

MORE UNIFORM HOT AIR: LESS ENERGY OR MAYBE BOTH

Tom White
American Wood Dryers
Clackamas, OR

Since January, when Harry Estlow said, "you will talk on both fan conversions and variable frequency drive installations at the May meeting," there has been considerable change in the energy situation in the western states. In view of this development then, the presentation today will start with VF drives and conclude with some general thoughts on fan conversions.

VF Drives

If we polled the attendees in this room to determine their particular kiln air velocities, we could come up with figures from 300 to 400 fpm, out to over 1000 fpm in a variety of kiln designs. However, in order to provide some magnitude of potential energy savings, I've elected to start with a double track kiln, 85' long, having 9 each 10hp motors and 72" diameter prop type fans, loaded with 3 packages high, of 20 courses of 2" dimension on 0.75" thick stickers and a net lumber length of 80 lineal feet per track.

Such a kiln, well loaded and properly baffled, would produce 900 to 1000 fpm velocities at the sticker exit, on the discharge side of the far track in either fan rotation direction. This same kiln, with a VF drive, would still be capable of producing as follows:

900fpm at	90hp	100% load
800fpm at	68hp	75% load
720fpm at	45hp	50% load

Or put another way, if we elected to run the above charge consisting of:

1st third	900fpm	90hp,
2nd third	800fpm	68hp,
3rd third	720fpm	45hp,

the resultant electrical energy savings for that charge would be approaching 25%.

Now, while not all of you have air velocities in the 900fpm range; in general, if you can reduce your air flow by 10%, you will reduce your energy consumption during that time frame by 20% or more and a 20% reduction in air flow will be approaching 50% reduction in electric usage.

At the lower end of the air velocity range, if someone with 650fpm could lower their flow to 550 to 580 fpm during the last third of the charge, they would reduce their total charge consumption by 10 to 12%.

Obviously the above comments, while accurate as presented, need to be reviewed in some existing dated kiln designs where restricted air plenums, poor baffling, and/or poor loading practices contribute to a wide variation in air flow distribution, which,

while marginally acceptable at full fan output, may have a tendency to develop wet spots with reduced flow.

In view of the above statements, now is a good time to inject as most of us know, but sometimes forget, with the press of on-going activities.

Any time you attempt a new procedure, whether it's a kiln schedule modification, or an equipment revision, such as VF drives, we need to verify our continued compliance with good drying practices. Things as routine as proper lumber stickering; package placement; all baffles in place, control sensors functioning, including clean wet bulb wicks water flow properly regulated; plus valve and vent actuators responding as directed.

Additional Savings

A couple of areas where additional energy savings may occur with the use of VF drives at the kilns are:

Eliminating the implosion cycle at fan reversals.

With the use of dynamic braking via the VF drive, you can coast down from your current speed and fan direction, and ramp back up in the opposite direction to your selected output.

Early in most schedules with heavy steam demand, this not only prevents vents from exhausting heat, but also, since most conventional systems actually shut down during the 3 to 5 minute reversal cycle, can push the boiler into a cut back cycle, followed by a heavy demand cycle once the fan reversal has been completed. Later in the schedule for you who equalize and then condition, this fan reversal and implosion cycle can exhaust a considerable amount of the spray induced humidity. This of course requires additional spray make-up water, treatment, and energy.

Another possible potential energy saving, in view of the current west coast electrical situation, which, we as kiln operators won't be particularly happy about is: Peak electrical demand periods reduction in consumption requirements.

This may be as simple in theory as cutting the fan motor(s) demand during mill start up to reduce the mill peak load factor.

Beyond that however, particularly in California, it may actually entail 3 or 4 hour reductions during morning and evening area peak electrical loads.

Incentive Programs

Over and above the energy savings discussed above, there are incentive programs in existence to aid your company in procuring VF drives. These programs vary in amount of participation and are provided by such groups as Bonneville Power Authority; British Columbia Hydro; Local PUD's; and of course, local private electrical suppliers. My suggestion would be to contact your local power company and discuss your application with one of their industrial representatives. At the same time, some states such as Oregon, also have tax incentives which would apply and could be beneficial to your company.

Other Factors to Consider

Once you determine to investigate VF drives for your kiln fan system(s), either with a kiln manufacturer or more critically, with a local VF manufacturing rep and/or in-house electrician, you need to be aware of some possible problem areas.

1. Sizing the VF drive, use total motor(s) amperage, not total motor(s) hp.
Example:

$$10 (10hp) = 100hp \text{ total} \quad (100hp \text{ motor} = 124Amp \text{ full load})$$

However,

$$10 \text{ at } 10hp \text{ at } 14 \text{ Amp each} = 140Amp \text{ full load}$$

Then the maximum fan output would only be roughly 90% at 100% drive output.

2. If possible, employ a Delta ground rather than a WYE ground.
3. Most VF drive manufacturers call for a 300 to 500' long maximum lead length. What you need to remember, this is accumulative of all motor leads. Therefore, with most multi-motor dry kiln installations, it would be advisable to install a long lead filter with the drive.
4. There are instances where VF drive harmonics have fed back out on the incoming power line. This possibility should be discussed, regarding isolation or line reactors, with your power company.
5. Other areas to consider, especially on older kilns, are conditions of in-kiln motor wiring; in some cases motor windings; and to a lesser degree, thermocouple and/or RTD cables which may be near motor cables and have failing insulation, and thus subject to electrical interference which could cause faulty temperature and humidity readings and possibly faulty in-kiln moisture meter readouts..

Since VF drives are considerably more sensitive to voltage spikes and/or ground faults (leaking motor cables) they will shut down, whereas, directly across the line motor control centers will not react so quickly, if at all.

Most drives can be programmed to automatically attempt to restart after such a failure, but usually at some point, the ground fault will reoccur and the system go into a shutdown.

Pointing out the above potential problems is not meant to deter your consideration of VF drives but rather to be realistic. Things can and do happen, and the better advised you are, the less surprises and cost overruns you will have to bury in any budgets.

Line Shaft to Cross Shaft Conversions

The second topic scheduled for presentation, line shaft conversion to in-kiln, direct mounted fan systems, may at first seem at odds with the VF presentation. Invariably, such a conversion involves increasing the connected horsepower, but in reality may or may not increase the total consumed energy. Usually when fan conversions are considered, people are talking about line shaft fan kilns which date back to the sixties or

earlier, and were installed to dry products such as Douglas-fir clears and other upper grades.

Early design air flows were in the 200 to maybe 600 fpm range, with 30 to 60 hp line shaft drives. At the same time, a variety of kiln designs with air plenums of from 18" or less, evolved up to 48" and later, 60" or 72" in width. Those early kilns had flat roofs with most track kiln designs, later going to gable roofs. In either case, vents could be located in 1 or maybe 2 rows down the center, or 2 rows 10' or 12' off the center line. These design restrictions then must be considered when contemplating fan conversions as each combination of the above (plenum sizes; and/or vent size, and location) will have an effect on performance and/or costs.

Also, early in a fan system remodel program, you need to confirm your power source is sized large enough to handle the projected load without major revision, such as a maxed out transformer, and if so, costs are so allocated.

Hand in hand prior to a fan system revision, as with the VF drive you need to review your kilns' performance capabilities. Make any available circulating air work for you, passing through the heat transfer area and through the sticker slots, not over, around or under the lumber load.

Based on the above then, a general statement can be made that conversions can produce higher air flows with more uniform distribution. While this results in approximately 20% faster, and more uniform drying, each application needs to be qualified as to what is achievable, and at what cost.

For instance, locating new vents on a prefab gable roof kiln is normally a matter of cutting out vent openings in the panel and inserting vent frames; however, care should be taken not to locate vent openings directly over heat coils and/or building structural members. On a masonry roof kiln, you are likely to find reinforcing rods on 1' centers which not only requires cutting but also demands serious resealing to keep moisture away from the rebar. If moisture is allowed to penetrate along the rebar, rust will build up until it can actually cause the concrete to fall away into the kiln chamber. This is especially true if your existing masonry type roofs are already showing some tendency to separate from the rebar.

As with the previously mentioned rebate or assistance programs for installation of VF drives, you may well qualify with fan conversions for like rebates via high efficiency fan motors; and if your fan revision provides sufficient air, it may well be advisable to install VF drives for reduction of electrical consumption later in the drying cycles. This relates back to my statement, while a fan conversion may increase the connected hp, however, if you reduce the overall time by 20% or more, and also are able to cut the air flow by 10 to 20%, roughly halfway through the charge your total consumption may be less.

While the above has been general, in view of the potentially wide variation of dry kiln designs represented in this room, and along the way, several areas of concern have been submitted with one or two exceptions these problems can be overcome.

While the solutions to these problem areas very well may increase the cost of the conversions, by knowing of their existence up front, allows you to incorporate that cost in your R.O.I. analysis without major surprises. Especially with the average pay back on the VF drive conversion in particular, being less than two years, and in most cases roughly a year.