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DESIZING GLASS FABRICS AND DESIZED PRODUCT

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This invention relates to a method of desizing glass fabrics and more particularly to a thermal desizing process. In another aspect it relates to a cleaned desized glass fabric or material which has a very low ignition loss and which retains a very high proportion of the original strength of the greige goods. The term "glass fabric" as herein used refers to fabrics knitted, netted or woven from yarns comprising a number of filaments of glass. In the specific examples given herein by way of illustration the treated fabric was a square or plain weave.

It is well known that before the individual glass filaments can be formed into strands they must be coated with a sizing material which serves as a continuous filament binder and affords a measure of protection to the filaments during weaving or knitting or subsequent textile treatments. The size also lubricates the filaments and the fibers produced therefrom. This size is organic in nature and for example consists of starch or dextrinized starch, gelatine, a complex amine, and in most instances a lubricant such as mineral, animal or vegetable oil. It is usually applied to the fibers in amounts between about one and three percent by weight. The size must be more or less removed from the woven or knitted fabric or textile goods prior to coloring when the goods are to be used for decorative purposes. This also applies to goods to be finished prior to treatment with resins to be used for laminated or coated glass products.

This invention is especially useful where the glass fabric is to be used for industrial uses such as in glass fabric resinous or plastic laminates or coatings. In such laminates it is of great importance to have a desized glass fabric which not only has a strength as near that of the greige goods as possible but one that is substantially free of all size residue.

Several methods have been suggested for desizing and most of these methods find current application. For example, the size may be washed with suitable detergents. However, washing and equivalent chemical methods are either expensive or require a great deal of time. By far the simplest methods and the ones which are in most general use today are thermal treatments of which three are illustrative. Two of these are characterized by low temperature treatments, one a batch treatment known in the trade as the "112 Finish" and the other a continuous feed treatment known in the trade as the "111 Finish." The third is a high temperature continuous feed treatment, known as "Coronizing."

The batch treatment (112 Finish) is not only time-consuming (from 55-80 hours) but the tensile strength of the finished fabric is only about 40%-50% of its original strength. The treated fabric has a low ignition loss, but it does not possess the optimum strength desired for industrial uses.

The low temperature continuous treatment (111

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Finish) which produces a fabric having a reasonably high tensile strength does so at the expense of leaving on the finished fabric a large portion of the sizing in the form of a caramelized residue which is highly undesirable for many industrial uses, such as where bonding between glass fabric and resins or the like are desirable.

High temperature continuous treatment (Coronizing) is characterized by subjecting the goods to a comparatively drastic treatment, including a relatively high furnace temperature and to an intense burning flame such as to remove substantially all of the carbonaceous material of the size. This treatment is in popular use for producing glass fabrics for decorative purposes where "hand" and yarn "set" are the ultimate aim, and retention of original tensile strength is unimportant. While the ignition loss of the finished fabric is low, the tensile strength is also very low, being from 30%-60% only of the greige goods. Therefore, the fabric produced by this process does not give the strength desired for industrial uses.

While "Coronizing" produces a clean fabric having a very low ignition loss, the strength of the goods is reduced to about half. The 111 Finish or low temperature continuous desizing does not detract as greatly from the tensile strength of the fabric. Nevertheless, retention of strength is obtained at the expense of incomplete desizing. Not much more than about half of the size is removed, that which remains is caramelized, which gives the goods a dark brown color. Because of their high ignition loss, 111 finished goods, per se, are not particularly satisfactory for building glass laminates, since the resins employed do not adhere well to the caramelized coating of the fabric. Accordingly, additional treatment is required to condition the goods before they can be laminated. Furthermore, because of the relatively slow speed at which the goods are passed through the heating zone or the heated drum, production rates are less than those obtainable by "Coronizing." The time-consuming batch or 112 Finish, while producing goods having an ignition loss in the order of 0.2 percent, also greatly reduces tensile strength of the goods.

While a major part of the strength of glass laminates is derived from the resin, higher strength materials are definitely producible when high strength glass fabrics are employed. Accordingly, a process of desizing which would not only permit a high retention of the tensile strength of the greige goods but also produce fabrics with very low ignition loss is highly desirable. Strength of the fabric and low ignition loss are the fundamental attributes desired in laminates. The present invention is directed to such a process which is susceptible of continuous operation and provides desized goods with the desired combination of very high tensile strength and very low ignition loss, i.e., tensile strength equal to and in most instances greater than the 111 Finish, and an ignition loss as low as that obtainable by "Coronizing."

In accordance with the present invention the greige glass fabric in open width is passed through a muffle furnace at a temperature sufficiently high to preheat the size, volatilize the same, and ignite the volatile material, but not above about 1050° F. The oxygen supplied to the furnace is limited to an amount sufficient only to support combustion of the size with a yellow, carbon-containing, wide, lazy flame, as distinguished from a blue flame, evidencing complete combustion of the carbonaceous size. The resulting fabric is of an off-white color, that is to say, beige to light amber. It has a very high tensile strength as compared with the greige goods, that is to say, at least 70 percent of the tensile strength of

the greige goods and in many instances, particularly in the heavier fabrics, from 80 to above 95 percent. Furthermore, the fabric treated in accordance with the present invention has an ignition loss of only about 0.04-0.1 percent. It thus produces a fabric which is both clean and has high physical strength, i.e., it has a low ignition loss of "Coronized" or batch oven treated fabric without the corresponding loss of physical strength, and it has the high strength of continuous low temperature treatment (111) without the high ignition loss or caramelized coating. The fabrics produced by the method of the present invention are suitable for a wide variety of industrial uses, including coating applications, and as reinforcements for plastic laminates.

More specifically, the muffle furnace in which the process of the present invention is carried out is preferably disposed horizontally and is open at both ends to permit a natural air draft. While the process may also be carried out in an upright or vertical furnace, the muffle furnaces in most general use today are of the horizontal type and are about 6-8 feet in length. As indicated, the fabric is drawn in open width through the furnace and is therein heated sufficiently to volatilize and ignite the size. By reason of the fact that supplementary air, oxygen, or oxygen-containing gas is not introduced to the furnace (as is done in the prior art continuous high temperature process), the size burns with a yellow flame, which evidences unoxidized carbon in the flame. While it is difficult to definitely specify the oxygen content in the atmosphere surrounding the flame, it can be said that it is sufficiently low to cause the type of burning just described. The burning occurs in a fairly wide band across the width of the fabric being drawn through the furnace. By reason of an insufficient oxygen supply to effect complete combustion of the carbonaceous material of the size, the flame is not only yellow, but it is a fluttering, lazy flame which extends over a considerable length of the fabric. The type of burning which occurs is thus quite different from the relatively much narrower band of blue flame produced during "Coronizing" and other prior art processes. The latter types of burning evidence complete combustion and occur because the atmosphere immediately surrounding the flame abounds with a substantial excess of oxygen. By reason of the insufficiency of oxygen in the present process, the flame temperature is substantially lower than that occurring in the aforementioned processes.

As indicated above, the temperature of the furnace is sufficiently high to cause burning of the size but below 1050° F. The temperature is preferably between 900-1050° F. At these temperatures, the size is raised to ignition temperature much more slowly, and burning occurs in the exit half of the furnace. In many instances the size is not ignited until the fabric is about to emerge from the furnace, and the wide band of yellow flame often extends outwardly of the exit end of the furnace. There are indications in the prior art that burning so close to the exit end of the furnace is detrimental to the process. However, the production of thousands of yards of desized material in accordance with the method of the present invention, wherein burning occurred partly within and partly without the furnace at its exit end did not result in erratic operation or detract from the aforementioned desirable characteristics of the desized glass product.

It has been found that the necessary amount of oxygen to support the type of burning necessary in the present invention may be obtained by a natural draft into the furnace from the exit and entrance ends thereof. In accordance with the present invention the fabric is drawn through the furnace at such a rate that burning will occur in the second half of the furnace as above indicated. Speed will, of course, depend upon the temperature within the furnace and the weight of the goods. For example, a six ounce fabric will be in the high temperature zone

approximately 4-6 seconds. Thus, in a six foot furnace, these goods may be desized at the rate of about 20-30 yards per minute. With heavier goods the speed will be less, since they are preheated more slowly. Generally, 3-25 seconds exposure to the aforementioned temperatures is sufficient.

The reason why the product of the present invention exhibits the very high tensile strength as compared with "Coronized" goods is believed to be due to the fact that it is not subjected to the higher flame temperature. Flame temperature and the type of burning are controlled by an insufficient supply of oxygen to cause complete combustion of the carbon of the size. The yellow flame characterizes the desired type of burning at a substantially lower temperature, as distinguished from the complete oxidizing action which occurs in the blue flame of "Coronizing." By reason of lower flame temperatures, the fabric at the base of the flame is not weakened to so high a degree. It is possible, although I do not wish to be bound by this explanation, that by reason of the fact that burning occurs near the exit end of the furnace, the quick cooling which occurs as the fabric passes into cooler apparatus or into the atmosphere surrounding the furnace may contribute to the higher strength of the product.

In order to point out the advantages of the process of the present invention and the superior characteristics of the glass fabric following the treatment, as compared with the batch, the continuous low temperature treatment and the continuous high temperature or "Coronizing" treatment, a six ounce material designated HG-28, having a square weaving construction of 42 counts in the warp by 32 in the fill, was treated by each of the above three discussed methods in use today and also by the method in the present invention. The fabric initially contained 2 percent by weight of organic size. The tensile strength of the greige goods was measured in pounds per inch of width in both the warp and fill directions. Samples of the fabric were taken near each of its linear edges and in the center, and the average tensile strength noted. Commercial lots were treated by each method. In the batch operation several rolls of the fabric were placed in an oven closed to the atmosphere and the temperature raised over a period of about 18 hours to approximately 650° F. The total residence time in the oven was 80 hours. In the continuous low temperature treatment, the fabric in open width was passed over a roller maintained at a temperature of 550-650° F., which was open to the atmosphere. The length of time during which the glass was in contact with the roller was approximately 1 to 3 minutes. No open flame occurred. "Coronizing" or high temperature continuous treatment was effected in an oven disposed horizontally. The length of the oven was approximately six feet, and air under pressure was injected into the furnace so as to impinge upon the upper and lower surfaces of the cloth at a point in the forward half of the oven just forward of the point at which the size ignited and burned. The furnace was maintained at 1250-1300° F., and the goods were passed through at a rate of 23 yards per minute.

The goods treated in accordance with the present invention were passed through the furnace above described in connection with "Coronizing," but the temperature in the oven was maintained between 900-1050° F. No air or oxygen-containing gas was injected into the furnace. The only flow of air therein was by natural draft through the entering and exit ends. The size was ignited and burned with a yellow flame approximately six inches wide at the exit end of the furnace.

Following these treatments, the ignition loss for each of the fabrics was determined as was the tensile strength of the warp and fill, the latter being measured as indicated above. The results of these tests, together with similar tests carried out on 116 cloth, a 3.2 ounce ma-

terial, and HG-65, 12.6 ounce goods, as treated by the method of the present invention and the batch oven treatment are reported in the following table:

off cooling the fabric to below size ignition temperature.
2. A process for removing a combustible size from glass fabric in a thermal treating zone, which comprises

Fabric

Treatment	HG-28			HG-65			116 Cloth		
	Wt. 6 oz./sq. yd.; Thickness 0.0067 in.; Count: 42 (warp) X32 (fill)			Wt. 12.6 oz./sq. yd.; Thickness 0.015 in.; Count: 20X19			Wt. 3.2 oz./sq. yd.; Thickness 0.004 in.; Count: 60X64		
	Tensile Strength (lb./in. of width) and percent strength retained		Ignition Loss following treatment, percent	Tensile Strength (lb./in. of width) and percent strength retained		Ignition Loss following treatment, percent	Tensile Strength (lb./in. of width) and percent strength retained		Ignition Loss following treatment, percent
Warp	Fill	Warp		Fill	Warp		Fill		
Greige Goods.....	281	217	-----	564	569	-----	168	166	-----
Process of the Present Invention..	244	213	-----	472	458	-----	131	127	-----
Batch Process (112 Finish).....	(87%)	(98%)	0.07	(84%)	(81%)	0.08	(78%)	(76%)	0.06
	90	39		148	148		80	79	
	(32%)	(41%)	0.12	(26%)	(26%)	0.10	(48%)	(48%)	0.12
Continuous Low Temp. Process (111 Finish).	206	189	-----	-----	-----	-----	-----	-----	-----
Continuous High Temp. Process (Coronizing).	113	87	-----	-----	-----	-----	-----	-----	-----
	(40%)	(40%)	0.07	-----	-----	-----	-----	-----	-----

It is immediately apparent that the ignition loss in "Coronizing" and in the present invention are substantially the same, and the loss in the batch process is just slightly higher. With reference particularly to the HG-28 fabric, it is seen that the goods treated by the method of the present invention retain 87 percent warp and 98 percent fill of the tensile strength of the greige goods. The respective figures for the batch process are 32 and 41 percent respectively. "Coronizing" retained only 40 percent of the initial tensile strength. While the slower continuous low temperature treatment did produce goods of reasonably high tensile strength, their strength was not nearly so high as those produced by the method of the present invention. The high ignition loss and caramelized coating on the goods make them unsatisfactory for the industrial uses for which applicant's goods are especially adapted. The superiority of the product produced by the present invention over that obtainable by the batch process is evident from the results on 116, HG-28 and HG-65 fabrics. Tensile strengths in the present product ranged from over one and one-half to over three times greater than the batch product, and also the present product was substantially cleaner.

The present invention thus provides a desired glass fabric product of high tensile strength and exceedingly low ignition loss, and this invention provides a continuous, convenient and more economical process of producing this desirable product. Production rates in accordance with the present invention are equivalent to those attainable by "Coronizing" or like method but at a reduced cost, due in part to the reduced fuel requirement for the furnace and the elimination of the air compressor.

Having thus described my invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding my invention, that various changes and modifications may be made therein without departing from the spirit and scope thereof, and I aim in the appended claims to cover all such modifications and changes.

What I claim is:

1. A process for removing a combustible size from a glass fabric which comprises heating a strip of said fabric to a temperature sufficiently high to cause ignition and burning of said size with an open flame on the surface of the fabric, and maintaining an atmosphere in the area of said flame only sufficiently rich in oxygen to support burning of said size with a yellow, carbon-containing flame, and after the size has been burned

passing said fabric into said zone, maintaining the temperature therein sufficiently high to ignite the size on the fabric, providing an atmosphere in said zone in the area of size ignition only sufficiently rich in oxygen to permit burning of the size with a yellow, carbon-containing flame on the surface of the fabric, and after the size has been burned off withdrawing the fabric from said zone and substantially immediately cooling the same to below zone temperature.

3. A process for removing a major portion of combustible size from glass fabric in a thermal treating zone, which comprises maintaining the temperature in said zone sufficiently high to raise the temperature of the fabric to between 900° and 1050° F., introducing a length of sized fabric to said zone, retaining the fabric therein until the size ignites and burns with an open flame on the surface of the fabric, providing said zone with oxygen in amount only sufficient to support burning of the size with a yellow, carbon-containing flame, and after the size has been burned off withdrawing the fabric from said zone and cooling the same.

4. process for continuously removing a major portion of a combustible size from glass fabric in a thermal treating zone, which comprises continuously passing said fabric in strip form through said zone, maintaining the temperature in said zone sufficiently high to ignite the size, supplying air to said zone in amount only sufficient to permit burning of the size with a yellow, carbon-containing flame on the surface of the fabric, so regulating the speed of passage of the fabric through the zone that burning of the size occurs in a wide band across the fabric adjacent the exit end of the thermal treating zone, and after the size has been burned off cooling said fabric to below zone temperature.

5. A thermally desized glass fabric product desized by the process of claim 1.

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