EE9-1 INNOVATIVE MATERIALS: BIO-FIBER BATTS AND BOARDS[1]

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ABSTRACT

A short review of historic development from macerated paper introduced in 1919 as a commercial insulation product in Canadian Prairies lead us to the 2009 American production of cellulose fiber batts and blankets and European flexible and rigid wood-fiber thermal insulation boards. A short expansion from the current R/D activities bring us a new world of bio-fiber thermal insulations where different recycled and fresh fibers are mixed and bonded with advanced chemical technology to produce composites for several construction and industrial applications.

FORWARD

The climatic extremes in Prairie regions of North America fostered the need for building enclosures that provided improved protection and environmental control for humans. As they say ‘‘necessity is the mother of invention’’ - innovative thinking of 1920’s and 1930’s in this region started the development of wood-based thermal insulation.

PART 1: HISTORIC DEVELOPEMENT

Since early wood-frame houses were as cold and leaky as their predecessors–log houses–improvements were focused on both thermal insulation and air leakage control.

AIR FLOW CONTROL: INTRODUCTION OF BUILDING PAPER

Pioneering work at the University of Minnesota on air leakage through frame walls led to acceptance of building paper, as distinct from roofing materials. The building paper was placed on the external side of the wall sheathing, impeding the movement of air and rain while permitting some moisture to permeate to the outdoors. The building paper reduced heat losses by limiting air leakage, improved indoor comfort by reducing drafts, and reduced moisture damage to the walls by preventing wind washing[4] which also could decrease the temperature of air and surfaces in the wall cavities.

With so many functions performed by building paper, different terms were ascribed to this material. Canadians, with a focus on the position, called it a ‘‘sheathing membrane.” In Scandinavia, it is called a ‘‘weather barrier’’, which perhaps is the most correct and least descriptive name. Americans call it either ‘‘weather resistive barrier’’ or ‘‘water resistive barrier’’ but, agree when the acronym “WRB” is used.

HEAT FLOW CONTROL: THERMAL INSULATION IN THE FRAME CAVITY

To improve thermal comfort, whatever the source of energy for heating, wall cavities were filled with insulation – first using wood chips stabilized with lime-water later shredded newsprint, and eventually mineral fiber batts. In 1922 Greig [2] performed research on test huts at the University of Saskatchewan and demonstrated the value of thermal insulation placed in the frame cavity. Sawdust, shavings, straw, seaweed and mineral fibers (rock wool) were also used where they were readily available. The use of insulation in the framing cavities and in attics increased during the 1930s.

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[4] A wind-induced air enters in one place and exits in another place on the exterior of the wall.

In 1926, pneumatically applied cellulose fiber insulation (CFI) was used to fill the empty cavities of an existing wall. To this end, holes were drilled through plank sheathing. In contrast with today's CFI, the initial CFI products were not treated with chemicals except for small quantities of lime and boron salts that were added as protection against premature mold and rot. Despite this minimal protection, no moisture damage was found when the walls of this house were opened in 1975 (see Figure 1), except for moisture stains opposite an external staircase.

Figure 1: Walls of a wood-frame house built in 1919 at the University of Saskatchewan were retrofitted from the exterior with CFI in 1926 and opened in 1975. Inspection showed no traces of moisture and no visible damage.

The reason for the absence of moisture damage was explained much later [3], when advanced computer modeling allowed the calculation of the increase in temperature at the condensing plane caused by condensation and exfiltration of warm air into the cavity. When one looks at the results of such calculations, as shown in Figure 2, one sees that the amount of condensed vapor initially increases with the increase of air exfiltration, it eventually reaches a peak, and then decreases when the air leakage rate is high.

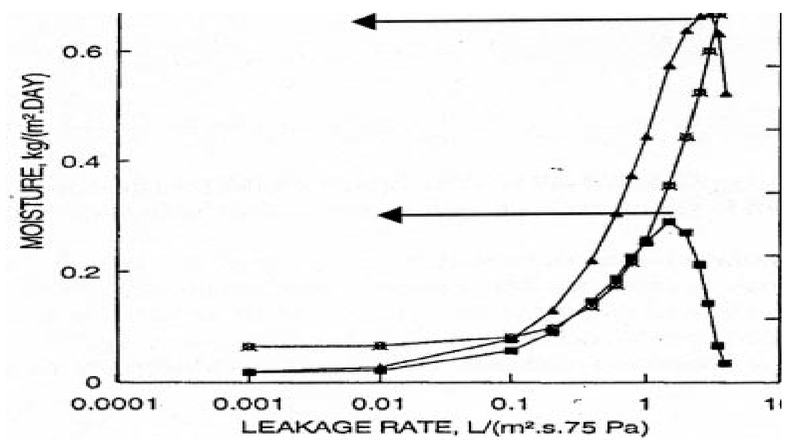

Figure 2: Moisture accumulation in the wood-frame cavity filled with MFI in relation to the leakage rate of indoor air with 36 and 48 %RH (From Ojanen and Kumaran, 1996).

There are two effects associated with air exfiltration. Moisture-laden indoor air that enters the wall cavity brings with it a significant amount of heat. Furthermore, the phase change that occurs during water vapor condensation also produces heat. As the rate of leakage increases, there is a point when the warming effect dominates the propensity for condensation and the amount of condensation is dramatically reduced. At the extreme, there would be no condensation – one would end up with a very energy inefficient building.

Introduction of cavity insulation reduced the temperature on the exterior side of the cavity causing water vapor condensation. While theory of water vapor diffusion was developed in US and Canada in years 1938 and 1939 [4, 5, 6] and applied in practice [7], neither this nor a rapid knowledge developments in Soviet Union (O.E. Wlasow, 1939; A.W. Lykov, 1952 -1956 and A.U. Franczuk, 1941-1957[5]) were observed in Europe where a simplified model of condensation served for almost 50 years.

Figure 2 also shows that the moisture accumulation is minimal at both extremes, very high and very low air tightness of the wall. The worst case scenario is a moderately loose wall. Therefore, the lack of moisture damage shown in Figure 1 permits one to state that:

- this house had a sufficiently high rate of air exfiltration to avoid prolonged periods of condensation, and
- the moisture buffer provided by the wood planks and the cellulose fiber insulation together with the drying capability of the walls were sufficient to accommodate periodic condensation without permanent damage.

1970'S EXPLOSION OF CFI AND SUBSEQUENT STAGNATION IN THE US

Less than 5 manufacturing plants of CFI existed in US and Canada the beginning of 1970's while several hundred of them could be seen in years 1977-8. The reason for it was simple – since 1958 when the glass fiber process was developed in France, glass fiber insulation batts and blankets were the least expensive and most popular form of insulation in the existing houses. Energy was inexpensive and abundant until the energy crisis in the mid-1970's, when adding insulation to empty wall cavities and attics became the mainstream of industry.

The inexpensive hammer mills and availability of newsprint resulted in there being little research done in this industry, and even worse, some of the technically oriented manufacturers were forced into bankruptcy before some degree of control was established. The marketplace saw a reduction of manufacturers in the aftermath of the energy crisis reduced by a factor of 5 to10 (mid 1980's). By this time several patents and R/D developments were taking place in the USA, such as use of additional fibers, (e.g. polypropylene) improved bonding of chemical add-on by use of the mixing cyclones with steam treatment, use of latex based or starch-based adhesive to manufacture bonded materials were transferred to Europe where they served as a basis for further development.

North American manufacturing did not use any of these concepts because the production here was measured primarily by one criterion, namely the cost. Yet, in the mid-1980's the fiberization process changed dramatically – rotational fiber mills, similar to those used in the wet wood-fiber board production, but operating in a dry environment, replaced hammer mills in either second or both stages of cellulose fiber production.

This change improved the production and performance of CFI by reducing density [8] and dust, except for stabilized cellulose (using about 20 % by weight water in installation process). On manufacturing side the progress has been remarkable and the blown density has been reduced by about 50%.

One has to admit that some companies attempted to do some research but this research was quickly abandoned when it did not yield immediate results. One event worth reporting was the evaluation of

[5] A.U. Franchuk,1957 published a book " Problems in theory and calculations of moisture content in the external components of building (Academy of Construction and Architecture, Scientific Research Institute of Building Physics and Building Enclosure, NIIST, 1957)

sealed polyethylene bags for packaging CFI that, to the surprise of the CFI manufacturers, accumulated more water under field exposure conditions than calculated by the prevailing diffusion theory equation.

MANUFACTURING CFI BATTS

The concept of producing a batt and board material from the base fiber of cellulose insulation was always a logical evolution for this recycled material. An early attempt was with the standard needle punch textile machine. Forest Products laboratory had, in 1993, a lab machine that could be rented for trials. The trials on the needle punch machine could not produce a batt with an adequate structure. Using the same technology, a reasonably thin board product was produced. One product that showed promise from these trials was a hydro-seeding mat. The board was made very thin and was perforated (Figure 3) allowing germinating seeds to sprout through the holes, all the while, having a biodegradable matt from the cellulose fibers.

Figure 3: Biodegradable mat from the cellulose fibers that allow germinating seeds to sprout though the holes.

AIR-LAY MACHINES FOR PRODUCING BATTS AND BOARDS

Market research showed that there was interest in a mat/ batt type product made from cellulose fibers. Work continued in this direction by using resins and attempting to make a board through compression on the production line. In this process a combination of temperature, steam and various adhesives were examined. Yet, the complexity of making a product in this manner resulted in a cost too high for the marketplace.

Air-lay equipment is used to make cotton products in clothing and bedding, in addition; primitive forms of CFI batts and blanket were also made on this machinery. In the present configuration, the batt/mat is being made in an existing cellulose insulation plant with a unique manufacturing technique (patent pending). This system has better economy. As the fibers are moved pneumatically from the cellulose insulation plant to the batt/mat production line, there is no need to package the material. The cellulose fibers are blended with other natural and synthetic fibers.

The combined fibers are then conveyed to a mat former and dropped on to a moving belt. The fiber mix then moves into an oven section where the synthetic fiber is activated by heat. After leaving the oven section of the modified air-lay line, the fibers move into the compression unit that sets the desired thickness of the final product.

An air-lay machine is designed to work best when the fibers are predictable. Cotton and other fibers used in textile machines have uniform thickness and length. Cellulose or wood insulation fibers are short and vary greatly. To overcome this difficulty different proprietary techniques are used by the industry. Firstly, some are using wood chips (recycling of wood scrap). Secondly, one may use different admixtures of "carrier fibers" or laying the fibers down on the carrying mat. Thirdly, selection of melting material that produces the binding action to the fiber mix may be the sole or an additional method of bonding.

Three different types of bonding processes are currently used in production of bio-fiber insulation to achieve a finished homogenous product. As a commentary, we can say that in the two production cases discussed in this paper were developed through trial and error to achieve the satisfactory level of uniformity at different product densities. Making a semi-rigid material (higher compression) was far easier than making a batt for frame wall insulation.

The first attempts at making a cellulosic batt resulted in a material that was too heavy for practical use. Adding other natural fibers enabled a spring-like reaction while reducing the product density. Part of the struggle with fiber variety is trying to maintain a high recycled content, one of the main virtues of this product, and reasonably low density.

Since the other fibers are introduced to the cellulose/wood fibers, even though their fraction may be small, yet their function is a key to the final performance of the product, it was decided to introduce the name bio-fiber insulations (BFI) to this new technology.

CURRENT EUROPEAN TECHNOLOGY

In Germany where the environmental focus was introduced some 20 years earlier than in the U.S., research was undertaken simultaneously in several different companies. This resulted in a history of product development that may still be new to some other countries. For instance use of hemp and fly ash in light-weight concrete is a hot research topic in some countries while a hemp insulating batt is one of the older thermal insulating products used in wood frame housing of Central Europe (Poland, Germany etc). Hemp or jute has centuries long history's of application as long and strong fibers. Yet hemp can be used effectively only by a manufacturer that produces different types of boards and insulation because only small fraction of the plant can be used as fibers.

We will classify technologies used for manufacturing bio-fiber thermal insulations depending on the binder being used:

1) starch binder
2) bi-component fibers (bico fiber)
3) urethane binder

Starch as a binder is used in the super green products as well as batts to be used inside the closed cavities. Technology that was first patented about 30 years ago is still used with the starch extract coming from a few different vegetables (corn, beans, etc).

Bico-fibers as an intermediate binding fiber are perhaps the most popular approach that is used in manufacturing different fiber systems such as wood or mineral fibers but are most effective with short fibers (wood) that need a log fiber reinforcement.

Urethane binders, similar to bico-fiber, it is an advanced manufacturing technology, for many years too expensive for wood fiber technology, but more recently finding its way to the manufacturing of insulation materials.

In closure of this historic review we need to come back to the title of this paper – we use the term bio-fiber insulation because the traditional wood or cellulose fiber insulation becomes now a multi-fiber system and the one binder is replaced by a multi-binder design while at the same time we are moving from a commodity product to a construction component.

PART 2: FROM PRODUCTS TO BIO FIBER-BASED INSULATION SYSTEMS

With a growing understanding of sustainability as the imperative of 21st century, the switch to re-use postconsumer products and renewable energy brought the renaissance of the local economy through agricultural production.

WHY BIO-FIBERS ARE NEW WAVE OF THERMAL INSULATION?

The second critical reason for application of bio-fibers is that the collapse of the current moisture management technology based on prevention of moisture ingress to building assemblies. As explained in the white paper [6] this model of moisture management stopped being efficient because of several changes in the wood frame housing, such as:

1) Increased levels of thermal insulation
2) Increased level of water vapor resistance
3) Increased air tightness of the walls
4) Reduced moisture buffering capability
5) Introduction of more moisture sensitive materials

These measures reduced the drying capability of walls to such extent that even small deficiencies, e.g., leaks at windows or cladding penetrations, may result in moisture-originated damage. From the building physics point of view, many U.S. states do not require a rain screen design and can be built with other moisture management principles [6]. The trend to mandatory rain screen design comes from a simplified version of science appearing in legal cases that involved the EIFS industry primarily in NC. Yet, it is technically more difficult to ensure durability of wood-frame assemblies when allowing wetting and drying of moisture. Furthermore, it requires use of real time calculations with models simulating heat, air and moisture movements in construction. On the other hand, the building science approach proposed here will reduce the cost of construction. In effect, application of hygroscopic materials like bio-fibers is one of the many elements that will change the paradigm of moisture design. One may even talk about developing design intelligence for a new generation of housing.

While more reasons could be listed here such as thermal rehabilitation of houses being a priority in reducing this tremendous drain on the North American power grid, labor and climate related considerations in construction, yet the single most important aspect of bio-fibers is introduction of “breathing” walls (see part 3 of this paper). Let us therefore quickly review the critical properties of biofibers that make this type of product suitable candidate for a high performance thermal insulation.

MOST IMPORTANT CHARACTERISTICS OF BIO FIBER INSULATION (BFI)

We are looking at three or four primary types of products each manufactured in three categories: standard (s), gold (g) and platinum (p). The types are:

1) cavity fill insulation (it will only be available in standard category)
2) exterior and roofing (including exterior basement) insulation
3) interior, (acoustic and moisture buffer) insulations
4) core of panels and sandwich assemblies

Cavity fill insulation will be in the density range 3.2 – 3.7 p/ft^2 (40 – 60 kg/m$^{3)}$ with thermal conductivity coefficient equal to (or better than) that of cellulose fiber insulation i.e., 0.038 W/(mK) or thermal resistivity 3.75 (BTUin)/(ft^{2}h oF) and specific heat about 2000 J/(kg·K). These boards will be manufactured either with a starch and bico-fiber bonding. The design of the fiber mix will primarily be based on wood waste or reground newsprint with additional contribution of other bio-fibers.

Exterior and roofing insulation will be in the density range 6.2 – 8.7 lb/ft^3 (100 – 140 kg/m^3) with thermal conductivity coefficient equal to (or better than) that of cellulose fiber insulation i.e., 0.038 W/(mK) or thermal resistivity 3.75 (BTUin)/(ft^{2}h oF) and specific heat about 2000 J/(kg·K). Note that thanks to the nature of the fibers the thermal performance of standard products is always the same.

While class (s) of these boards can be manufactured either with a starch and bico-fiber bonding, class (g) will be manufactured with urethane bonding and class (p) will include different fraction of long fibers from other bio-fiber types.

Interior, (acoustic and moisture buffer) insulations are new applications of bio fiber insulation (see later part of this paper). Density may range from 50 to 100 kg/m^3 with thermal conductivity coefficient equal to (or better than) that of cellulose fiber insulation i.e., 0.038 W/(mK) or thermal resistivity 3.75 (BTUin)/(ft^2h oF) for class (s) and specific heat about 2000 J/(kg·K). These boards will be manufactured either with a starch and bico-fiber bonding. The acoustic insulation may be primarily based on cellulose fiber insulation while the moisture buffer type will primarily be based on wood waste with additional contribution of selected bio-fibers. The inclusion of longer fibers helps to improve mechanical performance and assist in possible use of phase changing materials (PCM) if we decide on improvement of thermal performance of these materials beyond the current level of the cellulose fiber insulation. Types (g) and (p) will be optimized for higher thermal mass effects by application of PCM. Water alone will be used as PCM in class (g) while water and waxes will be used in class (p) materials.

The new bio-fiber thermal insulating materials may have only good average thermal efficiency (3.75 per inch or more) but, with high thermal capacity (typically 2 x more than inorganic insulations), high hygroscopic moisture content and good acoustic properties, they provide a good basis for modern thermal insulating systems.

Core of panels or sandwich assemblies. Most office panel systems are produced with a fiberglass core covered with fabric. The fiberglass cores have good Noise Reduction Coefficients (NRC), are light weight and are cheap. Some manufacturers have been testing the bio fiber mat as a direct replacement for glass cores. The fabrics adhere easily and securely to the cellulose board. The NRC ratings are acceptable. The main concern is heat aging to determine if a cellulose mat can withstand 140° F (60° C) and high humidity.

There is also a product made at a lighter density and a 1.5-inch thickness (38.1 mm) that is used as basement insulation. This takes the place of foam board at R6 but, if desired the board can be left exposed. With the current Energy Code in Michigan, for instance, the R6 cellulose board allows a home to pass the code requirements in a very cost-effective manner.The applications of bio-fibers are practically unlimited. For instance, bio-fibers can be molded for automotive and other applications.

Figure 4: Installation of cellulose batt

TESTING AIR TIGHTNESS OF BIO-FIBER BATTS

Spray cellulose products have been used for over twenty years. The performance of spray products, be it cellulose or foam, remains a benchmark for air infiltration efficiency that many people expect. Since the air infiltration performance of bio-fibers is similar to spray CFI, it was thought that there would be instant acceptance of the cellulose batt in the marketplace; this was not the case.

Habitats for Humanity (HH) organizations build many of the same design homes. They also tend, at least in the Midwest to use either spray cellulose or spray foam insulation. They use these products because HH has become more sophisticated and performance driven in making homes more sustainable and energy efficient. Energy efficient homes are more affordable for their client base.

The HH homes were chosen for a trial of the cellulose batt because of the existing history of blower door and infrared testing and their identical construction. The director of the HH homes initially refused to have the bio-batt installed as his world was programmed for batts

to be less efficient. After convincing the directors of the HH homes that the manufacturer would guarantee the performance to be equal to what they were using, the installation of the batts was allowed in
one home. This home was checked with a blower door. *Figure 5: Cutting with a masonry blade* and infrared by the installers, the home was also tested by a third party hired through HH.

The bio-fiber batt home equaled the air change rate of spray foam homes and no leaks were apparent using infrared testing. More testing has been done and the results are equal to the initial tests.

AMERICAN STANDARD FOR A BIO-FIBER BATT

A new product must have a testing protocol. Working with the International Code Council Evaluation Service (ICC-ES) and Underwriters Laboratories (UL), a group of tests were identified to develop a unique standard. Using standards developed by the ICC-ES for a polyester batt and cotton loose-fill served as the base for a cellulose batt. In those ICC-ES test protocols for cotton and polyester, nine parameters were specified. The actual testing was performed at UL and they also developed a classification for a cellulose batt enabling the start of an ICC-ES evaluation program.

The batt is also listed under the UL follow-up program. As this is a new product in the marketplace, having an ICC-ES listed evaluation was necessary to insure that building officials would accept the product. Figure 5 represents the testing in the standard for bio-fiber batt.

ASTM E 84	Surface Burning Characteristics
ASTM C 518	Thermal Transmission
ASTM C 739	Water Vapor Sorption
ASTM C 1338	Fungi Resistance
ASTM C 739	Corrosion Resistance
ASTM E 970	Critical Radiant Flux
ASTM C 1304	Odor Emission
ASTM C 167	Design Density

Figure 6: Tests required by the ICC_ES

INFRARED TESTING WITH STEEL FRAMING

It became immediately apparent that interest in the bio-fiber batt for commercial applications with steel framing was significant. The main advantage of the bio-fiber batt is its snug fit in the channels of the steel frames it was assumed that a tight fit would minimize convective loops and air passage around the framing. Infrared (IR) testing validated this assumption. Infrared pictures of steel framing with the cellulose batt showed a consistent temperature across the batt.

Figure 7: Steel Framing Visual

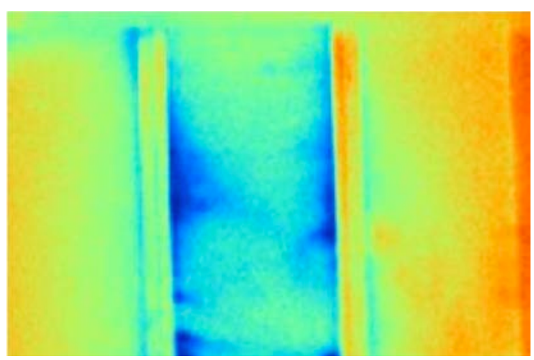

Figure 8: Steel Framing Infrared

Figure 8 shows a wall with all bio-fiber batts installed and one bay removed to compare the thermal effect using one fiberglass batt in its place. Figure 9 shows the thermal image of one center batt of fiberglass and the remaining cellulose batts. Although the temperature difference across the wall was only 20° F (11.1° C), the IR pictures showed a dramatic difference. The firm fit of the cellulose batt

should not only improve the thermal characteristics of the wall, acoustic performance should also be enhanced.
As a comment to Figure 8 one need to add that since the National Research Council of Canada published in 1966 a paper on convection in mineral fibers [9], two thing has happened. Canadian standard organization requested stop using the of faced batts that because of friction fit requirements increased density and thermal performance of typical Canadian batt by 17% over the US counterpart[6] and other companies used the approach of cigarette industry, the issue does not exist or if it exists it is not important. Only now with real look at the energy efficiency we may say – if you want to use convective prone batts you must also use an external insulation and air barrier system.

A DECADE OF EXPERIENCE IN GERMAN CONSTRUCTION

In Germany, attempts to manufacture batts using CFI were in place more than 15 years ago so it is safe to talk about a decade of experience. Figure 9 shows typical wall constructions

Figure 9: (a) Exterior insulation and (b) interior insulation on masonry blocks

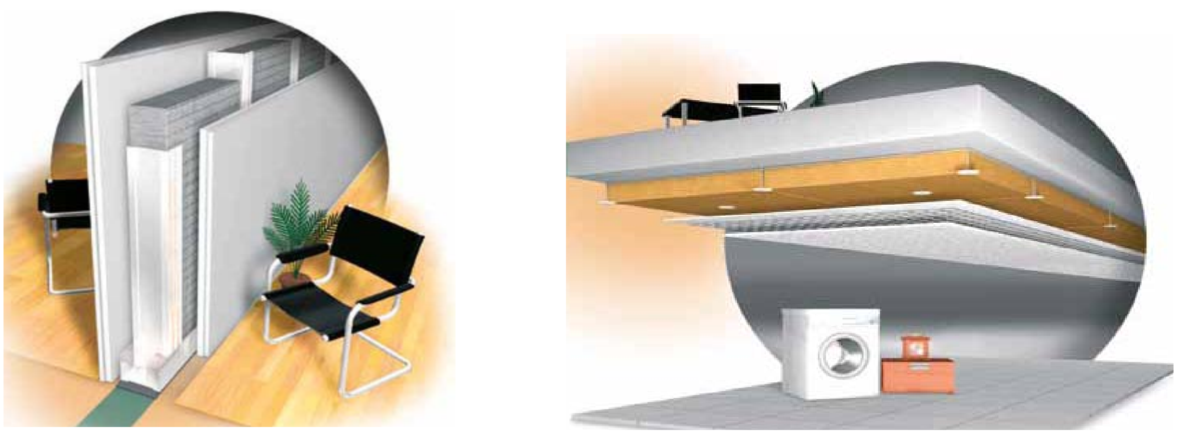

Figure 10: (a) Acoustic insulation and (b) thermal insulation above the unheated space.

Figure 10 show a combination that does not exist in USA namely of the exterior EIFS lamina and stucco as well the climatic stucco on interior. The climatic stucco, typically made on the basis of clay (kaolin) is highly hygroscopic and functions as moisture buffer modulating indoor humidity.

[6] These numbers are based on measurements performed by advanced European laboratory to observe how the Canadian manufacturing was changing immediately after the free trade agreement when a new American owner of the plants introduced unified production pattern; private communication to the author.

Adding to these examples the above and under deck roof insulation one may appreciate a broad range of the bio-fiber applications. We may pose a question – what else is there in bio-fiber development?

THE FUTURE OF BIO-FIBERS: INSULATING SYSTEMS AND BREATHABLE WALLS

Taking into consideration the current needs of thermal upgrade of the existing buildings one may speculated that one of the systems involving bio-fiber insulation will be rehabilitation exterior insulation bio-panel.

The main reason for development bio-fiber exterior insulation systems is compatibility between bio-fiber and any kind of plaster (stucco) or thin lamina that combined with acceptable fire protection and ease of attachment to existing surfaces makes such a development feasible.

The second area of growth is shown in Figure 10b – interior partitions that may be finished with a variety of materials (textile, thin metal, EIFS lamina, etc). The most important feature of these partitions is high noise reduction coefficient and capability of rapid installation (montage) or de-montage (when needed).

Last but not least, we can see the wheel of history comes around. We are now attempting to develop a wall system for the next generation. This system will have an air barrier somewhere in the middle of the wall. The air barrier material can be either OSB coated with WRB and located either on the exterior or interior of the wood or steel frame, it could be a peel and stick or similar membrane applied to the existing construction or it could be a concrete layer poured in between two layers of insulating panels - similar to the insulated concrete forms.

Good drying capability must be ensured on both sides of the air barrier material, and this is a clear advantage of bio-fiber based insulating panels. The industrial-academic consortium at Syracuse University goes even one step further – we intend to develop breathable dynamic wall that is integrated through ventilation channels to a heating and cooling system creating a hygrothermal field in the interior insulation panel that is different from that in the remainder of the wall. In this manner excellent thermal capacity of bio-fibers (twice higher than typical foam insulation) will be further reinforced and allow significant reduction of peak energy loads (either heating or cooling).

CLOSING REMARKS

The desire of manufacturers to improve the "green" aspects of their products is very strong in the present economy. There is not only a need to use recycled materials, there is a need to make the workplace safer and healthier. While most manufacturers are driven by the marketing gains, that goal, even though not as altruistic as we would like, would still have the end results that we all desire.

Some of the areas for the semi-rigid bio-material include the automotive market. While they originally envisioned the product as a replacement for the common acoustical products, through experimentation they discovered they could mold the material to make automotive panels. This makes a wonderful green story for automotive manufacturers as long as the price point is reached. Pricing is the recurring problem with many of the manufacturers that would like to use a more sustainable material. In many cases, the competition is fiberglass which remains very low in cost, and yet has the desired attributes and lightweight structure.

Another group to test the use the cellulose board is the office furniture manufacturers. Testing is continuing at this time to develop a board that holds its structure under severe heat/humidity conditions and a board that remains structurally sound. The weight/structure experimentation has to also maintain the acoustic requirements. Improving the board for one performance aspect often changes the value on another material characteristics.

The acoustic wall manufacturers showed an immediate interest in the semi-rigid bio-fiber material. The panels typically used in this area are thick, high-density fiberglass boards. The primary characteristic is the Noise Reduction Coefficient (NRC). Making a board for this market was much easier as it was simply a matter of finding the right “openness” of the board. A frame supports most of the acoustic-wall treatments so structure was not as important.

Recently a new application for the bio-fiber board became known by requests from people wanting a replacement for wall tack board systems. This market has grown very rapidly. The number one criterion for tack board is, of course, its ability to take a tack and hold the tack. Another advantage that manufacturers of these systems learned was that they could use the tack board in its “bare” form. This allowed the user of the board to show their green product in an obvious way. With a bare board one can see the fibers and newsprint pieces scattered across the surface.

There continues to be inquires on new and different uses for the recycled bio-fiber board. There has been a synergistic effect with the board as each manufacturing trial has led to more ideas being developed. Each idea brings with it a unique set of issues for testing and manufacture. We are all concerned with environmental focus – to stop waste, to move to green and sustainable products and to improve our domestic manufacturing capability. The bio-fiber materials are one path towards achieving those goals.

Necessity is the mother of invention. Innovation spirit of the pioneers settling in the harsh environment combined with abundance of wood initiated development of modern frame wall. Today North American need for thermal upgrade of existing housing and new near zero energy homes points in the direction of highly insulated, air-tight and breathable for moisture wall and we are sure that the current generation will take the challenge of breathable dynamic walls.

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