PROBLEMS IN KILN DRYING TREATED SHAKES AND SHINGLES

Sita (Warren) Millar
AMEC North America
Lexington Park, Maryland

Abstract

This paper describes an investigation of kiln drying quality problems at a plant treating shakes and shingles for the North American market with fire-retardant and preservatives.

The degrade problems associated with drying were:
1) Collapse (5% of production was affected) and splitting (1.5%),
2) Inadequate penetration of the preservative or fire retardants causing surface discoloration of the product after drying (3%),
3) Wet pockets where little or no drying had taken place.

The root causes of the quality problems were traced to the variable and uncontrolled feedstock – bundled shakes and shingles sent for processing by independent manufacturers – and some deficiencies in the preparation of the kiln charge and an overly aggressive drying schedule given these handicaps.

The recommendations for improving the treating and drying process were straightforward – improved kiln charge piling and moderated drying schedules dependent on the condition of the feedstock – and little different than the practices recommended in 1934 by J.H. Jenkins (Chief, Timber Products Division, Forest Products Laboratories of Canada).

However, the effectiveness and economics of these changes are dependent on, and secondary in potential impact to, measures to improve the consistency and adequacy of feedstock preparation by the shake and shingle manufacturers contracting the services of the treatment plant.

Investigation of the upstream processes identified systematic issues related to the diverse sources, forms and handling of the manufacturers' raw materials (cedar blocks and slabs), inconsistent grading standards and inadequate & inconsistent drying of the feedstock. Recommendations for improvements in these areas are also provided.

Background and Introduction

The plant commissioning this study does not manufacture the end product; it treats Western Red Cedar shingles, shakes, bevel & Japanese siding for its customers with a proprietary fire retardant treatment. (The plant also treats dimension lumber with its wood preservatives.) The plant originally provided CCA preservative treatment which was stopped due to environmental regulations, and it is still paying fees to government related to CCA use. The expertise of the staff is primarily in chemistry and lumber treatments, but during the period of the study they were been focusing on improving the treatment process quality and economics. The author has provided training for kiln & quality staff and advice on process improvements for many years in support of these process improvements.
The feedstock processed at the plant is primarily provided by British Columbia wood product manufacturers treating product they are selling to Californian and other western US users. Some comes from larger firms but most shakes and shingles come from small operations. This study related to problems in treating and drying shakes and shingles. The degrade associated with drying this product were:

1. Collapse (5% of production was affected) and splitting (1.5%)
2. Inadequate penetration of the preservative or fire retardants causing surface discoloration of the product after drying (3%)
3. Wet pockets where little or no drying had taken place and treatment penetration was inadequate.

Shakes and Shingles Feedstock

Shakes and shakes sent for treatment arrive in packages on 4’ x 3’6” pallets in individual packages stacked 7 – 9 feet high. Individual bundles of closely packed shakes are approximately 18” wide, 22-26” long, 10” – 12” thick. Shakes are up to 2” thick at butt, tapering to ¾ to ½ inch & about 24” long, with considerable variation. Sawn shingles are thinner and more consistent in their dimensions.

Product Handling and the Fire Retardant Treatment Process

Arriving pallets are stored in the mill yard and the plant manages its customer's inventory on a First In, First Out basis, i.e. the shingles that have been in the yard longest are processed first. The time the product is held in the yard varies widely depending on the volume of shipments received. This provides some limited but uncontrolled air-drying prior to processing, but the process does not include any control of product moisture content prior to fire retardant treatment.

Once the pallets are moved to the treatment plant they are broken down and the packages of shingles are places in the treatment tanks and impregnated with the required chemical solution. The impregnation process is controlled by weighing individual bundles before & after treatment to measure uptake of the chemical solution.

After treatment, bundles of wet shakes are taken direct to dry kilns for drying to reduce shipping weight and stabilize the chemical treatment. Shakes and shingles are stacked 300 bundles on each kiln cart and dried in two 150 bd.ft. Salton steam heated kilns. The bundles were weighed again after drying to check shipping weight.

Quality Concerns and Issues

The plant received an unacceptable level of customer complaints about product quality impairment during the treatment and the study being reported here was instituted to bring the process under control and eliminate degrade. The degrade issues associated with fire retardant treatment of shingles and shakes were quantified for this study:

Collapse (5% of production was affected) and splitting (1.5%)
1. Inadequate penetration of the preservative or fire retardants causing surface discoloration of the product after drying (3%)
2. Wet pockets where little or no drying had taken place and treatment penetration was inadequate. (Unquantified)

Thus up to 10% of processed product was unusable, as it did not meet fire safety standards, and this was clearly unacceptable and had resulted in customer claims for compensation.
Original and Modified Drying Schedules

The immediate concern for the study was the drying process; since classic drying problems with cedar were the apparent cause of most of the observed degrade. The drying schedule used had an initial heat up stage to 120 – 130 deg. F @ 66% RH. Then the kiln was ramped up to 170 deg. F @ 28% RH and held for 10 days at those conditions. No MC measurements, during or after drying, were used to control this schedule, which met the criteria of adequate reduction in shipping weight.

This schedule is typical of classical cedar lumber drying schedules, which also lead to major problems with collapse if the feedstock is saturated with water. The relatively poor quality of cedar material typically used for shakes and shingles (whatever is unsuitable for siding and higher value products) also makes it prone to splitting when dried aggressively.

Research of the literature provided much good advice on dealing with cedar drying problems, however, the most effective and practical advice we found on cedar drying and prevention of collapse dated from the 1930's, published by J.H. Jenkins, Chief, Timber Products Division, Forest Products Laboratories of Canada.

Based on these recommendations, we developed a schedule that would minimize collapse by keeping load temperatures low until the wood was below fiber saturation point, when the wood became less malleable and air could infiltrate into the cells, then ramping up to the temperature needed to set the fire retardant treatment. This schedule (Fig 1.) proved to be effective in achieving adequate drying while limiting collapse with acceptable levels of splitting - even though the overall 10-day cycle time was maintained.

Part of this success may be explained by concurrent improvements made to the piling bundles of shingles in the kiln.

Figure 1. Modified drying schedule.
Kiln Load Stacking Arrangements

The original practice at the plant was to stack bundles horizontally (flat on their sides) on the kiln carts, as the most stable and direct method, with no provision for air circulation. It was noted from the data on bundle weights before and after drying, and direct inspection and spot moisture content measurements, that drying of the bundles was uneven. While overall weight reductions were adequate, drying of many bundles was incomplete, possibly resulting in degrade after delivery and higher than necessary shipping charges.

Mr. Jenkins of the Forest Product Laboratories also reported on trials in the 1930's on the best way to pile shakes for drying (Fig. 2). He concluded that was to pile the bundles on end. These trials were made with natural circulation kilns, and Jenkins observed that drying was much more effective in a forced air circulation kiln with loose piled bundles.

We introduced shelving to allow airflow through the stacks of bundles, and conducted trials where bundles were stacked both on end and flat on their sides. With the shelves, either way of stacking the bundles gave uniform and complete drying.

As Received Moisture Content Variability

From bundle weight data and our observations, we suspected variation in incoming moisture content as a contributing factor in uneven fire retardant uptake and surface discoloration. This is critical as the rating of fire retardants is based on chemical uptake:

- Category B - 8% solids uptake
- Category C - 3 ½ % solids uptake

The plant undertook to sampled shakes and measure their moisture content (MC) over 12 months, on the following regime: 35 shakes from each pallet to be weighed, dried, & weighed again.

The findings were that the monthly average MC was reasonably constant, 40% – 65% MC but that Individual samples varied between 20% and 200% MC. Jenkins and later observers have noted that high MC shakes are thought to come from the “sinker heartwood” logs commonly used for shakes & shingles. Follow up with some shake manufacturers confirmed this suspicion. We concluded that suppliers should to consider sorting out and pre-drying high MC product prior to shipment to ensure adequate fire retardant treatment.

Wet Pockets and Quality Assurance

Jenkins observed the occurrence of wet pockets in cedar in his day, and noted that the affected wood was of relatively low density. Current research indicates that wet pockets are associated with infections and that the impermeable surface layer is due to contaminants introduced by the infection. Jenkins also noted that wood prone to collapse often displays abnormally coarse or markedly fine grain, and comes from swampy locations.

Our conclusion is that better chemical treatment of shakes could be achieved by improved quality control at the source, by rejecting tree butts from swampy areas displaying poor growth and screening out shakes with indications of wet pockets or obvious grain abnormalities. This will also likely improve shake quality in general.
Figure 2a. Piled on edge with circulation ducts.

Figure 2b. Mixed edge and flat piling.