FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT NO. 6 OF 1950.

INVESTIGATION OF THE POSSIBLE FORMATION OF EXPLOSIVE MIXTURES DURING THE IMPREGNATION OF TIMBER.

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The introduction of oil mixtures for impregnating timber in which penta-chloro-phenol is the active medium and kerosene the major vehicle component, caused some apprehension that explosive mixtures might be formed in the impregnating vessels.

This problem was submitted to the Fuel Research Institute by the Forest Products Institute and, in order to be able to give a positive answer, the following investigation was undertaken.

SAMPLES:

Most of the work was done on three samples submitted viz.:

1. T.R.I. - P.C.P. Solution (P.C.P. 50 lbs. (5%)), dehydrated castor oil 7 gal.(7%), Power Paraffin 88 gal. (88%).

2. P.C.P., Fuel Oil, A.W.P.A. Creosote [P.C.P. 2½%, Fuel Oil 35%, Sovaloid W (15%), Creosote (50%)]

3. A.W.P.A. creosote.

The samples were dried by shaking them with anhydrous calcium chloride and filtering or, as in the case of samples 2 and 3, effecting separation of the calcium chloride by centrifuging.

GENERAL ANALYSIS:

The results of distillation tests are given in Table 1.

TABLE 1/.....2.

TABLE 1.

Sample No.:	1	2	3
Atmospheric Pressure (ins. Hg)	25.75	25.77	25.77
Temperature after 2 mins. (°C)	16.0	15.2	20.0
Initial Boiling Point (°C)	147	210	184.5.
Temperature (°C) at 10% Distillate	155	230	205
at 20% distillate	159	347	225
" 30% "	162	267	248
" 40% "	165	292	272
" 50% "	170	(x)	298
" 60% "	175		327
" 70% "	183		(x)
" 80% "	196		
" 90% "	223		
Final Boiling Point	243		
(x) Distillation discontinued.			

The flash points of these samples are given in Table 2.

TABLE 2.

Flash Points (Pensky-Martens).

Sample No.	1		2		3	
	°F	°C	°F	°C	°F	°C
Closed Cup	110	43.3	214	101.1	198	92.2
Open Cup	120	48.9	224	106.7	220	104.4

The vapour pressure data shown in Table 3 have been determined for these oil samples. These figures are sufficiently accurate for the present purpose.

TABLE 3.

VAPOUR PRESSURES OF IMPREGNATING MIXTURES.

Sample 1.		Sample 2.		Sample 3.	
Temp. (°C)	Vap.Pres. (m.m. Hg)	Temp. (°C)	Vap.Pres. (m.m. Hg.)	Temp. (°C)	Vap.Pres. (m.m. Hg.)
16.1	8.0	51.5	2.0	46.0	14.0
26.0	15.7	61.1	3.6	58.3	21.7
37.0	25.8	72.2	7.2	67.1	35.0
51.0	48.4	81.1	11.0	77.0	46.1
65.1	69.5	93.0	22.5	89.8	73

In view/.....3.

In view of the relatively low vapour pressures of these oils in the region of the temperatures where they are normally used in practice, it seemed doubtful that the upper explosive limit would ever be reached and therefore the lower explosive limit was considered to be of greater importance.

EXPLOSIVE LIMITS:

The explosive limits of the oil were determined in a cylindrical vessel with upward propagation of the flame. A sample of oil was placed in this vessel which was then immersed in a thermostatically controlled water bath. The temperature was increased stepwise until an explosion could be initiated.

In the case of the kerosene both the upper and lower explosive limits could be determined. With the A.W.P.A. Creosote, only the lower limit could be determined, while with the sample 2, the lower limit could not be reached at the highest temperature attainable in the water bath.

In Table 4 the values obtained are compared with the flash points (closed cup) of these oil samples.

TABLE 4.

Temperature at which Explosive Limits are reached and Flash Points of Oil Samples.

	Sample 1.	Sample 2.	Sample 3.
Lower Explosive Limit at Temp.(°C)	41.7	-	89.9
Upper Explosive Limit at Temp.(°C)	64.8	-	-
Flash Point (closed cup) °C	43.3	101.1	92.2

Since the /.....4.

Since the P.C.P.-Kerosene mixture is used at normal atmospheric temperatures and the Creosote-Furnace oil mixture at about 93.5 - 100°C (200 - 212°F), it is clear that only the lower explosive limit need be considered.

The results in Table 4 suggest that for practical purposes the closed cup flash point may be used to determine "safe" operating conditions.

In the above tests the flash point was 2 - 3°C higher than the temperature at which the lower explosive limit was reached and this would have to be borne in mind and a suitable allowance made in using the flash point for control purposes.

Bearing in mind the normal operating temperatures used in practice, the creosote mixtures could be regarded as more dangerous than the P.C.P.-Kerosene mixture.

It was therefore considered desirable to establish what the effect modifications in the ratios of furnace oil to creosote would have.

Fresh samples of creosote and furnace oil were therefore procured from the Forest Products Institute. Two mixtures were made and flash points were determined on the oil samples and mixtures. Results are reported in Table 5.

TABLE 5.

Flash Point of Oils.

Sample.	Flash Point (°F).	
	Closed Cup.	Open Cup.
A.W.P.A. Creosote (Sample 3)	195	222
" " (new sample)	190	229
S/V. Sovaloid W.	375	420
Furnace Oil A (F.O.A.)	172	220
Sample 2 (F.O. 35% Creosote 50% Sovaloid 15%)	215	224
Mixt. 1 (F.O.A. 20% Creosote 65% Sovaloid 15%)	185	227
Mixt. 2 (F.O.A. 35% Creosote 50% Sovaloid 15%)	178	222

Since the/.....5.

Since the Mixture 2, although of the same percentage composition, had a rather lower flash point than the sample 2, it was concluded that the sample "Furnace Oil A" was probably a lighter oil than that used in preparing sample 2. One should therefore be careful in the selection of the furnace oil and if a lighter oil has to be used it would be advantageous (from the present point of view) to maintain the percentage of creosote in the mixture at a high level.

CONCLUSIONS:

A. Kerosene-P.C.P. Mixtures:-

It would appear from these tests that the Kerosene-P.C.P. mixture should be quite safe under normal operating conditions. If the storage tanks and the impregnating vessel are sheltered from the direct rays of the sun, the temperature at which the formation of explosive mixtures may be expected will normally not be reached in South Africa.

B. Furnace Oil - Creosote Mixtures:-

In the case of these mixtures the lower explosive limit may be reached and exceeded when the oils are heated to 200°F. The closed cup flash point may be taken as an indication of the temperature at which the lower explosive limit may be reached. If used, the operating temperature should be limited to a temperature some 10 - 20°F lower than the closed cup flash point.

As regards the impregnating vessel, the most favourable conditions for the formation of explosive mixtures, is probably reached at the stage when the oil is drained after a batch of timber has been treated. If the vessel is packed with timber the conditions would be very unfavourable for the propagation of an explosion wave, so that, even if ignition did occur, the "explosion" would probably be limited

to a/.....6.

to a localised "flash." There should be no danger from explosions after the vessel has cooled down to a temperature equivalent to the closed cup flash point of the component of the oil mixture having the lowest flash point.

The conditions in any tank used for preheating the oil are more critical. If air is allowed to enter such a tank while hot oil is pumped out, explosive mixtures may be formed if the temperature of the oil is high enough. This explosive mixture would be in a vessel, substantially free from obstructions and conditions would therefore be favourable for the propagation of an explosion wave. Ignition may therefore be followed by a forceful explosion.

RECOMMENDATIONS TO PROMOTE SAFETY.

Kerosene - P.C.P.:

The only recommendation that need be made in this case is, to place the plant under some shelter, i.e. in the shade. The danger from explosions should then be negligible.

Normal fire hazard precautions would, of course, have to be taken, but this report is not concerned with them.

Furnace Oil - Creosote Mixtures:

It is recommended:

1. That in addition to any other control tests conducted before purchasing and during the preparation of mixtures, the closed cup flash point (Pensky-Martens) of components and mixtures should be determined (preferably on dried samples).

2. That/.....7.

2. That the maximum temperature to which the mixture is heated at any stage in the impregnation process should be 10 - 20°F lower than the flash point of the oil mixture.

3. That naked lights should not be used in the vicinity of the preheating tanks (if any). (This implies that smoking should be prohibited).

4. That spark proof tools should be used when working on pre-heating tanks and impregnating vessels, at least while they are hot.

5. That the vessels should be properly earthed to dissipate any static charges.

PRETORIA.

15th March, 1950.
