The progressive kiln process.

Simulation, quality, energy and drying cost considerations

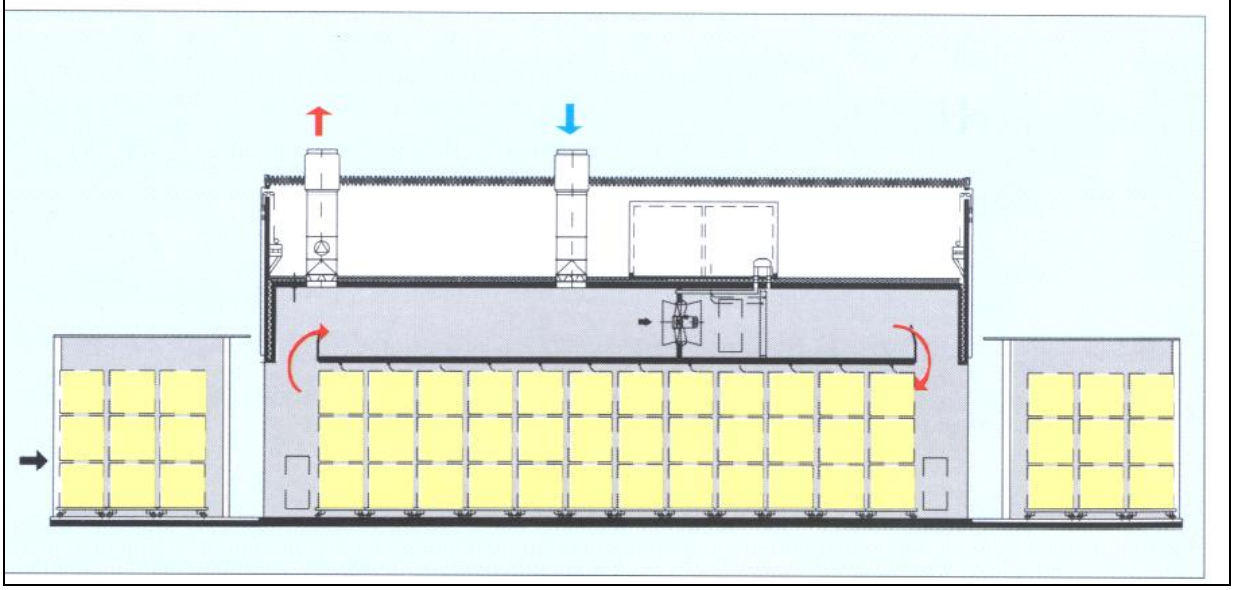
Jarl-Gunnar Salin

SP Technical Research Institute of Sweden
Wood Technology
Stockholm, Sweden

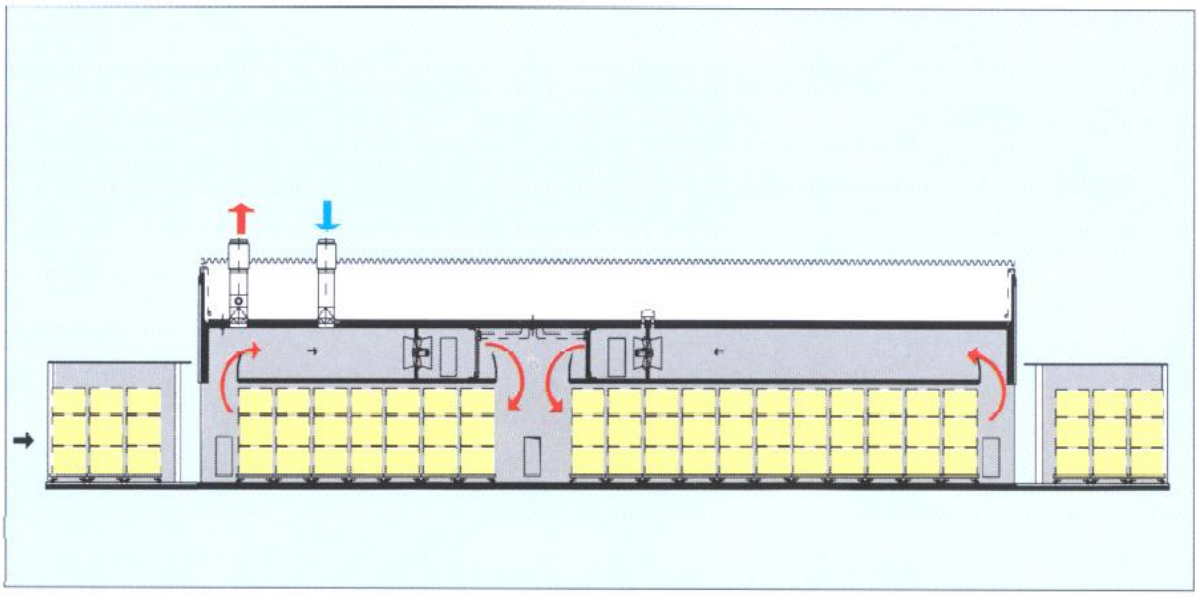
Introduction

- Progressive kilns for sawn timber have a **semi-continuous** working mode and have been very popular in some countries such as Finland, Sweden, Russia etc.
- In Finland and Sweden about **half of the total production** is dried in progressive kilns
- This kiln was earlier considered suitable only for low quality bulk timber
- There are three different types of these kilns
- A tool, TorksimLC, that simulates the drying process has been used for some theoretical results presented in the following.

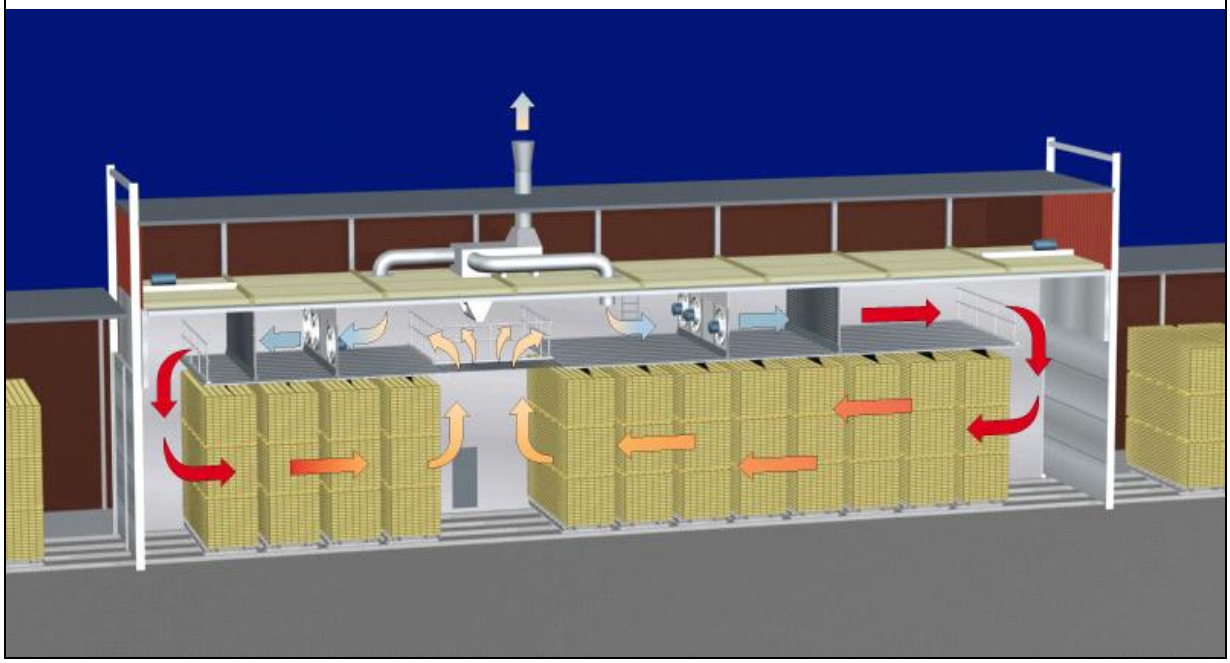
Single zone progressive kiln



Traditional two-zone progressive kiln



Two-zone OTC-type progressive kiln



Simulation model features for TorksimLC

- Both single zone and two-zone kilns.
- Drying described as a continuous process (not stepwise) in order to keep it simple.
- Simulation is done for a single piece with average properties. Drying of pure heartwood/sapwood in the climate established is also included.
- Layout is similar to the batch kiln software TORKSIM and TorksimGlobal, that are familiar to many kiln operators in Sweden and some in Norway.

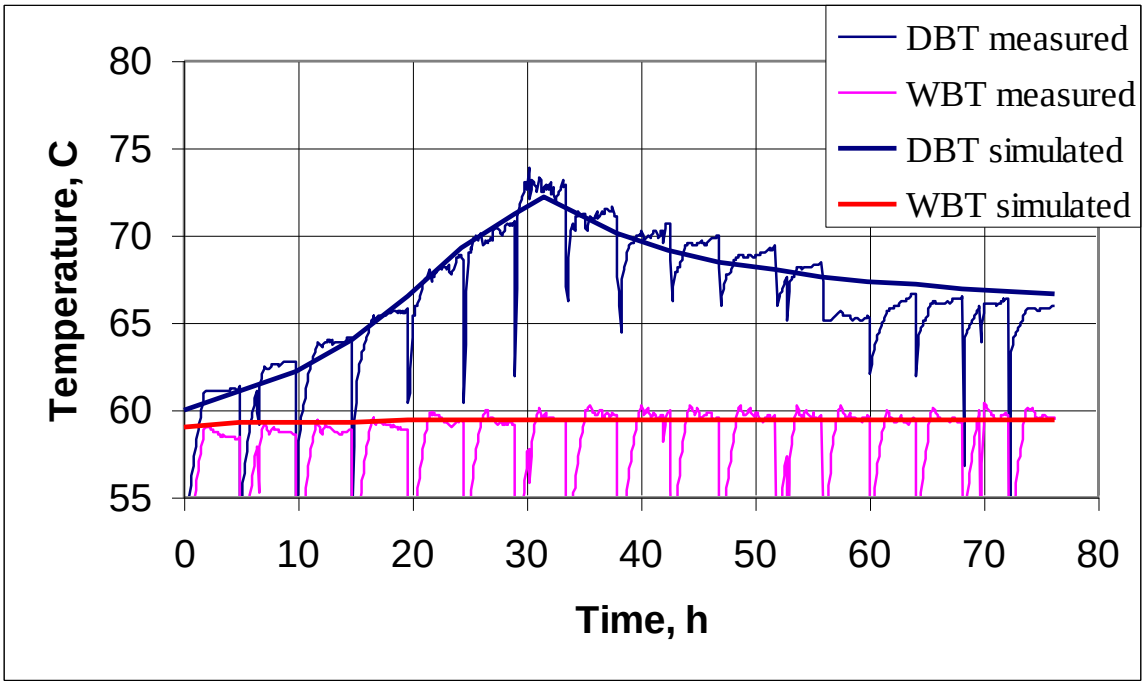
Software features, (cont.)

Data output

1. Climate in the length direction
2. Average MC -”-
3. MC profile -”-
4. Wood temperature -”-
5. Stress development -”-
6. Slicing test gap -”-
7. Energy consumption
8. Drying costs (fixed costs + energy)

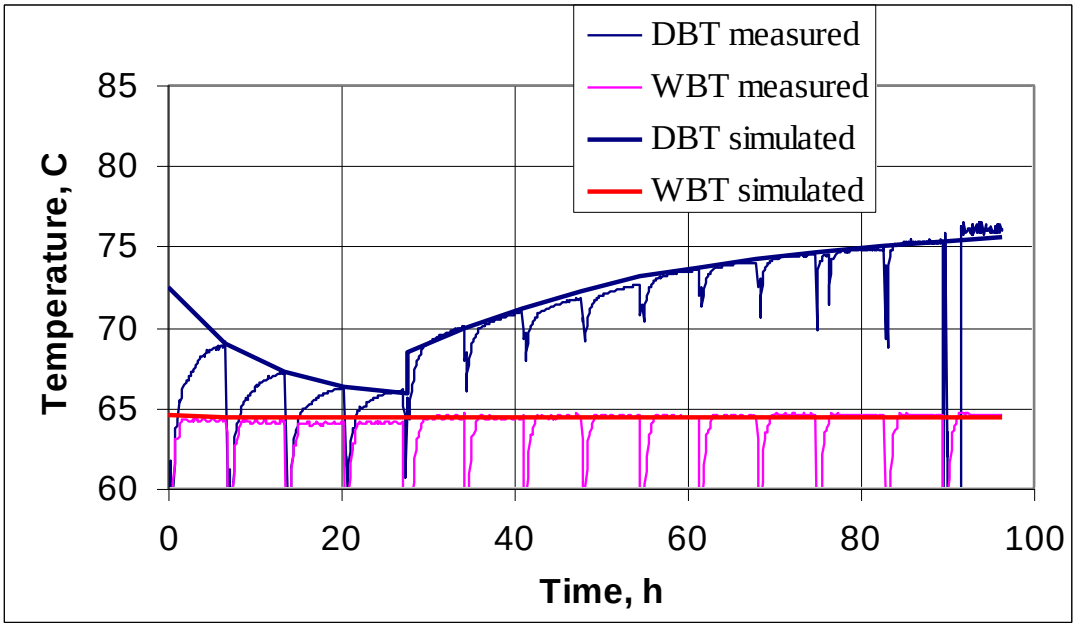
Simulation model verification

Traditional two-zone kiln

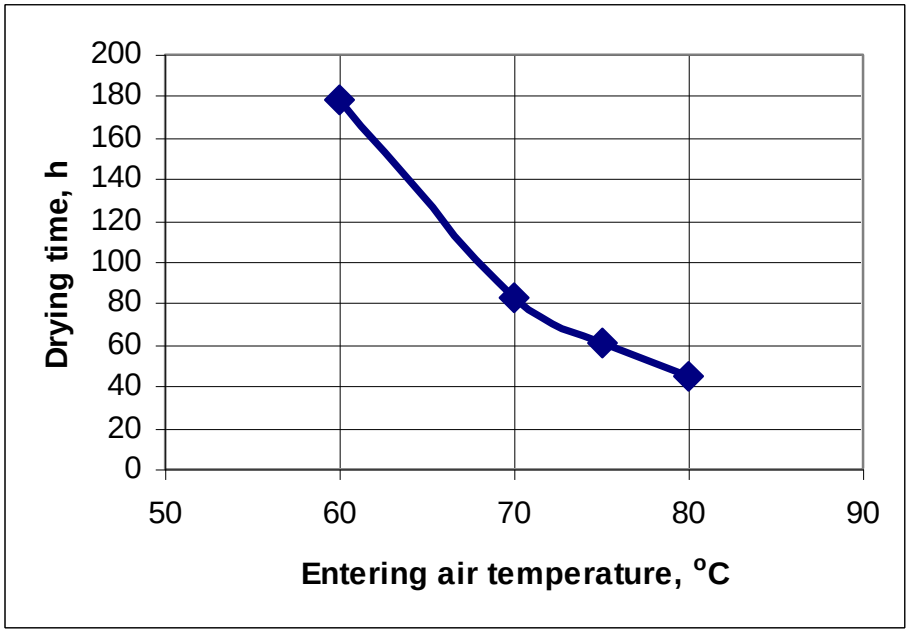


Model verification

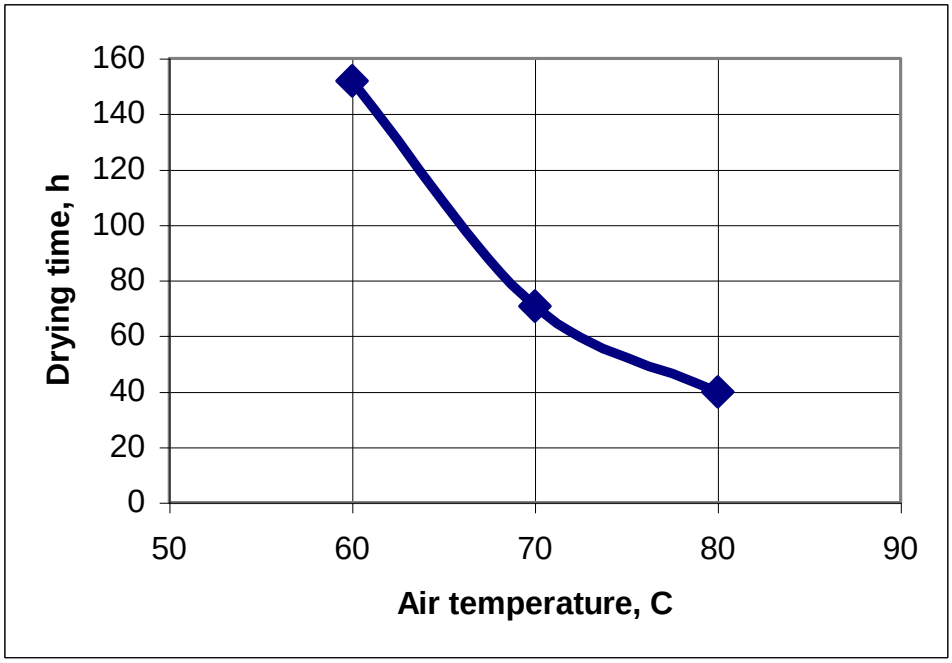
OTC kiln



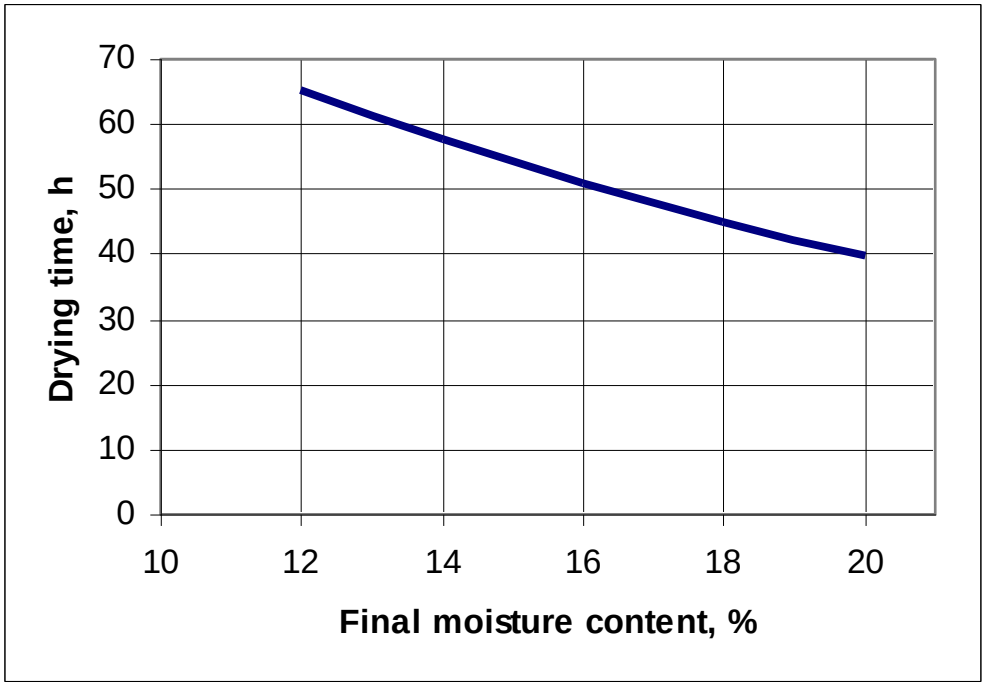
Drying time as a function of temperature in a traditional progressive kiln with 47x100 mm^2 Norway spruce



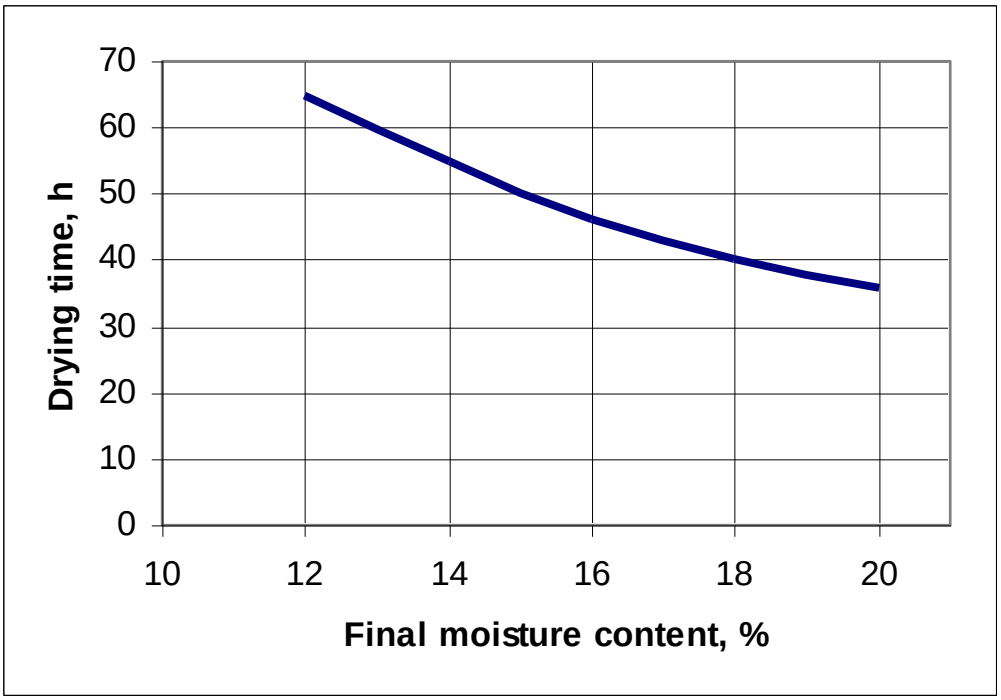
Drying time as a function of temperature in an OTC kiln with 47x100 mm^2 Norway spruce



Drying time as a function of final MC in a traditional progressive kiln with 47x100 mm^2 Norway spruce



Drying time as a function of final MC in an OTC kiln with 47x100 mm^2 Norway spruce



Experimental comparison traditional progressive - batch

	Progr.	Batch	Progr.	Batch
Pine	50 x 125		50 x 125	
Max. temp., ^{o}C	72	(75 ?)	75	75
Drying time, h	84,3	91	81	84
Final MC %	16,1/1,5	17,6/1,6	13,5/0,6	15,5/2,1
Slicing test, mm	1,29/0,5	0,91/0,45	2,0/0,38	1,5/0,5
Check length, %	0,4	1,2	1,6	1,8
Twist mm/3m	7,5/5,9	5,8/4,9		

Notation: average/standard deviation

Experimental comparison OTC - batch

	OTC	Batch	OTC	Batch
Pine	50 x 200		50 x 125	
Max. temp., °C	77	75	80	75
Drying time, h	96	107	99	108
Final MC %	14,9/1,7	15,8/2,1	12,3/1,3	14,2/1,4
Slicing test, mm	1,1/0,4	1,22/0,52	1,4/0,4	1,18/0,4
Check length, %	6,8	3,4	2,2	0,9
Twist mm/3m	3,0/3,1	2,6/3,2		

Notation: average/standard deviation

Cost optimised single zone kilns for 47x100 mm^2 Norway spruce

Temp., °C	Target MC 16 %		Target MC 12 %	
70	Stacks	15	Stacks	20
	Drying time, h	96	Drying time, h	153
	Energy, kWh/m^3	205	Energy, kWh/m^3	219
	Cost, €/m^3	11,3	Cost, €/m^3	12,9
80	Stacks	15	Stacks	18
	Drying time, h	51	Drying time, h	70
	Energy, kWh/m^3	205	Energy, kWh/m^3	217
	Cost, €/m^3	8,9	Cost, €/m^3	9,7

Cost optimised kilns for 47x100 mm^2 Norway spruce to 16% MC with max 80^{o}C

Kiln type	Kiln stacks	Drying time, h	Energy kWh/m^3	Cost €/m^3
Single zone	15	51	205	8,9
Traditional 2-zone	9+12	54	204	8,3
OTC 2-zone kiln	5+17	50	206	8,1
Batch kiln constant DBT, decreasing WBT	5	37	229	10,1
Batch kiln constant WBT, increasing DBT	5	39	232	10,5

Cost optimised kilns for 47x100 mm^2 Norway spruce to 12% MC with max 80^{o}C

Kiln type	Kiln stacks	Drying time, h	Energy kWh/m^3	Cost €/m^3
Single zone	18	70	217	9,7
Traditional 2-zone	11+11	71	217	9,3
OTC 2-zone kiln	4+21	70	219	8,9
Batch kiln constant DBT, decreasing WBT	5	46	248	11,6
Batch kiln constant WBT, increasing DBT	5	54	246	12,5

Conclusions

- A higher temperature level has a strong positive influence on progressive kiln efficiency
- Two-zone progressive kilns are more efficient than single zone kilns
- The energy consumption and drying costs are clearly lower than in batch kilns
- No simple way to achieve a final timber equalisation/conditioning in a progressive kiln
- Preferably the same dimension should be dried all the time, i.e. relatively big sawmills

Further information: jarlgunnar.salin@sp.se