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The impact of beech lumber open air storage on kiln drying. Part. I

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Abstract: *The impact of beech lumber open air storage on kiln drying. Part. I.* The paper presents the methodological assumptions set for beech lumber drying in the open air and then in the drying chamber and mechanically dried lumber

Keywords: beech timber drying, drying chamber, natural drying

INTRODUCTION

This paper scope is a quality comparison of water free naturally dried lumber which subsequently undergoes kiln re-drying, with fully mechanically dried lumber. The procedure in both cases lasted until the samples moisture content level of 10-11% was reached. Both, the weather and the drying chamber internal conditions were monitored. The acquired data was used in charts and applied in order to describe transformations occurring in lumber in particular drying phases.

RESEARCH METHODOLOGY

One of the problems is estimation of heat consumption which is necessary for 1m^3 lumber drying completion. This will allow one to identify the highest drying cost component. Expenses are complemented with electricity cost. Water supply expenses related to lumber wetting purposes were not accounted for due to their marginal role in the drying process.

The amount of heat required for timber drying is independent from its species, type or thickness. The important factor is only water contained in the wood in its different forms, that is the substance to evaporate. In this case, it is justified to perceive timber as water keeping „carcass" or „network" only. Further calculations require identification of the amount of water in timber, the amount of water which evaporates, and the amount of remained water per 1m^3. The input being beech data (wet wood mass 1m^3 = 1070 kg, fully dry wood mass 1m^3 = 680 kg [2]) the contained water amount was calculated on the 57,3% level. If lumber is dried up to 11% moisture content then the 315,2 kg weight loss is the result, consequently the given moisture content wood mass equals 754,8 kg. If the amount of water to evaporate from 1m^3 is known then it is possible to calculate the required heat amount for 1m^3 drying.

The heat balance for 1m^3 lumber drying was set as below [3]:
- water in the wood defrost heat (ice melting) 0,334 MJ/kg
- water in the wood warming heat 0,004186 MJ/kg/°C
- dry wood mass warming heat 0,001674 MJ/kg/°C
- water evaporation heat 2,359 MJ/kg
- heat loss through kiln walls 0,00154 MJ/m^2/°C
- heat loss through kiln substructure plate 0,036 MJ/m^2/°C
- kiln inlet air warming heat 20 MJ/m^3 of wood.

Optimal drying heat consumption for a kiln of 220,8 m^3 cubature and batch volume up to 40 m^3 with the set of the above parameters can be approximately estimated on the level of 5300MJ = 1431kWh for each 1 m^3 of lumber. In order to calculate a kiln 24h operation average cost one should take into account fuel efficiency and its price accompanied by incurred electricity and maintenance expenses. Beech chips were the fuel. The assumed price for 1 mp beech chips with 15% moisture content equals 92PLN/mp. The calorific value equals 2100 kWh/mp. In order to dry 1m^3 of lumber (1431 kWh) 0,68 mp of chips are needed, which in turn generates the cost of 62,56 PLN. Consequently 40 m^3 dried for 12 days generate the cost of 2502,40 PLN. The cost of chips consumed within one day for the whole batch drying amounts to 210,45 PLN. The average electricity cost which is consumed within 24 hours of the kiln operation equals 76,00 PLN. The kiln maintenance followed by electricity and fuel consumption costs with the above parameters taken, amount to approximately 336,00 PLN.

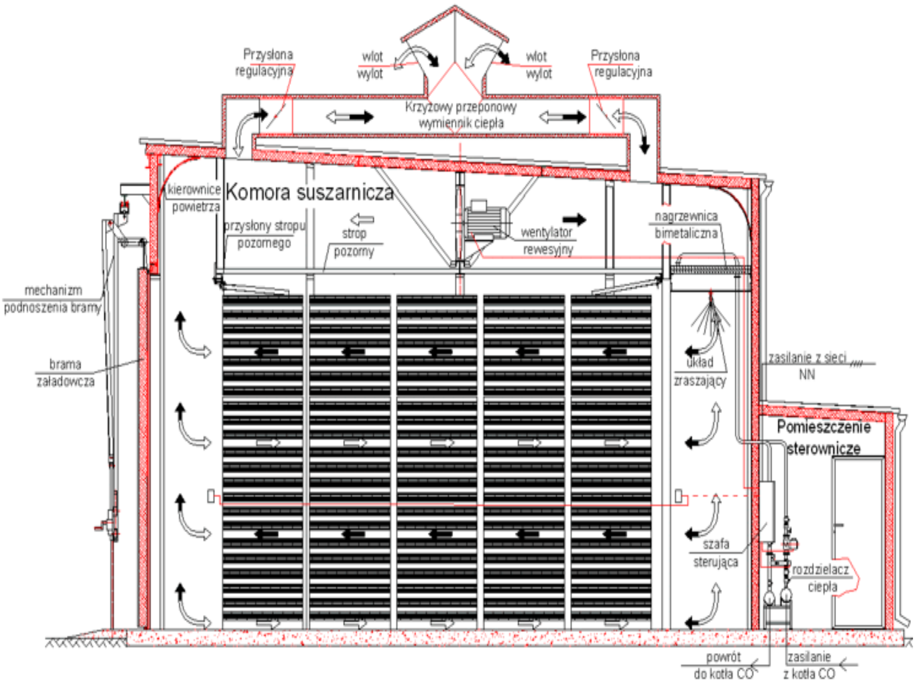

Fig.1 Kiln section

Figure 1 presents kiln operation diagram. Timber drying process parameters, compared and interpreted, were input data for the carried out research. Timber defects resulting from the drying process underwent visual assessment. The research course of conduct was as follows: from open air drying beech lumber stacks one was selected, three places (bottom, middle and upper part) were appointed in it as the actual moisture content measuring points. Three times daily with 7h intervals starting from 8 o'clock weather conditions were identified in the lumber storage proximity. The second observation subject was beech lumber which had been kiln dried directly after the lumbering. Throughout the whole drying process monitoring reports were filed every two hours. The final phase was placing the formerly dried timber with 30% moisture content value in the kiln chamber and initiation of the re-drying process until the target value was reached. Similarly to previous operations the running process was monitored.

RESEARCH OUTCOME

In the light of the observed lumber quality changes while it was dried in the open air, no fungal vulnerability was noted throughout the whole storage period if the stacks were properly stored and formed. Average wind speed confined to the level of 2,5 – 3 m/s and air humidity taking approximately values similar to 65% did not create conditions optimal for mold development. Maximum air temperatures and strong sunlight had negative impact on boards shapes. Warping and torsions of individual lumber units were observed accompanied by cracks in end checks exceeding depths of 15 mm in 12 % of sample units. Faster air flux at stacks ends, and consequently more intense shrinkage in these areas of lumber is the factor causing cracks at ends. Single surface cracks in the outer zones of stacking walls could come from too extreme parameters of the drying air. They resulted from too intense water evaporation from subsurface lumber layer and they took place during higher temperature occurrence and sudden air humidity decrease. No change in lumber color was observed. After 30% moisture content had been reached in boards, the lumber was placed in a kiln chamber. After the drying process had been completed no deterioration in quality was observed as compared with the moment of placing the lumber in the kiln. Moisture distribution was normal, no cracks appeared after the lumber had been unloaded from the kiln nor during mechanical processing.

SUMMARY

It should be noted that the method for stacks forming and securing is of high significance as far as the final result of drying. It is described extensively in the field literature, however, it should be stated that with unedged lumber storage it is not always possible to follow the generally accepted rules. Majority of problems come from saw logs, which after they have been edged, feature irregularly and arcuately shaped edges. It makes it impossible to preserve the required distances between individual boards. There is a risk, that in these places air flow may be anomalous, and in particular stack areas water evaporation speed will differ significantly. This will cause internal stress and result finally in cracks.

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Streszczenie: *Wpływ składowania tarcicy bukowej na wolnym powietrzu na suszenie komorowe.Cz.I.* W pracy przedstawiono założenia metodyczne ustalone dla suszenia tarcicy bukowej na wolnym powietrzu a następnie dosuszanej w suszarni komorowej oraz dla tarcicy suszonej tylko mechanicznie.

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