A friction material for a dry friction device

FIELD OF THE INVENTION

The invention relates to a friction material for a dry friction device, to friction lining for clutches, to a rotatable clutch friction disc and to methods for producing the same.

More particularly, the dry friction device may, without limitation, be a clutch disc or a brake disc, for example for a motor vehicle, and the friction material may be formed into a friction liner in the form of a flat annular ring.

BACKGROUND OF THE INVENTION

Dry friction materials employed at the present time fall into three main types, namely, filament based materials, woven materials, and molded materials. Filament based materials and woven materials, consist essentially of filaments which are provided for reinforcing purposes, being impregnated with thermosetting resin or with rubber, and having various fillers incorporated. Materials of this general type have various disadvantages.

One of which is the price of friction material.

When making a friction material for a brake disc or a motor vehicle clutch, the raw materials are compressed at high temperature and under pressure to form a baked part with a crosslinked matrix or network. Due to the creep of the resins, the shape factors of the materials present such as the fibers and the powders, and the design of the molds, the baked part at the molding outlet exhibits a thickness variation between 0.1 mm and 0, 3mm.

Thus, in order to obtain parallel faces required by the clutch or braking system, a machining operation is carried out, on one or both sides of the material. This machining operation generates between 10 and 25% by mass of material losses engaged for the manufacture of the friction lining for the automobile clutch or the brake pad. This loss of friction material also represents a financial loss insofar as the machined material is complex and costly.

Therefore, there is a need for a friction material for a dry friction device that would be cheaper to produce and a method for producing such friction material.

One object of the present invention is to provide such a friction material and method.

SUMMARY OF THE INVENTION

To this end, the invention proposes a friction material for a dry friction device, the friction material comprising:

- friction material powder waste,
- rubber,
- metal addition,

binded with a thermoset resin.

Advantageously, the friction material of the invention comprises friction material powder waste that reduces the overall cost of the friction material.

According to further embodiments which can be considered alone or in combination:

- the friction material powder waste has a median diameter smaller than or equal to 200µm; and/or
- at least 90% in mass proportion of the friction material powder waste has a diameter smaller than or equal to 0.8 mm; and/or
- the friction material powder waste comprises between 30% and 60% of mass proportion of organic content; and/or
- the friction material powder waste provides from friction material
- the friction material powder waste represents a mass proportion greater than or equal to 15%, for example greater than or equal to 25%, and smaller than or equal to 60% of the overall friction material; and/or
- the uncured thermoset resin represents a mass proportion greater than or equal to 20% and smaller than or equal to 40% of the overall friction material; and/or

- the thermoset resin comprises a phenolic resin, for example a novolac phenolic resin, and/or a melamine formaldehyde resin; and/or
- the friction material further comprises fibers with a length greater than or equal to 3 mm and smaller than or equal to 25 mm; and/or
- the fibers represent a mass proportion greater than or equal to 0 % and smaller than or equal to 20% of the overall friction material; and/or
- the fibers are glass fibers; and/or
- the fibers have a diameter greater than or equal to 6 micrometers and smaller than or equal to 21 micrometers; and/or
- the rubber is rubber powder; and/or
- the rubber represents a mass proportion greater than or equal to 2 % and smaller than or equal to 20%, for example smaller than or equal to 10%, of the overall friction material; and/or
- the rubber is recycled rubber; and/or
- the rubber is synthetic rubber of the type NBR or SBR.
- the metal addition represents a mass proportion greater than or equal to 2 % and smaller than or equal to 10% of the overall friction material; and/or
- the metal addition is selected in the list consisting of copper, brass and aluminum powder; and/or
- the friction material is asbestos-free.

The invention further relates to a friction lining for clutches comprising friction material according to the invention.

The invention also relates to a rotatable clutch friction disc having at least a friction lining according to the invention.

The invention further relates to a method for producing a friction material, the method comprising:

- a mixing step during which friction material powder waste, rubber and metal addition are mixed with a thermoset resin,

- a curing step during which the mixture issued of the mixing step is cured between 1 and 15 minutes at a temperature greater than or equal to 160°C and

smaller than or equal to 210°C under a pressure greater than or equal to 50 bars and smaller than or equal to 300 bars so as to obtain a crosslinked friction material.

According to further embodiments which can be considered alone or in combination:

- the friction material powder waste provided during the mixing step has a median diameter smaller than or equal to 200μm; and/or
- at least 90% in mass proportion of the friction material powder waste provided during the mixing step has a diameter smaller than or equal to 0.8 mm; and/or
- the friction material powder waste provided during the mixing step comprises between 30% and 60% of mass proportion of organic content; for example between 50% and 60% of mass proportion of organic content and/or
- the friction material powder waste provided during the mixing step provides from friction material manufacturing process, for example drilling and/or grinding; and/or
- the friction material powder waste represents a mass proportion greater than or equal to 15%, for example greater than or equal to 25%, and smaller than or equal to 60% of the overall material provided during the mixing step; and/or
- the uncured thermoset resin represents a mass proportion greater than or equal to 20% and smaller than or equal to 40% of the overall material provided during the mixing step; and/or
- the thermoset resin comprises a phenolic resin, for example a novolac phenolic resin, and/or a melamine formaldehyde resin; and/or
- during the mixing step fibers with a length greater than or equal to 3 mm and smaller than or equal to 25 mm are further added; and/or
- the fibers represent a mass proportion greater than or equal to 0 % and smaller than or equal to 20% of the overall material provided during the mixing step; and/or
- the fibers are glass fibers; and/or

- the fibers have a diameter greater than or equal to 6 micrometers and smaller than or equal to 21 micrometers; and/or
- the rubber is rubber powder; and/or
- the rubber represents a mass proportion greater than or equal to 2 % and smaller than or equal to 20%, for example smaller than or equal to 10%, of the overall material provided during the mixing step; and/or
- the rubber is recycled rubber; and/or
- the rubber is synthetic rubber of the type NBR or SBR; and/or
- the metal addition represents a mass proportion greater than or equal to 2 % and smaller than or equal to 10% of the overall material provided during the mixing step; and/or
- the metal addition is selected in the list consisting of copper, brass and aluminum powder; and/or
- the friction material is asbestos-free.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, and with reference to the following drawings in which:

- Figure 1 illustrates a friction material according to an embodiment of the invention,
- Figure 2 is a flow chart representing a method for producing a friction material according to the invention,
- Figure 3 compares the burst resistance of different friction material,
- Figure 4 compares the flatness properties of different friction material, and
- Figure 5 compares the friction level evolution of different friction material.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the

elements in the figure may be exaggerated relative to other elements to help improve the understanding of the embodiments of the present invention.

The invention relates to a friction material for a dry friction device. The dry friction device may, without limitation be a clutch or a brake disc.

For example, the dry friction device may be used for truck and/or tractor clutch facings, or truck and/or bus brake shoes.

Typically, the dry friction device according to the invention may be for trucks and/or tractor clutch facings, such as molded facings for diameter varying from 150 mm to 430 mm and with thickness varying from 2.5mm to 6.9mm that may contain groove of various shapes or without grooves.

The dry friction device may also be used for passenger, light trucks, medium trucks, heavy trucks and buses of various range which uses drum brake Shoes, this includes pasted type arc facings on shoes of drum brake or riveted type arc facings on shoes of drum brake.

As illustrate on figure 1, a friction material 10 according to the invention comprises:

- friction material powder waste 12,
- rubber 14, and
- metal addition.

The friction material powder waste, rubber and metal addition are binded with a thermoset resin.

Advantageously, using friction material powder waste combined with rubber allows obtaining a friction material that meets the requirements in particular in terms of low deformation of a friction disc made of the friction material in hot conditions while being cheaper than prior art friction material to produce.

For environmental and health consideration, preferably the friction material of the invention is asbestos-free.

The friction material powder waste may provide from friction material process, for example from drilling and/or grinding process on a friction material manufactured with a traditional process.

Advantageously, the friction material being recycled the overall process is cheaper and more environmental friendly.

According to an embodiment of the invention the friction material powder waste has a median diameter smaller than or equal to 200μm, for example the friction material powder waste has a median diameter smaller than or equal to 150 μm and greater than or equal to 50 μm.

According to an embodiment of the invention at least 90% in mass proportion of the friction material powder waste has a diameter smaller than or equal to 0.8 mm, for example smaller or equal to 0.7 and greater than or equal to 0.05 mm.

Typically, the friction material powder waste may comprise between 30% and 60% of mass proportion of organic content, for example between 50% and 60% of mass proportion of organic content.

The organic content may be stabilized comprising either crosslinked resins, crosslinked rubbers, carbon in different structures such as crystalline or amorphous, organic fibers, etc.

The friction material powder waste may represent a mass proportion greater than or equal to 15%, for example greater than or equal to 25% or greater than or equal to 35%, and smaller than or equal to 60%, for example smaller than or equal to 55% of the overall friction material.

So as to meet the strict deformation criteria, the friction material according to the invention comprises rubber.

Preferably the rubber is rubber powder. For example, rubber powder has a diameter smaller than or equal to 1 mm.

According to an embodiment of the invention, the rubber represents a mass proportion greater than or equal to 2%, for example greater than or equal to 3%, and smaller than or equal to 20%, for example smaller than or equal to 10%, or smaller or equal to 7%, of the overall friction material.

Typically, the rubber is synthetic rubber of the type NBR or SBR.

Preferably, the synthetic rubber comprises less than 10% by weight calcium carbonate, less than 10% by weight of amorphous silica and less than 5% by weight of vulcanizing agent. The rubber may be recycled rubber so as to reduce the overall cost even more, for example the rubber may be waste tires.

Preferably, the recycled rubber comprises less than 10% by weight calcium carbonate.

The particles of the rubber powder may have round to oval shapes in the synthetic rubber, and complex random shapes (angles, peripheral shredding) for the recycled rubber.

The metal addition may represent a mass proportion greater than or equal to 2 % and smaller than or equal to 10%, for example smaller than or equal to 8%, of the overall friction material.

The metal addition may be selected in the list consisting of copper, brass and aluminum powder.

The friction material powder waste, rubber and metal addition are binded with a thermoset resin that may represent when uncured a mass proportion greater than or equal to 20%, for example greater than or equal to 30%, and smaller than or equal to 40%, for example smaller than or equal to 37%, of the overall friction material.

The thermoset resin comprises a phenolic resin, for example a novolac phenolic resin, and/or a melamine formaldehyde resin.

The inventors have observed that the addition of regular and homogenous waste from friction materials in size and composition, allows to manufacture stable new friction materials with good friction behavior.

The use of rubber from new synthetic and or waste rubber in powder to provides low deformation of the friction disc in hot conditions.

As illustrated on figure 1, the friction material according to the invention may comprise fibers 16, for example glass fibers, with a length greater than or equal to 3 mm and smaller than or equal to 25 mm, for example smaller than or equal to 15 mm.

The fibers may represent a mass proportion greater than or equal to 0%, for example greater than or equal to 5%, and smaller than or equal to 20%, for example smaller than or equal to 15%, of the overall friction material.

According to an embodiment of the invention the fibers may have a diameter greater than or equal to 6 micrometers and smaller than or equal to 21 micrometers.

As illustrated on figure 2, a friction material according to the invention may be obtain by a method for producing friction material comprising:

- a mixing step S1, and
- a curing step S2.

During the mixing step S1, friction material powder waste, rubber and metal addition are mixed with a thermoset resin.

The friction material powder, rubber, metal addition and thermoset resin may have the property and proportion indicated previously when describing the friction material.

During the mixing step S1, fibers as described previously may also be mixed.

During the curing step S2, the mixture issued of the mixing step is cured between 1 and 15 minutes at a temperature greater than or equal to 160°C and smaller than or equal to 210°C under a pressure greater than or equal to 50 bars and smaller than or equal to 300 bars so as to obtain a crosslinked friction material.

The inventors have tested 3 friction materials with the formulation reported in table 1.

	Friction waste	Glass chopped	Thermoset resin as	Synthetic rubber +	Recycled	Sulfur

Formula	from grinding	strands 14mm	phenolic	catalyst	rubber	
Formula A	48%w	15%w	33%w	4%w	-	-
Formula B	53%w	10%w	35%w	-	-	2%w
Formula C	46%w	15%w	33%w	-	6%w	-

Table 1

The friction material corresponding to formula A and C are according to the invention while the friction material corresponding to formula B does not contain rubber powder and therefore is not according to the invention. The friction waste from grinding in the examples of table 1 comprises about 5% of copper.

As illustrated on figure 3, the inventors have compared the burst resistance of the different friction material of table 1 at 200°C with an annular friction material of 254mmx150mmx3.6mm.

As one can observe from the burst resistance reported on figure 3, when rubber is added, new synthetic rubber, and or recycled rubber, the flexibility of the friction material is improved and the mechanical resistance is enhanced.

As illustrated on figure 4, the inventors have compared the flatness properties of friction material of formula A and B of table 1.

The flatness of an annular friction material of 254mmx150mmx3.6mm after having been heated at 300°C for 10 minutes is compared to the initial flatness.

In this case, the general flatness difference represents the difference between the actual shape of the surface and that of a flat surface. The local flatness difference is the difference between a given line and a straight line.

The flatness of a surface is checked by means of a straight and rigid ruler of a well defined length ($\leq$ 3 m) carrying at its ends cleats whose thickness is equal to the permissible tolerance (Y). It is also possible to tighten a rope on two cleats with a

thickness Y. Measurement (X) is carried out by means of a batten or a third cleat (measuring wedge) the thickness of which is twice tolerance. The distance (X-Y) is an indication of flatness.

As illustrated on figure 4, the friction material according to the invention, formulation A has greater flatness properties than the friction material according to formulation B.

As illustrated on figure 5, the inventors have compared the friction properties of friction material of formula A and B of table 1.

The friction coefficient of an annular friction material of 254mmx150mmx3.6mm is measured in a clutch assembly.

As illustrated on figure 5, for the friction material according to formula B, at 200°C and medium energy, the facing (Ø240x160x3.6mm) deformation is high and the failure of the system liberation occurs.

Whereas for the friction material according to formula A, when rubber is present, the flexibility is better and no liberation issue occurs.

The invention has been described above with the aid of embodiments without limitation of the general inventive concept; in particular the mounted sensing device is not limited to a head mounted device.

Many further modifications and variations will suggest themselves to those skilled in the art upon making reference to the foregoing illustrative embodiments, which are given by way of example only and which are not intended to limit the scope of the invention, that being determined solely by the appended claims.

In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. The mere fact that different features are recited in mutually different dependent claims does not indicate that a combination of these features cannot be advantageously used. Any reference signs in the claims should not be construed as limiting the scope of the invention.

CLAIMS

1. A friction material (10) for a dry friction device, the friction material comprising:
- friction material powder waste (12),
- rubber (14),
- metal addition,
binded with a thermoset resin (16).

2. The friction material according to claim 1, wherein the friction material powder waste has a median diameter smaller than or equal to 200μm.

3. The friction material according to claim 1 or 2, wherein at least 90% in mass proportion of the friction material powder waste has a diameter smaller than or equal to 0.8 mm.

4. The friction material according to any of the preceding claims, wherein the friction material powder waste comprises between 30% and 60% of mass proportion of organic content.

5. The friction material according to any of the preceding claims, wherein the friction material powder waste provides from friction material manufacturing process, for example drilling and/or grinding.

6. The friction material according to any of the preceding claims, wherein the friction material powder waste represents a mass proportion greater than or equal to 15% and smaller than or equal to 60% of the overall friction material.

7. The friction material according to any of the preceding claims, wherein the rubber is rubber powder.

8. The friction material according to any of the preceding claims, wherein the rubber represents a mass proportion greater than or equal to 2 % and smaller than or equal to 20% of the overall friction material.

9. The friction material according to any of the preceding claims, wherein the friction material is asbestos-free.

10. Friction lining for clutches comprising friction material according to any of the preceding claims.

11. A rotatable clutch friction disc having at least a friction lining according to claim 10.

12. A method for producing a friction material, the method comprising:

- a mixing step (S1) during which friction material powder waste, rubber and metal addition are mixed with a thermoset resin,
- a curing step (S2) during which the mixture issued of the mixing step is cured between 1 and 15 minutes at a temperature greater than or equal to 160°C and smaller than or equal to 210°C under a pressure greater than or equal to 50 bars and smaller than or equal to 300 bars so as to obtain a crosslinked friction material.

13. The method according to claim 12, wherein the friction material powder waste provided during the mixing step has a median diameter smaller than or equal to 200µm.

14. The method according to claim 12 or 13, wherein at least 90% in mass proportion of the friction material powder waste provided during the mixing step has a diameter smaller than or equal to 0.8 mm.

15. The method according to any of claims 12 to 14, wherein the friction material powder waste provided during the mixing step comprises between 30% and 60% of mass proportion of organic content.

16. The method according to any of claims 12 to 15, wherein the friction material powder waste represents a mass proportion greater than or equal to 15% and smaller than or equal to 60% of the overall material provided during the mixing step.

17. The method according to any of claims 12 to 16, wherein the uncured thermoset resin represents a mass proportion greater than or equal to 20% and smaller than or equal to 40% of the overall material provided during the mixing step.

18. The method according to any of claims 12 to 17, wherein the rubber is rubber powder.

19. The method according to any of claims 12 to 18, wherein the rubber represents a mass proportion greater than or equal to 2 % and smaller than or equal to 20% of the overall material provided during the mixing step.

ABSTRACT

A friction material for a dry friction device

A friction material for a dry friction device, the friction material comprising:

- friction material powder waste,
- rubber,
- metal addition,

binded with a thermoset resin.

Figure 1

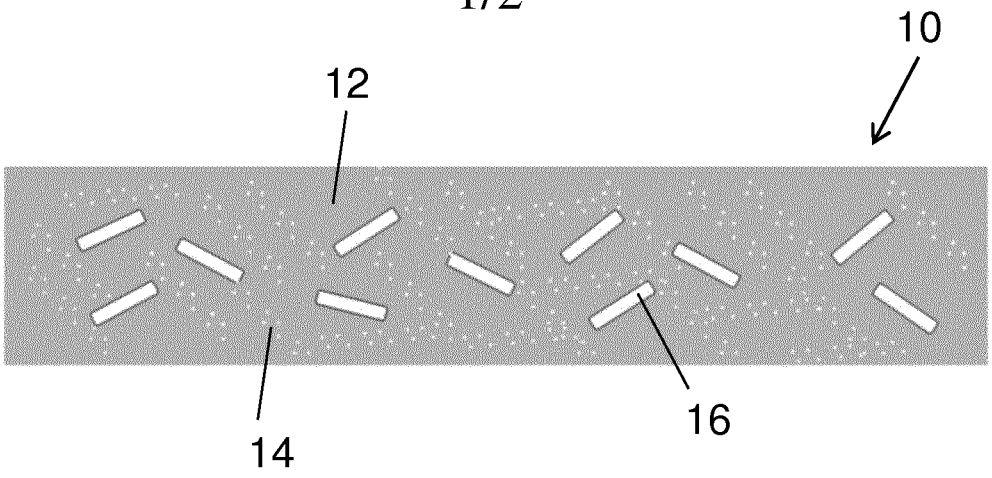

Figure 1

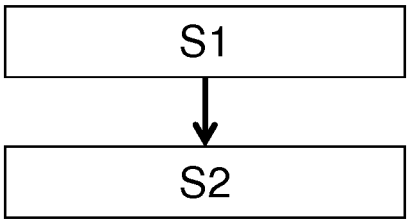

Figure 2

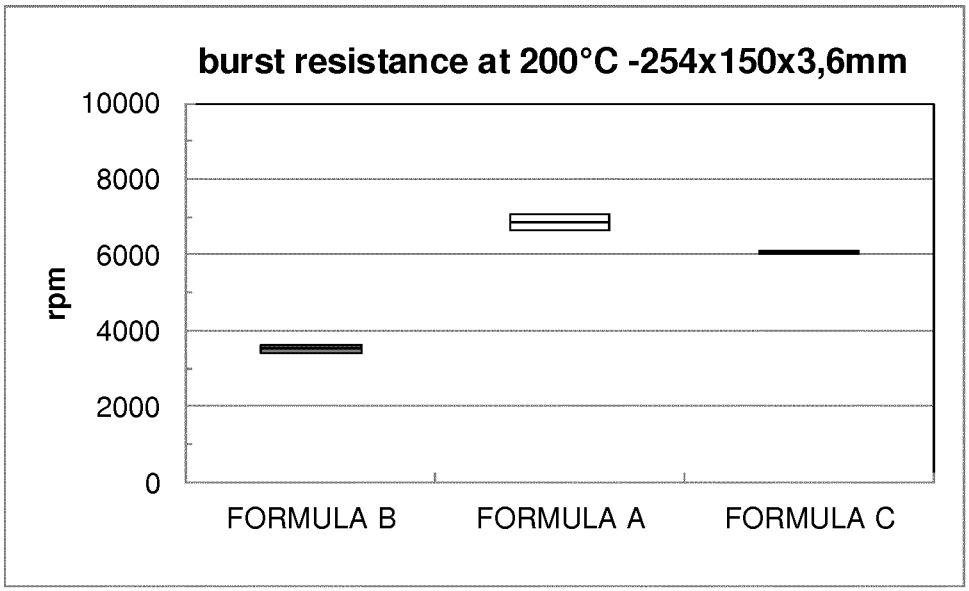

Figure 3

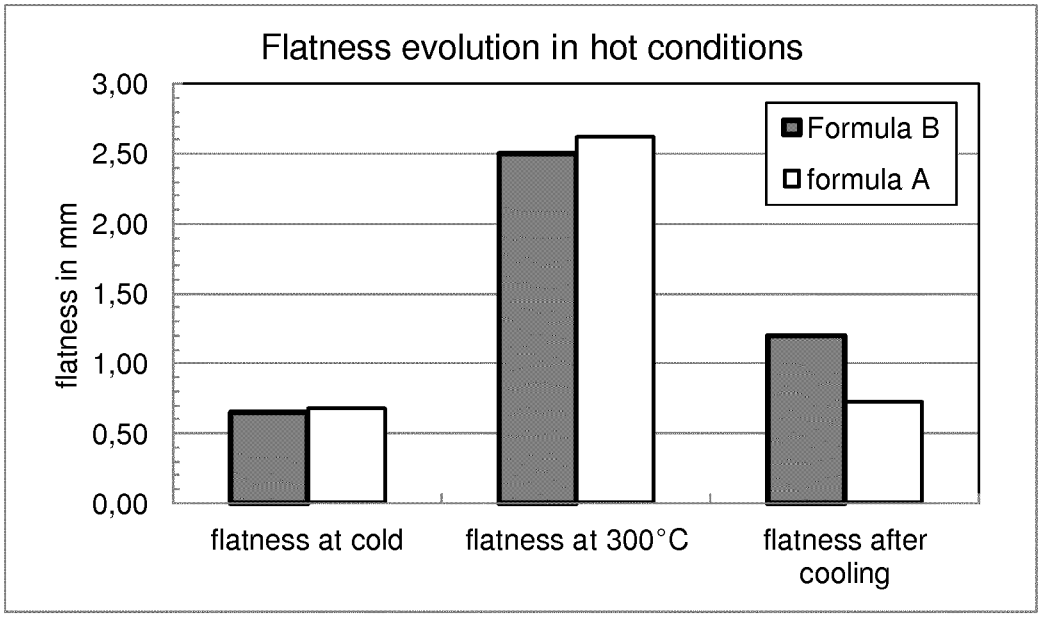

Figure 4

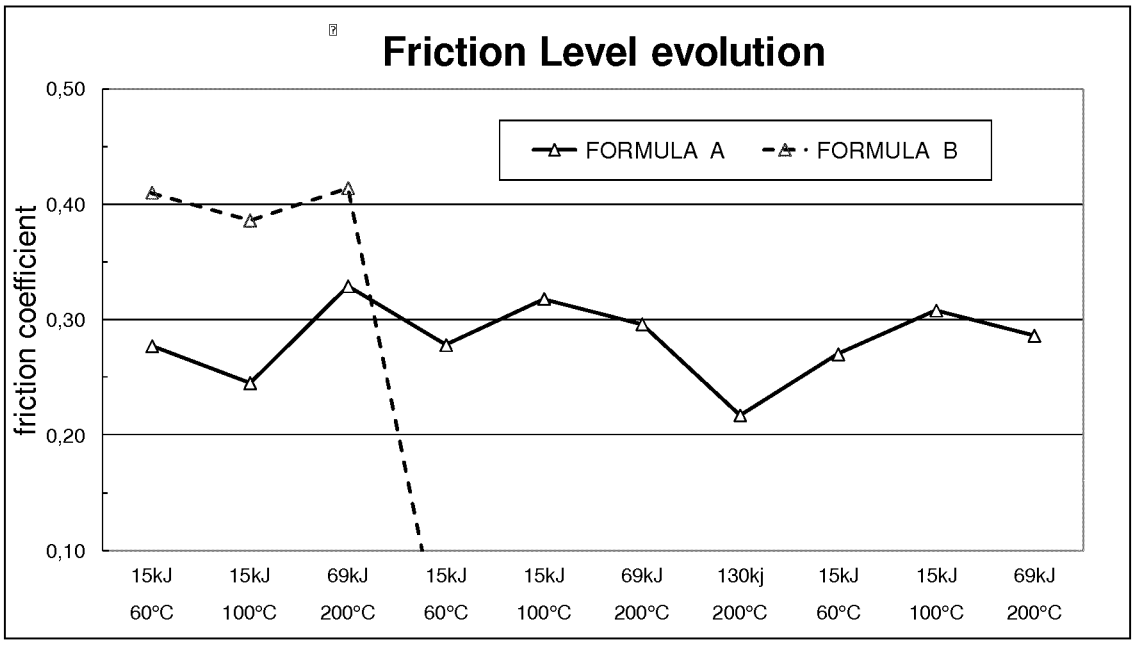

Figure 5