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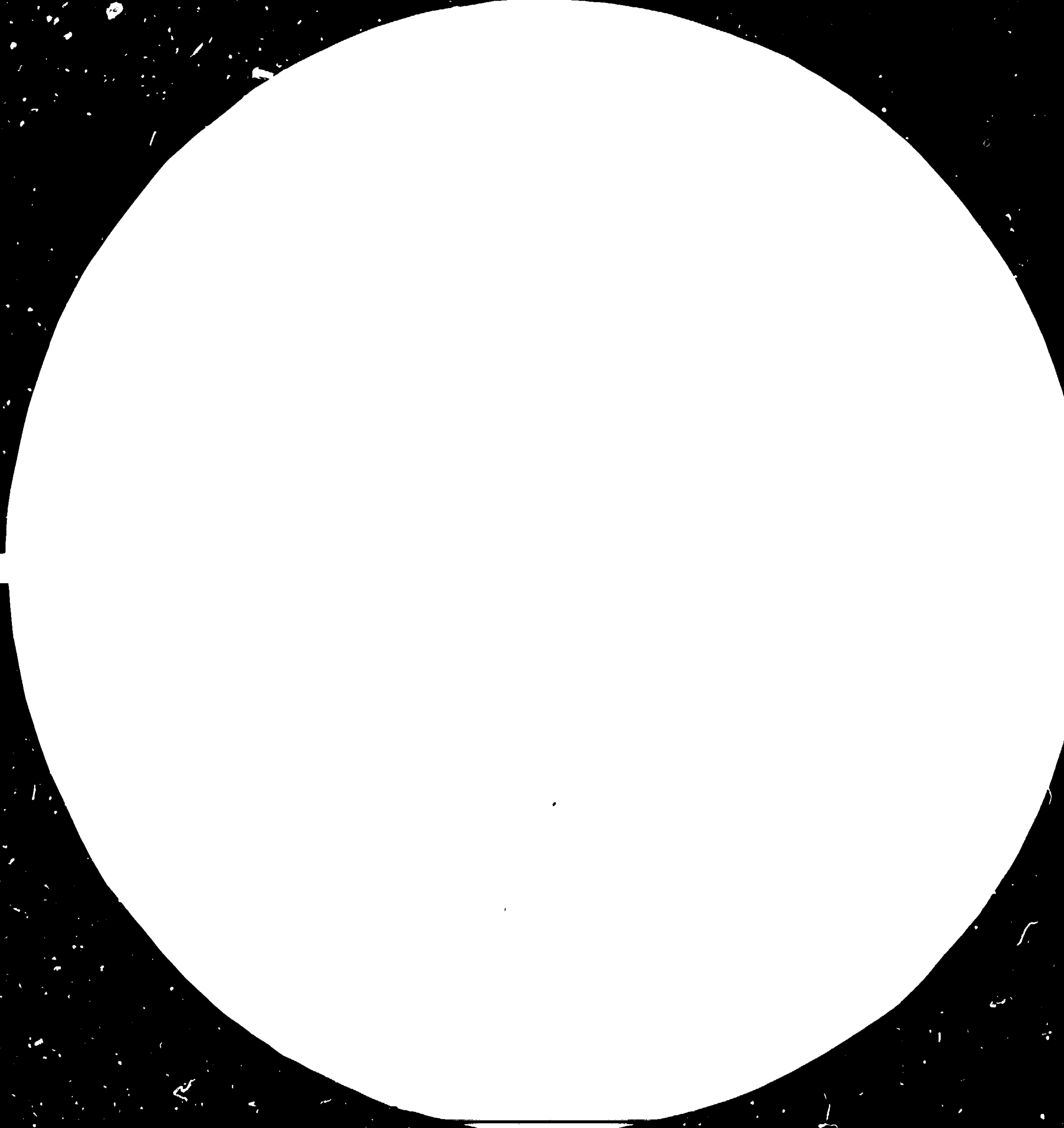

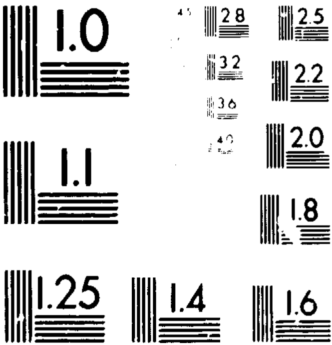

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RESEARCH AND DEVELOPMENT FOR THE UTILIZATION OF RUBBERWOOD AND COCONUT WOOD

DP/SRL/79/053

SRI LANKA

Technical report: The pressure treatment of timber*

Prepared for the Government of Sri Lanka
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of C. R. Francis, Timber Engineer

United Nations Industrial Development Organization
Vienna

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GLOSSARY

Retention:	The weight of salts introduced into treated timber. Expressed as kg per cubic metre (kg/m^3).
Charge:	The timber which is introduced into the treatment cylinder as a batch.
Penetration:	The depth from the surface which the treatment salts reach. Measured in mm, determined by chemical test.
Displacement:	The volume of timber in a charge (q.v.) as measured by the known capacity of the cylinder with bogies inside, and the difference in contents of the store tank before and after flooding or blowback.
CCA:	Copper - Chromium - Arsenic.
Density:	Weight per unit volume - Measured in kg/m^3.

Units

In this manual the S.I. system of metric units is followed and the following abbreviations are used:

kg:	Kilogramme
kPa:	Kilopascal = 1000 n/mm^2
m, m^3:	Metre, cubic metre
kg/m^3:	Kilogrammes per cubic metre
ltr:	litre (non standard abbreviation)
dm, dm^3:	Decimetre, cubic decimetre (non-preferred unit)
1 dm^3:	1 ltr

Occasional reference is also made to Imperial units.

1. WOOD PRESERVATION - INTRODUCTION

Wood is a very durable material - providing nothing is present to attack it. However, there are a number of life forms - fungi, insects, molluscs - whose natural habitat is wood and which devour it for food or tunnel into it for their homes.

Wood is a vital material, for furniture, buildings, boats - a host of end uses. It is very necessary to maintain the value of all these, and not have to renew at frequent intervals. Wood preservation can extend the life of wood by anything from a year to a century.

The term "wood" describes a substance with an enormous range of properties, from very soft to very hard, porous to dense, decay prone to very durable. Similarly "wood preservation" covers processes ranging from a quick painting with a dubious efficacy to rigidly controlled pressure processes backed by sophisticated quality control laboratories giving almost unlimited service life.

This manual has been written for the operators of small vacuum-pressure plants (Bethell process) using copper-chrome-arsenic (CCA) preservatives. Its aim is to give operators an understanding of what they are doing, and hopefully to encourage them to study further in any aspects of wood preservation which interest them.

Specifically it has been written round the small (0.76 m dia x 6 m long) plant designed and built by the expert for Borwood Ltd. at Horana, Sri Lanka. Reference to this plant has been kept to a minimum and the manual has been written for as wide an audience as possible. Emphasis has been placed on the practical side of operations, including routine calculations. At the same time an attempt has been made to give sufficient background to enable operators to understand how to be able to meet results-type specifications such as those of the New Zealand Timber Preservation Authority, rather than only specific instructions to comply with a process type specification.

2. THE MECHANISM OF WOOD PRESERVATION

In order to have an understanding of wood preservation, some knowledge of the structure of wood is necessary. This section has been written in as simple terms as possible, avoiding technical terms and jargon. It gives only the barest outlines of wood anatomy. For those interested in further study the books in the bibliography should be studied.

"Solid" wood is not in fact absolutely solid, but consists of tubes and hollow cells. The tubes and cells consist largely of cellulose and the substance binding them together is lignin. The combination of the two in some ways is similar to fibre glass, and gives wood its outstanding mechanical problems.

The absolute solid substance in wood has a density of about 1.50 i.e. 1500 kg/m^3. Timber is always less dense than this - even "sinkers" which when dry sink in water. The difference in density is due to the empty voids in the wood structure.

Example: A dry piece of wood has a density of 0.55. What proportion of its volume is voids?

Consider 1 m^3 of solid wood substance.

Its weight = 1500 kg.

Therefore volume of solids in sample = $\frac{550}{1500} m^3 = 0.367 m^3$

Volume of voids = 1000 - 0.367 = 0.633 m^3

Nearly two-thirds of our medium dense sample is made up of emptiness.

Wood consists mainly of bundles of minute tubes running up the stem. These form the "grain". A few tubes run radially. These are called "rays".

In hardwoods i.e. broadleafed trees the tubes tend to be relatively short and in some species quite coarse and open. In softwoods the tubes are longer and cigar shaped. In either cases the tubes connect with one another by small holes which may or may not have a thin membrane covering all or part of the hole.

In sapwood, that is the outer layer of wood in a tree, the tubes conduct sap with its nutrients. In the centre of the tree, the tubes are generally filled with resin, that is sap which has undergone chemical changes. Frequently this is darker in colour than sapwood, and the resins may impart a degree of immunity to insect or fungus attack to the heart wood.

With the vast number of different species of trees and their differing conditions of growth and habitat, there are equally large variations in sizes, connections and dispositions of the microstructure of wood, but it all follows the general pattern described above.

The idea of pressure treatment is to completely fill all the wood with poisonous substances. This can only ever be partly achieved. In many timbers, particularly the dense ones, the tubes in the wood and the connections between them are so small that the pressures used in commercial plants are not sufficient to force a solution into the wood in a sufficiently short time to be economic. In other timbers, the tubes or cells may be of adequate size for the flow of solution, but the connecting holes are tightly closed by an impenetrable membrane. In many species with permeable sapwood, the resin deposits in the heartwood plug up the tubes like rust plugs up old water pipes.

Even so there are a great number of species which can be penetrated by pressure treatment, and it is to these that we will turn our attention.

When wood is green, its cells and tubes are filled with sap, which is water which contains dissolved nutrients. Before preservative salts can be introduced this water must be removed to make room for the preservative. The wood must therefore be dried.

Most of the water is merely physically contained in the voids of the wood, as water is contained in a bottle. This is called 'free' water. As wood is dried from the green state, the free water comes away. At a moisture content of about 25% all the free water will have disappeared. This moisture content (MC) is called "fibre saturation point" (FSP) and can vary from 20% to 30% depending on species. The water which remains is called combined water. This is attached to the walls of the cells and inside them with a weak chemical bond, and is more difficult to remove than free water. As combined water is removed, shrinkage and warping commence.

The wood must be dried reasonably uniformly. All the wood which is to be impregnated must be dried below FSP. Imagine a piece of wood dried with a dry surface but still with a wet core. In detail it might have a moisture content distribution as in Fig. 1.

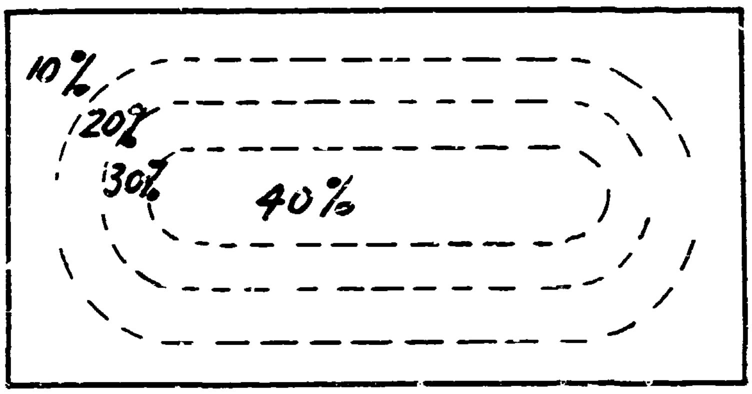

Fig. 1 - MOISTURE CONTENT DISTRIBUTION

A surface moisture test would show it well dried. A cross section oven dried would give a moisture content of about 22% - still apparently dry enough for treatment. But in fact three-eighths of the cross section is too wet to treat.

Pressure treatment consists quite simply of forcing a solution of preservative into the wood, to completely fill all the voids in the wood. Before this is done, the air in the wood must be removed. Imagine a bicycle tyre pump with a finger placed firmly over the air hole. The piston cannot be pushed fully home, because of the force exerted by the compressed air. Further, when the handle is released, the air will push the piston out again. Exactly the same would happen in wood if the solution was pumped in without first removing the air. It could not completely penetrate the voids and when the pressure was released, the air would push it out of the wood again. NOTE: In the empty cell or "Lowry" process this procedure is in fact followed. However, the Lowry process is only suitable for a relatively few species of wood, and control is more difficult than with the full cell process. It is not recommended for use by inexperienced operators on species whose treating characteristics are not well known.

A vacuum pump is therefore included in the system, and the treating process commences with the drawing of a vacuum for a period of 20 - 60 minutes to evacuate the pores of the wood. This vacuum is usually specified as 635 mm (25") of mercury, i.e. the height to which a column of mercury is sucked up at air level by the vacuum. It would be more correct to describe this in terms of an absolute pressure, e.g. 165 millibars equivalent to minus 85 kPa. At high altitudes even a perfect vacuum may not be equivalent to 635 mm of mercury.

After the vacuum has been maintained for the specified time, the valve of the store tank full of solution is opened and the solution is allowed to flow in under atmospheric pressure. This must be done cautiously to maintain the vacuum at a level not less than 560 mm (22") of mercury, or much of the benefit of the vacuum is lost.

The vacuum system is then sealed off and the pressure pump is started. Pumping is continued until flow into the cylinder ceases or reaches a negligibly low level. The solution is then returned to the store tank and a second vacuum is drawn. Despite the first vacuum, some air always remains in the wood. The purpose of the second vacuum is to allow this air to expand and push some of the surface solution out of the wood. If this is not done, the treated wood will drip for an objectionably long time. Since the wood nearest the surface always has an excess of treatment, no harm is done by removing this relatively small volume of solution. It is allowed to run into the sump under the cylinder door and pumped back into the store tank.

At all stages of the process, records are taken of volumes and times, so that the concentration of preservative in the wood can be calculated.

The mechanics of the plant operation and details of the calculations are explained in later sections.

3. DESCRIPTION OF PLANT

Vacuum-pressure treatment plants may vary in physical layout but they all contain the same basic components.

1. Mix tank, equipped with level gauge and circulating pump or stirrer.
2. Transfer pump from mix tank to storage tank. This may also have a suction hose connection and may double as the circulating pump in (1) above.
3. Storage tank equipped with level gauge and sampling tap.
4. Pressure cylinder, to which are connected:
5. Pressure pump.
6. Barometric leg or vacuum chest.
7. Vacuum pump, arranged so that it can also function as a low-pressure air compressor.
8. A sump under the cylinder door, calibrated for volume.
   Accessories and safety equipment includes:
9. Combined vacuum-pressure gauges connected directly to the cylinder. These should be in duplicate. A significant difference in reading between them will indicate that one is faulty and requires repair or renewal.
10. Liquid pressure relief valves. One valve is set to the working pressure, and discharges directly to the store tank. The other is set slightly above the working pressure and should have a visible discharge. It acts as a back-up and as a warning that the working valve has come out of adjustment.
11. Rate-of-flow meter. This is used to check when the charge has been pumped to "refusal" that is, when no more solution will

flow into the wood. In some older plants fitted with a vacuum chest, this is arranged as an accurate temporary storage tank, and the flow into the charge is observed by changes in the volume of the solution stored in the vacuum chest.

The mix tank and the store tank (s) should be fitted with ball valves on the water supply pipes to avoid spillages if the water supply is forgotten. They should also have a high level alarm which sounds a gong or horn. A typical plant is shown diagrammatically in Fig. 2 and a photograph of the plant at Horana in Fig. 3.

Vacuum System

There are two types of vacuum pumps which are commonly used:

- Liquid Ring
- Positive displacement.

In the liquid ring vacuum pump a mass of water is propelled at high speed round the periphery of a chamber. Due to the eccentric path of the water, negative pressures are generated in parts of the pump body and by suitable porting a vacuum can be drawn. This type of pump can tolerate a moderate amount of water being drawn into it.

The positive displacement pump may be reciprocating i.e. piston and cylinder, or rotary vane. Because of its construction only a very small amount of water can be admitted without causing damage.

During the treatment cycle, a vacuum is first drawn on the cylinder, then the solution is admitted whilst the vacuum is maintained at a fairly high level. In other words, the solution is sucked into the cylinder. It is necessary that the solution should completely fill the cylinder. When a liquid ring pump is used, a vacuum chest is connected to the highest point of the cylinder. The vacuum chest is a small (50 - 100 ltr) tank fitted with a sight port and level gauge. Solution is admitted until the chest is about half full, then the chest is closed off from the cylinder. The solution in the chest is later used for the rate of flow determination as described above. Should solution inadvertently flood the vacuum pump, no very great harm is done.

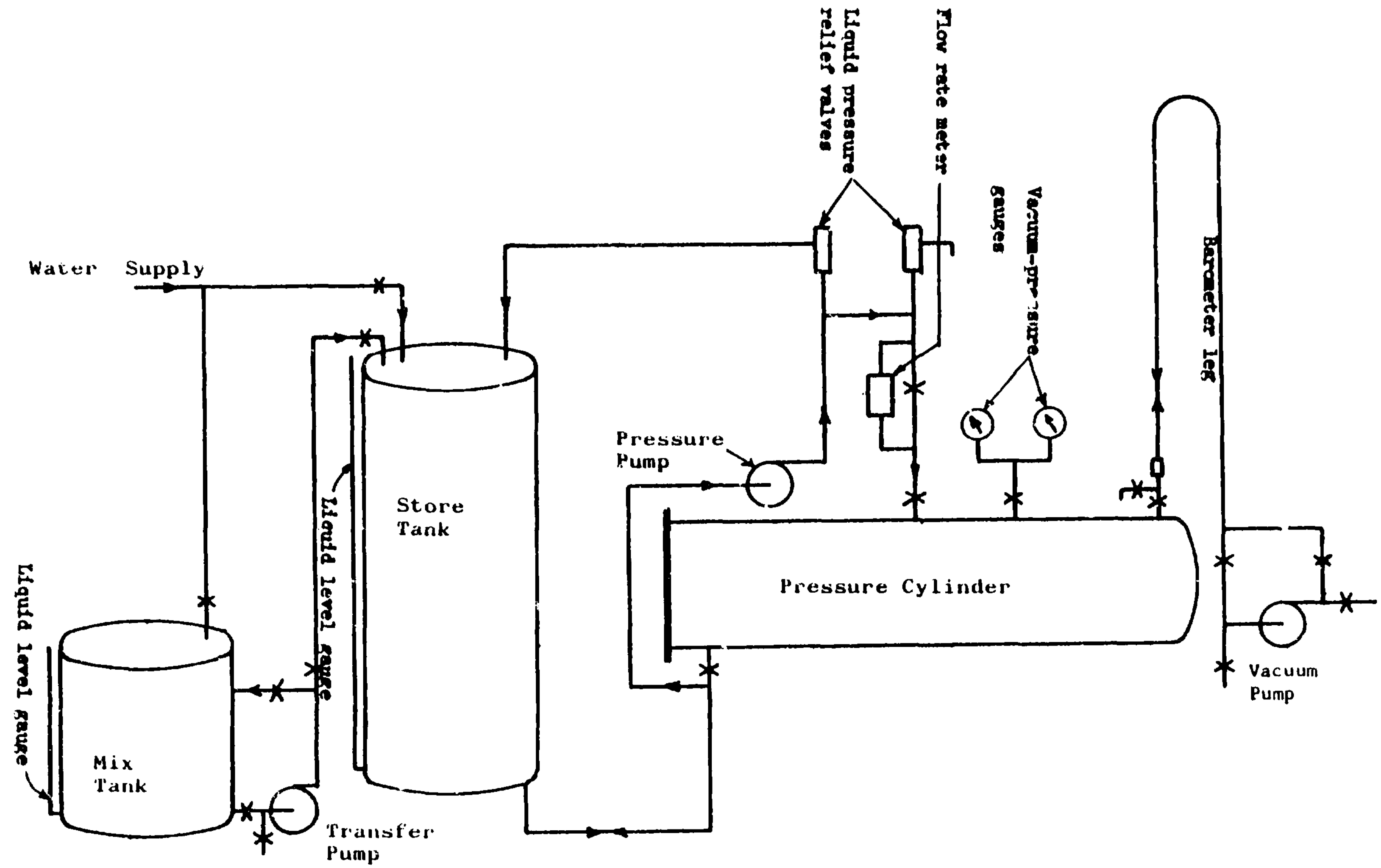

Fig. 2 - VACUUM-PRESSURE TREATMENT PLANT
Diagramatic only - Not to Scale

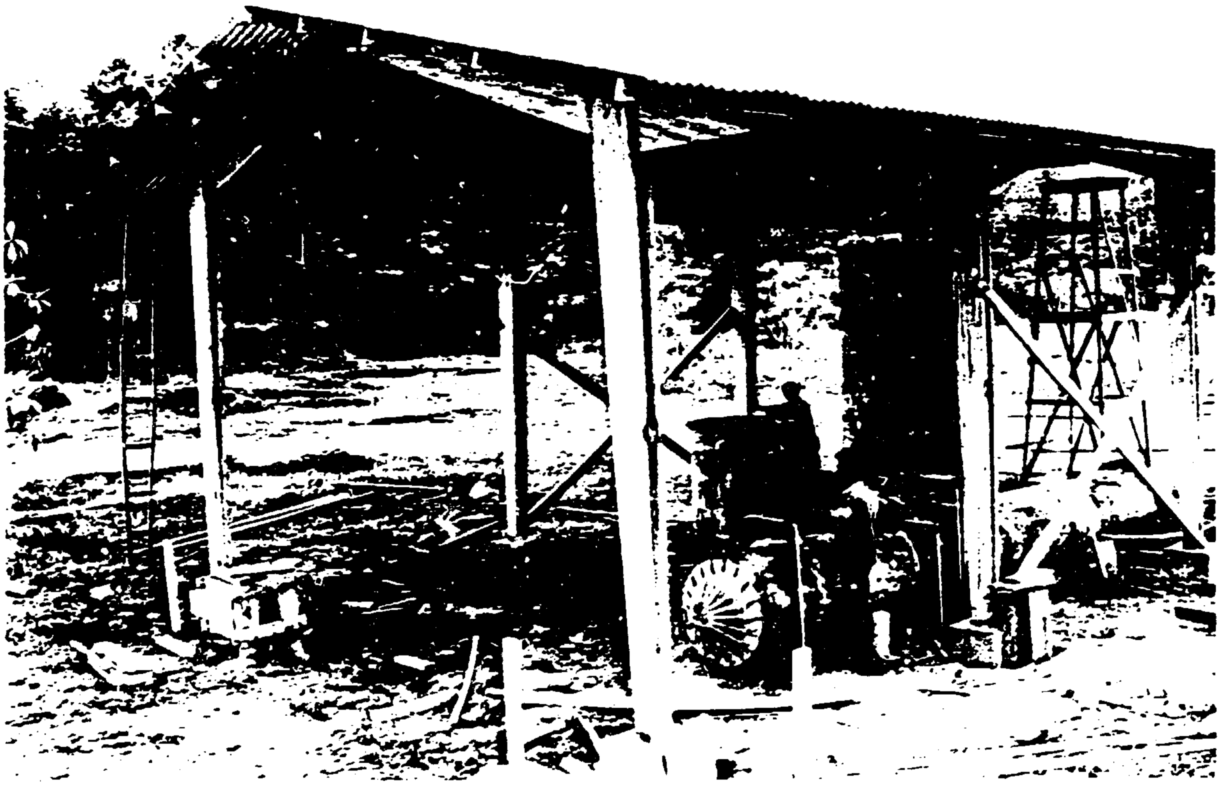

Figure 3 - Preservation Plant, Horana, Sri Lanka

With a positive displacement pump, more definite safety measures are required. A frequently used method is a barometric leg. This is an inverted U pipe, higher than a vacuum can draw water above the top level of the store tank. In practice it should be about 2 metres higher than this to avoid the possibility of overtopping by velocity surges. Such an arrangement makes it physically impossible to draw liquid over the top of the barometric leg and into the pump. If no rate-of-flow meter is fitted, then a subsidiary small tank must be fitted for rate-of-flow measurements.

Timber Handling

In almost all vacuum pressure plants, the charges of timber are run in and out of the plant in cradles mounted on flanged wheel bogies running on a light tramway. The rails extend to the rear of the cylinder, with a gap just at the door, which is bridged with short pieces of rail. Outside the cylinder a turnout is constructed in the tramway with two spur lines. In this way, a set of bogies may be unloaded, then reloaded with a fresh charge while the previous charge is being treated and the plant may operate continuously.

The cradles are made to closely fit the inside of the tank, so as to contain the maximum volume of timber. CAUTION. The cradles must never be so overloaded with timber that they have to be forced into the cylinder. Dry wood expands when it becomes wet. It has happened that a charge expands and becomes stuck in the cylinder. The effort involved in extracting such a stuck charge is very large, the more so if the cylinder is small and can only be entered on hands and knees.

Charges may be pushed into the cylinder by a tractor or by manpower. In small plants where no tractor is available a motorized capstan may be used to shunt the bogies in and out, using a pulley at the rear of the cylinder, and another at the ends of the spur tracks.

Freshly treated charges drip considerably. In the interest of environmental protection the area round the tracks should be sealed and graded towards the sump. In areas of heavy rainfall this area should also be roofed over.

4. SOLUTIONS

A treatment plant operator must be completely familiar with solutions, adjustments to solution strengths and the necessary calculations.

A solution is a completely liquid mixture of a solid in a liquid which cannot be separated by mechanical means. For treatment purposes the solid is CCA salts and the liquid is water.

Solution strengths are expressed as the weight of solid per volume of solution, in percentage form. Thus 10 kg of salt dissolved in water to make 100 litres of solution has a strength of $\frac{10}{100} \times 100 = 10\%$. Note that the solid occupies some volume in the solution. Thus 10 kg of salt dissolved in 100 litres of water will yield a volume of solution of nearly 110 litres, and the solution strength would be about 9%.

When making up solutions with salts, allow about 10 litres of volume per kg of salt. Run in this amount less than the volume of solution required of water into the mix tank, dissolve the salt completely, then make up to the required volume with water and mix again.

Example: To make 500 litres of 10% solution:
Weight of salt $= \frac{10}{100} \times 500$ kg $= 50$ kg
Volume allowance = 50 litres
Run in (500 - 50) = 450 litres of water
Add 50 kg of salt and dissolve
Make-up solution to 500 litres
Mix again.

For calculations, percentages are easier expressed in decimal form, e.g.:

10%	=	0.1
3.5%	=	0.035
0.8%	=	0.008

This practice is followed in the following worked examples. Also, remember the relationships:

$$\text{Strength} = \frac{\text{Weight}}{\text{Volume}}$$

$$\text{Weight} = \text{Volume} \times \text{strength}$$

$$\text{Volume} = \frac{\text{Weight}}{\text{Strength}}$$

Solutions are frequently altered in strength, and mixtures made of different strength solutions. The plant operator must be capable of carrying out the calculations involved without hesitation. In all these calculations, the same sequence is followed:

1. Calculate the weight of salt
2. Calculate the volume of solution.

Several of the practical problems encountered in a preservation plant will now be worked through.

1. Dilute 600 ltr of 10% solution to 2% strength

   Weight of salt = 0.1 x 600 = 60 kg (0.1 = 10%)

   60 kg = 0.02 x volume (0.02 = 2%)

   $$\text{Volume} = \frac{60}{0.02} = 3000 \text{ ltr}$$

   Ans: Make the 600 litres up to 3000 ltr with water.

2. The store tank contains 450 ltr of 2.5% solution.

   The mix tank contains 1200 ltr of 10% solution.

   5000 ltr of 2.5% solution are required in the store tank.

   What to do?

   Weight of salt in store tank = 0.025 x 450 = 11.25 kg

   Required weight of salt in store tank = 0.025 x 5000 = 125 kg

   Wt. of salt to add = 125 - 11.25 = 113.75 kg

   $$\text{Volume of 10\% solution containing this weight} = \frac{113.75}{0.1} = 1137.5 \text{ ltr}$$

   Ans: Add 1137.5 ltr of 10% solution to store tank.

   Make up to 5000 ltr with water.

3. The mix tank contains 800 ltr of 10% solution.

   The store tank contains 2000 ltr of 2.35% solution.

   4500 ltr of 5% solution are required.

   What to do?

Ans: Wt. of salt in store tank = 2000 x 0.0235 = 47 kg
Wt. of salt in mix tank = 800 x 0.1 = 80 kg
Total 127 kg
Wt. of salt required = 4500 x 0.05 = 225 kg
Additional wt. of salt required 98 kg
Amount of water required = 4500 - 2000 - 800 ltr = 1700 ltr.

Procedure: Transfer contents of mix tank to store tank (store tank now contains 2800 ltr)
Weigh 98 kg of salt into mix tank.
Add about 1600 ltr of water and dissolve the salt.
Transfer this to store tank (contents now about 3800 ltr)
Make up volume to 4500 ltr
Note that we did not need to make up an exact strength solution in the mix tank, the final adjustment of solution volume being made in the store tank.

4. The 5000 ltr store tank is nearly full at 4850 ltr of 2.3% solution and the store tank is empty. This has to be increased in strength to 3.5%.
What to do?

Ans: Existing wt. of salt = 4850 x 0.023 = 111.55 kg
Reqd. wt. of salt = 4850 x 0.035 = 169.75 kg

Additional salt required = 58.20 kg

If this is added as 10% solution, as in normal practice, the additional volume will be $\frac{58.2}{0.1}$ = 582 ltres. This would make the store tank overflow. Instead, the additional salt will be mixed in solution drawn from the store tank. However, as explained earlier, the salt takes up some room in the solution, and an adjustment will be required.

Run in 600 ltr of store tank solution into mix tank.
Weigh 58.2 kg of salt, dissolve in mix tank.
Read volume = 645 ltr
Increase in volume = 45 ltr
Prev. volume in store tank 4850 ltr
Total volume now 4895 ltr
Total salt 169.75 kg

Concentration	$= \frac{169.75}{4895} = 0.0347 = 3.47\%$	
Reqd. total salt	$4995 \times .035 =$	174.82 kg
Total salt	=	169.75 kg
Add salt		5.07 kg

Add a further 5.1 kg of salt to the mix tank and dissolve. A second adjustment will not be necessary. Run the mix tank contents into the store tank and mix with the circulating pump.

5. COPPER - CHROME - ARSENIC SALTS

Copper-chrome-arsenic treatment salts, generally abbreviated to CCA salts, are mixtures of:

- Copper sulphate $Cu\ SO_4$
- Sodium dichromate $Na_2\ Cr_2\ O_7$
- Arsenic pentoxide $As_2\ O_5$

The active elements are the copper, against fungus attack, and the arsenic against insect attack, but also with some efficacy against fungi. The dichromate acts to fix the first two elements on to the wood in a loose chemical bond. When fixed the copper and arsenic are no longer soluble in water and cannot be washed or leached out of the wood, even if it is used as marine piles or building foundations in damp soil.

The formulations and presentations used by different manufacturers vary slightly. It has been decided in New Zealand, which is a major user of CCA salts, that formulations with the active elements in the following proportions are all equally effective:

Cu	20%	-	30%
As	30%	-	50%
Cr	25%	-	45%.

Most CCA salts are sold as crystals, more or less finely ground. The copper sulphate may be the pentahydrate $Cu\ SO_4 - 5H_2\ O$ ("bluestone") or to save weight for transport anhydrous copper sulphate may be used. Coarse crystals are easy to handle but slow to dissolve. Powdered crystals dissolve quickly but blow about in strong breezes, which can be a hazard if small quantities have to be weighed out from bulk supplies. Where transport costs are not high, pasty very thick solutions may be supplied, which are easier to measure and handle than powders.

Where more than one brand of salt is available, plant operators should require the suppliers to advise the composition of the salts in terms of the active elements, and make a cost comparison in terms of the arsenic and copper contents. This work should be done by a chemist who is competent to calculate the various proportions by atomic weights.

6. TREATING

The procedure for treating a charge is:

1. Prepare the store tank solution to the strength required.
2. Run the timber charge into the cylinder and bolt the door in position.
3. Start the vacuum pump, with valves arranged to evacuate the cylinder.
4. Retighten the bolts.
5. Open the vacuum gauge valve, if a separate vacuum gauge is fitted.
6. When the vacuum reaches minus 85 kPa (25" of mercury) note the time. Maintain this vacuum for 30 minutes.
7. After 30 minutes, open the main valve to the storage tank and allow solution to be sucked into the cylinder. Do not let the vacuum drop below minus 75 kPa (22.5" of mercury).
8. When solution flows up the barometric leg and is visible in

the sight glass, close the main valve, the valve to the barometric leg, the vacuum gauge valve and stop the vacuum pump. Note the level of the store tank. Open the barometric leg drain valve.

9. Open the by-pass to the rate-of-flow meter and start the pressure pump. When the pressure reaches 1400 kPa (200 psi) note the time.

10. After the period appropriate for the type of timber, cautiously shut the by-pass to the rate-of-flow meter. If the flow rate has not fallen to the required value, continue pumping until it drops to the figure required. Note the level of the store tank and the time.

11. Turn off the pressure pump. Open the main valve to the store tank, arrange the vacuum pump valves to apply pressure, open the valves to the barometric leg and close its drain. Start the vacuum pump and blow the solution back into the store tank. When the cylinder is empty, a violent bubbling noise will be heard from the store tank.

12. Close the main valve to the store tank, change the vacuum pump valves to "suck" and draw a vacuum of minus 85 kPa (25" of mercury) on the cylinder.

13. After 20 minutes of vacuum, turn off the vacuum pump, open the barometric leg to atmosphere, open the cylinder door and withdraw the charge.

14. Measure the volumes in the store tank and sump, sample the store tank, then complete the treatment charge sheet.

The plant operator's duties are divided between physically operating the plant and the paper work required in completing charge sheets and mix calculations. For a period of an hour or so the operator will be physically engaged in controlling the plant at the end of one treatment cycle, changing the charges over, and starting the next cycle. During the pressure period there is nothing to do to the plant except keep an eye on the pressure gauge and an ear on the pump.

During this slack period the charge sheet for the previous charge is completed and new mixes may be made up in the mix tank. Make up of the store tank should not be done during this period however, since control of the volume pumped into the charge would be lost. Store tank make up should be done when there is no charge being treated.

The plant operator should not be required to load and unload timber into the cradles. That is labourers' work. However he should be in charge of moving the cradles in and out of the cylinder.

7. MIXING

Most CCA salts are supplied in powder form although one or two brands are supplied as pastes or liquids.

The first solution of CCA is usually mixed to a concentration of 10% since this makes the subsequent arithmetic simple. Mixes should be made as large as conveniently possible, to minimize errors. For a 1.2 m dia x 1.2 m deep tank a mix of 100 kg of salt diluted to 1000 ltr of solution would be reasonable.

Stirring is done with the transfer pump, and is an effective means of getting the powder to dissolve. Scales should be of large enough capacity to weigh both the batch of salt and its container in one or at most two weighings, and the arrangements should be such that weighing the powder and pouring it into the tank can be done without mess or spillage.

After mixing has been completed, the tanks, mixing platform, weighing container etc. should be washed down. Empty drums should be scrubbed out carefully, including seams and lids.

All protective clothing - gloves, mask and overalls should be washed inside and out and hung up to dry. If no overalls are worn, the operator should shower and change his shorts or sarong.

The hygiene precaution detailed in the final section should be strictly observed.

8. COMMISSIONING A NEW PLANT

After a new treatment plant is constructed, it must be tested to ensure that everything is working correctly, and that machinery is performing to specifications.

Most important are the calibration of liquid level gauges and pressure gauges. The mix tank and store tank gauges should be calibrated by weighing in water from a 209 ltr. drum resting on suitable platform scales. This is a tedious process, but more accurate than measuring the dimensions of the tanks and computing the graduation spacing. Graduations should be marked at every 10 ltr. level and numbered at every 100. At the same time the transfer pump performance can be checked.

The cylinder should then be filled with water and pumped up to pressure. Any leaks which occur should be rectified and the cylinder itself carefully inspected for weeping seams. A test should be made of how the cylinder holds its pressure with the pump off.

An accurate large diameter pressure gauge should be obtained and used to calibrate the two vacuum-pressure gauges, also to accurately set the two relief valves at 14.3 kPa (200 psi) and 15 kPa (210 psi).

The vacuum system should be tested and the gauges calibrated with the aid of a mercury-filled glass U tube, having one end connected to the cylinder with vacuum tubing. Again, the system should be tested for leaks and the ability of the cylinder to hold the vacuum should be tested.

Finally, all liquid level alarms and any safety interlocks which may be fitted should be tested. When all these tests are completed satisfactorily the plant may be considered ready for operation.

9. STARTING UP

There is much to be learned when a new plant is started up. The operator must learn the functions of the different valves, and know exactly what each valve does and why. He must also develop a "feel" for his plant. This will include a knowledge of how long it takes to fill and empty the tanks and cylinder, how long it takes to draw the vacuum and how far to open the flooding valve.

After a while this knowledge will become almost instinctive. Initially, several dummy runs should be made with water. This will lessen the risk of spilling large volumes of expensive poisonous solution. During these dummy runs, times for all operations should be taken and flow rates determined. The results should be made into a poster thus:

Transfer pump	- 8 minutes per 100 litres
Time for vacuum, empty cylinder	- 22 minutes
Blow-back time	- 7 minutes
	etc. etc.

This data, available at a glance, will help the operator to plan his work.

Pressure treatment requires experience of how a particular timber behaves in the process. The first half dozen charges must therefore be regarded as experimental. A fair volume of timber must be sacrificed to cross section colour tests. Also a large number of moisture content tests should be done, and in each charge about 10 pieces should be accurately measured and weighed before and after treating.

The pressure cycle should be prolonged, perhaps for 8 or 12 hours, with half hourly readings of the rate of flow meter and the levels of the store tank and sump. These readings should be made as accurately as possible since it is from the changes in readings that the process of impregnation may be followed.

The interpretation of this data should be done by an expert in wood preservation and a discussion of the factors involved is inappropriate in this Manual. Two primary decisions can be covered.

1. Can a particular result-type specification be met? Examination of the treatment records combined with colour tests will readily show if specification given in terms of retention and penetration can be met easily, with difficulty or not at all.

2. Assuming that such a specification can be met, what are the most economic parameters? The variables under the operator's control are vacuum and pressure periods, solution concentration and to a lesser extent initial moisture content. Systematic variation of each of these variables and sampling of a number of pieces of differing moisture contents will reveal trends in the treatment results. From these a schedule which will guarantee compliance in at least 90% of the pieces can be determined, and checked in practice.

10. RETENTION, PENETRATION AND COLOUR TESTS

Two requirements must be met for a piece of wood to be adequately treated. It must contain sufficient treatment salts, and these must be distributed over an adequate depth of wood.

The quantity of salts contained in a unit volume of wood is the "retention". This is specified in kg per cubic metre (kg/m^3) or pounds per cubic foot (lb/ft^3, pcf) if Imperial units are being used. The retention of a charge can be calculated from the charge volume, the solution strength and the volume of solution consumed in treating the charge.

For example: Charge volume 1.234 m^3
Solution strength 2.87%
Volume of solution consumed 456 ltr

Weight of salt	= 456 x 0.0387 kg
	= 13.087 kg
Retention	= $\frac{13.087}{1.234}$ kg/m^3
	= 10.6 kg/m^3

Retention can also be determined for individual pieces by weighing them before and after treatment. The dimensions of the piece should be measured accurately, and the solution strength must be known.

For example:

Timber dimensions	155 x 80 x 4850 mm
Weight before treatment	37.6 kg
Weight after treatment	55.0 kg
Solution strength	3.14%
Timber moisture content	25%

We can now calculate:

Volume of solution absorbed	= 55.0 - 37.6 ltr
	= 17.4 ltr (1 ltr of solution weighs 1 kg)
Weight of salt	= 17.4 x 0.0314 kg
	= 0.546 kg
Volume of timber	= 0.155 x 0.080 x 4.850 m^3
	= 0.0601 m^3
Retention	= $\frac{0.546}{0.0601}$ kg/m^3
	= 9.09 kg/m^3

Note that in neither of the above calculations is there any information yielded as to how the preservative is distributed in the piece or pieces of wood. In the first example, half the charge could have zero retention, and the other half a retention of 21.2 kg/m^3, but the average retention would still be 10.6 kg/m^3.

Even the more complicated individual weighing process does not tell the whole story. In the second example we can calculate:

Dry weight of wood $= 37.6 \times \frac{100}{125}$ kg

$= 30.08$ kg

Volume of solid wood substance $= \frac{30.08}{1.7} dm^3$

(see p. 2)

$= 17.69 dm^3$

Volume available for liquid $= 60.1 - 17.69 - (37.6 - 30.08) dm^3$

(Note: $100 dm^3 = 1 m^3$ (The volumes within the brackets give the volume of water initially in the wood at 25% mc.)

Volume of treatment solution $= 17.4$ ltr

Volume of wood not treated $= 34.89 - 17.4 dm^3$

$= 17.49 dm^3$

Proportion not treated $= \frac{17.49}{60.1} = 29\%$

This volume of "untreated" wood might be uniformly distributed at a microscopic level throughout the timber i.e. one cell in three approximately, or it might be in the form of an untreated core of dimensions about 10 cm x 3 cm through the length of the piece.

Another measure of treatment must be used. This is "penetration". Penetration is the depth to which the treatment solution has reached from the surface of the wood.

Ideally, penetration is measured by chemical analysis of the wood at various depths to determine the concentrations of the three active preservative elements Cu, Cr and As. This can only be done in a laboratory and is slow and expensive, and is not possible for industrial use. For plant purposes colour tests are used.

The element tested for in this way is copper. No satisfactory colour test exists for arsenic. It is assumed that if sufficient copper is present then a corresponding quantity of arsenic is also present, and this has been supported by numerous exact analyses.

Some species of wood, notably denser softwoods of Podocarpus species tend to screen out the copper near the surface of the wood, leaving the chromium and arsenic to penetrate. Colour tests would show a low penetration in this case and the assumption would be that the core was completely untreated, whereas in fact it might be adequately treated with arsenic against insect attack. At the same time, incomplete treatment has occurred and such timber should not be sold as "treated".

Two convenient tests are used to detect copper - the chrome azurol S test and the rubeanic acid test. Reagents and procedures are as follows:

1. 5 gm of chrome azurol S and 50 gm of sodium acetate are dissolved in 1 ltr of distilled water.
   This solution, sprayed on to wood will show a strong royal blue colour in the presence of copper. Untreated areas are orange.

2. (a) 5 gm of rubeanic acid (dithio oxamide) are dissolved in a one litre mixture of 90 parts of ethanol (or iso-propynol) and 10 parts of acetone.

   (b) Ammonia buffer. 1 part of 0.880 S.G. ammonia is diluted with 6 parts of distilled water, or 1 part of 0.91 S.G. ammonia is diluted with 4 parts of distilled water.

The wood is first sprayed with the ammonia solution, followed by spraying with the rubeanic acid solution. Copper containing areas show a greenish black to almost black colouration, untreated areas retain their natural colour. The colouration is permanent and samples may be kept for reference for years, if need be.

These reagents are most conveniently applied by spray, but they can also be brushed on. Cross section samples should be cut at least 0.5 m away from the ends of timbers. Alternatively a core borer ("increment borer") may be used to extract a small diameter specimen from soft timbers. In hard timbers a dowel plug cutter driven by an electric drill can be used to remove a core. In these cases the core should be taken in clear straight grained wood away from knots, splits or checks, and near the centre of the piece. Borings should be directed towards the centre of the piece to give a true cross section sample.

Even after the initial start up period a check must be kept on charge sheets and penetration test results to determine whether any undesirable trends are appearing, so that corrective action may be taken. The early detailed records will be found invaluable for this purpose.

11. TREATMENT RECORDS AND CALCULATIONS

It is essential to maintain records of all charges treated. The data on the calculation sheets will demonstrate that a consistent product is being sold and will protect the plant in any future disputes. They also show the operator whether he is maintaining the process under control and whether treatment to a satisfactory but not uneconomically excessive level is being maintained.

Two parallel lines of calculations are used where possible, a theoretical and an actual. The theoretical calculations predict what should happen under ideal conditions. The actual calculations show the facts. The nature and size of discrepancies allow the operator to take appropriate remedial action.

The aim of preservation is to impregnate the wood with a specific retention of salts (kg/m^3) to a specific penetration depth. The penetration may be complete or to a specified depth. From experience the volume of solution per m^3 of wood to achieve a specific result in any particular type of timber (that is, species, whether round poles or boards, high or low density, etc.) will be known. From this information, the volume of solution per m^3 of charge can be predicted, and thus the solution strength required to achieve the specified loading may be calculated.

Various volume and time measurements are taken during the treatment process, and these are compared with the theoretical ones. A pre-printed "charge sheet" is used to record the data and enter the calculation. The charge sheet reduces the possibility of errors and ensures that all necessary calculations are performed. A suitable sheet is shown in Fig. 4 and the same sheet, completed, in Fig. 5.

Company Name and Address | Date

Treatment Plant Address | Charge No.

Timber	Description	Volume m^3			
			Loading reqd.		Kg/m^3
			Expected uptake		l/m^3
			Expected consumption		ltr
			Salt reqd.		kg
			Solution conc. reqd.		%
	Total		ROF reqd.	l/m^3 x	l/min.

Store tank level start	l	Time start vacuum pump		
" " after flooding	l	Time reach 25" vac.		
Gross flooding vol	l	Time start flooding		
Sump level start	l	Vacuum period		
Sump level after flooding	l	Time start pressure		
Nett flooding vol	l	Time reach 14.3 kPa		
Gross cylinder vol	l	RoF l/min	time	
Less bogies at l	l	RoF l/min	time	
Nett cylinder vol		RoF l/min	time	
Less nett flooding vol		Pressure time		min
Displacement vol				
Store tank vol after flood		2nd vacuum reached		hrs
Store tank vol after pump		2nd vacuum released		hrs
Vol pumped		2nd vacuum period		min
Sump vol after kickback				
Solution vol consumed				

Solution SG at °C=	% start	Mix tank SG at °C=		%
Solution SG at °C=	% fin	Mix tank level		ltr
Average conc	%	Mix tank salt wt		kg
Wt salt consumed	Kg			
By tally	% Over)charge Under)	Store tank conc	%	%
		Store tank level	l=	Kg
By displacement		Total salt in solution		Kg
	% Over)charge Under)			

Store tank make up

In tank l at	%=	Kg
Require l at	%=	Kg
Salt required		Kg
Mix tank level		ltr
Reqd vol if	% soln	ltr
Final mix tank level		ltr

Comments

Mix tank make up

In tank l at	%=	Kg
Require l at	%=	Kg
Salt reqd		Kg
Mix tank first level		ltr
Mix tank final level		ltr
Check SG = at	°C=	%

Signed ....
Plant Operator

Fig. 4 Charge Sheet

Company Name and Address

Date

Treatment Plant Address

Charge No.

Timber Description		Volume m³
Medium density coconut		
	100×25	·745
	150×25	·439
	Total	1·184

Loading reqd.	5·4	Kg/m³
Expected uptake	380	l/m³
Expected consumption	450	ltr
Salt reqd.	6·39	Kg
Solution conc. reqd.	1·42	%
ROF reqd. 0·16 l/m³ x 1·184	0·019	l/min.

Store tank level start	4270	l
" " after flooding	1750	l
Gross flooding vol	2520	l
Sump level start	0	l
Sump level after flooding	10	l
Nett flooding vol	2510	l
Gross cylinder vol	3610	l
Less 2 bogies at 10 l	20	l
Nett cylinder vol	3590	
Less nett flooding vol	2510	
Displacement vol	1080	
Store tank vol after flood	1750	
Store tank vol after pump	1285	
Vol pumped	465	
Sump vol after kickback	105	
Solution vol consumed	360	

Time start vacuum pump	1005		
Time reach 25" vac	1032		
Time start flooding	1036		
Vacuum period	31		
Time start pressure	1044		
Time reach 14.3 kPa			
RoF	l/min	time	
RoF	l/min	time	
RoF	l/min	time	
Pressure time			min
2nd vacuum reached			hrs
2nd vacuum released			hrs
2nd vacuum period			min

Solution SG at °C = 1·44 start

Solution SG at °C = 1·48 fin

Average conc 1·455 %

Wt salt consumed 5·24 Kg

By tally $\frac{5.24}{6.39}$ = ·819 = 18% ~~Over~~) charge Under)

By displacement

$\frac{5.24}{6.39} \times \frac{1.184}{1.08} = .9$ 10% ~~Over~~) charge Under)

Mix tank SG 1·09 at 28 °C = 9·86 %

Mix tank level 1950 ltr

Mix tank salt wt 192·3 kg

Store tank conc 1·46 % %

Store tank level 1390 l = 20·3 Kg

Total salt in solution 212·6 Kg

Store tank make up

In tank 1390 at 1·46% =	20·3	Kg
Require 2500 at 1·50% =	37·5	Kg
Salt required	17·2	Kg
Mix tank level	1950	ltr
Reqd vol of 9·86 % soln	175	ltr
Final mix tank level	1775	ltr

Comments Timber heavily sapstained. May account for under charge

Mix tank make up

In tank	l at	% =		Kg
Require	l at	% =		Kg
Salt reqd				Kg
Mix tank first level				ltr
Mix tank final level				ltr
Check SG =	at	°C =		%

Signed ....

Plant Operator

Fig. 5 Charge Sheet - completed

An example will be worked through. The basic plant data are shown in Table 1 and refers to the plant at Horana and experience gained there. However the form of calculation applies to any vacuum-pressure plant.

	litres
Mix tank volume	1775
Store tank volume	6934
Cylinder volume	3470
Volume of 1 pr bogies	10
Sump volume	210
Tank scales graduated to read 10, estimate to 5.	
Coconut wood uptakes, per m^3, average from past experience.	
High density	210
Medium	330
Low	670

Table 1. Horana Treatment Plant Data

It is required to treat a charge of medium density coconut boards to a loading of 5.4 kg/m^3 with complete impregnation. Charge volume tallied at 1.184 m^3.

Following the charge sheet through, the known figures are entered in the appropriate places. These are the measured or calculated volume of timber, the specified loading and from previous knowledge, the rate of uptake of the type of timber being treated. From these figures, the expected salt consumption and volume of solution are calculated in the top right hand corner of the charge sheet.

The actual conditions are entered in the column on the left hand side of the sheet. Near the bottom of this section is a space for determination of solution strength by hydrometer. Since the solution in the tank is slightly stronger at 1.45% than the required strength of 1.42% the operator has gone ahead. He has maintained the vacuum for 7 minutes longer than the prescribed time. After flooding is complete, some solution has been sucked up the barometric leg. He has run this back into the sump and measured its volume as 10 ltr. During the pressure period, some leakage has occurred, and during the final vacuum excess solution is sucked out of the charge and runs into the sump when the cylinder door is opened. This is also measured and the volume taken into account.

A second solution strength test is taken after treatment is complete. A convenient time for this is during the second vacuum. This and the initial strength are averaged for the calculations.

Finally, the success or otherwise of the treatment is calculated, using both the tallied or calculated volume of the charge and the displacement volume of the charge. Neither volume will be absolutely accurate. Sawn timber is nearly always oversize; and even if planed, the actual lengths will be longer than the tallied lengths. Consequently, even if the exact volume of solution which is calculated is actually consumed, the retention in the timber will be less than that calculated, since the actual charge volume is bigger than that shown.

The displacement volume will not equal the timber volume either, since some solution will immediately soak into the surface of the wood. Consequently the displacement volume will be less than the timber volume, and the retention calculated from it will be lower than the actual retention.

12. SAFETY AND HYGIENE

CCA salts are poisonous, but provided some simple precautions are taken they can be handled with perfect safety.

Personal cleanliness is the simplest and most effective precaution. A wash basin and shower should be installed at the plant and every time the operator handles solution or salts he should wash. In addition, if he gets badly splashed and at any rate at the end of each shift he should shower and change his clothes.

Eating and drinking must be prohibited in the treatment plant area and the operator should not smoke while handling salts or solutions.

A major hazard of spills exists at any treatment plant, and danger of damage to plant or acquatic life can be very great if precautions are not taken. The major cause of spills is human error or forgetfulness - a water supply left running into a tank so that it overflows, or the cylinder blown back into a store tank which has insufficient volume left to accommodate the cylinder contents.

Water supply lines should be terminated with float valves, so that if a supply is turned on and forgotten, it will automatically shut off before overflowing. The store tank level gauge should have three red arrows marked MIX

CYL

MIX + CYL.

These are the levels in the store tank beyond which addition of the contents of the cylinder, the mix tank or both will cause it to overflow.

Of course there are many situations when a partly full mix tank or cylinder may safely be added to the store tank when its level is above these marks, but their presence should be a reminder to the operator that he is starting a potentially hazardous operation, and should help to prevent him from acting thoughtlessly.

The mix tank and the store tank should each be fitted with a float switch arranged to activate a car horn or siren when the liquid level is close to overflowing. This may not prevent spillages, but it should stop them from being very large.

Finally, the float valves and level switches should be tested once a week.

In some countries, regulations require that personnel handling CCA salts wear ankle length waterproof aprons, gauntlets and rubber boots and also wear a dust filtering respirator. In the writer's opinion the need for these is determined by factors such as the coarseness or powderiness of the salts, whether the air is still or breezy and the normal working dress of the operator. If coarse crystals are handled in the open by an operator who wears only shorts or a loincloth and if he stays upwind of the operations, a quick shower will be much more effective than hot and possibly contaminated protective clothing. Such requirements may be essential in a cold climate with warmly dressed workmen but are not necessarily appropriate everywhere. As a minimum, a dust filtering respirator and unlined rubber or plastic gauntlets should be worn when handling salts. The operator should always wash after handling salts or solutions.

Proper handling and measuring tools should be used and should be confined to the treatment plant area. These should include a square mouth shovel, plastic containers for weighing salts, scales for weighing up to 50 kg or 100 kg. This equipment should not be used in any other area since it will inevitably become contaminated with salts. This would be a hazard to workmen who are not aware of the poisonous nature of CCA salts.

13. SPECIFICATIONS

A very large number of preservation specifications have been prepared around the world by various authorities in different countries. They may vary from quite simple brief specifications to complicated documents with detailed requirements for elemental loadings, inspection and tests.

There are two different approaches to specifications: process-type specifications and results-type specifications. A "process-type specification" details solution concentration, pressures and times, for each type of wood to be treated. It is simple to follow but does not allow the operator any flexibility to take advantage of favourable timber, nor does it necessarily require him to increase treatment times or concentrations in batches of difficult-to-treat timber.

A "results-type specification" lays down the loadings and penetrations required; within limits the operator may vary the process as he wishes so long as these results are achieved. Compliance with a results-type specification requires more skill and experience on the part of the operator, but the level of treatment achieved is likely to be more uniform and ther may also be significant economic advantages compared with a process-type specification.

Various loadings and penetrations are specified according to the hazards of the service environment and the life expected from the treated timber, and also the end use. For example the inspection requirements for foundation piles, which are difficult and expensive to replace, are much more stringent than those for fence posts in the same environment where premature failure of a few posts has little more than nuisance value.

For Sri Lanka the expert proposes the initial adoption of three levels of treatment. These should give protection as follows:

1. Low hazard: Interior timbers protected against boring insect attack only
2. Medium hazard: Exposed building timbers such as barge boards, gates etc which are wetted by rain or condensation, but not in contact with the ground or permanently wet
3. High hazard: Timbers buried in the ground or in permanently damp situations.

The following specifications are abbreviated versions of the NZ Timber Preservation Authority standards C8 (low hazard), C7, moderate hazard and C3, high hazard. They will cover the majority of requirements for all structural work except for marine and foundation piles, and transmission poles.

Specification 1: Building Timbers - Low Hazard.

This specification applies to building timbers out of ground contact in situations which are continuously protected from the weather by roofs, external walls and paint, and are adequately ventilated. This includes timber which will be cut during installation such as framing, interior finishing, flooring, ceiling lining and weatherboards. Timber treated to this specification is protected only against insect attack and protection against fungal attack is minimal.

Specification 2: Building Timbers - Moderate Decay Hazard.

This specification applies to sawn timber to be used in moderate decay hazard situations where it may be exposed to the weather or occasional dampness, but is not in contact with the ground, such as barge boards, joinery 1/, garden furniture, fence palings 1/, unroofed exterior structures.

Specification 3: Posts and sawn timber buried in the ground or in contact with the ground, or in situations favourable to decay such as bridge or wharf decking, damp areas in wet process factories, fire escapes and other permanently damp situations.

This specification does not include marine piles, utility poles or foundation piles.

Requirement common to all specifications are:

1. These specifications apply to timber which can be consistently treated to satisfactory levels of retention and penetration by means of the vacuum-pressure (Bethell) process using copper chromium - arsenic preservatives.
2. Immediately before treatment the moisture content of any part of the zone to be treated shall not exceed 25 per cent.
3. An initial vacuum of not less than minus 85 kPa (25" Hg) shall be drawn and maintained for a period of 30 minutes before flooding the cylinder with solution. During flooding the vacuum shall not be allowed to drop below minus 75 kPa (22" Hg).

1/ The NZTPA specifications for these two items differ slightly from this specification, being more stringent for joinery and less stringent for fence palings in the requirements for penetration. At the initial stages of a developing industry these appear to be unnecessary refinements.

4. The solution temperature shall not be more than 49°C.

5. The pressure shall be maintained at 14.3 kPa (200 psi) for not less than the following periods:

Timber thickness	Pressure period
up to 20 mm	1 hour
21 mm - 37 mm	2 hours
38 mm and thicker	3 hours

and in any case until the rate of flow of solution into the cylinder has dropped to:

Specification	Rate of flow
1	0.016 ltr/m^3/minute
2	0.016 ltr/m^3/minute
3	zero.

6. After completion of the pressure period and emptying of the cylinder of solution, a vacuum of not less than minus 85 kPa (25" Hg) shall be drawn and maintained for not less than 30 minutes.

7. A charge sheet of the type shown on Fig. 4 of this report shall be completed for each charge. Copies of all calculations made for solution mixing shall be kept. Records of actual and theoretical salt consumption and stocks shall be kept and shall be updated daily, if several charges are treated in a day or after each charge is treated.

8. Solution strengths shall be determined by the use of hydrometers and charts approved by the manufacturer of the preservation salts.

9. The specifications apply to copper-chrome-arsenic formulations which have the active elements in the following proportions:

Copper:	20 - 30%
Chromium:	25 - 40%
Arsenic:	30 - 50%.

10. Loadings and penetrations shall comply with Table 2.

11. Penetration shall be measured by colour testing for copper on cross sections or cores taken at least 0.5 m from the end of the piece.

12. Timber which does not comply with the specification after treatment may be:

    1. Dried and retreated.
    2. Sold as complying with a lower class specification if it complies with that specification.
    3. Sold as untreated.

Toxicity of CCA Treated Timber

A frequent question raised by users of CCA treated timber relates to the toxicity of the treated wood. Arsenic is a well known poison and is notorious for having featured in many cases of murder and accidental poisoning.

After wood is impregnated with CCA salts, a chemical reaction occurs whereby the salts are fixed on to the cell walls. This fixation is about 97% complete as has been demonstrated by numerous laboratory leaching tests. This reaction is not immediate, but takes about 2 weeks to complete.

Timber which has just been removed from the treatment cylinder and is dripping with solution is poisonous and should be handled only by workmen wearing gloves. Drips should be confined to a sealed area leading to a sump.

After the timber has dried it is perfectly safe and contains almost no free arsenic. To ingest a lethal dose of arsenic it has been calculated that a human would have to consume 0.5 kg of timber treated to a retention of 8 Kg/m^3. That quantity is manifestly absurd.

New Zealand is the country with the highest per capita consumption of CCA salts. Most of this is used in the preservation of posts and poles for pastoral and horticultural farming. Most of these farm products are exported, being New Zealand's major industry.

TABLE 2 - RETENTION AND PENETRATION REQUIREMENTS

	1. Building Timbers - Low Hazard	2. Building Timbers - Moderate Hazard	3. Building Timbers - High Hazard and Ground Contact
Retention	Tanalith NCA 3.2 Kg/m^3 Celcure AN 3.2 Kg/m^3	Tanalith NCA 5.4 Kg/m^3 Celcure AN 5.4 Kg/m^3	Tanalith NCA 10.1 Kg/m^3 Celcure AN 10.1 Kg/m^3
Penetration	Sapwood: Complete Penetration	Sapwood : Complete Penetration	Sapwood : Complete Penetration Not less than 10 mm envelope
Retention Zone Loading	Sapwood core : 0.04% arsenic	Total active element loading of 0.36% of oven dry wood weight. Minimum elemental loadings: Cu 0.07% o.d. wood wt Cr 0.09% " " " " As 0.11% " " " "	Total active element loading of 0.66% of oven dry wood weight. Minimum elemental loadings : Cu 0.13% o.d. wood wt Cr 0.17% " " " " As 0.20% " " " "

Children's playground equipment in schools and parks is commonly constructed from CCA treated fencing materials since it is rugged, cheap and durable.

This would never be permitted in N.Z.'s rigid health and safety regulatory climate if there were any suspicion that CCA treated playground equipment was dangerous to children.

The CCA treatment process results in a de-toxification of the arsenic and it remains so until the wood is destroyed by burning.

Ash from CCA treated wood is toxic and should be buried. CCA treated wood should not be used for barbecuing or for charcoal manufacture, nor should it be used for cooking in an enclosed place.

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