CELLULOSICS UTILIZATION pdf

1: Cellulosic Man-Made Fibers

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This article has been cited by other articles in PMC. Abstract Fundamental features of microbial cellulose utilization are examined at successively higher levels of aggregation encompassing the structure and composition of cellulosic biomass, taxonomic diversity, cellulase enzyme systems, molecular biology of cellulase enzymes, physiology of cellulolytic microorganisms, ecological aspects of cellulase-degrading communities, and rate-limiting factors in nature. The methodological basis for studying microbial cellulose utilization is considered relative to quantification of cells and enzymes in the presence of solid substrates as well as apparatus and analysis for cellulose-grown continuous cultures. Quantitative description of cellulose hydrolysis is addressed with respect to adsorption of cellulase enzymes, rates of enzymatic hydrolysis, bioenergetics of microbial cellulose utilization, kinetics of microbial cellulose utilization, and contrasting features compared to soluble substrate kinetics. A biological perspective on processing cellulosic biomass is presented, including features of pretreated substrates and alternative process configurations. Two organism development strategies for CBP are examined: A concluding discussion identifies unresolved issues pertaining to microbial cellulose utilization, suggests approaches by which such issues might be resolved, and contrasts a microbially oriented cellulose hydrolysis paradigm to the more conventional enzymatically oriented paradigm in both fundamental and applied contexts. The carbon cycle is closed primarily as a result of the action of cellulose-utilizing microorganisms present in soil and the guts of animals. Thus, microbial cellulose utilization is responsible for one of the largest material flows in the biosphere and is of interest in relation to analysis of carbon flux at both local and global scales. The importance of microbial cellulose utilization in natural environments is further enhanced by the status of ruminants as a major source of dietary protein. Finally, microbial cellulose utilization is also an integral component of widely used processes such as anaerobic digestion and composting. Plant biomass is the only foreseeable sustainable source of fuels and materials available to humanity Cellulosic materials are particularly attractive in this context because of their relatively low cost and plentiful supply. The central technological impediment to more widespread utilization of this important resource is the general absence of low-cost technology for overcoming the recalcitrance of cellulosic biomass. A promising strategy to overcome this impediment involves the production of cellulolytic enzymes, hydrolysis of biomass, and fermentation of resulting sugars to desired products in a single process step via a cellulolytic microorganism or consortium. Notwithstanding its importance in various contexts, fundamental understanding of microbial cellulose utilization is in many respects rudimentary. This is a result of the inherent complexity of microbial cellulose utilization as well as methodological challenges associated with its study. Understanding of cellulose hydrolysis can be approached at several levels of aggregation: In general, our understanding is progressively less complete at more highly aggregated levels of study. Thus, although much remains to be elucidated at the level of enzyme components and the underlying genetics of such components, understanding of cellulose hydrolysis by unfractionated cellulase systems is still less complete, understanding of hydrolysis by pure cultures is more limited yet, and hydrolysis in multispecies cultures and mixed communities is least understood of all. There is a natural tendency for science to proceed over time toward a finer level of aggregationâ€”e. With respect to cellulose hydrolysis, such integration is essential for research advances to be translated into advances in technological, ecological, and agricultural domains. The great majority of cellulose hydrolysis research to date has focused on the genetics, structure, function, and interaction of components of cellulase enzyme systems. Whereas hydrolysis of cellulosic biomass has been approached in prior reviews and the research literature primarily as an enzymatic phenomenon, this review approaches the subject primarily as a microbial phenomenon. Thus, we intend our review to embody the integrative approach described in the previous paragraph. The goals of this review are to collect and synthesize information from the literature on microbial cellulose utilization in both natural and

technological contexts, to point out key unresolved issues, and to suggest approaches by which such issues can be addressed. In seeking to consider microbial cellulose utilization from an integrative perspective, we endeavor to consider a diversity of cellulolytic organisms and enzyme systems. This effort is, however, constrained by the information available, which is much more extensive for some types of systems and some levels of consideration than for others. Information on anaerobic organisms and their enzymes is included in this section as possible, but is much more limited. We conclude with a discussion of the genesis, status, and future direction of the microbial cellulose utilization field from both fundamental and biotechnological perspectives. In a few cases notably cotton bolls , cellulose is present in a nearly pure state. Although these matrix interactions vary with plant cell type and with maturity , they are a dominant structural feature limiting the rate and extent of utilization of whole, untreated biomass materials. A detailed description of these interactions and the mechanisms by which they limit hydrolysis and utilization is beyond the scope of this paper and is the topic of several recent reviews , The discussion below is focused primarily on cellulose itself, since it appears thatâ€”once stripped of the protective effects of other plant biopolymersâ€”cellulose in native plant material shares many characteristics across plant taxa, including its potential for complete hydrolysis and utilization under the proper microbial and environmental conditions. An important feature of cellulose, relatively unusual in the polysaccharide world, is its crystalline structure. Cellulose is synthesized in nature as individual molecules linear chains of glucosyl residues which undergo self-assembly at the site of biosynthesis There is evidence that associated hemicelluloses regulate this aggregation process Approximately 30 individual cellulose molecules are assembled into larger units known as elementary fibrils protofibrils , which are packed into larger units called microfibrils, and these are in turn assembled into the familiar cellulose fibers. The arrangement of individual chains within the elementary fibrils has largely been inferred from the fitting of X-ray diffraction data to statistical models that calculate structure based on minimum conformational energy. Individual models are a source of considerable controversy, even in terms of such fundamentals as the orientation of adjacent chains parallel up versus parallel down , , Regardless of their orientation, the chains are stiffened by both intrachain and interchain hydrogen bonds. Adjacent sheets overlie one another and are held together in cellulose I, the most abundant form of cellulose in nature by weak intersheet van der Waals forces; despite the weakness of these interactions, their total effect over the many residues in the elementary fibril is considerable The crystalline nature of cellulose implies a structural order in which all of the atoms are fixed in discrete positions with respect to one another. An important feature of the crystalline array is that the component molecules of individual microfibrils are packed sufficiently tightly to prevent penetration not only by enzymes but even by small molecules such as water. Although cellulose forms a distinct crystalline structure, cellulose fibers in nature are not purely crystalline. In addition to the crystalline and amorphous regions, cellulose fibers contain various types of irregularities, such as kinks or twists of the microfibrils, or voids such as surface micropores, large pits, and capillaries 63 , , , The total surface area of a cellulose fiber is thus much greater than the surface area of an ideally smooth fiber of the same dimension. The net effect of structural heterogeneity within the fiber is that the fibers are at least partially hydrated by water when immersed in aqueous media, and some micropores and capillaries are sufficiently spacious to permit penetration by relatively large moleculesâ€”including, in some cases, cellulolytic enzymes , Purified celluloses used for studies of hydrolysis and microbial utilization vary considerably in fine structural features, and the choice of substrate for such studies undoubtedly affects the results obtained. Holocelluloses such as Solka Floc are produced by delignification of wood or other biomass materials. These materials contain substantial amounts of various hemicelluloses and often have a low bulk density suggestive of some swelling of cellulose fibers. Commercial microcrystalline celluloses differ primarily in particle size distribution, which as indicated below has significant implications for the rate of hydrolysis and utilization. Cellulose synthesized by the aerobic bacterium Acetobacter xylinum has been tremendously useful as a model system for studying cellulose biosynthesis, but has only been used for a few studies of microbial cellulose utilization. Like plant cellulose, bacterial cellulose is highly crystalline, but the two celluloses differ in the arrangement of glucosyl units within the unit cells of the crystallites 20 , and genetic evidence suggests that the two celluloses are synthesized by enzymatic machinery that differs considerably at the molecular level The two celluloses also

differ substantially in rate of hydrolysis by fungal cellulases and in rate of utilization by mixed ruminal bacteria , The variable structural complexity of pure cellulose and the difficulty of working with insoluble substrates has led to the wide use of the highly soluble cellulose ether, carboxymethylcellulose CMC , as a substrate for studies of endoglucanase production. Because of the substituted nature of the hydrolytic products, relatively few microbes including some fungi and Cellulomonas strains can use CMC as a growth substrate. Plant tissues differ tremendously with respect to size and organization. Some plant cell types e. Others, like sclerenchyma, have thick cell walls and a highly lignified middle lamella separating cells from one another. These cell walls must be attacked from the inside luminal surface out through the secondary wall as opposed to particles of pure cellulose, which are degraded from the outside inward. Thus, in addition to constraints imposed by the structure of cellulose itself, additional limitations are imposed by diffusion and transport of the cellulolytic agent to the site of attack. These constraints may severely limit utilization in some habitats Taxonomic Diversity Until recently, hydrolysis and utilization of cellulose in amounts sufficient to provide usable energy to an organism were thought to be carried out exclusively by microorganisms. It now appears that some animal species, including termites and crayfish, produce their own cellulases, which differ substantially from those of their indigenous microflora , although the contribution of these enzymes to the nutrition of the animal is unclear. In examining the distribution of cellulolytic species across taxonomic groups, it is useful to consider microbial taxonomy based on phylogeny, rather than on a set of arbitrary morphological or biochemical characteristics as used in classical taxonomy. Current views of the evolutionary relatedness of organisms are based largely on phylogenetic trees constructed from measurements of sequence divergence among chronometric macromolecules, particularly small-subunit rRNAs 16S rRNA of procaryotes and 18S rRNA of eucaryotes [,]. An inspection of these trees reveals that the ability to digest cellulose is widely distributed among many genera in the domain Bacteria and in the fungal groups within the domain Eucarya, although no cellulolytic members of domain Archaea have yet been identified. Within the eubacteria there is considerable concentration of cellulolytic capabilities among the predominantly aerobic order Actinomycetales phylum Actinobacteria and the anaerobic order Clostridiales phylum Firmicutes. Fungal cellulose utilization is distributed across the entire kingdom, from the primitive, protist-like Chytridomycetes to the advanced Basidiomycetes. The broad distribution of cellulolytic capability could suggest conservation of a cellulose-degrading capability acquired by a primordial ancestor early in evolutionary development; however, this would seem unlikely, given that the capacity for cellulose biosynthesis did not evolve until much later, with the development of algae, land plants and the bacterium A. More likely is the convergent evolution toward a cellulolytic capability under the selective pressure of abundant cellulose availability following the development of cellulose biosynthesis. Fungi are well-known agents of decomposition of organic matter in general and of cellulosic substrates in particular 94 , Fungal taxonomy is based largely on the morphology of mycelia and reproductive structures during various stages of the fungal life cycle rather than on substrate utilization capability. Indeed, systematic characterization of growth substrates has not been carried out for many described fungal species. Therefore, it is currently unclear how broadly and deeply cellulolytic capability extends through the fungal world, and a consideration of the taxonomy of cellulolytic fungi may ultimately prove to be only a slightly narrower topic than consideration of fungal taxonomy in its entirety. Nevertheless, some generalizations can be made regarding the distribution of cellulolytic capabilities among these organisms. A number of species of the most primitive group of fungi, the anaerobic Chytridomycetes, are well known for their ability to degrade cellulose in gastrointestinal tracts of ruminant animals. Although taxonomy of this group remains controversial 94 , members of the order Neocallimastigales have been classified based on the morphology of their motile zoospores and vegetative thalli; they include the monocentric genera Neocallimastix, Piromyces, and Caecomyces and the polycentric genera Orpimomyces and Anaeromyces Cellulolytic capability is also well represented among the remaining subdivisions of aerobic fungi. Within the approximately species of Zygomycetes, only certain members of the genus Mucor have been shown to possess significant cellulolytic activity, although members of this genus are better known for their ability to utilize soluble substrates. By contrast, the much more diverse subdivisions Ascomycetes, Basidiomycetes, and Deuteromycetes each of which number over 15, species [94] , contain large numbers of

cellulolytic species. For a more detailed consideration of fungal taxonomy and some of its unresolved issues, see reference Generally, only a few species within each of the above-named genera are actively cellulolytic. The distribution of cellulolytic capability among organisms differing in oxygen relationship, temperature, and salt tolerance is a testament to the wide availability of cellulose across natural habitats. Complicating the taxonomic picture is the recent genomic evidence that the noncellulolytic solventogenic Clostridium acetobutylicum contains a complete cellulosomal gene cluster system that is not expressed, due in part to disabled promoter sequences Examination of the rapidly expanding genomics database may reveal similar surprises in the future. Major morphological features of cellulolytic bacteria Oxygen relationship.

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2: Wood and cellulosics: industrial utilisation, biotechnology, structure and properties.

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Overview[edit] Cellulosic ethanol is a type of biofuel produced from lignocellulose , a structural material that comprises much of the mass of plants. Lignocellulose is composed mainly of cellulose , hemicellulose and lignin. Corn stover , Panicum virgatum switchgrass , Miscanthus grass species, wood chips and the byproducts of lawn and tree maintenance are some of the more popular cellulosic materials for ethanol production. Production of ethanol from lignocellulose has the advantage of abundant and diverse raw material compared to sources such as corn and cane sugars, but requires a greater amount of processing to make the sugar monomers available to the microorganisms typically used to produce ethanol by fermentation. Switchgrass and Miscanthus are the major biomass materials being studied today, due to their high productivity per acre. Cellulose, however, is contained in nearly every natural, free-growing plant, tree, and bush, in meadows, forests, and fields all over the world without agricultural effort or cost needed to make it grow. The first commercialized ethanol production began in Germany in , where acid was used to hydrolyze cellulose. Later, a second plant was opened in Louisiana. However, both plants were closed after World War I due to economic reasons. It involved the use of dilute acid to hydrolyze the cellulose to glucose, and was able to produce 7. This process soon found its way to the US, culminating in two commercial plants operating in the southeast during World War I. These plants used what was called "the American Process" â€” a one-stage dilute sulfuric acid hydrolysis. A drop in lumber production forced the plants to close shortly after the end of World War I. The Vulcan Copper and Supply Company was contracted to construct and operate a plant to convert sawdust into ethanol. The plant was based on modifications to the original German Scholler process as developed by the Forest Products Laboratory. Chemical pretreatment of the feedstock is required to prehydrolyze separate hemicellulose, so it can be more effectively converted into sugars. Recently, the Forest Products Laboratory together with the University of Wisconsinâ€”Madison developed a sulfite pretreatment to overcome the recalcitrance of lignocellulose [12] for robust enzymatic hydrolysis of wood cellulose. US President George W. Bush , in his State of the Union address delivered January 31, , proposed to expand the use of cellulosic ethanol. Half of the six projects chosen will use thermochemical methods and half will use cellulosic ethanol methods. The two ways of producing ethanol from cellulose are: Cellulolysis processes which consist of hydrolysis on pretreated lignocellulosic materials, using enzymes to break complex cellulose into simple sugars such as glucose , followed by fermentation and distillation. Gasification that transforms the lignocellulosic raw material into gaseous carbon monoxide and hydrogen. These gases can be converted to ethanol by fermentation or chemical catalysis. As is normal for pure ethanol production, these methods include distillation. Cellulolysis biological approach [edit] The stages to produce ethanol using a biological approach are: Although lignocellulose is the most abundant plant material resource, its usability is curtailed by its rigid structure. As a result, an effective pretreatment is needed to liberate the cellulose from the lignin seal and its crystalline structure so as to render it accessible for a subsequent hydrolysis step. To achieve higher efficiency, both physical and chemical pretreatments are required. Physical pretreatment is often called size reduction to reduce biomass physical size. Chemical pretreatment is to remove chemical barriers so the enzymes can have access to cellulose for microbial reactions. Even though pretreatment by acid hydrolysis is probably the oldest and most studied pretreatment technique, it produces several potent inhibitors including furfural and hydroxymethyl furfural HMF which are by far regarded as the most toxic inhibitors present in lignocellulosic hydrolysate. SPORL is the most energy efficient sugar production per unit energy consumption in pretreatment and robust process for pretreatment of forest biomass with very low production of fermentation inhibitors. Organosolv pulping is particularly effective for hardwoods and offers easy recovery of a hydrophobic lignin product by dilution and precipitation. Cellulolytic processes[edit] The cellulose molecules are composed of long chains of sugar molecules. In the hydrolysis of cellulose that is, cellulolysis , these chains are broken down to free the sugar before it is fermented for alcohol production. Chemical

hydrolysis[edit] In the traditional methods developed in the 19th century and at the beginning of the 20th century, hydrolysis is performed by attacking the cellulose with an acid. A decrystalized cellulosic mixture of acid and sugars reacts in the presence of water to complete individual sugar molecules hydrolysis. The product from this hydrolysis is then neutralized and yeast fermentation is used to produce ethanol. As mentioned, a significant obstacle to the dilute acid process is that the hydrolysis is so harsh that toxic degradation products are produced that can interfere with fermentation. BlueFire Renewables uses concentrated acid because it does not produce nearly as many fermentation inhibitors, but must be separated from the sugar stream for recycle [simulated moving bed SMB chromatographic separation, for example] to be commercially attractive. Agricultural Research Service scientists found they can access and ferment almost all of the remaining sugars in wheat straw. To access these sugars, scientists pretreated the wheat straw with alkaline peroxide, and then used specialized enzymes to break down the cell walls. This reaction occurs at body temperature in the stomachs of ruminants such as cattle and sheep, where the enzymes are produced by microbes. This process uses several enzymes at various stages of this conversion. All major pretreatment methods, including dilute acid, require an enzymatic hydrolysis step to achieve high sugar yield for ethanol fermentation. Various enzyme companies have also contributed significant technological breakthroughs in cellulosic ethanol through the mass production of enzymes for hydrolysis at competitive prices. The fungus Trichoderma reesei is used by Iogen Corporation to secrete "specially engineered enzymes" for an enzymatic hydrolysis process. The CRAC production facility uses corn stover as raw material. A recent breakthrough in this regard was the discovery and inclusion of lytic polysaccharide monooxygenases. These enzymes are capable of boosting significantly the action of other cellulases by oxidatively attacking a polysaccharide substrate. In , BP Biofuels bought out the cellulosic ethanol venture share of Verenium , which had itself been formed by the merger of Diversa and Celunol, and with which it jointly owned and operated a 1. BP Biofuels continues to operate these facilities, and has begun first phases to construct commercial facilities. Ethanol produced in the Jennings facility was shipped to London and blended with gasoline to provide fuel for the Olympics. It is the first operating commercial cellulosic ethanol facility in the nation. The KL Energy process uses a thermomechanical breakdown and enzymatic conversion process. The primary feedstock is soft wood, but lab tests have already proven the KL Energy process on wine pomace, sugarcane bagasse, municipal solid waste, and switchgrass. Due to the complex nature of the carbohydrates present in lignocellulosic biomass , a significant amount of xylose and arabinose five-carbon sugars derived from the hemicellulose portion of the lignocellulose is also present in the hydrolysate. As a result, the ability of the fermenting microorganisms to use the whole range of sugars available from the hydrolysate is vital to increase the economic competitiveness of cellulosic ethanol and potentially biobased proteins. In recent years, metabolic engineering for microorganisms used in fuel ethanol production has shown significant progress. Recently, engineered yeasts have been described efficiently fermenting xylose, [36] [37] and arabinose, [38] and even both together. Combined hydrolysis and fermentation[edit] Some species of bacteria have been found capable of direct conversion of a cellulose substrate into ethanol. One example is Clostridium thermocellum , which uses a complex cellulosome to break down cellulose and synthesize ethanol. Some research efforts are directed to optimizing ethanol production by genetically engineering bacteria that focus on the ethanol-producing pathway. Instead of breaking the cellulose into sugar molecules, the carbon in the raw material is converted into synthesis gas , using what amounts to partial combustion. The carbon monoxide, carbon dioxide and hydrogen may then be fed into a special kind of fermenter. Instead of sugar fermentation with yeast, this process uses Clostridium ljungdahlii bacteria. The process can thus be broken into three steps: Gasification â€” Complex carbon-based molecules are broken apart to access the carbon as carbon monoxide, carbon dioxide and hydrogen Fermentation â€” Convert the carbon monoxide, carbon dioxide and hydrogen into ethanol using the Clostridium ljungdahlii organism Distillation â€” Ethanol is separated from water A recent study has found another Clostridium bacterium that seems to be twice as efficient in making ethanol from carbon monoxide as the one mentioned above. Fermentation of glucose, the main product of cellulose hydrolyzate, to ethanol is an already established and efficient technique. However, conversion of xylose, the pentose sugar of hemicellulose hydrolyzate, is a limiting factor, especially in the presence of glucose.

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Moreover, it cannot be disregarded as hemicellulose will increase the efficiency and cost-effectiveness of cellulosic ethanol production. The researchers created a recombinant Saccharomyces cerevisiae strain that was able to: The strain was able to convert rice straw hydrolyzate to ethanol, which contains hemicellulosic components. Moreover, it was able to produce 2. However, most of its production is with the use of corn ethanol. In the year , only 6. Environmental Protection Agency implemented the Renewable Fuel Standard RFS , which required that a certain percentage of renewable fuel be included in fuel products. The shift to cellulosic ethanol production from corn ethanol has been strongly promoted by the US government. However, as of it was projected that the production of cellulosic ethanol would be approximately Currently, there are many pilot and demonstration facilities open that exhibit cellulosic production on a smaller scale. These main facilities are summarized in the table below. Start-up costs for pilot scale lignocellulosic ethanol plants are high. On 28 February , the U. In contrast, cellulosic ethanol is obtained from cellulose, the main component of wood, straw, and much of the structure of plants. Since cellulose cannot be digested by humans, the production of cellulose does not compete with the production of food, other than conversion of land from food production to cellulose production which has recently started to become an issue, due to rising wheat prices. The price per ton of the raw material is thus much cheaper than that of grains or fruits. Moreover, since cellulose is the main component of plants, the whole plant can be harvested. An estimated million tons of cellulose-containing raw materials which could be used to create ethanol are thrown away each year in US alone. All these, except gypsum board, contain cellulose, which is transformable into cellulosic ethanol. It is estimated that each person in the US throws away 4. However, the Department of Energy is optimistic and has requested a doubling of research funding. In September , a report by Bloomberg analyzed the European biomass infrastructure and future refinery development. Estimated prices for a litre of ethanol in August are EUR 0. It was estimated that the plant would be producing 36 million gallons a year at its location in Highlands County of Florida. Poet is also in midst of producing a million dollar, million-gallon per year in Emmetsburg, Iowa. Mascoma now partnered with Valero has declared their intention to build a 20 million gallon per year in Kinross, Michigan. The family-held company is commissioning an 82 million liters per year 22 MMgy cellulosic ethanol plant 2G ethanol in the state of Alagoas, Brazil, which will be the first industrial facility of the group. Breaking ground in January , the plant is in final commissioning.

3: USA - Process for forming a cellulose sponge - Google Patents

The main reason for failure of injection is the high pressure necessary to inject the PTFE with subsequent extrusion of material from the injection site or through the urethral mucosa.

Volatile Silicone Hyaluronic acid HA is well-known for the benefits it provides in topical formulations, including moisturization, delivery of water and actives to the skin, film formation and antioxidant effects. Such cross-linked HA gelsa were developed first for use in medical devices as soft tissue augmentation agents, to correct soft tissue deformities, e. Non-equilibrium gels are typically better able to incorporate and entrap actives, as they may be further swollen in the presence of a solution of the active. The actives therefore become part of the hydrated molecular cage of the cross-linked HA gel. Excerpt Only This is a shortened version or summary of the article you requested. To view the complete article, please log in or create an account. As is described here, the cross-linked HA gels were assessed for potential personal care applications by testing their water-binding capacity, delivery of actives, and stability against heat, free radicals, other chemicals and pH changes, as compared with non-cross-linked native HA. Water Binding The water-binding properties of a polymer greatly influence its structure, stability and macroscopic properties. In formulations, water-binding acts as a reservoir for water that, upon application, enables the formation of a protective and hydrating film. A high water-binding capacity also facilitates and enhances the loading of actives. The water-binding capacity and characteristics of cross-linked HA gel, HA and other natural polymers were thus measured, using differential scanning calorimetry DSC thermograms transition temperature heating curves. Non-freezable bound water is highly structured, and tightly associated with and attached to the hydroxyl groups and hydrophilic portions of the HA and HA gel structures through hydrogen bonding. Also referred to as semi-bound water, freezable bound water is structured and characterized as having a phase transition temperature lower than bulk water due to weaker interactions with the polymer. Free water does not form hydrogen bonds with polymers. It can be distinguished from freezable bound water by the transition temperature measured in DSC heating curves, since its freezing temperature is the same as bulk water. However, free water may be compartmentalized or held within the polymer matrix, and it will exhibit restricted diffusion, which is influenced by the amount and type of bound water. Ex vivo Delivery to the Stratum Corneum As noted, the capacity to form stable clusters or traps of freezable bound water enhances the ability of cross-linked HA gels to deliver water and other actives to stratum corneum SC. This enhanced hydrating activity of cross-linked HA gel non-equilibrium form was demonstrated in an independent study by Rutgers,22 in which scientists measured the water content of human SC after treatment with cross-linked HA gel NEF or HMW HA, each having identical polymer content. After 24 hr, the skin sample treated with the cross-linked gel contained six times more moisture in the total sample, and five times more moisture in the SC than the HA-treated skin. Deuterated water D2O was used to quantify water content via confocal Raman spectroscopy see Figure 2. Free Radical-Scavenging A natural scavenger of free radicals, HA protects against both cell damage and damage to healing tissues while also inhibiting lipid peroxidation. This is most likely due to the ability of the larger molecule to absorb, neutralize and consume more free radicals as a result of the 3D matrix structure, greater space occupation, surface area, etc. It also exhibits greater stability due to covalent cross-links and higher water-binding capacity; hence, it has a greater capacity for free radical consumption. The amount of free radicals consumed was determined by monitoring the increase in absorbance, at nm, caused by the reduction of cytochrome c. Additionally, studies were conducted using polymorphonuclear leukocytes PMN , i. The cross-linked HA gel inhibited the generation of free radicals O2- by PMN data not shown in a dose-dependent manner. The sample was lathered for 15 sec, left on the arm for 30 sec, and rinsed for 2 min. The arm was dried and subjects were re-acclimated for 20 min before glycerol content was evaluated. In addition to deposition, the release kinetics of lactic acid, an alpha hydroxyl acid, from non-equilibrium cross-linked HA gel were evaluated and compared with those from a control solution. Alpha hydroxyl acids such as lactic acid are popular in anti-aging products due to their effects of increasing epidermal firmness and thickness, and improving skin smoothness. To measure the release rate, a

radio-labeled form of lactic acid was used; experiments were carried out in dialysis chambers. The cross-linked HA gel slowly released the lactic acid active from the matrix over a hr period see Figure 5. Previous studies18 also were conducted on a UV filterb combined with cross-linked HA gel in order to form a sunscreen product with increased surface retention and reduced absorption into the skin. The penetration of the sunscreen was measured by tape-stripping each skin site of application. This was followed by isopropanol elution of each tape, and measurements of absorption of the eluted solution at nm; i. In contrast, exposing the cross-linked HA gel to the same concentration of free radicals for 1 hr had a minimally degradative effect; a 2. Intact cross-linked HA gel does not pass through a 0. Conclusion Cross-linked HA gels provide a practical means to enhance the benefits associated with using HA in topical skin care formulations. The major properties shown here include: Hyaluronic acid prevents oxygen free-radical damage to granulation tissue:

4: Logos and Trademarks

Wood And Cellulosics: Industrial Utilisation, Biotechnology, Structure, And Properties by John F. Kennedy Glyn O Phillips Peter A Williams Biochemical Society (Great Britain).

The invention is concerned with a cellulose sponge and a process for its production. According to this known process, wood pulp is converted into the xanthate, the xanthate is mixed with a porophore and fibres, whereafter particles of an absorbing polymer coated with a polymer layer are added. Afterwards, the xanthate is regenerated using an acid or a base, and the regenerate is washed and bleached. A disadvantage of this process is that due to the by-products of the viscose process its environmental impact creates problems to be solved. For some decades there has been searched for processes able to substitute the viscose process today widely employed. As an alternative which is interesting for its reduced environmental impact among other reasons, it has been found to dissolve cellulose without derivatisation in an organic solvent and extrude from this solution moulded bodies, e. It has turned out that as an organic solvent, a mixture of a tertiary amine-oxide and water is particularly appropriate for the production of cellulose moulded bodies. Other amine-oxides are described e. A process for the production of mouldable cellulose solutions is known e. The production of cellulose bodies using tertiary amine-oxides generally is referred to as amine-oxide process. In EP-A-0 , a process for the production of cellulose solutions is described, wherein as a starting material among other substances a suspension of cellulose in liquid, aqueous N-methylmorpholine-N-oxide NMMO is used. This process consists in transforming the suspension in a thin-film treatment apparatus in one single step and continuously into a mouldable solution. The cellulose is precipitated from the solution in an aqueous spinning bath. During this process, amine-oxide accumulates in the spinning bath. For the economy of the amine-oxide process it is of vital importance to recover and reuse the amine-oxide nearly completely. In the literature, virtually nothing is known about the production of a cellulose sponge according to the amine-oxide process. Only in it was reported that a new process for the production of cellular cellulose, which is similar to sponges, from a solution of cellulose in an aqueous tertiary amine-oxide was searched. It is further reported that a number of parameters, whereof the water content is of foremost importance, influences the production, and that the products obtained are similar to those produced from viscose Peguy: However, a reproducible teaching for the production of sponges from the cellulose solutions cannot be deduced from this literature. It is the object of the invention to provide a cellulose sponge which is to be produced according to the amine-oxide process. SUMMARY OF THE INVENTION The process according to the invention for the production of a cellulose sponge is characterized in that a solution of cellulose in an aqueous tertiary amine-oxide is mixed with a pore forming agent and a sponging agent and subsequently exposed to conditions which cause a decomposition of the sponging agent and a foaming of the cellulose solution, whereafter the foamed cellulose is contacted with water to precipitate the cellulose. Afterwards, the tertiary amine-oxide is washed out of the cellulose sponge obtained. As the pore forming agent, an alkaline metal or an alkaline earth metal salt of an inorganic acid is preferably employed, sodium sulphate or magnesium sulphate showing particularly good results. The pore forming agent is conveniently used in an amount not exceeding three time of the mass of the cellulose solution employed. As the sponging agent preferably azodicarbonamide, which optionally may be modified, or sodium hydrocarbonate is employed. The sponging agent must be selected in such a manner that no exothermal reaction is initiated in the cellulose solution. Above all, it should not contain any metal ions capable of initiating a decomposition of the tertiary amine-oxide. It has been shown that the content of dissolved cellulose in the cellulose solution used has an immediate influence on the foaming behaviour. The lower the cellulose content, the higher the foaming degree and the lower the adhesion of the individual pores of the finished cellulose sponge among each other. This means that the mechanical resistance declines. On the other hand, when the cellulose content is too high, foaming declines such that no pore structure can be produced. It has proven particularly advantageous for the cellulose solution used to contain additionally undissolved cellulose particles such as fibres. These fibres serve as a reinforcing agent. Moreover, apart from the pore forming agent and the sponging agent, a pigment for colouring may be added to the cellulose

solution. The decomposition of the sponging agent may be carried out conveniently at elevated temperature. It has been shown further that in the process according to the invention, N-methylmorpholine-N-oxide is of particularly good use as the tertiary amine-oxide. Optionally, the foamed cellulose solution is contacted with water containing magnesium chloride to precipitate the dissolved cellulose and to fix the pore structure. In the process according to the invention also alternative cellulose sources such as used fabrics, garment scraps and waste paper etc. The invention is further concerned with a cellulose sponge obtainable according to the process according to the invention. The sponge according to the invention is characterized by a high water retention capacity and a satisfactory mechanical resistance. As documented below, it is possible according to the invention to control or adjust the mechanical resistance and the water absorption capacity of the cellulose sponges according to the invention, the influencing parameters being the cellulose concentration of the processed solution, the molecular weight of the cellulose used, the concentration of pore forming agent and the concentration of sponging agent in the mass to be foamed. The process according to the invention is not harmful to the environment, since the tertiary amine-oxide can be virtually completely recovered from the precipitation bath. The sponges according to the invention are biodegradable and may be composted, disposed of or incinerated in a simple way, no toxic emissions being produced during incineration. Since unlike conventional plastic sponges they are not produced from petrochemicals, they reduce oil consumption. The sponges according to the invention may also be produced from used materials, thus contributing to their disposal. The cellulose sponges are particularly appropriate as bathing sponges and for cleaning purposes. Subsequently, the pore forming agent and the sponging agent are added to the kneader, introducing them into the mixture. Foaming of the mixture is carried out in a warming cabinet under conditions whereunder the sponging agent may be decomposed while producing a gas. A reduced pressure of 60 mbar may be applied. According to the above, general production procedure, several series of cellulose sponges were produced, for series A employing cellulose solutions having a varied cellulose concentration pulp: Alicell LV, g; sponging agent: Viscokraft LV; cellulose concentration: The cellulose sponges produced were analyzed for their water absorption capacity using the weight method. The results are indicated in the following Tables 1 to 4. From these results it can be seen that the water absorption capacity increases as the cellulose concentration declines, as the molecular weight of the cellulose used declines, as the concentration of pore forming agent increases and as the concentration of sponging agent Tracel DBN NER; Tramaco, DE increases. The mechanical resistance of all cellulose sponges produced was satisfactory. A process for the production of a cellulose sponge comprising the steps of: A process according to claim 1, wherein as said pore forming agent an alkaline metal or an alkaline earth metal salt of an inorganic acid is employed. A process according to claim 2, wherein as said pore forming agent sodium sulphate or magnesium sulphate is employed. A process according to claim 3, wherein said pore forming agent is used in an amount which does not exceed three times the mass of said cellulose solution employed. A process according to claim 1, wherein said sponging agent is selected from the group consisting of azodicarbonamide, a modified azodicarbonamide and sodium hydrocarbonate. A process according to claim 7, wherein said cellulose solution contains additionally undissolved cellulose particles. A process according to claim 1, wherein a pigment is mixed additionally into said cellulose solution. A process according to claim 1, wherein the decomposition of said sponging agent is carried out at elevated temperature. A process according to claim 1 wherein as the source of cellulose, wood pulp, used fabric, garment scraps and waste paper are employed, either individually or in combinations of 2 or more. A process according to one of the claim 1, wherein said tertiary amine-oxide is N-methylmorpholine-N-oxide. A process according to claim 1, wherein said foamed cellulose solution is contacted with water containing magnesium chloride.

5: Cellulosic ethanol - Wikipedia

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9: Fibers and Cellulosics

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