

Description

The present invention relates to towed arrays and, in particular, to the jackets for such towed arrays.

It has long been known that the properties of the material comprising the jacket of liquid-filled towed acoustic arrays act as a "mechanical filter". This filter removes unwanted noise, such as that resulting from boundary layer turbulence as the array is towed through the water, whilst allowing the transmission of wanted acoustic signals with little attenuation. This "filtering" function is most influenced by two material properties of the jacket, namely its elastic strength and damping. In the terminology of material science, these properties are Tensile Modulus (Youngs Modulus) and the Loss Tangent (that is the ratio of the real and complex parts of the Tensile Modulus determined under dynamic conditions).

Theoretical studies of the towed array's filtering function indicate that an array jacket (termed a hosewall) will provide the most effective filtering when both the Tensile Modulus and the Loss Tangent have a high value. However, unfortunately the simultaneous presence of high values for both properties in a single material is virtually unknown. In fact, for most known engineering materials, a high value of one property tends to preclude a high value of the other. Thus, materials with a high Tensile Modulus, such as glass fibres, aramid (KEVLAR) fibres, and carbon fibres exhibit very low (substantially zero) damping, whilst the materials used in damping applications such as pitch and plastic putties (mastics) exhibit a very low (substantially zero) Tensile Modulus.

Therefore, in general, the choice of the material or materials from which the jacket has been made, has been a compromise to obtain hitherto acceptable, but not high, values of both the Tensile Modulus and the Loss Tangent.

A further practical consideration which has hitherto been taken into account is that prior art liquid filled towed arrays used methods of assembly which require the jacket or hosewall to be expanded (non-collapsed) by the application of an interior pressure for insertion of the interior components within the hose wall. This requirement placed a practical limit on the Tensile Modulus and, in particular, the tangential Tensile Modulus, of the jacket as a whole.

It is known from PCT application W087/03379 a jacket for a towed array of the preamble of claim 1 comprising an intermediate layer of material having a high loss tangent contained within two layers of material having a high modulus and a method for producing such a towed array. This intermediate layer may comprise short fibers disposed in it. This led only to a compromise between the desired characteristics.

The present invention seeks to overcome this fundamental problem in material science by the provision of a jacket having both a Tensile Modulus and Loss Tangent which are as high as possible. The present invention finds particular application in the production of modular

towed arrays of the type disclosed in Australian Patent Application N° PK5569 lodged 11 April 1991 (now Patent Application N°. 14795/92) in the name of Australia Sonar Systems Pty Ltd; since the assembly of such a modular array does not require the application of interior pressure to the jacket or hose wall in order to enable the interior components to be inserted within each module of the array.

According to one aspect of the present invention there is disclosed a jacket for a liquid filled towed array, said jacket comprising a two part combination of materials, one of said parts comprising fibres of high Tensile Modulus and the other one of said parts comprising a plastics material of high damping characteristics, said first part being embedded in said second part. A preferred form comprises the fibres extending circumferentially relative to the generally hollow cylindrical jacket and being embedded in a covering of the plastics material.

In accordance with a second aspect of the present invention there is disclosed a method of fabricating a jacket for a liquid filled towed array, the method being as disclosed in claim 9 and in the embodiment of said method to be described hereafter.

An embodiment of the present invention will now be described with reference to the drawing which is a fragmentary partially cross-sectioned perspective view of a jacket in accordance with the embodiment of the present invention.

Theoretical studies of the filtering function of the hosewall of the array have indicated that ideally a high circumferential Tensile Modulus is required to limit "bulge wave" propagation but that a low axial or longitudinal Tensile Modulus is preferable to limit the transmission of axial vibrations. In addition, a low shear modulus is ideally required to limit the transmission, by viscous shear, of vibrational energy through the hosewall or jacket. Such vibrational energy is input to the jacket via its outer boundary from the boundary layer turbulence caused by the array being towed through the water.

An embodiment of the present invention will now be described with reference to the figure. As seen therein, the overall jacket 13 is formed from an inner jacket 14 of conventional hosewall material such as polyvinyl chloride (PVC) or polyurethane thermoplastic, which material has a low permeability to the paraffin-based fill fluid and is also relatively strong. The inner jacket 14 is overwound with a spiral of continuous reinforcing fibre 11. The fibre 11 can be glass, aramid or carbon fibres, however, metals such as high tensile steel are also suitable. A mixture of various types of fibre could also be used. The diameter and pitch of the fibre 11 are able to be selected to suit.

Over this fibre 11 is extruded an intermediate layer 15 of very high damping material, such as a hot-melt EVA. This intermediate layer 15 bonds strongly to both the fibres 11 and the inner jacket 14.

Preferably, in order to complete the jacket 13, the intermediate layer 15 is covered by an extruded tough outer jacket 16, preferably of a polyurethane thermoplas-

tic. If desired, within the outer jacket 16 can be embedded longitudinally extending strength members 17 preferably of aramid fibre. The strength members 17 are preferably co-extruded with the outer jacket 16.

It will be apparent that the fibre 11 provides continuous, unbroken reinforcing along the tangential axis (or circumferential direction) but leaves the jacket strength in the axial direction substantially unchanged. The intermediate layer 15 of high damping material provides low shear strength across the jacket 13 and the required high damping in all three orthogonal axes. The preferred co-extrusion of the strength member 17 with the outer jacket 16 provides the required load transfer from the strength members 17 through the jacket 13 to any winch or array handling system (not illustrated), but these strength members 17 (which can carry axial vibrations) are isolated from the array interior by the intermediate damping layer 15.

It will be apparent to those skilled in the art that the above described arrangements provide, to a large extent, the nonhomogeneous mix of material properties sought for increasing the acoustic performance of the towed array.

The foregoing describes only one embodiment of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention.

Claims

1. A jacket for a liquid filled towed array, said jacket comprising a two part combination of materials, a first one of said parts comprising fibres of high Tensile Modulus and a second one of said parts comprising a plastics material of high damping characteristics, said first part being embedded in said second part, characterized in that said first part comprises said fibres (11) extending circumferentially relative to the jacket which is generally hollow and cylindrical and said fibres are embedded in a covering (15) of the plastics material forming said second part.
2. A jacket according to claim 1, characterized in that it comprises an inner layer (14) of polyvinyl chloride or polyurethane thermoplastic, over which said circumferentially extending fibres are overwound.
3. A jacket according to claim 2, characterized in that said second part forms an intermediate layer (15) which is bonded to the inner layer.
4. A jacket according to claim 3, characterized in that it further comprises an outer layer (16) provided over said intermediate layer.
5. A jacket according to claim 4, characterized in that

it comprises longitudinal strength members (17) embedded in said outer layer.

6. A jacket according to any preceding claim, characterized in that said fibres are either glass fibres, aramid fibres or carbon fibres, or a mixture thereof.
7. A jacket according to any one of claims 1 to 5, characterized in that said fibres are metallic fibres.
8. A jacket according to claim 7, characterized in that said fibres are high tensile steel fibres.
9. A method of manufacturing the jacket for a liquid filled towed array according to claim 1, characterized by the steps of:

providing an inner layer (14);
winding a fibre (11) of high Tensile Modulus over said inner layer;
extruding an intermediate layer (15) of plastics material of high damping characteristics over said inner layer so that said fibre is embedded in said intermediate layer; and
extruding an outer layer (16) over said intermediate layer.

10. A method according to claim 9, characterized in that fibre (11) is either glass fibre, aramid fibre or carbon fibre.
11. A method according to claim 10, characterized that said fibre is metallic fibre.
12. A method according to claim 11, characterized in that said fibre is high tensile steel fibre.
13. A method according to any one of claims 9 to 12, characterized in that said inner layer (14) is of polyvinyl chloride or polyurethane thermoplastic.
14. A method according to any one of claims 9 to 12, characterized in that longitudinal strength members (12) are embedded in said outer layer (16).

Patentansprüche

1. Mantel für ein flüssigkeitsgefülltes, geschlepptes Array, wobei der Mantel eine zweiteilige Kombination aus Materialien enthält, wobei ein erstes Teil Fasern mit einem hohen Elastizitätsmodul und ein zweites Teil ein Kunststoffmaterial mit hohen Dämpfungseigenschaften enthält, wobei das erste Teil in das zweite Teil eingebettet ist, dadurch gekennzeichnet, daß das erste Teil die Fasern (11) enthält, die sich relativ zu dem Mantel in Umfangsrichtung erstrecken, der allgemein hohl und zylindrisch ist,



tic. If desired, within the outer jacket 16 can be embedded longitudinally extending strength members 17 preferably of aramid fibre. The strength members 17 are preferably co-extruded with the outer jacket 16.

It will be apparent that the fibre 11 provides continuous, unbroken reinforcing along the tangential axis (or circumferential direction) but leaves the jacket strength in the axial direction substantially unchanged. The intermediate layer 15 of high damping material provides low shear strength across the jacket 13 and the required high damping in all three orthogonal axes. The preferred co-extrusion of the strength member 17 with the outer jacket 16 provides the required load transfer from the strength members 17 through the jacket 13 to any winch or array handling system (not illustrated), but these strength members 17 (which can carry axial vibrations) are isolated from the array interior by the intermediate damping layer 15.

It will be apparent to those skilled in the art that the above described arrangements provide, to a large extent, the nonhomogeneous mix of material properties sought for increasing the acoustic performance of the towed array.

The foregoing describes only one embodiment of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention.

Claims

1. A jacket for a liquid filled towed array, said jacket comprising a two part combination of materials, a first one of said parts comprising fibres of high Tensile Modulus and a second one of said parts comprising a plastics material of high damping characteristics, said first part being embedded in said second part, characterized in that said first part comprises said fibres (11) extending circumferentially relative to the jacket which is generally hollow and cylindrical and said fibres are embedded in a covering (15) of the plastics material forming said second part.
2. A jacket according to claim 1, characterized in that it comprises an inner layer (14) of polyvinyl chloride or polyurethane thermoplastic, over which said circumferentially extending fibres are overwound.
3. A jacket according to claim 2, characterized in that said second part forms an intermediate layer (15) which is bonded to the inner layer.
4. A jacket according to claim 3, characterized in that it further comprises an outer layer (16) provided over said intermediate layer.
5. A jacket according to claim 4, characterized in that it comprises longitudinal strength members (17) embedded in said outer layer.
6. A jacket according to any preceding claim, characterized in that said fibres are either glass fibres, aramid fibres or carbon fibres, or a mixture thereof.
7. A jacket according to any one of claims 1 to 5, characterized in that said fibres are metallic fibres.
8. A jacket according to claim 7, characterized in that said fibres are high tensile steel fibres.
9. A method of manufacturing the jacket for a liquid filled towed array according to claim 1, characterized by the steps of:
 - providing an inner layer (14);
 - winding a fibre (11) of high Tensile Modulus over said inner layer;
 - extruding an intermediate layer (15) of plastics material of high damping characteristics over said inner layer so that said fibre is embedded in said intermediate layer; and
 - extruding an outer layer (16) over said intermediate layer.
10. A method according to claim 9, characterized in that fibre (11) is either glass fibre, aramid fibre or carbon fibre.
11. A method according to claim 10, characterized that said fibre is metallic fibre.
12. A method according to claim 11, characterized in that said fibre is high tensile steel fibre.
13. A method according to any one of claims 9 to 12, characterized in that said inner layer (14) is of polyvinyl chloride or polyurethane thermoplastic.
14. A method according to any one of claims 9 to 12, characterized in that longitudinal strength members (12) are embedded in said outer layer (16).

Patentansprüche

1. Mantel für ein flüssigkeitsgefülltes, geschlepptes Array, wobei der Mantel eine zweiteilige Kombination aus Materialien enthält, wobei ein erstes Teil Fasern mit einem hohen Elastizitätsmodul und ein zweites Teil ein Kunststoffmaterial mit hohen Dämpfungseigenschaften enthält, wobei das erste Teil in das zweite Teil eingebettet ist, dadurch gekennzeichnet, daß das erste Teil die Fasern (11) enthält, die sich relativ zu dem Mantel in Umfangsrichtung erstrecken, der allgemein hohl und zylindrisch ist,



und daß die Fasern in eine Abdeckung (15) aus dem Kunststoffmaterial eingebettet sind, welche das zweite Teil bildet.

2. Mantel nach Anspruch 1, dadurch gekennzeichnet, daß er eine Innenschicht (14) aus Polyvinylchlorid oder Polyurethan-Thermoplast enthält, auf welche die sich in Umfangsrichtung erstreckenden Fasern aufgewickelt sind. 5
3. Mantel nach Anspruch 2, dadurch gekennzeichnet, daß das zweite Teil eine Zwischenschicht (15) bildet, die mit der Innenschicht verbunden ist. 10
4. Mantel nach Anspruch 3, dadurch gekennzeichnet, daß er außerdem eine Außenschicht (16) enthält, die auf der Zwischenschicht vorgesehen ist. 15
5. Mantel nach Anspruch 4, dadurch gekennzeichnet, daß er sich in Längsrichtung erstreckende Verstärkungselemente (17) enthält, die in der Außenschicht eingebettet sind. 20
6. Mantel nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Fasern entweder Glasfasern, Aramidfasern oder Kohlenstofffasern oder eine Mischung aus diesen sind. 25
7. Mantel nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß die Fasern Metallfasern sind. 30
8. Mantel nach Anspruch 7, dadurch gekennzeichnet, daß die Fasern aus hochfestem Stahl bestehen.
9. Verfahren zum Herstellen des Mantels für ein flüssigkeitsgefülltes, geschlepptes Array nach Anspruch 1, dadurch gekennzeichnet, daß es die folgenden Schritte enthält: 35
 - Bereitstellen einer Innenschicht (14);
 - Wickeln einer Faser (11) mit hohem Elastizitätsmodul auf die Innenschicht;
 - Extrudieren einer Zwischenschicht (15) aus einem Kunststoffmaterial mit hohen Dämpfungseigenschaften auf der Innenschicht, so daß die Faser in der Zwischenschicht eingebettet ist; und
 - Extrudieren einer Außenschicht (16) auf der Zwischenschicht. 40
10. Verfahren nach Anspruch 9, dadurch gekennzeichnet, daß die Faser (11) entweder eine Glaserfaser, eine Aramidfaser oder eine Kohlenstofffaser ist. 45
11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß die Faser eine Metallfaser ist. 50
12. Verfahren nach Anspruch 11, dadurch gekennzeichnet, 55

net, daß die Faser aus hochfestem Stahl besteht.

13. Verfahren nach einem der Ansprüche 9 bis 12, dadurch gekennzeichnet, daß die Innenschicht (14) aus Polyvinylchlorid oder Polyurethan-Thermoplast besteht.
14. Verfahren nach einem der Ansprüche 9 bis 12, dadurch gekennzeichnet, daß in der Außenschicht (16) sich in Längsrichtung erstreckende Verstärkungselemente (12) eingebettet sind.

Revendications

1. Une enveloppe pour un système remorqué rempli de liquide, associant deux matériaux différents, le premier comprenant des fibres au Module de Traction élevé et le second en plastique aux propriétés d'amortissement élevées. Le premier matériau est incrusté dans le second. Le premier matériau de cette enveloppe est formé de fibres (11) enroulées autour de la circonférence de la couche interne de l'enveloppe, généralement creuse et cylindrique; lesdites fibres sont incrustées dans le revêtement plastique (15) constituant le second matériau.
2. Une enveloppe telle que décrite dans la revendication 1, constituée d'une couche interne (14) en polyvinylchlorure ou matériau thermoplastique polyuréthane, sur la circonférence de laquelle lesdites fibres sont enroulées.
3. Une enveloppe telle que décrite dans la revendication 2, où le second matériau forme une couche intermédiaire (15) assemblée à la couche interne.
4. Une enveloppe telle que décrite dans la revendication 3, caractérisée par le fait qu'elle comprend en outre une couche extérieure (16) recouvrant ladite couche intermédiaire.
5. Une enveloppe telle que décrite dans la revendication 4, caractérisée par des éléments longitudinaux résistant aux contraintes (17) incrustés dans la dite couche extérieure.
6. Une enveloppe semblable à celles décrites dans n'importe laquelle des revendications précédentes, où lesdites fibres sont des fibres de verre, des fibres d'aramide ou des fibres de carbone, ou un mélange de ces fibres.
7. Une enveloppe conforme à n'importe laquelle des revendications allant de 1 à 5, où lesdites fibres sont métalliques.
8. Une enveloppe conforme à la revendication 7, où



lesdites fibres sont des fibres en acier à haute résistance à la traction.

9. Une méthode de fabrication de l'enveloppe pour un système remorqué rempli de liquide conforme à la réclamation 1, dont les étapes sont les suivantes: constitution d'une couche interne (14), enroulement de fibres (11) au Module de Traction élevé sur la couche interne; extrusion d'une couche intermédiaire (15) en plastique aux propriétés d'amortissement élevées sur ladite couche interne, de telle sorte que lesdites fibres sont incrustées dans ladite couche intermédiaire. 5 10
10. Une méthode conforme à la revendication 9, où les fibres (11) sont des fibres de verre, d'aramide ou de carbone. 15
11. Une méthode conforme à la revendication 11, où lesdites fibres sont métalliques. 20
12. Une méthode conforme à la revendication 11, où lesdites fibres sont des fibres en acier à haute résistance à la traction. 25
13. Une méthode conforme à n'importe laquelle des revendications de 9 à 12, caractérisée par le fait que ladite couche intérieure (14) est en chlorure de polyvinyle ou en polyuréthane thermoplastique. 30
14. Une méthode conforme à n'importe laquelle des revendications de 9 à 12, caractérisée par le fait que les éléments longitudinaux résistant aux contraintes (12) sont incrustés dans la couche intérieure (16). 35

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