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Apparatus and method for extruding pencils

Vorrichtung und Verfahren zur Extrusion von Bleistiften

Appareil et méthode d'extrusion de crayons

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Description

[0001] The invention relates to apparatus for extruding and in particular to an apparatus and method for extruding pencils from synthetic materials such as plastics.

[0002] Wood substitute materials have been known for many years and generally comprise a foamed thermoplastic such as polystyrene containing fillers for colouring and fibrous fillers to provide texture. Such materials are also known for use as sheath materials for pencils. For example US 3993408 discloses a pencil made with a resin-based sheet consisting essentially of a resin binder, a fibrous filler and a metallic soap. The material is extruded around a lead or marking core. The core material is a traditional ceramic. The extrusion process comprises pre-heating the core material to approximate the temperature of the molten sheath material that is coated onto the core in a crosshead die of conventional construction. The extrudate is chilled and then cut once cooled.

[0003] The main problems with using substitute materials for pencils are in providing the correct properties. Pencils must be easily sharpened and whether this is possible depends on how hard the sheath material is and also, because of the impacting torsion, on how brittle the lead is; it also depends on the adhesion between the lead and the sheath. The lead must be of constant thickness and the manufacturing process must not introduce variations in tensions or show any fractures.

[0004] GB-A-1363161 gives suitable synthetic compositions for pencil casings. The composition is a polystyrene, polyethylene and glass fibre composition together with blowing agents, say, 0.2-1.5%. The synthetic pencils have the required sharpenability together with a flexural modulus greater than 30000 Kg/cm².

[0005] Pencils are made increasingly of synthetic materials, whereby profiles are extruded and subsequently cut to the length of a pencil. The binding material and the coating material (sheath) use various polymer materials but SAN and ABS polymers have previously been preferred.

[0006] In US 5531947 a polymer binding material is melted in a lead extruder in order to manufacture a synthetic lead. In a loading extruder a mixture of additives is added to the melted polymer material, including colours, gliders and adhesive substances. A substitute lead is extruded and cooled in a first cooling range to the point where, upon entering the coating nozzle the "lead" is no longer molten but is not completely cold. In a coating extruder the coating materials are introduced for the formation of the pencil coating or sheath. The lead extruder includes first and second loading stations a melting and transportation range and a mixing and kneading range downstream of the second loading station. First and second cooling ranges lie between the lead extruder and the coating nozzle and downstream of the coating nozzle respectively.

[0007] US 3936519, discloses apparatus for extruding a lead pencil in which the lead is securely bonded to a sheath formed from foamed plastic material. US-A-5531947 discloses an apparatus and method for manufacturing pencils in which the lead material is extruded in a first extruder. The extruded lead is cooled in a first cooling range. The extruded lead then enters a coating extruder where a pencil coating is applied. The coated lead is then cooled in a second cooling range and then cut at a sawing station.

[0009] It is an object of the present invention to provide an improved extrusion process and apparatus for manufacturing pencils and the like. It is also desirable as much as possible to recycle materials such as plastics. More particularly where the 'lead' uses recycled plastics such as polystyrene, the extrusion process becomes very difficult to implement because of the poor physical properties of the extruded recycled material. It is, therefore, another object of the present invention to provide a process and apparatus to allow extrusion and coating of materials such as recycled polystyrene which have poor physical properties.

[0010] The invention provides an apparatus for manufacturing pencils comprising a core material extruder, a sheath material extruder, a crosshead and die assembly for coating the sheath material onto the core material, and a means for sizing the extrudate from the crosshead die wherein the sizing means is separated from the face of the crosshead die by a predetermined distance to provide a cooling zone in which the co-extrudate is allowed to cool at ambient temperature, the apparatus comprises means for maintaining the length of the co-extrudate in said cooling zone between a minimum and a maximum length and sensors for detecting when the length of the extrudate reaches either said minimum or maximum length.

[0011] The apparatus of the invention allows the manufacture of pencils using synthetic materials even when these are unconventional materials or materials having less than optimum properties, for instance recycled materials. In the cooling zone the sheath material is allowed to expand and the adhesion between the core and sheath are thereby improved.

[0012] The apparatus may further comprise a cooling unit between said core extruder and said crosshead and die assembly, the cooling unit being separated from the core material extruder by a predetermined distance providing a second cooling zone in which the extrudate from the core material extruder is allowed to cool at ambient temperature.

[0013] The invention further provides a method for extruding pencils having a core and a sheath, comprising loading the core and sheath materials into respective extruders, cooling the core material and coating the sheath material onto the core material in a crosshead and die assembly, cooling the extrudate from the crosshead and die assembly and sizing the extrudate to a predetermined diameter in a sizing means, the step of cooling comprises allowing the extrudate to cool at ambient
temperature and maintaining the length of extrudate in
die assembly and said sizing means between minimum
and maximum lengths. In the cooling zone the sheath
material is allowed to expand and the adhesion between
the core and sheath are thereby improved.

The extruded sheath material preferably com-
prised an endothermic blowing or foaming agent.

The core material may be initially allowed to
cool at ambient temperature before cooling in a cooling
unit to provide a rigid and straight core material to be
fed into the crosshead and die assembly.

The invention will now be described in more
detail and by way of example only, with reference to the
accompanying drawings, in which:

Figure 1 is a simplified schematic drawing of ele-
ments of extrusion apparatus according to the in-
vention;

Figure 2 is a schematic drawing of a core material
extruder according to one embodiment;

Figure 3 is a cross sectional view of the core extrud-
er die shown in figure 1 shown in more detail.

Referring now to figure 1, the apparatus com-
prises an extruder 1 of a conventional type and having
an inlet hopper 2 at one end. An outlet end of the ex-
truder is connected to an extruder die 3 shown in more
detail in figure 3. A first cooling zone 4 is provided be-
tween the face of the extruder die 3 and a cooling unit
5. In the cooling zone 4 the extruded lead or core ma-
terial 6 forms a catenary loop the length of which is con-
trolled by means of proximity sensors 7. The sensors 7
determine that the height of the loop is between carefully
controlled limits. The distance between the cooling unit
5 and the face of the extruder die 3 being adjustably set
to maintain the length of the catenary loop.

The cooling unit 5 is also conventional and may be
a six hole cooler attached to a compressor operating at
10 bar. The cooled, by now rigid, core material is fed
from the cooler to a crosshead die 8 where the core ma-
terial is coated with the sheath or coating material. The
cooler die shown in figure 1 shown in more detail.

A coating extruder 10 is attached to an inlet hopper
11. The coating extruder 10 may also be of conventional type.

The extrudate from the crosshead die 8 under-
goes cooling in a second cooling zone 12 during which
the coating material undergoes expansion due to a
foaming or blowing agent added to the coating material
in the coating extruder 10. The blowing agent may be,
for example EPICOR (TM). The length of the extrudate
6 in the cooling zone 12 is also maintained in an manner
similar to that in the cooling zone 4. The core material
is heated by the sheath material and is no longer rigid
when leaving the die 8.

The extrudate is fed into a calibrator 13 which
sizes the extrudate to the correct diameter. After a fur-
ther cooling stage in a cooling tank 14 the product is fed
by a conventional haul off device (not shown) to a con-
ventional cutting device (not shown) which cuts the
cooled extrudate into suitable lengths.

Figure 2 shows the core extruder 1 in a sche-
matic manner. The extruder may be any conventional
extruder, for example a single or double worm extruder.
In the present embodiment, the core material is fed in
the form of pellets through hopper 2 by means of a suit-
able dosing device, for example a conventional gravi-
dometric dosage installation. In the present embodiment,
the material supplied has already been compounded
with suitable additives such as graphite, adhesives, glid-
ing substances and fillers. However, the extruder 1 may
be of a modular form and may comprise one or more
mixing, kneading degasification stations as well as fur-
ther loading stations for additives.

Regions 15, 16 and 17 are heating stages; re-
region 15 heats the material beyond the melting point of
the core material, for example to 200 °C. In regions 16
and 17 the temperature is progressively reduced so that
the material contracts slightly before entering the ex-
truder die discussed in more detail below with reference
to figure 3.

The extruder core die is shown in figure 3
which is attached to the outlet of the extruder die at its face
16 so as to communicate with the outlet of the extruder
1. The core die has two zones 18 and 19. The internal
diameters of zones 18 and 19 reduce in stages as shown
in the figure. The inlet of zone 18 has a typical
diameter of 32 mm which reduces to 10 mm. Zone 18
is typically 95 mm long and heaters 20 to maintain the
temperature of the core material at 125 °C. Zone 19 is
typically 20 mm long and has a rounded taper which re-
duces from 10 mm to say 2.5 mm at the die outlet 21.
Heaters 22 maintain the temperature at say 155 °C so
that the core material is soft as it exits the extruder 1.

The purpose of the decreasing and increasing
temperature profiles is to ensure proper gliding of the
extrudate giving a higher throughput and importantly a
better surface finish to the core which improves the
strength of the core material.

The distance between the outlet 21 of the core
die and the cooling unit 5 is typically 1.5 m and the length
of the molten core material is maintained between set
limits by proximity sensors 7 which are connected to a
control device. The control device varies the throughput
of the system in a known manner by increasing or de-
creasing the haul off rates and the dosage rate into the
extruder 1. The length of the core material sus-
pended between the extruder 1 and the cooling device
5 is important to the cooling process. If the core material
cools too much it will become rigid before entering the
cooling device 5 and may break.

The proximity sensors 7 may take any conven-
iant form, for example two photo detectors and corre-
sponding light or laser sources arranged opposite to the
respective sensor at the minimum and maximum
heights as shown schematically in figure 1.

The distance between the outlet of the cooling
device 5 and the inlet of the crosshead die 8 is typically
1 m. Whilst in any particular embodiment the cooling
method may vary it is important that the core material
extrudate 6 is straight and rigid as it enters the cross-
head die 8.

The assembly 8 is a large diameter die and has
central passage of greater diameter (e.g. 3.2 mm) along
its length than the extruded core material 6. The cross-
head die may be a two part crosshead and die assembly
formed of a male and female section in keeping with
common design practice. One section (female) has a
threaded wall adapted be connected to a threaded con-
duit adapter (not shown) to provide the necessary com-
unication with an extruder 10 which is used to feed
molten sheath material through inlet 11. Another section
(male) of the assembly 8 holds the die plates, which may
be held in place by a machine screw arrangement such
that the distance between the plates can be varied. Al-
ternatively, as the sections are also replaceable, a new
male section can be substituted with a wider die spac-
ing. The male and female sections are secured together
by means of a machine screw arrangement and an an-
nular passage is formed between them. The sheath
material flows along the annular passage from the inlet un-
der pressure from the extruder 10 and the temperature
is maintained at e.g. 150 °C by a heater 25.

In a typical prior art crosshead die assembly
for extrusion of pencils as described in US 3993408, a
cone insert having a central passage communicating
with and forming a continuation of the central passage
of the crosshead die assembly 8. The annular passage
of the prior art therefore ends in a conical portion ex-
tending into and between the die plates.

The extrudate from the die 5 is typically 2/3 of
the cross-sectional diameter (e.g. 7.3 mm) of the cali-
brator 13. The sheath material is mixed with a blowing
agent in the extruder and expands over time in the cool-
ing zone 12. The blowing agent is an endothermic blow-
ing agent. The length of the extrudate in the cooling zone
12 is, therefore, also regulated by proximity sensors 7
and a control device in similar manner to the cooling
zone 4. The distance between the die face 27 and the
calibrator 13 is typically 0.75 m.

As the sheath material expands in the cooling
zone 12, good interfacial adhesion between the sheath
and the core is assured. The problem of assuring good
adhesion between core and sheath is a crucial problem
to be solved when manufacturing pencils.

Expansion of the sheath material is completed
in the cooling zone 12 and the extrudate is then sized
by the calibrator 13 before further cooling in a cooling
tank 14. Finally the extrudate is cut into pencil lengths
by a conventional cutting machine.

The apparatus and technique of the present in-
vention allow unconventional materials to be used to
manufacture pencils having all the required properties
such as ease of sharpening.

It is a feature of the present invention that the
apparatus and method provided by the invention allow
the use of materials such as recycled medium impact
polystyrene which could not previously have been used.
In the case of both the core and sheath materials it is
necessary to mix the recycled materials with other ma-
terial to improve the properties.

Instead of adding graphite to produce a tradi-
tional pencil, the apparatus and method can also be
used to produce pencils of various colours by adding
different additives.

Whilst an embodiment of the invention has
been specifically described, modification and variations
will suggest themselves to those skilled in the art without
departing from the scope of the invention as defined in
the appended claims.

Claims

1. An apparatus for manufacturing pencils comprising
a core material extruder (1), a sheath material ex-
truder (10), a crosshead and die assembly (8) for
coating the sheath material onto the core material
(6), and a means (13) for sizing the co-extrudate
from the crosshead die (8), characterized in that
the sizing means (13) is separated from the face of
the crosshead die by a predetermined distance to
provide a cooling zone (12) in which the co-extru-
date is allowed to cool at ambient temperature, the
apparatus comprises means for maintaining the
length of the co-extrudate in said cooling zone be-
tween a minimum and a maximum length and sen-
sors (7) for detecting when the length of the co-ex-
trudate reaches either said minimum or maximum
length.

2. Apparatus as claimed in claims 1, wherein the co-
extrudate of the crosshead and die assembly (8) is
allowed to form a catenary loop in said cooling zone
(12).

3. Apparatus as claimed in claim 1 or 2, further com-
prising a cooling unit (5) between said core extruder
(1) and said crosshead and die assembly (8), the
cooling unit (5) being separated from the core ma-
terial extruder (1) by a predetermined distance pro-
viding a second cooling zone (4) in which the extru-
date (6) from the core material extruder (1) is
allowed to cool at ambient temperature.

4. Apparatus as claimed in claim 3 wherein the extru-
date (6) is allowed to form a catenary loop in said
second cooling zone (4).
5. A method for extruding pencils having a core and a sheath, comprising the steps of, loading the core and sheath materials into respective extruders (1, 10), extruding the core material (6), cooling the core material (6) and coating the sheath material onto the core material in a crosshead and die assembly (8) by co-extrusion, cooling the co-extrudate from the crosshead and die assembly (8), and sizing the co-extrudate to a predetermined diameter in a sizing means (13), the step of cooling the co-extrudate comprises allowing the co-extrudate to cool at ambient temperature, and maintaining the length of the co-extrudate in a cooling zone (12) between an outlet of said crosshead and die assembly (8) and said sizing means (13) between minimum and maximum lengths.

6. A method as claimed in claim 5, wherein said co-extrudate of the crosshead and die assembly (8) forms a catenary loop in said cooling zone (12).

7. A method as claimed in claim 6, wherein the extruded sheath material comprises an endothermic blowing or foaming agent.

8. A method as claimed in claim 5, 6 or 7, wherein the core material (6) is initially allowed to cool at ambient temperature before cooling in a cooling unit (5) to provide a rigid and straight core material to be fed into the crosshead and die assembly (8).

9. A method as claimed in claim 8 wherein said core material (6) is allowed to cool at ambient temperature in the form of a catenary loop the length of which is maintained between a predetermined minimum and maximum.

Patentansprüche


2. Vorrichtung nach Anspruch 1, bei der das Ko-Extrudat der Querhaupt- und Matrizenanordnung (8) eine Seillinienschlaufe in der Abkühlzone (12) bildet.

3. Vorrichtung nach Anspruch 1 oder 2, weiterhin enthaltend eine Abkühlheit (5) zwischen dem Kern-Extruder (1) und der Querhaupt- und Matrizenanordnung (8), wobei die Abkühlheit (5) über einen vorbestimmten Abstand von dem Kernmaterial-Extruder (1) getrennt ist, so dass eine zweite Abkühlzone (4) bereitgestellt wird, in der das Extrudat (6) aus dem Kernmaterial-Extruder (1) bei Umgebungstemperatur abkühlen kann.

4. Vorrichtung nach Anspruch 3, bei der das Extrudat (6) eine Seillinienschlaufe in der zweiten Abkühlzone (4) bildet.


8. Verfahren nach Anspruch 5, 6 oder 7, bei dem man das Kernmaterial (6) zunächst bei Umgebungstemperatur abkühlt, bevor es in einer Abkühlheit (5) abkühlt, um ein steifes und gerades Kernmaterial, welches der Querhaupt- und Matrizenanordnung (8) zuzuführen ist, bereitzustellen.

9. Verfahren nach Anspruch 8, bei dem dem Kemma-
terial (6) ermöglicht wird, in Form einer Seillinien-
schlaufe bei Umgebungstemperatur abzukühlen, wobei die Länge der Seillinien-
schlaufe zwischen einem vorbestimmten Minimum und einem vorbe-
stimmten Maximum aufrechterhalten wird.

**Revendications**

1. Dispositif de fabrication de crayons comprenant une extrudeuse de matériau de mine (1), une extru-
deuse de matériau de gaine (10), un ensemble à 
filière et tête d’équerre (8) destiné à enrober le ma-
tériau de mine (6) avec le matériau de gaine, et des 
moyens (13) permettant de calibrer le coextrudat 
sortant de la filière à tête d’équerre (8), caractérisé 
en ce que les moyens de calibrage (13) sont sépa-
rés de la face de la filière à tête d’équerre d’une dis-
tance prédéterminée de façon à constituer une zo-
ne de refroidissement (12) dans laquelle le coextru-
dat peut refroidir à température ambiante, l’appareil 
comprend des moyens destinés à maintenir la lon-
gueur du coextrudat dans ladite zone de refroidis-
sement entre une longueur minimale et une lon-
gueur maximale, et des capteurs (7) destinés à dé-
tecter à quel moment la longueur du coextrudat atte-
te la longueur minimale ou la longueur longueur 
maximale.

2. Dispositif selon la revendication 1, dans lequel le 
coextrudat de l’ensemble à filière et tête d’équerre 
(8) peut former une boucle en chaînette dans ladite 
zone de refroidissement (12).

3. Dispositif selon la revendication 1 ou 2, comprenant 
en outre une unité de refroidissement (5) entre la-
dite extrudeuse de mine (1) et ledit ensemble à fi-
lière et tête d’équerre (8), l’unité de refroidissement 
(5) étant séparée de l’extrudeuse de matériau de 
mine (1) d’une distance prédéterminée constituant 
une deuxième zone de refroidissement (4) dans la-
quelle l’extrudat (6) sortant de l’extrudeuse de ma-
tériau de mine (1) peut refroidir à température am-
biante.

4. Dispositif selon la revendication 3, dans lequel l’ex-
trudat (6) peut former une boucle en chaînette dans 
ladite deuxième zone de refroidissement (4).

5. Procédé d’extrusion de crayons ayant une mine et 
une gaine, comprenant les étapes consistant à :
charger les matériaux de mine et de gaine dans des 
extrudeuses respectives (1, 10), extruder le ma-
tériau de mine (6), laisser refroidir le matériau de mine 
(6) et enrober le matériau de mine avec le matériau 
de gaine dans un ensemble à filière et tête d’équer-
re (8) par coextrusion, laisser refroidir le coextrudat 
sortant de l’ensemble à filière et tête d’équerre (8)