

# IN-KILN MOISTURE MEASUREMENT FOR DRY KILNS

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## Introduction

In-kiln moisture measurement has always been a desirable feature for any operator of a dry kiln. Mainly because the whole reason for existence of the dry kiln is to "season" the lumber inside faster than it can be air-dried. The lack of technology to provide the in-kiln moisture content during the drying process has shifted the focus to available technology to control the drying process. This situation has existed for over a hundred years, new technology is available now but will the industry change? This paper will look at the history and new technology that is now available. This new technology has the potential to change the existing situation.

## History

Over 100 years ago when dry kilns were first introduced there were very limited tools available to control the drying process. Essentially the only tools available were a clock (timer) and a thermometer. To make up for the lack of control, the emphasis was on the experience of the kiln operator to produce dried lumber within an acceptable moisture content range and with a minimum of degrade. Unless the kiln operator had 20 years of experience it was unlikely he would be regarded as being competent.

Using the above tools and experience time based drying schedules were developed for all the various species of lumber. The result of this is that there are now volumes of drying schedules available from the various government departments and bodies working with the drying of lumber.

By the 1940's the drying process started to be mechanized. Fans could be reversed automatically, dry-bulb and wet-bulb temperatures were plotted on a chart showing the depression. All this was done by mechanical means to assist with the time based schedules.

In the early 1980's computers arrived on the scene and they were applied to the wood drying process. The combination of a computer system with the time based drying schedules resulted in the zonal control system. The application of computers further enhanced the controls available to the kiln operator in the 1990's and he had more information than ever before regarding every aspect of the time based drying schedule. BUT he still did not know what the actual moisture content of his lumber was in the dry kiln. He only knew once it had gone through the planer mill if he had a good charge or not. At that stage of the process the moisture content value was history for there was little that could be done about that particular charge.

## Types of Systems Used to Control Dry Kilns and Determine Moisture Content

A brief summary of various systems that have been and are currently used for shutting the kiln down or estimating moisture content is described here. These systems

are used either singly or in a number of various combinations. None of these systems come close to the accuracy and repeatability offered by the new technology.

## **Time**

This is the traditional system based on proven drying schedules and years of experience. If the lumber is too wet increase the drying time and if the lumber is too dry decrease the drying time. This system can produce good lumber but not on a consistent basis.

## **"Hot Check"**

This system uses a resistance type meter with a probe attachment to allow access to the core of the stack. It is normally used in conjunction with some other method of shutting the kiln down. A number of readings are taken of the charge immediately after the kiln is shut down. This system often does not give good correlation to end feed results and is used to confirm the kiln operator's decision to shut the kiln down. The results allow the operator three options.

- ▶ The charge is at the desired moisture content and he can pull the charge and/ or use the same schedule for the next charge.
- ▶ The charge is above the desired moisture content and he needs to restart the kiln but needs to guess for how long he must then run it.
- ▶ The charge is too dry and the damage is done. The best he can do is reduce the drying time for the next charge.

## **Pin Type Resistance Meter**

This system uses pins that are hammered into the wood to determine the moisture content. Its main limitation is that it can only be used on the outer layers of the stack. This will give a lower moisture content than the stack average. The main shortcoming is that the sample measured is very small. The distance between the pins is nominally 1".

## **In-kiln Pin Resistance Meter System**

An adaptation of the pin type meter is to install a number of sets of pins in the stacks to be measured during the drying process. These pins are connected to the outside of the kiln by a number of wires (one per pin) or more recently to a radio transmitter that operates within the kiln and sends the data to a receiver located in the control room. The disadvantages again are the large number of pins required for a representative sample and the amount of time required to install the pins and connect all the wires. Also these pins will be on the outside of the stacks unless the stacks are broken open to get core measurements.

## **Weight Based System Using Sample Boards**

This system is used mainly in the hardwood industry where sample boards are cut and weighed and then placed in various positions in the kiln during the drying process. These samples are weighed and the moisture content determined from the loss of moisture. A recent modification is to measure the weight on a continuous basis and transmit the data to a point outside the kiln where it is displayed as moisture content. Again the size of the sample is very small compared to the size of the charge. This process is also time consuming because it requires oven dries to be done on the samples.

## **Hand Held Meters**

Hand held meters are used for taking moisture contents of individual boards and are used by most consumers. Unfortunately the ease of use is an overriding factor and the accuracy of the measurement is never checked against oven dries. The hot checker is an extension of the hand held meter.

## **Dielectric Strip System**

This system uses aluminum strips placed in the stack to measure the moisture content. The system relies on measuring the dielectric loss as the lumber in the stack dries and only works below fiber saturation point. The system is extremely dependent on the strip being clean and making perfect contact with the lumber it lies on. This system has not been popular in the industry and is no longer available to kiln operators.

## **TDAL**

The advent of computers and the recognition that the drying process was subject to the rules of process control allowed the introduction of multizone kiln control systems. This system relies on a number of dry bulb temperatures being compared with a wet bulb temperature to infer a moisture content. This is prone to the inconsistencies with maintaining constant dry bulb and wet bulb settings. The "hot check" is still required to confirm that the schedule will end at the desired moisture content.

## **Other Methods**

These methods are less conventional and very subjective. They rely on the operators years of experience combined with his sense of smell, taste and touch. Some operators pull splinters off the lumber to gauge moisture content. Although some experienced operators do get good results from these techniques they are not repeatable and tend to be subjective.

## **Shortcomings of These Systems**

All the systems described above are effective below fibre saturation point and/or tend to use a small or selective sample size. Also some are time consuming and labor intensive. When compared to oven dry tests they often have shortcomings.

## **Desirable Features of an In-Kiln Moisture Measurement System**

A good in-kiln moisture measurement system will have the following desirable features:

- ▶ Easy to use and operate with a minimum of kiln downtime and preparation.
- ▶ Give a full range of moisture measurement to allow moisture driven schedules to be run.
- ▶ Continuous readings during the drying cycle.
- ▶ Repeatable.
- ▶ Accurate.
- ▶ The size of the samples must be large enough to be representative of the entire charge in the kiln.
- ▶ Allow the kiln to be shut down at a desired or preset moisture content.
- ▶ Show in graphic details the results of conditioning and equalization.
- ▶ Assist the kiln operator in terms of training and experience.

## Does Such A System Exist?

At present there are in kiln moisture measurement systems available. Using the new technology they can give both reliable and repeatable moisture measurements over a wide range of moisture contents. These measurements are taken in the dry kiln during the drying process and enable the kiln operator to monitor the moisture content in different locations in the kiln during the drying process. When the kiln reaches the desired moisture content the kiln can be shut down (manually or via PC/PLC). The benefits of this system are that it allows kiln operators to produce uniform charges and consistent charges on a charge to charge basis. Under normal conditions without this type of system most kiln operators can produce consistent charges 60 – 70% of the time, a good in-kiln system will increase this consistency to 85 – 90% of the time. (A potential 20% increase in recovery.)

### How do these systems work?

- ▶ Two steel plates are inserted into each of the selected stacks.
- ▶ The charge is pushed into the kiln and the probes are connected to each of the steel plates by means of a spring clip.
- ▶ A moisture meter mounted on the outside of the kiln wall measures the moisture content of the lumber between the plates.
- ▶ These measurements are sent to the controller where they are combined with a mathematical model and converted to the moisture content of the timber between the plates.
- ▶ An LCD screen plots the moisture content on a graph and also displays it as a percentage.
- ▶ This data can also be fed to a PC/PLC for direct application to the drying process. (This applies to kilns that have computerized controls.)
- ▶ The kiln operator has to watch the screen and monitor the drying process. He can act according to the information displayed and shut down the kiln at the desired moisture content.
- ▶ Kilns with computerized controls can use the data to:
  - Average the moisture content of the various probes.
  - Shut the kiln down at a preset moisture content.
  - Change steps in a drying schedule once a specific moisture content is reached.
  - Run moisture driven drying schedules.

### Some Limitations

There are two factors affecting its application.

1. **Softwoods only:** At present the system can only do the moisture measurement of softwood species.
2. **Temperature:** The system can only give reliable readings in dry kilns operating above 180 deg. Fahrenheit. Kilns that use lower temperatures at the beginning of their drying schedules but end with temperatures at or above 180 deg.F can use the system if they desire end point moisture measurement only.

The temperature dependence of the system also means that during the heat up stage at the start of the drying cycle there will be readings from the system which have to be ignored until the kiln is running at operating temperature.

3. These limitations are being addressed and it is expected that within the next 12-18 months a system will be available that can run conventional temperature schedules (less than 180 degrees F). These systems can then also be used for the drying of hardwoods and even for air drying systems.

### **Comparison to Other in Kiln Measurement Systems**

The new technology system measures a sample approximately 3' wide by 4' high across the width of the stack. This will give a sample of approximately 200-500 boards depending on board size and stack width.

This measurement also involves the entire stack, by measuring both the core and outer layers of the stack. The result is the average moisture content of the whole stack being sampled. Depending on the size of kiln a number of the samples are taken in the kiln and the average of these samples will give a good indication of the moisture content of the charge in the dry kiln. Based on this average the kiln can be shut down when the desired moisture content is reached. This is done on a repeatable basis charge after charge assuring consistent moisture contents and improved grade recovery.

### **Advantages of the System**

#### **Range of Measurement**

All of the resistance type systems discussed in the previous section are limited to moisture contents below fiber saturation point. The new technology system is capable of measuring moisture contents from 3% - 150+%. This range allows moisture driven drying schedules to be used.

#### **Accuracy**

The system is calibrated according to oven dry sampling for the species being dried. Oven dry sampling is accepted as the only reliable method for determining the moisture content of lumber.

This calibration can be adjusted to agree with various types of end feed system. (The accuracy in relation to the oven dry will then not be valid)

#### **Repeatability**

The most important feature of the system is to give repeatable results. Normally 60-70% of kiln charges are within an acceptable range. Use of the system will increase this number to 80-90% of an acceptable range. This increase will also have a corresponding increase in grade recovery.

#### **Reliability**

The system works reliably with little or no maintenance required from kiln operators. The system operates continuously and does not need to be recalibrated once set up.

#### **Other Features**

The system will also indicate problems that may arise in the kiln that affect the drying process. If a fan goes down it will be seen by the reduced drying rate of stacks in

that zone. Other in kiln defects such as bad baffling and poor airflows that affect drying rate will also be indicated by the system.

**Power failures:** The occurrence of power failures plays havoc with drying schedules, as the lumber is often cool by the time power is restored. This means that the operator has to bring the lumber up to temperature before drying can continue. At this stage he is not sure where he is in relation to the drying schedule and the moisture content. Invariably this leads to the charge being overdried. The system eliminates this problem. The kiln operator can see at all times what the drying rate is and shut the kiln down when the desired moisture content is reached.

### **Equalizing and Conditioning**

The information provided by the system is extremely useful for kiln operators that equalize or condition their lumber. They will have a graphic display of exactly what is happening to their charge during these processes.

### **Shutting the Kiln down**

This is a question that has plagued kiln operators since the inception of the dry kiln. **When do I pull the charge??** This is extremely important in high temperature kilns where the time window for shutting the kiln down is very small before the charge goes into an overdry condition. The information provided by the system eliminates this question. When the end point moisture content he wants for the charge is reached he can either shut the kiln down manually or allow the kiln to be shut down using the PC/PLC of the kiln controller and a preset end point moisture measurement.

### **Training of Kiln Operator**

The training of kiln operators is often a long process before the operator is sufficiently experienced to be able to produce consistent quality lumber. The ability for the operator to see the drying process and have the actual moisture content of the charge will greatly reduce the time it takes to become a skilled dry kiln operator.

### **Benefits of a Good In-kiln Moisture Measurement System**

Most new systems coming onto the market will offer a reduction in costs, increased profitability or an improvement in quality and consistency. Unless a system offers at least one of these it will not be considered to be better than existing systems. This applies to a good In-kiln moisture measurement system.

The main benefits of a good In-Kiln moisture measurement system are:

- Increased available kiln time.
- Available kiln time will be due to two factors

The general tendency is to over dry lumber, by drying the charge to the desired moisture content the cycle time of the charge is reduced and this will make more time available for additional charges.

The elimination of moisture checks where the kiln is shut down and a moisture check is done before pulling the charge. These types of checks are not necessary and a significant increase in kiln availability is made by not having to carry out these checks before each charge is pulled from the dry kiln.

## **General Improvement of Grade Recovery**

The use of an in-kiln moisture measurement system will show an improved grade recovery in the planer mill. This improvement is due to the ability to produce a consistent grade charge after charge.

## **Elimination of Degrade Due to over Drying**

Stopping the kiln at the desired moisture content on a repeatable basis will reduce over drying to a minimum. This will have the effect of improving grade recovery and hence the profitability of the sawmill.

All of the above benefits are based on the experience of kiln operators who have an effective means of measuring the moisture content in their dry kilns. There are a lot of other benefits such as removing the guess work on when exactly to shut the kiln off. A good in kiln moisture measurement system becomes an indispensable tool for the kiln operator.

## **Conclusion**

Timber is a resource that requires efficient management particularly on the saw milling aspect. High log prices demand saw mills to maximize their recovery from each and every log. This has been painfully obvious with the low prices that have been experienced the last couple of years.

It is essential that sawmills use every bit of technology available that will allow them to reach this goal. Also there is an increasing tendency to increase the amount of kiln dried lumber produced in sawmills. Dry kilns no longer have to be considered the black box of the sawmill, the technology is available to allow dry kilns to contribute their fair share to the efficiency of the sawmill operation. Dry kiln operators are obliged to make sure that the rest of their colleagues in the sawmill operation are aware of how much it is costing your sawmill by not using all of the available dry kiln technology!