Candidate's answer

Matches, Match Splints and Match Head Formulations

The present invention relates to the adherence of match head formulations to match splints and to matches and match splints which perform more advantageously than prior art matches and splints with regard to the adherence of match head formulations.

Often, prior art matches lose their heads. Up to 10% of matches can be affected which leads to substantial financial loss.

The loss can be ascribed to two reasons. Firstly the match head formulations/compositions are of poor quality and secondly the match splints are of a composition which does not retain the match head composition very well. Therefore, there is a need in the art for match splints which retain match head formulations in general, in a more effective manner and also a need for improved match head formulations which adhere more effectively to match splints.

Prior art compositions of the head usually contain phosphorus sesquisulphide and sulphur. The problem with such conventional compositions of the head is that these compounds have undesirable environmental properties, both in the production of the matches and in their use. Our research on compositions in which the above-mentioned compounds are not present has revealed a new type of composition that is not only more environmentally benign, but also provides high flexibility in the design of the matches. By varying some of the components of the composition of the head, matches can be obtained that have completely different properties. In this way, either strike anywhere matches or safety matches can be obtained.

Thus, according to one aspect of the invention there is provided a match head formulation defined according to claims 1 to 5.

Prior art compositions of the head are based on phosphorus sesquisulphide (P_4S_3). Such compositions have several disadvantages, the most important being that they are very difficult to handle during manufacture.

The general composition found in our laboratory consists of 40-60 wt.% potassium chlorate, 0.5-9 wt.% red amorphous phosphorus, 3-18 wt.% binder, 0.1-5 wt.% thickener and balance filler. The composition may also contain optional components such as pigments, pH adjusting agents, and fragrances.

The composition in liquid form before being applied to the splint must have a density of 1.1 to 1.4 g/cm^3. It is essential that the components are used in the ranges given above, in order to achieve good adhesion to the splint.

The filler is preferably feldspar. The filler is typically present in an amount of 10 to 30 wt.%. A pH adjusting agent such as limestone, if used, is present in proportions ranging from 3 to 14 wt.%.

Of course, our new matches can also contain up to 2 wt.% of a fragrance in order to avoid smells that can be generated on burning the match. Any fragrance that is compatible with the match material can be used. Such fragrances are well known in the art of making matches.

To make specific types of matches, specific choices within this general composition need to be made. Two well-known types of matches are strike anywhere matches and safety matches. Strike anywhere matches are matches that have a match head formulation which is ignited by abrasive contact with any suitable rough surface. Safety matches are matches that have a match head formulation which is ignited by an abrasive contact with a surface containing a formulation for initiating ignition of the match head.

For strike anywhere matches it is essential that there is a relatively high amount of 2 to 9 wt.% of red amorphous phosphorus, whereas for safety matches the amount of red amorphous phosphorus should not be more than 2 wt.%. For strike anywhere matches the amount should preferably lie between 4 and 9 wt.%, more preferably between 5 and 7.5 wt.%. For safety matches the preferred concentration of red amorphous phosphorus lies between 0.5 and 2 wt.%.

The thickener is preferably a starch present in proportions of 0.1-5 wt.%.

The presence of red amorphous phosphorus makes it difficult to achieve the clear bright colours characteristic of match head formulations based on phosphorus sesquisulphide. The muddy colour of red amorphous phosphorus in the above formulation is particularly difficult to mask and consequently a pigment such as iron oxide is often used. If present the pigment is used in an amount of from 3 to 10 wt.%. Iron oxide pigments can give red, yellow or black colour to the head of the match, depending on which type of iron oxide is chosen (Fe_2O_3, ferric oxide, is red; $Fe_2O_3.H_2O$, hydrated ferric oxide, is yellow; Fe_3O_4, ferroferric oxide, is black). Titanium dioxide (white) may also be used as a pigment.

Gelatine is preferably used as the binder. The binder content of the formulation is lower than is usual in the prior art. The low binder content improves the drying rate. Animal glue can also be satisfactorily used as the binder.

Prior art match splints have often been coated with wax (for example paraffin wax). This has been done to provide better burning characteristics. However, surprisingly, we have found that a very specific type of wax, namely beeswax, when coated onto match splints provides for very effective adherence of match head formulations to the match splint.

Thus, according to another aspect of the invention there is provided match splints defined according to any of claims 6 to 9.

These ~~matches~~ match splints *work well with any type of composition of the head. However, we have also found* ~~a~~ that the *new composition of the head* ~~that~~ as already described above *works extremely well with the new splint*.

The combination of the new head and splint provides a further advantage namely that the head is fixed much better to the splint than in the prior art.

As already mentioned above, the new splint can be used with any type of composition the head. However, extremely good matches are obtained when this splint is combined with the composition developed in our laboratories. Using this composition of the head, one can obtain matches in which the head is fixed very well to the splint. This is certainly caused by the use of the beeswax, although we do not yet know the exact reason for this. In the production of prior art matches almost 10 percent of the heads fall off during packaging. Even during use, some matches still lose their head. As far as we know only paraffin waxes have been used in the prior art.

Thus the match head formulation and the splint form a technical interaction which addresses the issue of adherence, although the splint can on its own be used with any particular head formulation and conversely the head formulations described herein can work more effectively with known splints. This is clear from the data in the accompanying examples (omitted in accordance with Instructions to Candidates).

Thus, according to another aspect of the invention there is provided matches as defined in accordance with claims 16 and 17.

According to another aspect of the invention there is provided methods for making the match splints of the invention, defined according to claims 10 to 15.

A method of manufacturing our new splint includes the steps of: (i) coating a portion of a porous match splint with a layer of beeswax, optionally *followed by (ii) coating the remaining part of the splint with a fire-retardant material.*

Any porous match splint may be used, for example wood, cardboard or stiff paper. Wood is the preferred material for the luxury market. For cheaper matches, cardboard or stiff paper is preferred.

The coating with a layer of beeswax takes place at a temperature such that a substantial part of the beeswax remains on the surface of said portion of the splint. Usually, the wax is applied by dipping the splint in a wax that is kept at a temperature of between 135 and 150°C for about 5 seconds. After dipping in the wax, it is essential that the splints are kept at 55 to 60°C for
10 to 15 seconds to ensure that the wax penetrates the splint and does not solidify on the surface of the splint.

By varying the amount of beeswax along the length of the splint, the burning of the match can be adjusted to the needs of the user. For example, often more wax is applied near the head of the match so that the start of combustion is easier. To apply more wax, the coating step is performed a second time, but only to the portion that needs the additional wax.

The fire-retardant material is applied in such a way that the material adheres only to part of the splint. The fire-retardant material is preferably monoammonium phosphate ($NH_4H_2PO_4$). However, other fire-retardant materials can also be used. Examples are diammonium phosphate ($(NH_4)_2HPO_4$), ammonium sulphate ($(NH_4)_2SO_4$), and ammonium chloride (NH_4Cl). We believe that, in order to be compatible with the splint material, the fire-retardant material must be an inorganic ammonium salt.

The fire-retardant material is applied by dipping part of the match in an aqueous s of the fire-retardant material. A typical solution will contain from 1 to 5 wt.% of the fire-retardant material, preferably about 3 weight percent. Aft dipping in the solution, the splint needs to be dried. No special conditions for this drying are necessary.

The finished splint is then provided with a head, which is needed to ignite the match. This can be done by dipping the splint in a liquid composition. Depending on the use of the match, the dipping has to be performed one or more times.

CLAIMS

1. Match head formulation comprising

   40-60 wt.% potassium chlorate;
   0.5-9 wt.% red amorphous phosphorus;
   3-18 wt.% binder;
   0.1-5 wt.% thickener;
   and balance filler;
   having a density in liquid form of 1.1 to 1.4 g/cm^3.

2. Formulation according to claim 1 wherein red amorphous phosphorous is present at an amount of 2-9 wt.%.

3. Formulation according to claim 2 wherein red amorphous phosphorous is present at an amount of 4 to 9 wt.%.

4. Formulation according to claim 1 wherein the amount of red amorphous phosphorous does not exceed 2 wt.%.

5. Formulation according to claim 4, wherein the amount of red amorphous phosphorous lies between 0.5 and 2 wt.%.

6. A porous match splint coated with beeswax.

7. The splint of claim 6 wherein the beeswax is coated over a portion of the splint.

8. The splint of claim 7 wherein the portion which has not been coated with beeswax is coated with a fire-retardant material which is an inorganic ammonium salt.

9. The splint of claim 8 wherein the fire retardant material is monoammonium phosphate, diammonium phosphate, ammonium sulphate or ammonium chloride.

10. Method of coating a porous match splint with beeswax comprising dipping the splint into molten beeswax and keeping the splint at 55 to 60°c for 10 to 15 seconds.

11. Method according to claim 10 wherein the temperature of the beeswax is between 135 and 150°c and the splint is dipped for about 5 seconds.

12. Method according to claim 11 wherein only a portion of the splint is coate beeswax and wherein the coating is followed by coating the remaining part o splint with a fire-retardant material which is an inorganic ammonium salt in a aqueous solution, followed by drying the splint.

13. The method of claim 12 wherein the aqueous solution contains from 1 to 5 wt.% of the fire retardant material.

14. The method of claim 13 further comprising coating the splint with a match head formulation.

15. The method of claim 14 wherein the match head formulation is defined according to any of claims 1 to 5.

16. A match comprising a splint as defined according to any of claims 6 to 9 coated with a match head formulation.

17. A match according to claim 16 wherein the formulation is a formulation as defined according to any of claims 1 to 5.