CHAPTER TWO

SURVEYING OF RUBBER SMOKING FACTORIES

SUMMARY

This chapter gives results of a survey of 25 rubber smoking factories to acquire information on rubber smoking technology and the amount of firewood used. Two types of smoking rooms were found in the survey:- single and double layer rooms. The double layer room is an old design and thought to be inefficient. Results obtained from the survey data were analysed with emphasis on energy (firewood) aspect. An energy analysis showed that both single and double layer rooms can possibly be improved by increasing loading density, wood burning rate and ventilation. The rubber industry was found to be a net producer of energy. The smoking process consumes only a small fraction of the available biomass obtained from replanting rubber trees.

2.1 INTRODUCTION

The research team agreed in principle that the technique of making smoked rubber must be well understood before an attempt for energy conservation could take place. The survey of rubber smoking factories will justify the succeeding activities of the project and at the same time pave way for cooperation with rubber smoking industry. The survey was confined to the Southern part of Thailand only.

2.2 PLANNING OF SURVEY

List of rubber smoking factories was kindly provided by the Center for Industry Promotion, Southern Branch. Letters requesting for permission to visit and collect data were sent to selected factories. Questionnaire was designed for the survey. Plan for travel was set and personnels involved were identified for early and late summer 1990 activities. Summer (March-May) is an appropriate time because of the University vacation but, unfortunately, is the fall season when latex tapping; hence rubber sheet making, is not possible. However, in early March and May, there were some large factories, which stored raw material (for the year-round operation), still operating. Number of factories visited and locations are shown in Table 2.1 and Figure 2.1.

2.3 RUBBER SMOKING TECHNIQUE

2.3.1 Making of Rubber Sheets [1,4]

Latex is obtained from the latex vessels without damaging the trees by the process called tapping. A slice of bark is shaved off with a special knife to a depth just short of the cambium layer. The cut is made at an angle of 25-30° to the horizontal to sever the maximum number of latex vessels. Tapping is done before sunrise, when the turgor pressure in the tree is maximum and the yield of latex highest. The latex flows from the cut along a metal spout and into a cup made of glass or glazed earthenware. Tapping is continued at regular intervals by reopening the cut down the tree. A very common method is to tap each tree halfway round the circumference every other day (half-spiral, alternate daily). After about 5 years, the tapped panel is rested and the bark allowed to regenerate. A new panel is opened on a different area of the tree.

Immediately after tapping, the latex flows rapidly, then declines to a steady rate, then slows down and finally stops. The stoppage of the flow is due to "plugging" of the latex vessels by the coagulum formed at the opening of the cuts. With yield stimulants, which were developed in the late 1960's, this plugging process can be belated and so the yield increased. Yield stimulants are ethylene liberating chemicals and are applicated to the bark near the tapping cut.

A tapper will normally tap about 500 trees each day, covering about 7 rais to do so. Tapping will be completed by mid-morning after which the latex in the tapping cups is collected and then transported to the place where it is to be processed.

Latex collected from rubber plantation is coagulated with formic acid. Before coagulation sets in, aluminium partitions are inserted vertically in slots in the coagulating tank. After storage for a few

Table 2.1 Number of Factories Visited by Provinces.

Province	No of Factories	Double * Layer	Single * Layer
Nakornsrithammarat	6	4	2
Surathani	6	3	3
Songkla	6	2	4
Phuket	3	1	2
Krabi	2	1	1
Trang	2	2	0
Total	25	13	12

* There are two types of smoking rooms; double layer and single layer rooms, see details in section 2.3.

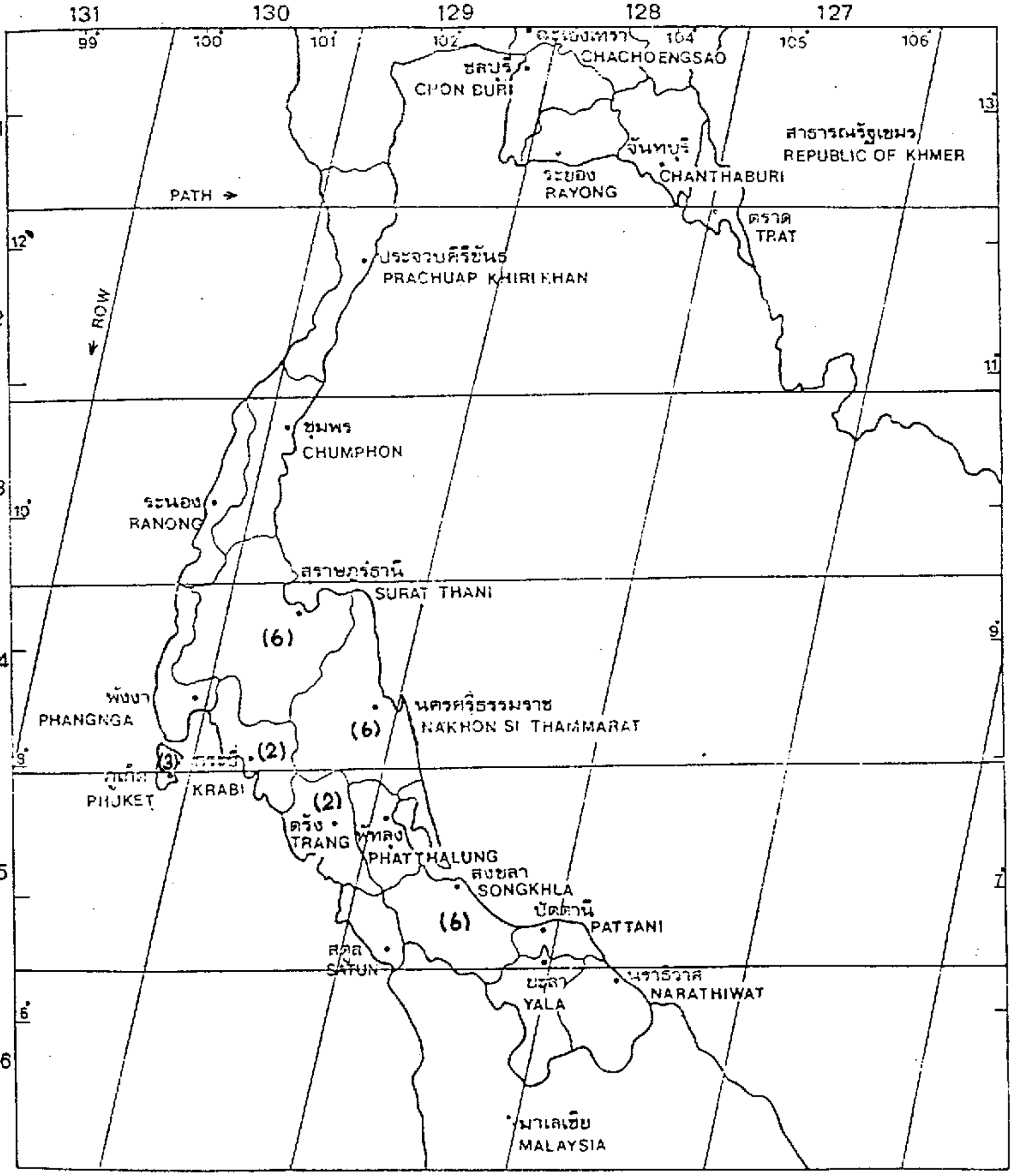

Figure 2.1 Geographical locations of factories visited

hours, the soft thick gelatinous slabs are compressed by passage through four to six rollers to remove water and produce sheets of about 5 mm thickness. The last pair of rollers are grooved and thus produce the characteristic criss-cross rib markings on the sheet. This pattern increases the surface area and facilitates drying.

2.3.2 Making of Smoked Sheets.

The rubber smoking factories acquire ribbed unsmoked rubber sheets through local dealers. Skilled workers in the factories visually grade the rubber sheets according to the moisture content and thickness. The sheets will subsequently be washed manually in a pool or by a machine before entering the smoking rooms where they are dried and cured for 5-9 days depending on the moisture, thickness and season. At the begining all windows and ventilating ports (of the smoking room) are open and the firewood is burnt at a high combustion rate to bring up the room temperature to 40-50°C in a short period. After reaching the required temperature, ventilation is prohibited and the opening of the furnace is adjusted to control the firewood burning and hence keep the temperature in the room at about 70°C. The process continues until the rubber sheets are dried and cured. The smoked sheets are then pressed to form bales of about 110 kg, wrapped with the sheets and coated with talc to hinder bale-to-bale adhesion.

2.3.3 Source of Energy.

At present rubber trees that are fallen down to make way for replanting are used exclusively as fuel in the rubber smoking industry. In Thailand rubber plantations cover an area of over 10.735×10^6 rais of which 90% is in the South and the rest is in the Eastern region [2].

Because of shortage of other types of wood in the country, rubber wood has been put to more uses recently. Through chemical treatment, a significant amount of rubber wood is converted into saleable commercial consumer products such as furniture, construction timber and toys and is increasing. It is envisaged that in the near future firewood will become scarce due to the worsening fuelwood situation in the country. The shortage and escalating price of rubber wood has already affected some rural industries, e.g. palm suger production [5]. As the price increases, fuelwood may be soon fading from the energy scene in other industries too. Its primary role in heat supply will be taken over by other sources of energy. But the smoked rubber industry cannot adopt other kinds of energy since smoking is an essential part of the process. The smoke acts as a disinfectant which renders the rubber less susceptible to mould attack.

2.3.4 Smoking Rooms and Furnaces.

It was found from the survey that there are two types of smoking rooms, called single and double layer rooms. Single layer rooms have one floor while double layer rooms have two (Figs. 2.2-2.4). The double layer type, which is an old design, has timber or brick walls. In the last 10-15 years one-layer big rooms have been considered the better design. A continous smoking process has been developed in neighbouring Malaysia, but no such process was found during the author's survey.

2.3.4.1 Double layer smoking rooms.

Although this is an old design, a great number of them are still in use. The rooms typically have the size of 2x6x4 m^3 with 2 rubber-hanging layers. The rubber sheets are hung on bamboo stems which are 2 metres long and 1.5-2 cm apart. About 2 matres above the furnace, bamboo stems are spread to form the floor and heat distributor. Moisture and heat exhaust through 0.5x0.5 m^2 windows up on the ceiling and walls.

2.3.4.2 Single layer smoking rooms.

The single layer smoking rooms are being adopted in the new factories and have become popular because their performance is superior to those of the double layer ones. The rooms are constructed of brick and mortar and the typical size of the rooms is 8x8x6 m^3. The front wall is typically a steel gate for loading and unloading the rubber. Ventilating windows are on the rear wall and the ceiling. The rooms are generally equipped with temperature sensing elements for temperature monitoring and control. Heat and smoke distributing tunnels are on the floor. The rubber sheets are hung on bamboo stems

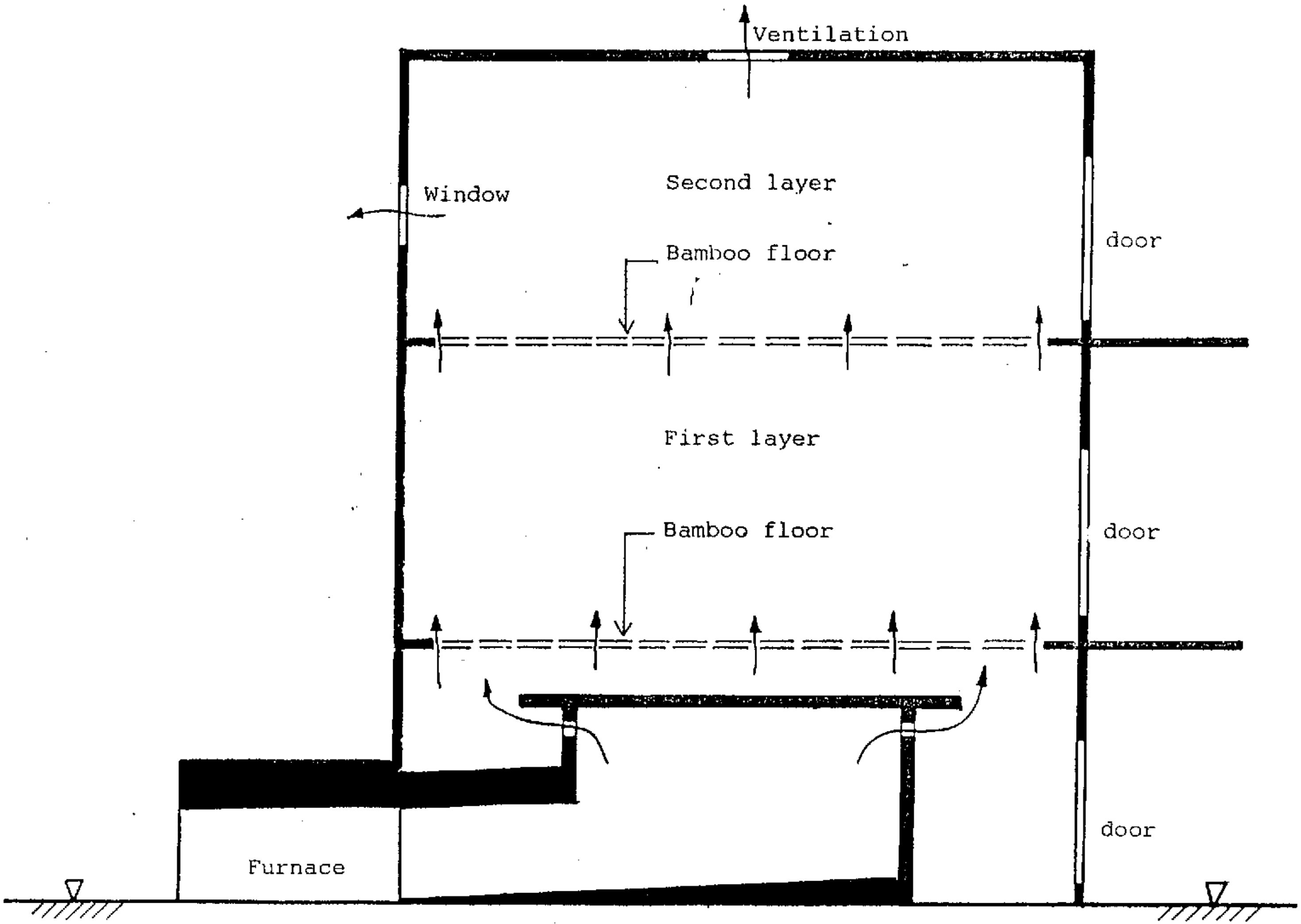

Figure 2.2 Double layer room

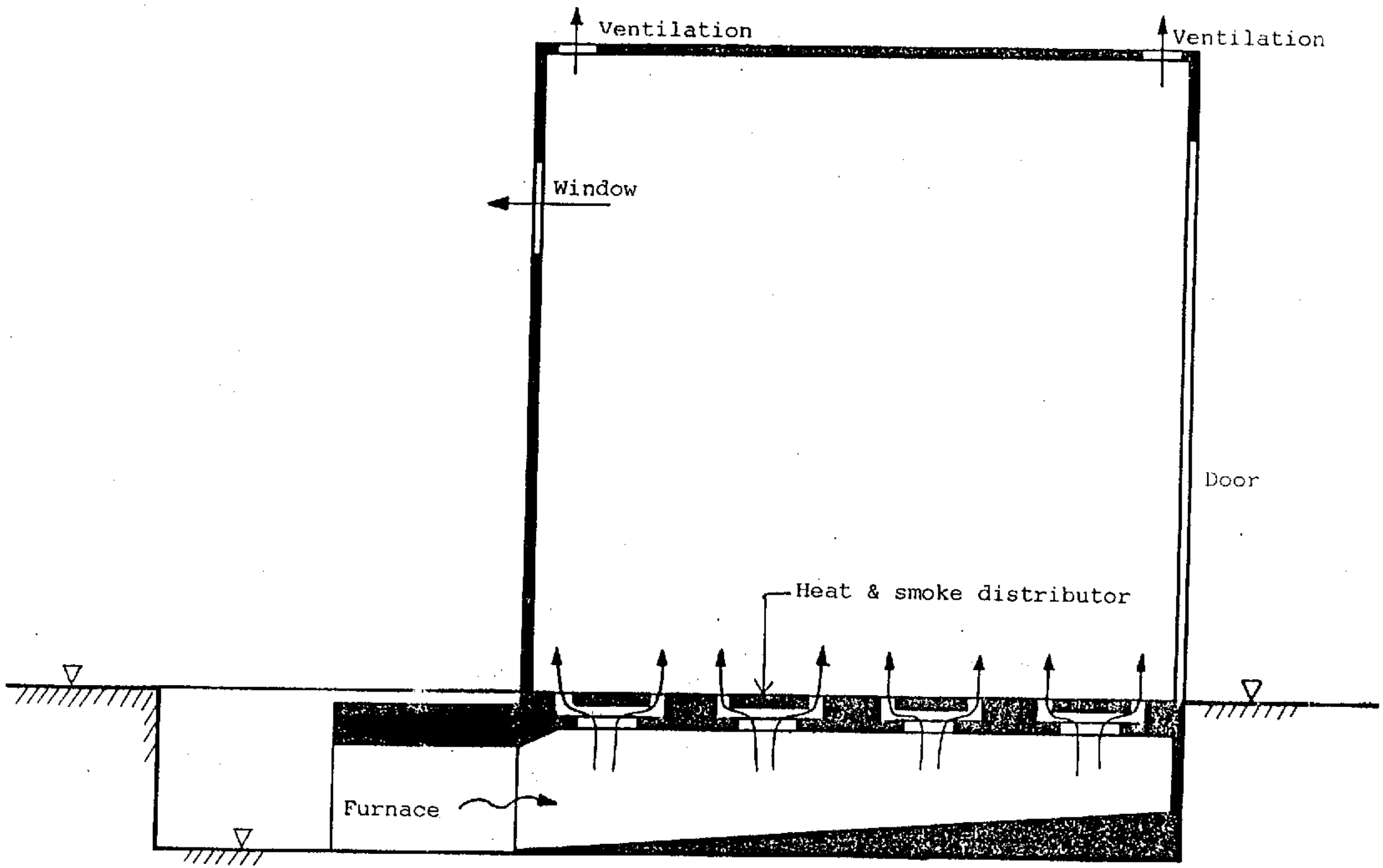

Figure 2.3 Single layer room (outside furnace)

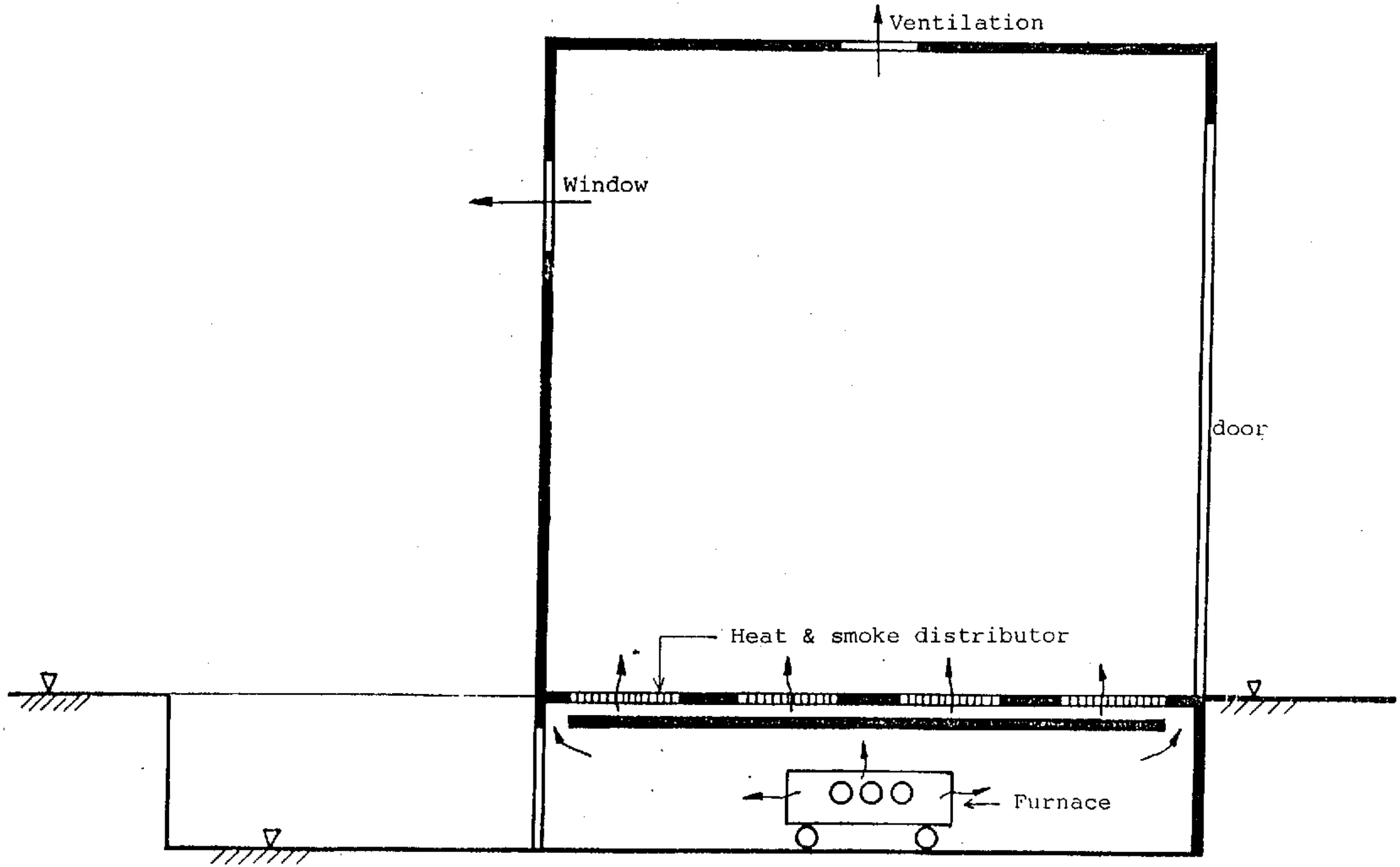

Figure 2.4 Single layer room (furnace underneath)

which are subsequently placed on 4.5x2x2 m^3 steel crates. A forklift truck is used to manoeuvre the crates into and out of the rooms.

2.3.4.3 The Furnaces.

Furnaces are normally located behind the rooms and about 0.5 metres below the floor. Hot gas and smoke are conveyed through the distributing duct and into the room. It was found from the survey that the furnaces can be classified according to their positions into two types :- those outside the room and those undereath the room (Figures 2.3 and 2.4). In the underneath-furnace type, a metal cart, traveling along a pair of rails, is used as a wood-burning carrier. However, the outside type is more popular because of safety concerns. It normally has dimensions of 0.6x0.6x1.5 m^3 and is constructed from refractory brick. The combustion rate is controlled by an adjustable steel gate in the front. The heat distribution duct was designed to have a 15-20 degree slope as shown in Fig. 2.3.

2.4 ENERGY USED IN THE PROCESS.

Tables 2.2 and 2.3 show the data collected from the survey. The analysed data are tabulated in Table 2.4. It shows the superiority of the single layer rooms to the double layer ones in terms of specific wood consumption (SWC) (m^3/t) and the specific fuel cost (SFC) (Baht/t). The average SWC of the double layer rooms (0.36 m^3/t) is over 70% higher than that of the single layer rooms (0.21 m^3/t). Even though the average fuel prices of the two types of rooms are about the same (129 and 127 Baht/m^3), the double layer rooms's SFC is 60% higher.

Loading density is defined as the ratio of room capacity (tons of rubber) to the room volume (m^3). The plot of SWC against loading density of the double layer rooms is shown in Fig. 2.5. It was found that SWC decreases with increasing loading density. Although the optimum point, for minimum SWC, should exist, it did not appear in this survey data. This therefore implies that the double layer rooms can be loaded more than is presently practised. Increased loading (that is, increases loading density) might, however, have an adverse effect of lowering monthly production unless the smoking time does not

Table 2.2 Survey Data of Double Layer Rooms.

No	Productivity (t/month)	Smoking Room Vol (m^3)	Smoking Room Capacity (t)	Smoking Room Number of Rooms	Firewood Wood Used (m^3/room)	Firewood Price (Baht/m^3)	Smoking Period (Days)
1	800	288	23	20	9.0	140	8-9
2	1200	144	15	18	3.7	130	4-7
		252	31	3	-	-	-
3	1200	288	25	12	8.0	140	6
4	700	324	21	3	9.0	150	4-7
5	730	144	11	18	4.2	90	5-10
6	800	192	16	12	5.5	130	7-8
7	750	192	16	10	-	130	4-5
8	400	216	20	10	11.2	110	7-10
9	800	216	17	16	6.1	150	6-15
10	750	399	22	16	7.3	150	8-10
11	500	216	18	17	5.8	120	9-12
12	750	100.8	6	20	3.6	120	3-7
13	2000	336	15	5	6.3	120	4-5
		252	22	27	6.3	120	4-5
					Average	129	7

Table 2.3 Survey Data of Single Layer Rooms.

No	Productivity (t/month)	Smoking Room			Firewood		Smoking Period
		Vol (m^3)	Capacity (t)	Number of Rooms	Wood Used (m^3/room)	Price (Baht/m^3)	(Days)
1	800	294	16	10	5.0	140	4-7
			23	6	5.0	140	4-7
2	5000	180	14	33	3.6	110	3-4
		317	28	16	7.3	110	3-4
		792	42	1	7.0	110	3-4
3	1500	384	22	20	6.4	160	4-5
4	1800	384	25	18	-	130	5
5	1800	384	25	12	3.7	130	4-5
6	1000	216	18	22	4.3	120	3-7
		467	25	6	6.0	120	3-7
7	1200	281	18	20	5.7	140	3-7
8	1500	252	25	25	-	140	5-10
9	1300	343	18	15	4.5	120	4-8
10	600	369	20	12	5.8	120	5-6
11	2500	591	22	24	8.0	120	5-6
12	4000	537	35	20	5.5	100	5-6

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Table 2.4 Analysed Data

No	Productivity (t/month)		Loading Density ($x10^3$ t/m^3)		SWC (^{3}/t)		SWC (m^3/month)		SFC (Baht/t)		MPD (t/m^3/month)	
	SL	DL	SL	DL	SL	DL	SL	DL	SL	DL	SL	DL
1	800	800	54.4	79.8	0.31	0.39	133	312	43.4	56.4	0.15	0.14
			na		0.22		81.5		30.8			
2	5000	1200	77.8	104.2	0.26	0.25	631	300	28.6	32.5	0.42	0.34
			75.4	119.0	0.26	na	612	na	28.6	na		
			53.0		0.17		37.5		18.7			
3	1500	1200	57.3	86.8	0.29	0.32	435	384	46.4	44.8	0.19	0.35
4	1800	700	65.1	64.8	na	0.43	na	301	na	64.5	0.26	0.72
5	1800	730	65.1	76.4	0.15	0.38	270	277	34.2	19.5	0.39	0.28
6	1000	800	83.3	83.3	0.24	0.34	142	272	28.8	44.2	0.39	0.35
			53.5		0.24		98.4		28.8			
7	1200	750	64.1	83.3	0.32	na	384	na	44.8	na	0.21	0.39
8	1500	400	99.2	92.6	na	0.56	na	224	na	61.6	0.24	0.18
9	1300	800	52.4	78.7	0.25	0.36	325	288	30.0	54.0	0.25	0.23
10	600	750	54.1	55.1	0.29	0.33	124	248	34.8	49.5	0.14	0.12
11	2500	500	32.7	83.3	0.37	0.32	925	160	44.4	38.4	0.18	0.14
12	4000	750	65.2	59.5	0.16	0.60	640	450	16.0	72.0	0.37	0.37
13	-	2000	-	44.6	-	0.42	-	94.2	-	50.4	-	0.24
				87.3		0.29		515		34.8		
Avg			63.8	80.0	0.25	0.38			30.7	49.0	0.27	0.30
					0.21*	0.36*						

* Calculated from total monthly productivity (t/month) and wood consumption (m^3/month)

SWC = Specific Wood Consumption (cubic metre of stacked wood per ton of rubber produced).

SFC = Specific Fuel Cost.

MPD = Monthly Productivity Density.

SL,DL = Single and double layer room, respectively.

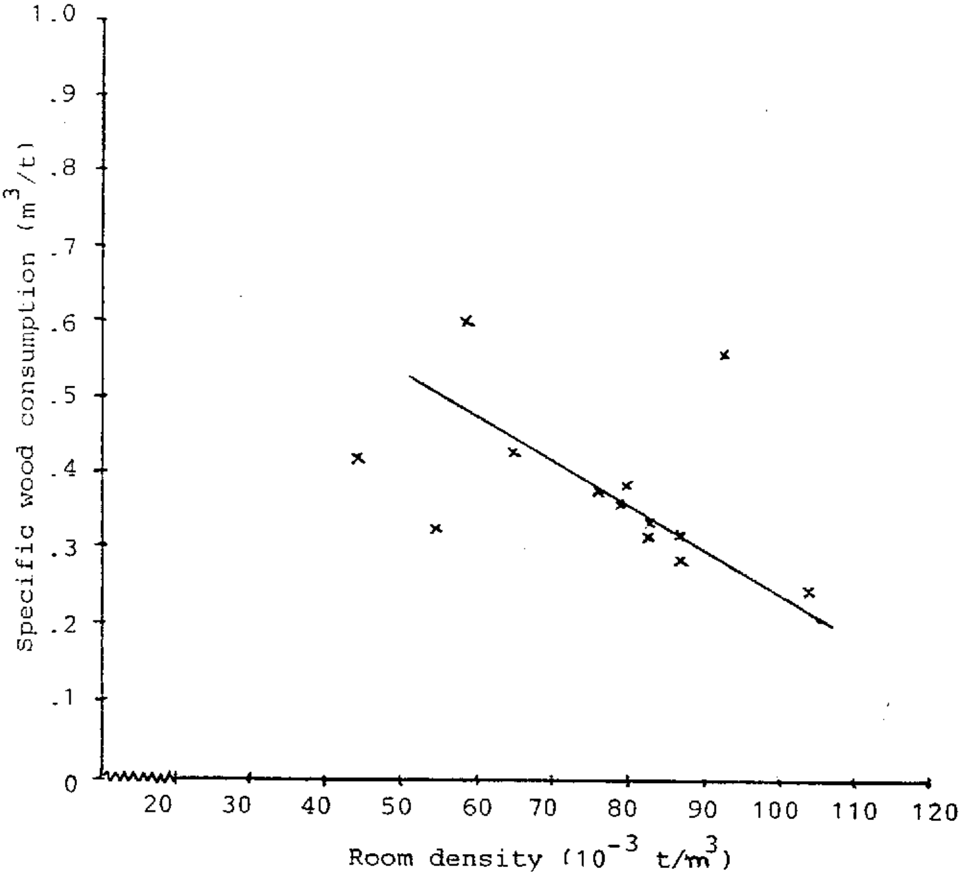

Figure 2.5 Effect of loading density on specific wood consumption of double layer rooms

increase. The smoking time can be unchanged or reduced by means of a high wood burning rate and ventilation as will be discussed later. At present, the smoking time of the double layer rooms is about 2 days longer than that of the single layer rooms. The lower loading density in the single layer rooms is responsible for the shorter smoking time. The loading densities of the single and the double layer rooms are 63.8×10^3 and 80×10^3 t/m^3, respectively.

It was also observed that the smoking period of the double layer rooms varied markedly from one factory to another (Table 2.2). This may be caused by inconsistent wood burning rates, different furnace designs and ventilation. Since the plot of SWC is inversely proportional to the loading density (Fig. 2.5), it indicates that some factories achieved the shorter processing time by increasing the wood burning rate and, subsequently, ventilation. Factories 6 and 7 in Table 2.2 are good examples. Nevertheless, the room parameters are identical, the smoking time spent in Factory 7 was about half of that in Factory 6. It is likely that in common practice the operator closes the windows and the wood burning rate has to be slowed down to aviod overheating. However, with closed windows, the smoking time will be longer and more wood will be consumed. In the very humid climate of Southern Thailand, ventilation is necessary in the drying process.

When examining the monthly productivity density (MPD), it is surprising that the double layer rooms are slightly more productive than the single layer rooms (0.30 compared to 0.27 t/m^3 per month). Thus, if the loading density (of the double layer rooms) increases as proposed and the processing time does not change much, i.e. increase the wood burning rate, it is possible to get even higher productivity than the single layer rooms do. However, the single layer rooms can substantially increase their loading density to at least the same level as in the double layer room case ($80\times10^3 t/m^3$). It must be kept in mind, however, that this comparison is based on the assumption that the heat and mass transfer characteristics of the two types of rooms are identical.

2.5 DISCUSSION

The survey of 25 rubber smoking factories indicated that in the last 90 years of the Thai rubber industry two types of smoking rooms were developed, i.e. double layer and single layer rooms. The double layer rooms are of an old design and thought to be inefficient. Many of them are still in operation, though. The analysis suggests that the double layer rooms can be improved by increasing the loading density, wood burning rate and ventilation. In doing so, the double layer rooms will be as efficient as the single layer rooms in term of SWC or even better in term of productivity. Similarly, the single layer rooms can be improved by increasing the loading density. Analysis aiming at examining the effects of the furnace sizes and types on the normalized energy consumption was tried, but yielded no absolute result with the data available.

The average hectareage production of RSS is 0.36 tons a year [6]. This leads to 9.07 tons per hectare in the 25 years of lifetime production. To smoke this amount of rubber, Table 2.4 reveals that about 2.58 m^3 of firewood is needed. A study by the Forest Research Institute of Malaysia indicated that the average green wood production from rubber trees could reach easily an average of 260 m^3 stacked wood per hectare of which 80 m^3 is classified as firewood (diameter less than 15 cm) [7]. Hence, the rubber industry is a net producer of energy.

The economical life time of rubber trees is generally taken as 25-30 years. This means that on average 3 to 4% of the total planted area must be replanted each year. Taking the overall planted area in Thailand as $1,717.56 \times 10^3$ ha, therefore, about 4.8×10^6 m^3 of rubber wood (diameter less than 15 cm) is available as firewood annually. The corresponding figure for the South is 4.3×10^6 m^3/year. This figure looks enormous but is misleading. In fact, not every single tree is procurable since 23% of the growing area is mountainous [2] and accessible only on foot or motorcycle. A certain portion of the plain area is hinterland and too far from the road for the wood to be acquired economically. It was found that only 40% of the cut down wood is claimable [8]. Consequently, $1.7x10^6$ m^3 of firewood is available annually from the rubber plantations. Unfortunately, there is no statistical data on the number of the single layer and double layer factories, but if we use the average SWC for the two types of rooms it can be estimated that the need of firewood for RSS industry is $202x10^3$ m^3/year. This figure is insignificant when compared with the supply. However, rubber wood is used as an energy source in as many as 13 other industries [9]. It is interesting to note that in the South, the number of rubber smoking factories is 131 compared with 260 for brick making, 32 for cement and lime industry and 19 for pottery [10].

2.6 CONCLUSION

There are two types of the smoking rooms currently being used : an old design and a new design. The performance of two types of rooms are significatly different. However, it is possible, regarding to the thermal aspect, that both types can be improved in order to reduce the smoking time and save wood. It is, therefore, time now to initiate programmes of research, development and demonstration projects aiming at using firewood more efficiently. This requires energy auditing and analysis in order to arrive at the optimum parameters, e.g. size of furnace, duct, loading density, wood burning rate, ventilation, etc. It is interesting to note that the smoked rubber industry is a net producer of energy. Energy from the surplus wood is enormous and deserves further research and development to make it available in a manageable form.