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Laboratory Preparation of Wood Preservatives Using Locally Available Mineral Resources

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မြန်မာနိုင်ငံတွင် ရရှိနိုင်သော သတ္တုကုန်ကြမ်း ပစ္စည်းများကို အသုံးပြုလျက် သစ်ကြာရှည်ခံဆေးစမ်းသပ်ထုတ်လုပ်ခြင်း။

ဦးဝင်းကြည် (၂) B.Sc.(For.)(Rgn.), M.Sc (SUNY)
လက်ထောက်ညွှန်ကြားရေးမှူး၊သစ်တောဦးစီးဌာန၊ ကယားပြည်နယ်။

စာတမ်းအကျဉ်းချုပ်

စီစီအေသည် အများလက်ခံသုံးစွဲနေသော သစ်ကြာရှည်ခံဆေးဖြစ်ပါသည်။ စီစီအေဖြင့် တူညီသော သစ်ကြာရှည်ခံဆေး ထုတ်လုပ်ရန်အတွက် မြန်မာနိုင်ငံတွင် (Nickel speiss) နှင့် (Chromite ore) တို့ကို ကုန်ကြမ်းအဖြစ်ရရှိနိုင်ပါသည်။ ၄င်းတို့တွင် သစ်ကြာရှည်ခံဆေးအတွက် အခြေခံလိုအပ်ချက်ဖြစ်သော (Copper) (Chromium) နှင့် (Arsenic)တို့အလုံအလောက်ပါရှိကြောင်း တွေ့ရှိရပါသည်။ သစ်ကြာရှည်ခံဆေးနည်းအဖြစ် ထပ်ဆင့် ဆေးစိမ်နည်း (Double-diffusion method) ကိုအသုံးပြုပါသည်။ ၄င်းနည်းစနစ်အရ သစ်သား နမူနာသစ်တုံးများကို (Nickel speiss) အက်ဆစ် ပျော်ဝင်ရည်တွင်လည်းကောင်း၊ ဆိုဒီယမ် ခရိုမိတ်ပျော်ဝင်ရည် သို့မဟုတ် အာမိုးနီးယား ပျော်ဝင်ရည်တွင်လည်းကောင်းတစ်ကြိမ်စီ စိမ်ရပါသည်။ အသုံးပြုသော သစ်ကြာရှည်ခံ ဆေးတို့၏ သစ်ဆွေးမှု ကာကွယ်နိုင်စွမ်းကို တိုင်းတာရန်အတွက် သစ်နမူနာတုံးများကို မြေတွင်မြှုပ်၍ဆွေးစေသည့်နည်းကိုအသုံးပြုပါသည်။(၁၀)ရာခိုင်နှုန်း(Nickel speiss) အက်ဆစ်ပျော်ဝင်ရည်တွင် ပထမစိမ်ပြီး(၁၀) ရာခိုင်နှုန်း ဆိုဒီယမ်ခရိုမိတ် ပျော်ဝင်ရည်တွင် ဒုတိယစိမ်သော နည်းလမ်းသည် အသင့်တော်ဆုံးဆေးသွင်းနည်းစနစ်ဖြစ်ကြောင်းတွေ့ရှိရပါသည်။

Laboratory Preparation of Wood Preservatives Using Locally Available Mineral Resources

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Abstract

Chromated copper arsenate (CCA) has been a widely accepted preservative for treatment of timber. Locally available nickel speiss and chromite ore were found to contain sufficient quantity of copper, arsenic and chromium for the production of preservative equivalent to CCA. Double diffusion method was adopted using sequential dipping of wood samples in nickel speiss acid solution, sodium chromate or ammonia solutions. Soil burrial test was used for the determination effectiveness of preservative formulations on decay-fungi. 10 percent acid solution of nickel speiss- 10 percent sodium chromate combination was found to be the most suitable formulation as a wood preservative.

Contents

1. Introduction

1. Wood is made up of biodegradable molecular structures. No wood is immue to attack of wood- rotting fungi. However, variations in durability of wood have been recognised among timber species. In fact, these variations are, somehow, influenced by inherent properties of wood concerned. The higher the component of toxic chemical deposited on wood the more the durability of wood. Therefore, impregnation of toxic chemicals into wood could certainly prolong the service life of wood.

2. Numerous investigations have been made to impregnate wood with chemicals in order to preserve wood since centuries ago. Use of earth oil as wood preservative has been a life long practice in Myanmar. Earth oil protects wood from soaking by rain thereby prevent the growth of wood- rotting fungi. Many people recognised the fact that smoked bamboo or thatch last longer than non-smoked ones. It is actually due to the effect of " wood tar" condensed on nearly materials when wood burns. Wood tar is believed to have antiseptic properties. An equivalent product of wood tar is coal tar which could be produced in large quantity. Therefore, it is commercially used as wood preservative.

3. Use of inorganic chemicals as wood preservatives was relatively recent to organic counterparts. Arsenical salts, Mercuric chloride, Copper sulphate and Zinc chloride were among the earlier patented wood preservatives and later followed by chromated arsenicals and boron compounds. Gaseous diffusion of active chemicals into wood would, probably, be the lastet development in the field of wood preservation.

4. Traditionally, Myanmar people accept only such durable woods as Teak (*Tectona grandis)* or Pyinkado *(Xylia dolarbriformis)* for their day to day use. Therefore, it is still difficult to divert their attention either to use alternatives or to recognise the effectiveness of preservative treatment of wood. However, we must accept the scarcity of valuable species. Modern wood preservative treatments involve hi-tech facilities and expenses. This paper attempts to introduce preservative treatment of wood as simple as possible using the locally available material at reasonable cost.

2. Literature Review

5. Generally, wood preservatives could be divided into oil- borne and water -borne chemicals. Creosote and penta chlorophenol are among the widely used oil- borne preservatives while chromated copper arsennate (CCA) is a world wide accepted water-borne wood preservative. (Ref: 1)

6. Almost all the mineral salts were found to be effective against wood-rotting fungi. Generally, the higher the electron negativity of metal the greater the fungistatic effecacy. Copper is highly electron negative. Therefore, copper sulphate was found to be very effective against wood rotting fungi. (Ref: 2) However, it could not prevent damage caused by insects. Addition of arsenic to copper salts offered improvement in that respect. But, both compounds are water leachable. Leaching of these compounds rendered not only reduce the possible extended life of treated wood but left the environment hazadous also. Hexavalent chromium compounds, such as sodium chromate, were found to "Fix" either by itself or with its copper and arsenic associates to wood. (Ref : 3 & 4)

7. Prompt reaction between CCA and treated wood requires such facility as vacuum pressure-treatment plant in order to " Push" the treating chemical into wood as quickly as possible. Slow diffusion of CCA would not premit the entrance of active chemicals since it preferably react and deposit only on the surface of the treated wood. Diffusion of active chemicals of CCA into wood is possible by dipping the wood in one chemical after another thereby allowing sufficient interval for the penetration of one compound before reacting with another. This method is called "Double Diffusion". (Ref: 5)

8. Phenol and coal tar were found to be the sources of oil- borne wood preservatives available in Myanmar. However, solvents of such preservatives are expensive. During the year 1981-83 a feasibility study was made on the suitability of Myanmar minerals for the production of an Ammoniacal copper Arsenate-wood preservative by the Forintek Canada Crop; contracted by CIDA for the Construction Corporation.

9. Dr.John N.R. Ruddick of Forintek Corp; in collaboration with Myanmar geologists found out nickel speiss, a biproduct of Bawdwin mine (No.1. Mining Corp:) as a suitable raw material for the production of wood preservative. He recommended the formulation of Ammoniacal copper Arsenate (ACA) out of nickel speiss and liquid Ammonia (Ref : 6). CCA is, in fact, more effective than ACA in protecting wood from decay or insect attack. If he had known the presence of chromium in Myanmar he would probably recommend CCA rather than ACA as a suitable wood presentative.

3. Preparation of Chemical Components Required for Wood Preservative

10. The earliest type of chromated copper arsenate wood preservative was patented by Kamesan of the Forest Research Institute, Dehra Dun 1933 and the product was named as Ascu (As for arsenic and Cu for copper). Now-a-day there are two basic types of CCA, Oxide type according to American wood Preserving Association and salt type according to British Standard 4072 (Ref: 7). However, both formulations contain the same basic active ingridients, chromium, copper and arsenic. Application of both types of CCA accomplished by the use of pressure impregnation.

11. Many hardwoods in the tropics are resistant to pressure impregnation. Baines and Saur, in their summary of the literature suggested use of diffusion process for such refractory woods (Ref: 8). One disadvantage of diffusion process is leaching of treating chemical out of the wood after it has been treated. If the chemical is fixed by another chemical in the wood by applying it subsequently the deposit so formed becomes non- leachable. This process is known as the double- diffusion process. Actually, diffusion is referred to as movement of isolated molecules of a solute through a solvent. However, the word "Diffusion" is usually referred in a broader sense as spontaneous spreading of either solute or the whole solution.

12. As stated in paragraph (10) in this paper, basic requirements for a formulation of chromated copper arsenate are copper, chromium and arsenic either in the form of oxide or salt. Following the guidance of suggestions made by the earlier researchers, attempts were made to interact one component of active chemical with another to form a non-water leachable precipitate. After the exhaustive study of raw materials available in Myanmar, nickels speiss, chromate ore and liquid ammonia were found to be the suitable sources required for the formulation of water -born wood preservatives.

13. In order to extract active components required for the formulation. Nickel speiss sample was grinded into powder. Extraction of elements was made by using concentrated nitric acid, hydrochloric acid, acetic acid, aqua regia and ammonium hydroxide. The extracted copper content in percents were found to be as follow.

Nitric Acid	33.0%
Hydrochloric Acid	23.8%
Hydrochloric Acid	9.6%
Acetic Acid	2.6%
Aqua Regia	3.6%

According to the results obtained, concentrated nitric acid was found to extract most copper from the given nickel speiss sample. However, using nitric acid in the digestion of nickel speiss is very expensive and nitric acid itself reacts and dissolves structural material of wood. Therefore, hydrochloric acid was used in this experiment instead of nitric acid.

14. One gm. of nickel speiss powder was digested with 10 ml. each of concentrated 50% and 10% hydrochloric acid. A highest copper content was found to be extracted by suing concentrated hydrochloric acid while no difference was found between two digestions with 50 % and 10 % hydrochloric acid. However, no difference in copper content was read between the nickel speiss powder samples of different sizes from 90 microns to 500 microns. Acid solution of nickel speiss thus obtained was regarded as copper, nickel and arsenic component of preservative used in this experiment.

15. Chromium component of the formulation was made by using chromite ore, sodium carbonate and calcium carbonate, all of which are locally available in Myanmar. Sodium chromate was prepared according to the process outlined by Partington (Ref: 9) using these raw materials. The yield of sodium chromate was about 80 % of the chromite ore used. The percentages of raw materials in preparation of sodium chromate were as follow: -

Chromite	36%
Sodium carbonate	20%
Calcium carbonate	44%

16. A 30 percent liquid ammonia was obtained from Kyun-chaung Fertilizer Plant. No further preparation was required for the formulation of wood preservative.

4. Reaction Between the Prepared Chemicals Leading to the " Deposition" of Toxic Substances in the Micro Voids of Wood

17. It has been stated in the paragraph 11 of this paper that idea of the double -diffusion treatment was to fix the toxic substances in cellular structure of wood by the deposition of compounds formed in the successive diffusion of active chemicals into the wood. Series of experiments were carried out using the prepared nickel speiss extract, sodium chromate and liquid ammonium in order to produce a solid substance. Combination of acid solution of nickel speiss with either sodium chromate or liquid ammonia at certain proportion was found to produce a quantity of water- insoluble deposit.

18. About equal volume of 30 percent liquid ammonia and acid solution of nickel speiss was required to react and precipitate. Addition of either acid solution or liquid ammonia was found to dissolve the precipitate so formed.

19. At least four times the volume of 20 % sodium chromate was required for initial deposition of precipitate when reacted with one volume of acid solution of nickel speiss. The higher the volume of sodium chromate added the heavier the precipitate deposited. With diluted acid solution of nickel speiss lesser amount of sodium chromate was required for precipitation.

5. Materials and Methods

(a) Serial dilution of prepared chemicals

20. As stated earlier in this paper, stock solutions of chemicals were prepared as followed: -

Hydrochloric acid extract of nickel speiss powder
20 percent sodium chromate
30 percent liquid ammonia

21. Denoting the above stock solutions as 100 percent for the purpose of this experiment, dilutions and arrangements were made for the double- diffusion treatment as shown in table (1).

(b) Double - diffusion treatment of wood

½ x ½ x 1 inch Didu (*Salmalia insignis*) wood samples were prepared for the treatment and decay- test. Ten specimens were allotted for each treatment and their identification numbers were marked on each specimen. Air-dry weight of each specimen was measured and recorded. Average moisture content of each group of identical samples was determined. Using these actual moisture content assumed, oven- dried weight of each specimen was calculated.

Each group of wood samples was first dipped in the respective solution for one hour. After ensuring that wood samples were thoroughly soaked with the prepared chemical, these were removed and air- dried for one day. The purpose of air drying was to allow sufficient space for the entrance of second solution. Dipping in the respective second solution was made for one hour, followed by air drying for one day.

Table 1. Concentrations and arrangement of chemicals for the double-diffusion process.

Treatment No.	Concentration (%)		Treatment No.	Concentration (%)	
	1st solution	2nd solution		1st solution	2nd solution
	Nickel speiss	Sodium Chromate		Sodium Chromate	Nickel speiss
1	50	100	29.	100	50
2.	50	50	30.	50	50
3.	50	25	31.	25	50
4.	25	100	32.	100	25
5.	25	50	33.	50	25
6.	25	25	34.	25	25
7.	25	10	35.	100	25
8.	10	50	36.	50	10
9.	10	25	37.	25	10
10.	10	10	38.	10	10
11.	10	5	39.	5	10
12.	1	5	40.	5	1
13.	1	1	41.	1	1
	Nickel speiss	Ammonia		Ammonia	Nickel speiss
14.	50	100	42.	100	50
15.	50	50	43.	50	50
16.	50	25	44.	25	50
17.	25	100	45.	100	25
18.	25	50	46.	50	25
19.	25	25	47.	25	25
20.	25	10	48.	10	25
21.	10	50	49.	50	10
22.	10	25	50.	25	10
23.	10	10	51.	10	10
24.	10	5	52.	5	10
25.	1	5	53.	5	1
26.	1	1	54.	1	1
27.	CCA (1%)				
28.	Control				

24. For the purpose of comparison one group of wood sample was treated with 1 percent chromated copper arsenate (CCA) solution. Control group was also included without any treatment. Extra wood samples, two for each group, were simultaneously treated with respective chemical solutions. After each treatment weights of these extra samples were measured followed by oven- drying and weighing.

(c) Decay Resistant Test

25. Soil burial test is one of the reliable, easily applicable and time saving method of testing durability either treated or untreated wood. This method requires burying the wood samples flush with the surface of normal moist fertile soil. Normally the period of testing ranges from 12 to 16 weeks depending on the durability of wood.

26. The treated and control Didu wood samples were washed with distilled water for three times before burying in the prepared trays of moist soil. Removal of that wood samples, only two from each group at a time, was made at 8th, 12th, 14th, and 16th weeks of soil burial periods. The wood samples were carefully cleaned and oven-dried for 5 hours at 103 ° C. Oven -dry weight of each sample was measured and recorded. Percent weight loss from the initial oven-dry weight was calculated. Weight loss indicates the severity of decay development in that wood.

6. Results and Discussion

27. Weight loss percentages of wood samples were shown in table (2). According to the results obtained conclusion could be made as follow:-

(a) Sequence of dipping was found to be important. Using the acid solution of nickel speiss as the first solution was found to offer better protection than the reverse sequence i.e. using either sodium chromate of liquid ammonia as the first solution.

(b) Better performance was found with the nickel speiss - sodium chromate combination than the nickel speiss liquid ammonia combination.

(c) Using the exact proportion of chemicals was found to fix more toxic substance in the wood, thus prevent decay, than using the concentrates.

(d) Nickel speiss-sodium chromate combination at any level of concentration in this study was found to perform better than 1 percent CCA.

(e) Except for 1 percent solution, nickel speiss ammonia combination was found to give satisfactory results when compared with CCA.

(f) Among all the combinations used in this study 10 percent acid solution of nickel speiss followed by 50 percent (equivalent to 10 percent) sodium chromate combination was found to be the best combination for the double-diffusion preservative treatment.

(g) Although inferior to chromate combination, 10 percent acid solution of nickel speiss followed by 5 percent (actual concentration would be 1.5 percent) ammonia solution was found to give a satisfactory results.

Table (2) - Weight loss percentages of treated and control Didu wood samples (Soil Burial Test)

Treat-ment No.	Weight loss (%) by weeks and sample numbers										Total weight loss(%)
	8'		10'		12'		14'		16'		
	1	2	3	4	5	6	7	8	9	10	
1.	1.80	6.59	7.39	4.78	0.39	5.37	4.75	5.62	3.07	2.06	22.84
2.	0.14	2.90	7.23	1.58	1.35	2.95	0.45	1.33	6.97	6.11	0.97
3.	11.79	7.76	0.72	3.42	4.51	4.44	5.73	7.37	8.44	9.86	55.76
4.	3.17	3.95	1.71	3.35	4.71	7.73	5.70	5.77	2.17	3.44	16.24
5.	0.55	6.90	15.67	1.13	3.35	1.56	2.35	1.19	0.32	0.56	11.94
6.	1.55	0.25	1.60	1.66	0.75	6.55	6.88	1.21	1.07	0.25	11.75
7.	6.24	3.48	1.00	2.07	6.79	4.22	11.15	11.63	1.69	9.68	51.81
8.	0.04	2.22	4.27	4.34	1.71	2.07	0.53	0.34	0.86	1.14	15.24
9.	0.33	2.18	1.46	5.57	1.20	2.48	0.88	0.61	0.29	1.53	15.32
10.	0.97	2.44	2.41	6.59	0.44	0.68	1.28	0.38	2.24	0.53	3.42
11.	3.84	4.32	3.70	2.47	4.44	4.35	5.34	5.45	6.53	6.76	34.86
12.	6.93	7.32	0.02	1.19	8.28	1.03	10.9	13.68	14.92	14.01	75.86
13.	7.07	6.33	4.56	1.24	7.02	9.36	18.54	8.56	13.59	11.05	87.32
14.	8.62	5.54	0.69	0.98	9.38	6.89	6.45	6.39	5.68	7.82	41.32
15.	8.65	6.29	0.62	1.28	6.45	8.46	8.60	8.22	5.94	5.96	59.23
16.	8.79	7.65	0.03	0.27	9.33	5.83	8.95	9.35	6.58	9.51	66.23
17.	5.36	6.70	1.73	2.72	8.25	7.37	8.00	5.84	9.16	9.36	66.03
18.	5.24	6.55	1.81	0.95	6.54	6.50	7.77	19.04	5.23	8.85	62.96
19.	6.48	5.59	0.44	0.81	6.40	7.30	6.45	5.93	6.79	5.13	51.32
20.	9.66	6.63	2.38	248	9.76	10.35	12.18	10.98	9.24	8.26	81.92
21.	8.65	8.39	0.55	3.20	12.66	10.90	12.90	8.90	13.06	8.87	88.08
22.	7.55	7.30	0.76	4.10	11.61	7.65	8.46	10.04	10.21	7.86	74.02
23.	8.89	7.88	0.88	4.51	7.24	11.45	7.58	5.78	8.84	11.21	74.26
24.	6.66	6.19	0.4	3.35	11.45	7.29	10.1	8.76	8.02	8.07	69.49
25.	14.47	12.31	7.42	10.72	23.17	19.43	30.25	16.05	26.25	17.19	177.26
26.	12.85	15.85	7.20	10.60	18.79	21.73	20.98	19.75	36.16	19.98	183.89
27.	12.54	13.24	1.49	6.00	13.25	9.78	16.28	12.53	14.26	16.20	115.57

Treat-ment No.	Weight loss (%) by weeks and sample numbers										Total weight loss(%)
	8'		10'		12'		14'		16'		
	1	2	3	4	5	6	7	8	9	10	
28.	15.54	21.45	5.82	14.74	21.35	16.53	21.29	25.88	20.14	21.86	184.60
29.	18.96	18.03	14.00	11.43	17. 81	15. 68	16.41	23.18	12.79	15.44	163.73
30.	16.48	18.63	12.90	14.82	19.18	19.22	17.13	16.45	16.18	14. 58	165.57
31.	17.21	21.44	12.25	14.48	21.61	13.11	15.35	14.36	15.85	12.72	158.38
32.	3.89	5.81	1.36	2.78	12.04	10.45	10.35	8.21	5.09	1.73	53.43
33.	11.35	12.62	5.4	8.26	10.95	15.45	16.17	19.14	15.61	15.66	130.61
34.	17.13	13.88	8.95	8.52	14.13	16.84	17.26	17.96	18.05	16.66	149.38
35.	18.22	17.22	10.87	11.17	18.99	16.5	17.62	13.48	18.05	12.79	154.91
36.	1.91	3.09	3.42	7.3	0.12	0.03	0.02	0.69	0.82	2.43	4.97
37.	3.98	4.28	2.31	1.62	9.2	12.04	9.69	8.10	8.87	4.93	57.16
38.	13.16	12.55	4.77	8.10	14.95	10.68	12.17	12.79	15.54	9.91	114.62
39.	16.69	15.3	9.05	10.5	15.34	17.58	16.54	13.57	16.78	14.13	145.48
40.	9.01	9.73	1.32	4.32	8.61	9.93	18.16	14.65	14.29	12.75	100.16
41.	7.53	10.29	0.06	6.51	8.43	6.62	11.77	12.29	12.05	14.39	84.94
42.	22.44	19.84	16.00	16.75	25.67	20.1	23.7	36.46	15.94	16.43	213.31
43.	18.69	23.29	13.4	18.16	8.64	21.63	20.42	23.19	23.44	15.09	196.05
44.	21.01	23.84	19.2	19.0	21.28	20.64	17.08	22.21	23.04	21.36	208.66
45.	20.14	19.83	13.06	15.11	14.61	15.61	19.74	14.63	19.54	15.35	167.22
46.	20.55	19.53	13.26	14.7	16.84	14.6	18.96	21.37	21.2	17.73	178.74
47.	20.63	20.41	13.49	15.56	15.96	21.03	23.38	20.98	17.4	18.97	187.81
48.	19.53	20.29	13.52	15.78	22.88	16.3	21.08	22.5	17.03	14.23	183.14
49.	17.88	15.4	9.81	12.86	17.12	18.75	18.34	13.58	18.88	16.66	159.28
50.	16.57	16.98	8.71	11.8	16.82	13.77	14.32	15.99	15.14	13.82	143.92
51.	14.22	13.4	8.74	11.4	19.17	14.47	16.22	16.5	14.87	10.13	139.12
52.	19.78	15.11	10.03	12.63	19.03	12.37	20.3	14.91	13.76	11.36	149.28
53.	11.54	12.11	2.80	10.29	8.31	16.4	20.13	14.56	16.17	18.17	130.48
54.	13.8	12.18	4.24	10.34	10.54	11.3	14.91	16.78	16.8	16.49	127.38

7. Recommendation and Conclusion

28. Modern wood preservative treatment required pressure impregnated facilities and imported chemicals. One metric ton of Tanalith (CCA) now being used costs about US $ 2200 FOB (1979). The values of chemical component used per metric ton of CCA was found to be as follow:-

Chromic acid	992.2	US $ (dollars)
Cupric oxide	327.8	US $ (dollars)
Arsenic acid	387.2	US $ (dollars)

29. Depending on the situation of wood utilization, thus depending on the concentration of CCA used in pressure impregnation, cost of CCA alone for the treatment of one ton of

timber amounted 25-60 US $ dollars. Pressure treatment of wood requires about US$,200,000 worth impregnation plant and skilled labour.

30. On the other hand, diffusion treatment requires only dipping tank and chemical. However, it takes longer time enough for the penetration of solution into wood than the pressure process depending on the sizes of wood used. Double diffusion thus means double duration of dipping and drying periods.

31. Following the recommendation made in paragraph 27 (f) of this paper the cost of raw materials per metric ton of solution could be as follow: -

(a) 100 percent acid solution of nickel speiss

100 kg. Nickel speiss costs		K 1400
1000 kg Hydrochloric acid		K 5000
	Total	K 6400

Therefore, cost of 10 percent solution = K 640

32. Assuming one ton of air-dried timber absorbs about 500 liters of solution at a time, cost of raw materials used in the double- diffusion process would be -

10 % acid solution of nickel speiss	=	K	320
10 % sodium chromate solution	=	K	477
Total		K	797
Say		K	800

33. When nickel speiss-ammonia combination is used for the process value of raw materials used per metric ton would be as follow : -

10 percent nickel speiss acid solution	=	K	640
1.5 percent ammonia solution (1000 kg = K 552)	=	K	28
Total		K	668

Therefore, cost of raw material required for the process would be about K334.

34. Cost of treating chemicals required for the treatment of one ton of timber as calculated above could be summerised as below.

(a)	CCA (0.4 -1.0 pound / cuft. of wood)	US$	25-60
(b)	10% nickel speiss and 10 % sodium chromate combination	K	800
(c)	10% nickel speiss and 1.5 % ammonia combination	K	334

35. At official exchange rate cost of CCA require to treat one ton of timber is found to be cheaper than that of recommended formulations. However, using CCA involves foreign exchange and high initial investment for the installation of treatment plant.

36. Laboratory-scale preparation of recommended preservative chemicals is relatively simple. However, commercial scale production would require specially designed machine for grinding nickel speiss and gigantic furnace for roasting chromite ore. Thus, initial investment would be considerable.

Apart from this initial investment, following processes are quite simple and could be applicable anywhere having a dipping tank of any size for the diffusion treatment to be carried out .

37. Except for boron compounds, Myanmar possesses many raw material resources for the production of wood preservatives. Further attempts should be made to utilize these resources for the purpose of promoting the wood- based industries.

38. Failure of wooden structures such as bridges, housing components, railway sleeper due to decay is quite frequent anywhere and replacement of these failure parts involves timber and labour. Therefore, any effort should be suggested to visualize the timber consumers to use treated timber in order to safe our forests from unnecessary cuttings.

Appendix

Cost of raw materials used per metric ton and their availability.

Sr. No.	Material	Cost K	Source	Availability
1.	Nickel speiss	14000	Bawdwin Mine (biproduct)	No. (1) Mining Industry
2.	Chromite ore	1240	Ta- gaung	No. (3) Mining Industry
3.	Sodium Carbonate	11000	Sagaing and Thazi	Myanmar Salt and Chemical Industry
4.	Calcium Carbonate	-	-	No. (3) Mining Industry
5.	Liquid ammonia	552	Kyun-chaung	No. (3) Mining Industry

References

1. Fungicides - Volume II Edited by Targeson (1969) P 107.
2. General and Inorganic Chemistry, for University students by J.R. Partington (1961) P 749 .
3. Indian Forest Records (1987) Ascu, A wood preservative. Indian Forest Record I (6), 143-147.
4. Peservation of timber in the tropics, edited by W.P.K Findlay (1985) 141-143
5. Preservative Treatment of Spruce and other Refractory Wood by E.F. banies and H.M. Saur (1985) in A.W.P.A Proc. 81-136-147.
6. The biologic and economic assessment of pentacholoro phenol, inorganic arsenicals, creosote. Cooperative impact assessment report submitted to the environmental Protection Agency by the United States, Department of Agriculture on November 4, 1980.
7. The Chemistry and Kinetic Behavior of Cu- Cr- As wood preservatives. IV. Fixation of CCA to wood by Pizzi, A (1982) journal of Polymer Science. Polym, Chem., Ed. 20: 739-64.
8. The Double-diffusion Method of Treating Wood: A Review of studies (1964) by R.H.Bachler and H.G Roth. Forest Product Journal 14 (4): 171-178.
9. The suitability of Burmese minerals production of an ammoniacal copper arsenate wood preservative-A report to Canadian International Development Agency (CIDA) by J.N.R Ruddick, Forentek Canada Corp. 1983.