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ECONOMIC EVALUATION OF CONTROL SYSTEMS FOR KILN DRYING EQUIPMENT FOR SAWN LUMBER*

by

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Introduction

The continuous rationalization up to the automated level in all branches of the wood processing industry during the last decade has also influenced the development of automated kiln drying of sawn timber. Modern drying chambers with large capacities as well as the requirements of the industrial production lead to automated controls for the drying process.

For any investment, the question of the amortization time and the economy of operation of such a system is a decisive subject so that it is sensible to consider control equipment for sawn timber drying systems from different view points.

As control systems are only part of the whole investment, although an important part, it is very difficult to prove by facts and examples the profitableness of partial investment. In this connexion one has to answer the following question: Why are fully automatic control systems for kiln drying of sawn timber used at all:

1. Reasons for installing automatic controls.

The requirements for the final accurate moisture distribution of kiln dried wood has increased during th last few years. One example is the quality standards for wooden window sashes or the specifications for obtaining permission in gluelam manufacture.

- increased utilization of tropical species where the kiln operator has less knowledge and experience of how to dry these species;
- because of increased use of high grade wood, the stock of oak, for example, has decreased. This means that oak has to be kiln dried in a condition above fibre saturation point. This is more difficult to control than starting the drying process at the stage of fibre saturation;
- this knowledge led to the fact that the total drying chamber capacity has to be enlarged. However, the necessary specialized personnel is not available to control the kiln drying operation;
- the drying time will be reduced by application of fully automatic controls whereby the drying chamber capacities available can be increased;

- the increased prioes for wood influenoed the value of the wood oharge in the drying chamber so that it finally beoame impossible to run kiln equipment without supervision of specialized personnel, or without controls to operate kilns at night and weekends.

The different reasons for automated controls of the drying prooess led to the development of automatic kilns to be adjusted for any requirement. Thus the range of the controls available, include simple and semi-automatic systems for regulating temperature and climate in the ohamber and lead to equipment whioh can be extended according to the development of the oompany and at a later date being changed into a fully automatio system which oontrols any function, viz: stopping the fans at the end of the drying prooess, oontrolling the actual heating process, eto.

These manifold reasons are simultaneously the reason for the limited eoonomio evaluation of control systems beoause fully automatio controls oost for example DM 15.000. This investment however is also necessary for a small drying ohamber whioh is about DM 20.000 on a fixed output rate per year but also for a large drying chamber at oosts of DM 100.000 or DM 200.000 with muoh higher output per year.

This refleots in the depreciation and interest rate values for the invested capital. The depreciation period of eight years is based on f1 = 12.5 per oent.

The interest rate is fixed with I = 8 per oent and investment for the automatio oontrols at 1a = DM 15.000. As an example we shall take a relatively small drying system (approximately DM 20.000 without automatic control) with a capacity of about 6 m3, a drying time of about 16 days for Sipo-Mahogany, and a yearly drying capacity of 330 days, results in an annual amount of kiln dried lumber: VH = 124 m3.

The opposite would be an average size of drying chamber for about DM 80.000 without automatic control and a oapacity of about 50 m3 sawn timber. Under the same conditions as afore-mentioned: SIPO specie a drying oycle of 16 days and 33C days per year results in a oapacity of VH 2 = 2 558 m3.

2. Calculating the drying costs per cubic meter sawn lumber

Since the drying costs per m3 of kiln dried lumber are of decisive significance, one has to compare these values in view of the depreciation and interest rates, on the basis of 6 m3:

1) Depreciation costs $\frac{Ia \cdot f1}{VH = 100} = \frac{15.000 \cdot 12.5}{124 \cdot 100} = 15.12$ DM/m3

2) Interest for system $\frac{I a \cdot i}{VH = 100 \cdot 2} = \frac{15.000 \cdot 8}{124 \cdot 100 \cdot 2} = 4.83$ DM/m3

On the basis of 50 m3:

1) Depreciation costs $\frac{Ia \cdot f1}{VH2 \cdot 100} = \frac{15.000 \cdot 12.5}{2\,558 \cdot 100} = 0.73$ DM/m3

2) Interest $\frac{Ia \cdot i}{VH2 \cdot 100 \cdot 2} = \frac{15.000 \cdot 8}{2.558 \cdot 100 \cdot 2} = 0.23$ DM/m3

This comparison dinstinctly shows the influence of the entire system on the costs, and that an economic evaluation of control systems for kiln driers for sawn timber, can only be made within the scope of a oollective calculation, as indicated in the report on the financial evaluation of heating systems.

Thus this evaluation has to be based on comparisons of other fields. In the calculation it is stated that Sipo-Mahogany starting on a Monday, the process is completed after 16 days on Wednesday evening. The next load would be ready on Thursday and is completed on the Saturday 16 days later. In other words, practically every second drying charge would unnecessarily have to run throughout the weekend if not using an automatic control system to switch off the drying process. This means a saving of more or less 6.500 kW - hours per year for a medium size kiln with approximately 50 m3 capacity at 18 kW input.

This applies to all kiln drying operations running more than five days, whereby only the value savings are different.

3. Changes of kiln dryers when adjusting to automatic controls.

A drying chamber was re-adjusted last year in a large industrial plant and equipped with a fully automatic control and improved fans, still at the same capacity but less KW-output, improved guidance of airflow by reversible operation. Net volume: 50 m3 sawn lumber

The result:

- drying time reduced from 170h to 145h;
- saving of time plus exchanging the fans is resulting in an annual total saving of about 50.000 kWh per year for this system;
- the final moisture distribution was improved considerably which consequently influenced the quality of the final product.

Because of the shortening of the drying time, a higher capacity of 600 m3 was achieved; this is an increase of 25 per cent which improves the profitableness of the entire system decisively, due to the lower depreciation and interest rate costs, etc. per cubic meter of sawn timber apart from the afore mentioned saving of kW power. Since various factors causing this final result, e.g. the reversible air flow, new fans and new automatic controls, it is difficult to draw conclusions exclusively for installing the automatic control. However, it is certainly not wrong to assume that the change to automatic control results in improvement of quality, effecting in shortening the drying time, due to the continuous and accurate temperature and climate control; the economic evaluation of the control system can be shared to 25 - 30 per cent at the total improvement.

A short investigation by Messrs. Robert Giardi and William W. Rice, University of Massachusetts at Pine Plains Lumber Company on a semi-automatic and fully automatic lumberdrier showed interesting results.

Comparative measurements of the steam consumption resulted in a significant difference for the requirements of steam spray. While the semi-automatic drier needed 33.081 lbs of steam, representing according to the measurements carried out, about 33 per cent of all used energy necessary to dry the sawn timber, the fully automatic system used only 9.977 lbs of steam for spraying, which can be calculated as about 8.6 per cent of the total amount of drying energy used. Due to the opinion of Messrs. Richard Giardi and William W. Rice, these

special percentages are only valid for the drying processes investigated but the resulting ratio equation can be understood as valid for other drying processes too. They also state in their findings the consumption of steam for heating and spraying in kiln drying of sawn timber is dependent on four factors:

- the operator;
- the programme applied;
- amounts of wood and species;
- the initial and final moisture content of the wood, whereby points 1, 3 and 4 cannot be influenced by the use of an automatic or semi-automatic system, while on the other hand, the amount of steam spray necessary can be influenced by this system, whether semi- or fully automatic.

Specialized and qualified personnel is essential for the supervision of manually operated drying equipment. Due to the fact that specialized personnel is not always available, significant savings can be made by the use of fully automatic control systems. These savings indicate that more drying equipment has to be operated and that more control has to be carried out during the night and at weekends. It can thus be concluded that in average 1-2 hours operation can be saved per working day and per system.

Thus the economic evaluation of control systems is in fact possible for kiln drying systems, apart of the profitableness of an entire drying chamber for sawn timber. Here we do not want to discuss the economic evaluation only but the economic necessity of such a system.

Nowadays a fully automatic system controls the entire drying process, viz: heating, drying, conditioning and cooling, based on the prinoiple that control comes before measuring, and adjusts the necessary temperature and atmosphere data for the drying process with respect to the drying level. The system controls the data by means of nominal and actual values and adjusting them accordingly at any time during the drying process. Not even the best drying specialist can do this. He can only supervise the process at specific times and can control the

temperature and atmospheric values manually. A stacked lumber load chamber amounts to DM 50.000 and even more, thus it is not necessarily correct to consider the economic evaluation of control systems only. On the contrary there is an imperative necessity to equip kiln driers for sawn timber with automatic controls.

4. Conclusions:

- The profitableness of a control system for drying sawn timber is significantly influenced by the entire system. It can only be evaluated, however, according to the capacity, which the system can of course influence.

- It is possible to evaluate the profitableness of such a system, as illustrated in the examples. This will in the future certainly be confirmed by further measurements and research carried out by the industry and research institutions.

- Certainly no one can doubt the economic necessity of such systems. Raw timber is becoming more and more expensive and this is the reason of striving to avoid defective drying processes and to eliminate failures in drying operations. However, due to the lack of specialized personnel one cannot eliminate every error which could occur night or day, companies are being compelled to install modern control systems to their existing drying chambers.

The fact that in Western Europe more than 90 per cent of all new systems delivered are equipped with fully automatic controls and control systems, proves the validity of the mentioned hypotheses.

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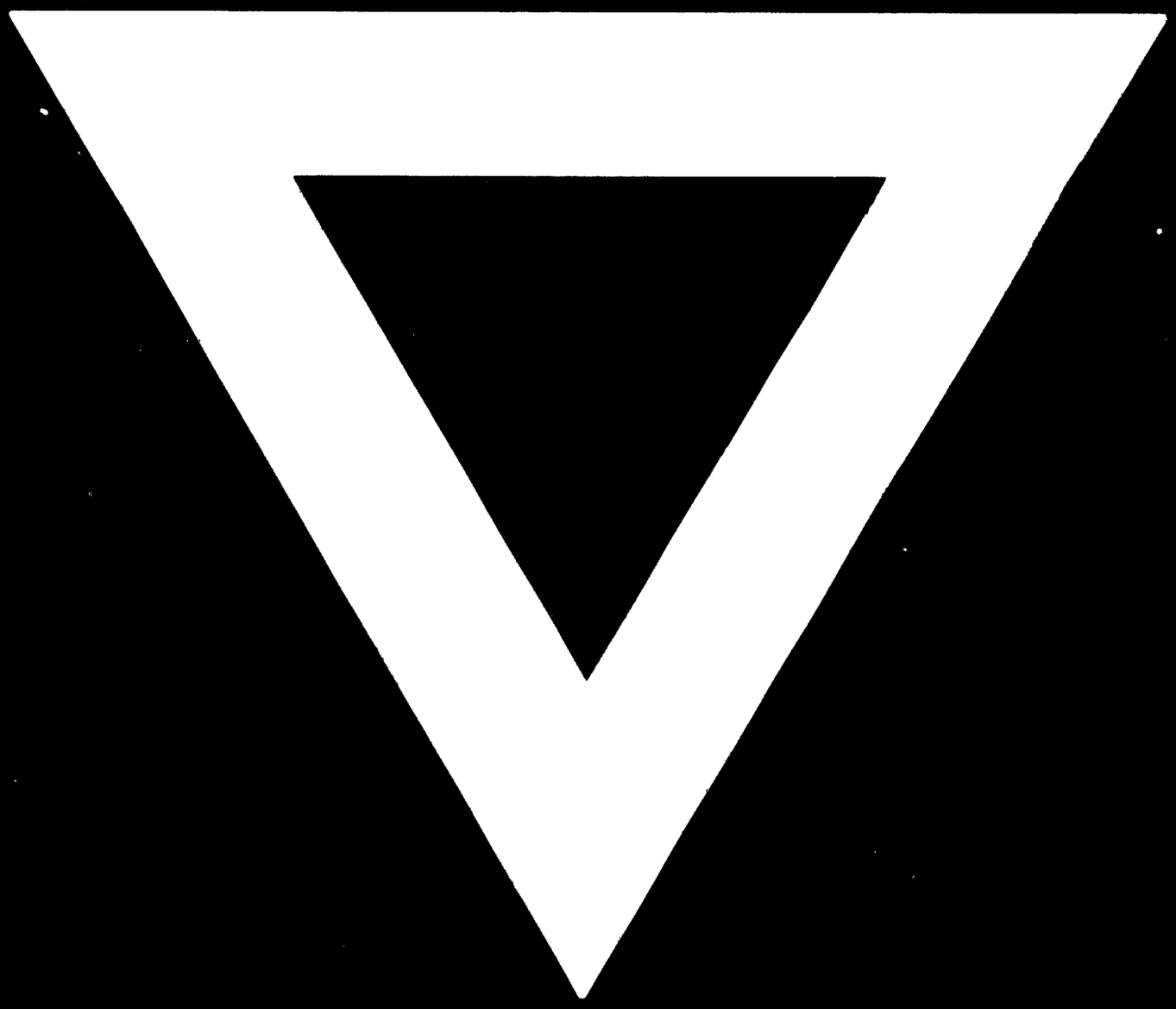

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