Technology Profile

Value to Wood

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Improve Product Quality Through Humidity Control

Introduction

Just as human beings and plants need moisture to stay healthy, the same principle applies to organic materials such as paper, wood and textiles. With an ever-growing demand for increased productivity and the expectation of uniform product quality within the secondary wood manufacturing sector, natural materials such as wood require a climate in which processes and storage occur at a certain air humidity. As indoor climate and humidity constantly change with heating, ventilation and exhaust systems, humidification systems can help ensure uniform quality throughout production.

The influence air humidity has on production is often underestimated within the wood-processing sector. A constant, ideal air humidity level not only serves to ensure quality, but also serves to guarantee trouble-free production. Wood is a hygroscopic material, meaning that it continually tries to achieve an equilibrium moisture content (EMC) within its environment. As such, when the relative humidity changes, so does the moisture content of the wood. If the relative humidity of the air increases, wood will take on moisture and swell. Likewise, if the relative humidity decreases, wood will lose moisture and shrink. While modern preparation techniques such as applying a finish coating help reduce wood's hygroscopic characteristic, it is never totally eliminated, even after processing. Insufficient humidity will result in serious manufacturing problems including:

- irregularities, unevenness and surface cracking
- splitting of veneer joints
- joint cracks at frame corners
- distortion of component parts in furniture, interior and exterior fittings
- shrinkage of laminate and parquet flooring
- adhesion problems associated with water-soluble paints and varnishes.

The Humidity Factor Defined

Relative air humidity (RH) is defined as the ratio of current vapor pressure of water in any gas (particularly air) to the vapor pressure at which the gas would become saturated at the current temperature. Simply stated, relative humidity is the actual water content expressed as a percentage of a saturated volume. It is a relative measure because the air temperature influences the percentage saturation of the air with water vapor. As such, warm air is able to absorb a larger quantity of water vapor than cold air due to its higher energy content.

Equilibrium moisture content (EMC) refers to the relationship between wood's water content and the relative humidity of the air at which no further exchange of moisture takes place. In a situation where MC and EMC are not very close, wood will lose or gain moisture in an effort to achieve an equilibrium between

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the present MC and EMC causing significant shrinkage or swelling, and/or warping during or after the manufacturing process. Additional implications to having moisture contents that fall outside a manufacturer's specifications include: chipped grain; weak joints due to variable glue absorption; increased fuzziness when planing, boring, routing and sanding; and dulling of the tools.

EMC and RH are related to one another roughly by a factor of five. The rule of thumb employed is that EMC is approximately one-fifth of an environment's RH. Thus, if a cabinet manufacturer, for instance, has a plant relative humidity of 40%, the equilibrium moisture content that the wood will reach will be approximately 8%.

A common tool used to illustrate various properties of air vapor mixtures such as the MC, volume, and RH of air at a range of temperatures is a psychometric chart. Fundamentally, a psychometric chart can help plant operators determine the internal temperature rise needed to attain a set EMC.

Controlling RH, MC, and EMC

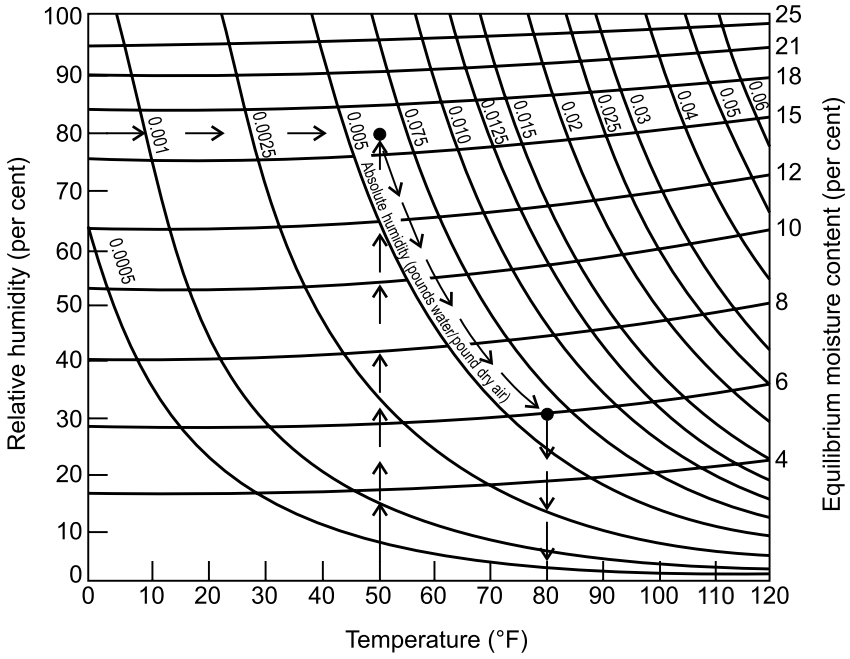
One of the first steps to controlling manufacturing problems associated with humidity is the implementation of an inbound material inspection program. This system involves testing all inbound wood material with a high quality moisture meter. As a starting point, a minimum of 20 to 30 pieces of each load should be tested. Not only will this inspection assist in determining appropriate RH levels in the plant, it also will reduce the introduction of off-spec lumber to further processing. A furniture operation, for example, that allows a piece of lumber with a high MC to be cut and processed into perhaps as many as a dozen or more parts, will potentially allow many finished furniture pieces to become defective with parts that will likely shrink.

Once the plant has determined that all inbound material meets its specified moisture content, the material must be stored and processed within controlled conditions. This involves controlling the relative humidity in the facility through humidification – the addition of moisture to the air. Using the relationship factor of five between EMC and RH, the relative humidity of a plant should be set at a level that corresponds to EMC desired. This will, of course, depend on the type of wood products produced. Most hardwoods, for example, are dried to a MC of between 7 and 8%, while the average EMC in most wood manufacturing plants is within the range of 7 to 9%.

Relative humidity levels will require adjustment as seasons and temperatures change throughout the year. RH levels can be regulated using a humidistat or hygrostat. Humidification is extremely important during the winter heating season to ensure that the indoor air does not become excessively dry. Low RH levels during the cold winter months can lead to a host of manufacturing problems including undesirable shrinking and cracking in wood.

Relationship of Relative Humidity and Temperature on EMC

In the Figure below, a RH of 70% and a temperature of 70°F results in an EMC of approximately 12%.



Psychrometric chart showing the relationship between temperature, RH, absolute humidity, and EMC of wood at a barometric pressure of 29.92 in Hg. The chart and arrowed lines illustrate the temperature rise required to attain 6 per cent EMC by heating outside air originally at 50°F and 80 per cent RH. (ML88 5558)

Source: Dry Kiln Operator's Manual. USDA Agricultural Handbook 188.

A humidity control system in operation

Humidification Advantages:

- stabilizes wood moisture content
- prevents warping, checking and splitting
- quality improvement
- ensures high quality products
- lower static electricity
- less dust
- healthier work conditions
- even humidity balance.

Humidification Technology

Humidification problems associated with wood have existed for years. While technology has refined the humidification systems used today, solutions such as humidifying the floor, setting out barrels of water and soaking hanging sheets of burlap are common practices still employed by some wood processors.

« Knowledge and control of wood moisture and relative humidity levels are critical in the manufacturing of quality products made from wood! »

Two common humidification technologies used in the wood-manufacturing sector include steam and water line.

Steam

Steam humidifiers operate isothermally, meaning that the latent heat of vaporization of water is drawn from an external source such as a boiler. Consequently, the air temperature supplied does not vary as a result of humidification. This type of system requires a boiler and steam-to-steam heat exchanger.

Water Line Humidification

Water line humidifiers, also referred to as hydraulic atomizers, generate humidity adiabatically, meaning that the latent heat of vaporization of water is drawn from the surrounding environment. As a result, the supplied air temperature will be slightly lower due to humidification. In this system, air is humidified by generating a fine water mist using pressurized water and a specially designed nozzle. A reverse osmosis/de-ionized water system is also required to provide mineral-free water.

Regardless of which type of humidification system is chosen, some important considerations to take into account include:

- initial equipment costs
- ease of installation and costs associated with set up
- energy requirements, as some humidification systems are more energy efficient than others
- maintenance, since some humidification systems require regular maintenance, adding to the overall system cost
- building type and size
- local climate.

Recommended Moisture Content Values for Installation of Wood Products in the US

Use of wood	Moisture content for –					
	Most areas of United States		Dry Southwestern areas[1]		Damp, warm coastal areas[1]	
	Average[2]	Individual pieces	Average[2]	Individual pieces	Average[2]	Individual pieces
	Per cent					
Interior: Woodwork, flooring, furniture, wood trim, laminated timbers, cold-press plywood	8	6 – 10	6	4 – 9	11	8 – 13
Exterior: Siding, wood trim, framing, sheathing, laminated timbers	8	9 – 14	9	7 – 12	12	9 – 14

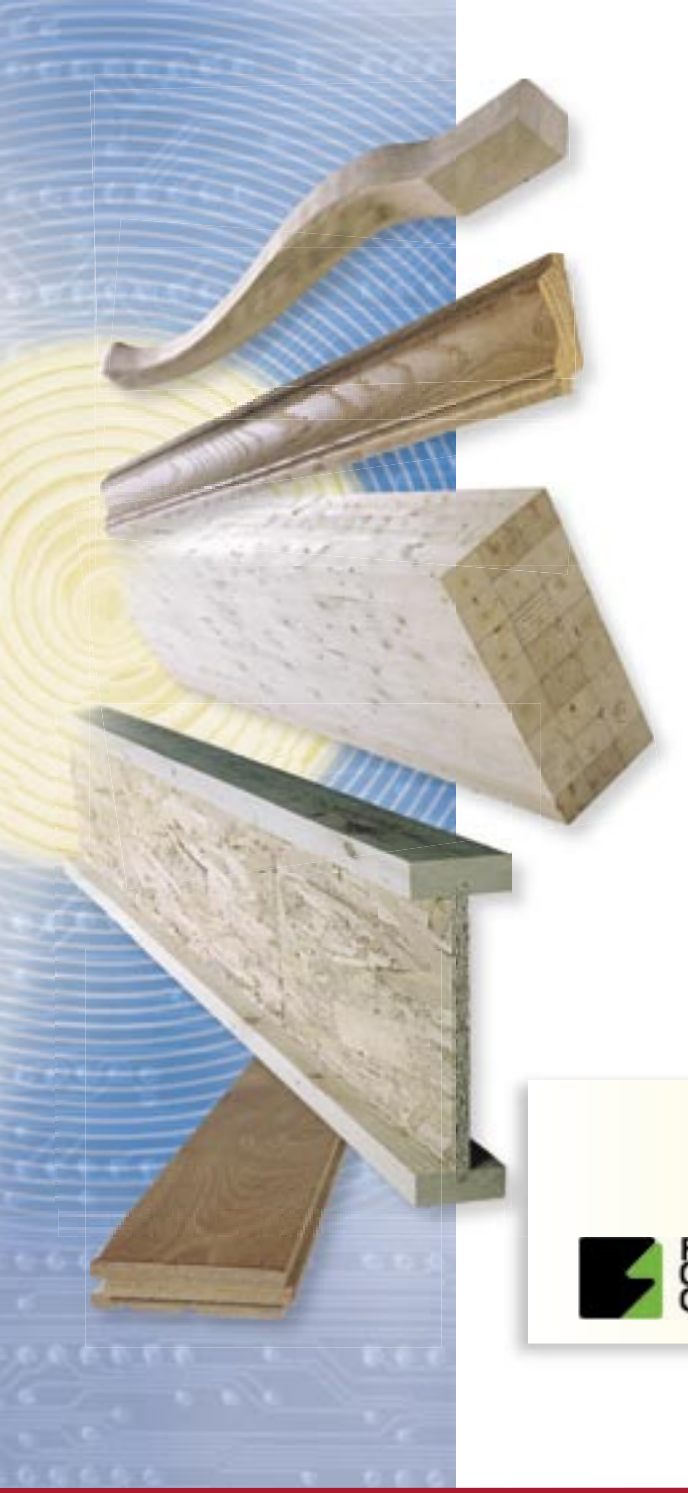
[1] Major areas are indicated in Figure below

[2] To obtain a realistic average, test at least 10 per cent of each item. If the amount of a given item is small, several tests should be made. For example, in an ordinary dwelling having about 60 floor joists, at least 10 tests should be made on joists selected at random.

The Figure below illustrates the recommended average MC for wood products destined for interior uses in various parts of the United States. Along the Eastern Seaboard, the recommended average moisture content is 8%. Within the more humid areas along the Gulf of Mexico, the recommended average MC is 11% (ranging from 8% to 13%). However, within the dry Southwestern States, the recommended MC is 6%.

Recommended average MC for interior use in the United States

Source: Wood Handbook: Wood as an Engineering Material. USDA Agricultural Handbook 72.



Summary

Many modern manufacturing processes benefit from proper humidification – the woodworking sector is no exception. The properties of wood change as it tries to achieve EMC with its environment. As a result, gluing, machining, fastening and finishing activities are influenced.

Many manufacturers maintain a moisture content equilibrium in the plant by using a humidification system. While many different types of systems are available on the market, the type chosen will ultimately depend on the size of the building, the ambient environment and the cost.

While some companies may choose to ignore the importance of humidification, problems related to quality will not only cost time and money, they may also upset your customer. Prevention is always the least expensive and most valuable solution!

To speak with your nearest Forintek Industry Advisor about this article, or other ways to improve the performance of your business, call Forintek at the numbers below, or visit us at **www.valuetowood.ca** to find out about upcoming workshops or seminars in your area.

For information on the 2004-2005 ***Value to Wood*** research program,
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Value to Wood

As part of the ***Value to Wood*** program, funded by Natural Resources Canada, Forintek's Industry Advisors are providing technical services to value-added wood product manufacturers in all regions of Canada. If you need information on any technical issue related to wood product manufacturing, you can:

- Send a request via *valuetowood.ca* (Help Desk).
- Contact a *Value to Wood* co-ordinator at one of the following locations:

Forintek Canada Corp.
Value to Wood Co-ordinator (West)
2665 East Mall, Vancouver, BC
Canada V6T 1W5

Tel: (604) 224-3221
Fax: (604) 222-5690

Forintek Canada Corp.
Value to Wood Co-ordinator (East)
319, rue Franquet, Quebec, QC
Canada G1P 4R4

Tel: (418) 659-2647
Fax: (418) 659-2922