 1.

VISCOSITY DEVELOPMENT OF TX—350 SOLUTION AS A FUNCTION OF TIME

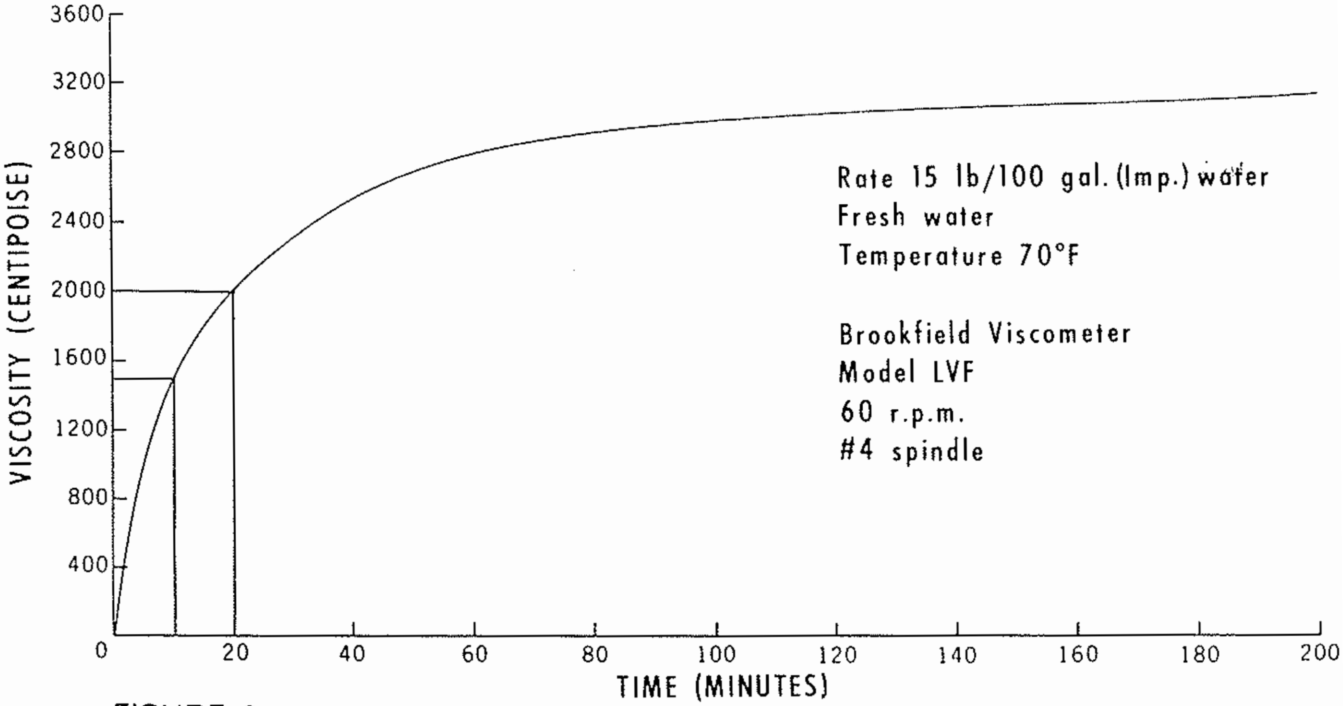


FIGURE 2.

EFFECT OF MAKE-UP WATER TEMPERATURE ON THE VISCOSITY OF TX—350 SOLUTIONS

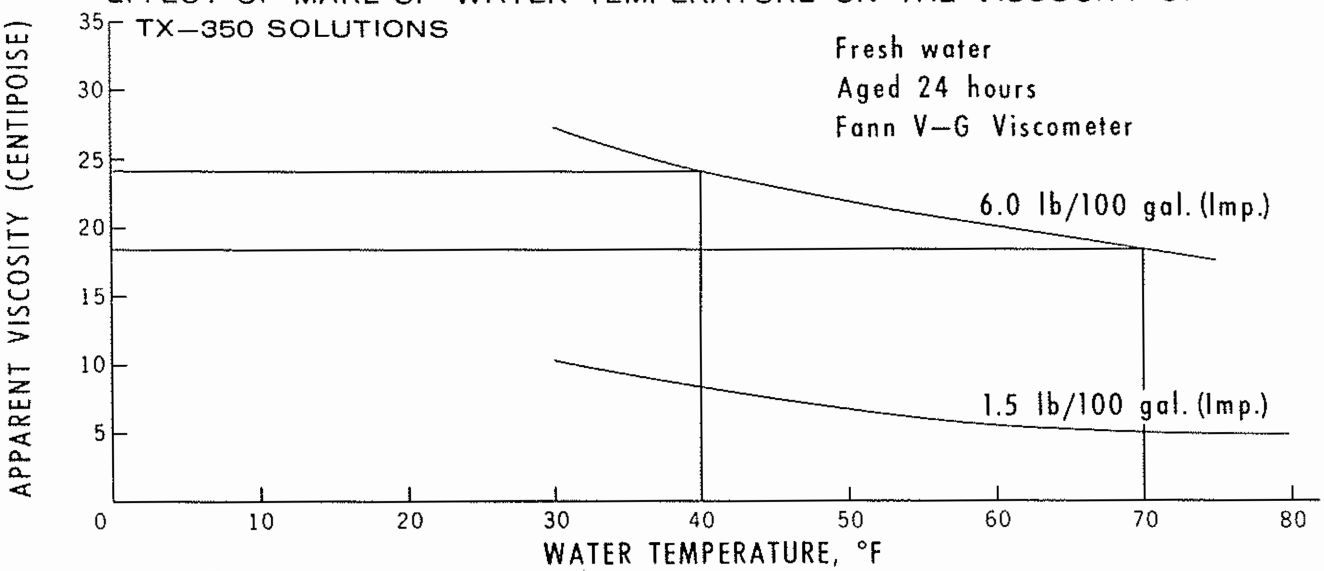
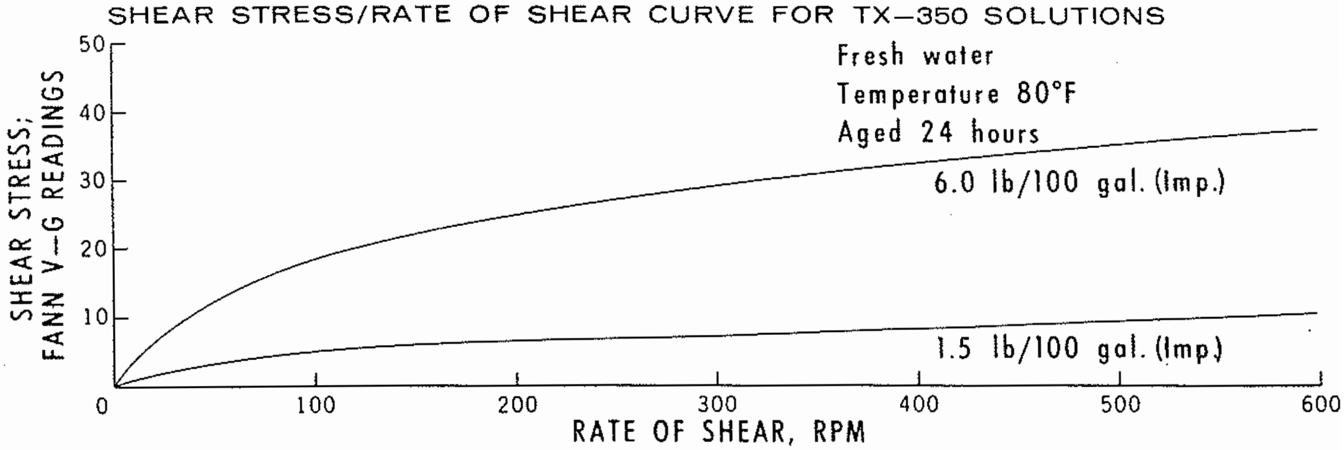


FIGURE 3.

SHEAR STRESS/RATE OF SHEAR CURVE FOR TX—350 SOLUTIONS



Data provided by Oil Center Research, 211 Rayburn Street, Lafayette, Louisiana.

rate of application of retardant necessary to obtain TX-350 mixtures suitable for air drops. One-liter mixtures were prepared by adding powder at rates equivalent to 5, 10, 15 and 20 lbs/100 gal to the water, stirring, then shaking vigorously. The mixtures were allowed to stand for 20 minutes. A mixture considered suitable for aerial application was 15 lb/100 gal water.

Field tests using a mechanical batch mixer equipped with a blade agitator were carried out to determine if the small laboratory application rate could be applied to larger volumes. Four 500-gallon batches of mixture were prepared, 16 lb powder/100 gal water. Available water was at 53^{o} F.

Viscosities varied, and ranged from 850 centipoise units (cps) to 2240 cps[2]. The variation was related to our inability to control the speed of the agitator and the formation of hydrated balls of powder resulting from bulk application.

Stored samples of the mixture lost much of their viscosity within four days.

Fire Retardant Effectiveness

Limited ignition tests were conducted to determine the fire retardant properties. Fire retardant properties of TX-350 are related to a coat on the fuel which with the application of heat forms a glaze to exclude oxygen and prevent the escape of volatile products of pyrolysis. One-quarter-inch dowels were dipped into a TX-350 mixture having a viscosity of 1550 cps and exposed to a propane flame. The coating absorbed

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[2] Brookfield Viscometer Model LVF, No. 4 spindle, 60 rpm.

great amounts of heat before drying and no ignition occurred while the mixture remained wet. Once the solution dried, however, the treated dowels ignited and readily burned. Several dowels were allowed to dry following immersion into the retardant. These dowels burned quite easily when subjected to the flame.

In a comparison of the fire retardant effectiveness of TX-350 with that of two retardants containing diammonium phosphate and ammonium sulphate salts[3], the latter were more effective both in preventing ignition and in delaying combustion upon ignition of the dowels. Their greater effectiveness was especially noticeable when the dried dowels were exposed to the flame.

Air Drop Characteristics

A series of air drops was made with TX-350 mixtures and the Thrush Commander airtanker. That aircraft has a tank capacity of 330 imperial gallons. Three air drops (I, II, and III) were made from 80-85 feet onto an open area and one (IV) from 60 feet above the canopy onto a stand of mature fully-stocked lodgepole pine 65 feet in height. Drop speed was 100 mph. Grid sampling systems were established on the areas to calibrate the drops. Air temperatures during the tests varied between 44.5^{o} to 61^{o}F, relative humidities between 44% to 67%. There was no wind. Viscosity of the TX-350 mixtures were 1140, 1900, 2240 and 850 cps respectively. There were no great differences in the ground distribution patterns for the open-area drops. Material in Drop I dispersed more than in Drop II, resulting in greater areas and lengths in the lower contour

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[3] Diammonium phosphate and ammonium sulphate are used as flameproofing chemicals.

levels[4]; this trend was reversed in the higher levels. Contour level areas and lengths were smaller for Drop IV because of the interception of material by tree crowns. Only fifty per cent of the mixture reached the ground in Drop IV, indicating good retention by crowns of the lodgepole pines. A considerable amount of the solution retained in the crowns ran down the branches and stems of the trees or dripped from the tree crowns for 15 minutes.

DISCUSSION AND CONCLUSIONS

With land-based operations, adequate mixing, which greatly affects viscosity of the mixture, is a problem that can be eliminated by use of a 50- to 75-pound capacity hopper having a controlled rate of "feed-out" mounted directly onto the water-intake pipe of the mixing tank. A tank of near 500 gallons would be sufficient. The hydrated balls which form with inadequate mixing of TX-350 would be eliminated by use of such an apparatus. Optimum viscosity would be obtained following transfer to storage facilities. If the retardant is required immediately after mixing, and before the solution is sufficiently hydrated (refer to Figure 1), additional amounts of material could be added to bring the mixture to the desired viscosity, i.e. near 1500 cps. Loss in viscosity during storage is a critical factor.

TX-350, as presently compounded, is not suitable for water-based operations because of the length of time required for the solution to reach the desired viscosity, and the quantity of material required. Loading time for the PBY Canso water-bomber, which fills its 800-gallon-

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4 Contour levels represent depth of retardant in inches.

capacity tanks while skimming the water surface and at the same time injects powder with a nitrogen injection system, is approximately 15 seconds. Although the agitation occurring during the water-pickup is intense, it is probably of inadequate duration to permit the retardant particles to become completely dispersed and hydrated. The solution would then have to thicken without further agitation. On the water-based operations, the water source is usually located near the wildfire, which makes the time between successive drops relatively short. Therefore, a form of quick setting TX-350 which gives the desired viscosity in 10 minutes or less would be necessary.

A maximum of 7 pounds of TX-350 or less per 100 gallons of water should be set to reduce the weight problem. The PBY Canso water-bomber can carry a maximum of 300 pounds of retardant material in its two storage cylinders. At an application rate of 7 lbs/100 gal water, the aircraft can make five drops with TX-350 retardant mixture. The potential use of this "quick-setting" composition would increase with a decrease in the quantity of powder required per load.

Loss in viscosity with time is not a critical factor with water-based operations, but the material should contain sufficient amounts of preservative to ensure that the original viscosity does not decrease before the solution dries on the fuels.

The addition of a dye to the TX-350 powder during the manufacturing process is considered essential for water-based operations. Applications of a dye into the aircraft's water tanks prior to loading produces a foaming action which, in the case of the PBY Canso waterbomber, prevents the co-pilot from determining when the tanks are full and results in loss of retardant solution through the overflows. On the other hand, the dye does not readily disperse if added after the solution has been prepared.

Although the potential use of the retardant material has been directed towards aerial applications, the possibility of utilizing the TX-350 during ground suppression operations appears good. Results of the preliminary evaluation of TX-350 composition, along with recommendations for improvement of the product for use as a fire retardant, have been forwarded to the manufacturer.

In the aerial test drop on a forest canopy (Drop IV), it appeared that while the needles were coated with a retardant film, the addition of a "sticking-agent" would improve retention. It is suspected the retardant coating on aerial fuels is too thin, at present, to absorb any great amount of heat and be effective in preventing crown fires.

Visibility of the drop area from the air was poor despite presence in the mixture of a pink dye. An increased concentration of dye, or substitution of another, might remedy that problem.

While preliminary tests on TX-350 have given promising results, more information is necessary. In particular, more data on its effectiveness as a fire retardant, schedules of drying rates following application, behavior of mixtures in storage and techniques for improvement, and methods of mixing are needed.

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Hardy, C. E. 1967. The fire retardant development plateau in western fire forest fire conditions, 1967. (Paper presented at Western Forestry and Conservation Association Annual Meeting, Seattle, Washington, December 5, 1967).