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AUSTRALIA
PATENTS ACT 1990
NOTICE OF ENTITLEMENT

We, **Alcan International Limited**, the applicant/Nominated Person in respect of Application No. 80985/91 state the following:-

The Nominated Person is entitled to the grant of the patent because the Nominated Person derives title to the invention from the inventors by assignment.

The Nominated Person is entitled to claim priority from the application listed in the declaration under Article 8 of the PCT because the Nominated Person made the application listed in the declaration under Article 8 of the PCT, and because that application was the first application made in a Convention country in respect of the invention.

DATED this TWENTY EIGHTH day of JANUARY 1993



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a member of the firm of
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CAVE for and on behalf
of the applicant(s)

(DCC ref: 1560991)



AU9180985

(12) PATENT ABRIDGMENT (11) Document No. AU-B-80985/91
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 651833

- (54) Title
DECONTAMINATION AND/OR SURFACE TREATMENT OF METALS
- International Patent Classification(s)
(51)⁵ C22B 001/00 C22B 021/00 F23C 005/30
- (21) Application No. : 80985/91 (22) Application Date : 18.07.91
- (87) PCT Publication Number : WO92/01825
- (30) Priority Data
- | (31) Number | (32) Date | (33) Country |
|-------------|-----------|--------------|
| 2021638 | 20.07.90 | CA CANADA |
- (43) Publication Date : 18.02.92
- (44) Publication Date of Accepted Application : 04.08.94
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- (56) Prior Art Documents
US 4508564
FR 2372905

(57) Claim

1. A process of decontaminating magnesium-containing aluminum scrap contaminated with organic material, in which the scrap, which has a melting point, is heated in a fluidized bed of solid particles fluidized by a fluidizing gas to a decontaminating temperature high enough to consume said organic material but below the melting point of said metal, characterized in that said heating step is carried out in the presence of a fluoride compound as a protective material which protects the metal against oxidation while said scrap is held in said bed at said decontaminating temperature, said fluoride compound being capable of reacting with said magnesium at a surface of said scrap to form MgF_2 under the conditions prevailing during said heating step.

OPI DATE 18/02/92

APPLN. ID

80985 / 91



ANJP DATE 26/03/92

PCT NUMBER PCT/CA91/00252

INTERNA

TREATY (PCT)

<p>(51) International Patent Classification ⁵ : C23G 5/00, C22B 1/00, 21/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 92/01825 (43) International Publication Date: 6 February 1992 (06.02.92)</p>
<p>(21) International Application Number: PCT/CA91/00252 (22) International Filing Date: 18 July 1991 (18.07.91) (30) Priority data: 2,021,638 20 July 1990 (20.07.90) CA (71) Applicant (for all designated States except US): ALCAN INTERNATIONAL LIMITED [CA/CA]; 1188 Sherbrooke Street, West, Montreal, Quebec H3A 3G2 (CA). (72) Inventors; and (75) Inventors/Applicants (for US only) : DUBE, Ghyslain [CA/CA]; 76 de Crespieul, Chicoutimi, Quebec G7H 7M3 (CA). TREMBLAY, François [CA/CA]; 243 Michel Simard, St-Fulgence, Quebec G0V 1S0 (CA).</p>	<p>(74) Agents: KIRBY, Peter et al.; Kirby, Eades, Gale, Baker & Potvin, Box 3432, Station D, Ottawa, Ontario K1P 6N9 (CA). (81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), US. Published With international search report.</p> <p style="text-align: center; font-size: 2em; font-weight: bold;">651833</p>	
<p>(54) Title: DECONTAMINATION AND/OR SURFACE TREATMENT OF METALS</p>		
<p>(57) Abstract</p> <p>The invention relates to a process of decontaminating metal (especially aluminum or aluminum alloy) scrap contaminated with organic material. The problem with such methods is that undue oxidation of the metal may take place as the decontamination proceeds, leading to reduced recovery rates. The process involves heating the scrap in a fluidized bed of solid particles fluidized by a fluidizing gas to a decontaminating temperature high enough to consume the organic material but below the melting point of the metal. The heating step is carried out in the presence of a protective material which protects the aluminum or aluminum alloy against substantial oxidation while the scrap is held in the bed at the decontaminating temperature. Preferred protective materials include organic and inorganic fluorine-containing compounds, particularly AlF₃. The process is particularly effective for the treatment of aluminum alloys containing magnesium, which are especially susceptible to oxidation. Scrap decontaminated in this way can be subjected to conventional metal recovery processes, e.g. metal melting, and provide high recovery rates of the metal. The process of the invention can also be used for protecting metal (particularly aluminum and alloys thereof) against excessive oxidation during heat treatments other than decontamination. The invention also relates to the treatment of briquettes of compacted scrap without the need for protection from oxidation and without the need for prior shredding or grinding.</p>		

DECONTAMINATION AND/OR SURFACE TREATMENT OF METALSTECHNICAL FIELD

This invention relates to the decoating of contaminated scrap metals, particularly aluminum scrap, and/or to the surface treatment of metals, particularly aluminum and alloys thereof, in order to reduce the susceptibility of such metals to oxidation during heat treatments.

BACKGROUND ART

10 The recycling of contaminated metal scrap material, particularly aluminum scrap, is a large and important industry nowadays but it depends to a very large extent for its commercial viability on the percentage of metal that can be successfully recovered from the scrap. Metal
15 scrap material may be of a variety of types, such as turnings from machining operations, used food and beverage containers, large castings, and the like, but in virtually all cases the major contaminants are organic materials such as oil, paints, adhesives and paper. In order to
20 maximize the recovery and minimize the emission of pollutants, it is necessary to remove such organic contaminants from the scrap material before subjecting the scrap to remelting for metal recovery. By removing or substantially reducing organic contaminants, it is
25 possible to increase the percentage of recovered metal by as much as 10 - 15% by weight, or sometimes more.

One of the best known and most used processes for the decontamination of scrap utilizes the pyrolysis of the organic contaminants in a hot air current, e.g. as carried
30 out in a rotary kiln or packed bed conveyor decoater. This involves contacting the scrap with a moving current of air at a temperature of 400 - 600°C in order to bring about heating of the scrap and combustion of the contaminants. Because of a limited rate of heat transfer
35 when large pieces of scrap are processed, the scrap must first be shredded or ground to increase the surface to

volume ratio, which requires a troublesome and costly additional step. Even when shredding is carried out, however, it is difficult to control the temperature of the scrap during the decontamination process and it is found 5 that the temperature can vary considerably according to the position of the scrap in the load, i.e. due to channelling of the heated air, some of the scrap may be overheated and other parts may remain unsuitably cool. Temperature variation of this type results in some of the 10 scrap being unduly oxidized while other parts of the scrap may be only partially decoated. Aluminum alloys having high magnesium contents (e.g. 4 - 5% by weight) are especially susceptible to oxidation or even melting when overheated and metal recovery can be considerably reduced 15 when such metals are subjected to the conventional decoating process.

The conventional hot air process encounters further difficulties when attempts are made to decoat thin gauge aluminum scrap (e.g. up to 100 microns, and usually 6 - 7 20 microns, in thickness) containing from 15 to 70% by weight of aluminum and a high proportion of flammable material, such as paper, e.g. as is the case for thin laminated materials used for the manufacture of hermetically sealed food and beverage containers, and the like. Processing of 25 such material in a stream of hot air is generally not possible because the rapid combustion of the flammable material causes overheating and oxidation of the thin aluminum and may result in partial fusion. Given the thinness of the sheets, the least amount of surface 30 oxidation dramatically decreases the metal recovery and complete oxidation or melting of the metal may result.

Alternative apparatus for decoating metal scrap has been suggested, but not put into practice on a wide scale. For example, British patent publication no. 2,046,888 B of 35 November 19, 1980 in the name of Tolltreck Ltd. discloses the use of a heated fluidized bed for the decoating of contaminated scrap. Similar procedures are also mentioned

in US patent no. 4,508,564 issued on April 2, 1985 to Kennedy and in US patent no. 3,250,643 issued on May 10, 1966 to Sergeant. However, while the use of a fluidized bed improves the heat distribution throughout the charge of scrap
5 undergoing the decoating treatment, it is found that the degree of oxidation of the metal remains high and thus there is no great advantage. Furthermore, the fluidized bed process has still required the prior shredding or grinding of compacted or large size scrap.

10 DISCLOSURE OF INVENTION

It is therefore an object of the present invention, at least in its preferred forms, to provide a process for the decoating of aluminum scrap that can be operated without undue loss of metal.

15 Another object of the invention, at least in a preferred ~~forms~~^{form,} is to provide a process for the protection of the surface of aluminum and alloys thereof against oxidation.

The present invention is based, at least in part, on the finding that certain solid or gaseous materials can be
20 introduced into a fluidized bed used for the decoating or surface treatment of contaminated metal scrap to prevent undue oxidation of the scrap. Moreover, it has also been unexpectedly found that bundles of compacted scrap can be treated in a fluidized bed without the need for prior
25 shredding or grinding.

Thus, according to one aspect of the present invention, there is provided a process of decontaminating magnesium-containing aluminum scrap contaminated with organic material, in which the scrap, which has a melting point, is heated in
30 a fluidized bed of solid particles fluidized by a fluidizing gas to a decontaminating temperature high enough to consume said organic material but below the melting point of said metal, characterized in that said heating step is carried out in the presence of a fluoride compound as a protective
35 material which protects the metal against oxidation while said scrap is held in said bed at said decontaminating temperature, said fluoride compound being capable of reacting with said

magnesium at a surface of said scrap to form MgF_2 under the conditions prevailing during said heating step.

According to another aspect of the invention, there is provided a process of heat treating a magnesium-containing
5 aluminum alloy to modify properties of said alloy, in which the alloy is heated in a fluidized bed of solid particles fluidized by a fluidizing gas to an elevated treatment temperature below the melting point of said alloy, characterized in that said heating step is carried out in the
10 presence of a fluoride compound as a material which protects the metal against substantial oxidation during said heating step, said fluoride compound being capable of reacting with said magnesium at a surface of said alloy to form MgF_2 under the conditions prevailing during said heating step.

15 According to another aspect of the invention, there is provided a process of recovering magnesium-containing aluminum alloy from scrap containing said alloy contaminated with organic material, in which said scrap is decontaminated by heating the scrap in a fluidized bed of solid particles
20 fluidized by a fluidizing gas to a decontaminating temperature high enough to consume said organic material but below the melting point of said alloy, said decontaminated scrap is removed from said bed without removing all adhering solid particles of said bed from said scrap, said decontaminated
25 scrap is melted in the presence of a salt flux to produce molten alloy and residual contaminants, and said molten alloy is separated from said residual contaminants; characterized in that said bed of solid particles includes particles of a fluoride compound as a solid protective material which
30 protects the alloy against oxidation while said scrap is held in said bed at said decontaminating temperature and which is capable of acting as a salt flux for the alloy, said fluoride compound being capable of reacting with said magnesium at a surface of said alloy to form MgF_2 under the conditions
35 prevailing during said heating step; and in that said melting step is carried out in the absence of a salt flux added to said alloy after removal of said alloy from said bed.

A particular advantage of the present invention is that the fluidizing gas may be an oxygen-containing gas, such as air or a mixture of air and other gases, so that the process can be operated economically. A further advantage of the present invention is that it is unnecessary to carry out a preliminary shredding or grinding operation on bundled scrap, so that scrap in virtually any form, even compacted scrap received from



recycling stations, can be used directly. Briquettes or bundles of scrap having densities in the range of 150-800 Kg/m³, generally 250-800 Kg/m³ and most preferably at least 500 Kg/m³, can be treated in this way. The elimination of the preliminary shredding or grinding step provides a considerable economic advantage.

The surprising ability to treat compacted bundles in a fluidized bed contrary to previous assumptions applies to the treatment of compacted material whether or not a protective material is present in the fluidized bed or fluidizing gas. As a result, it is believed that this aspect of the invention is independent of the requirement for a protective material and applies to otherwise known fluidized bed treatments, all of which previously were directed to the treatment of small individual pieces rather than to compacted bundles of individual pieces.

Thus, according to yet another aspect of the invention, there is provided a process of decontaminating bundles of compacted scrap metal contaminated with organic material, which process comprises heating the bundles of scrap in a fluidized bed of solid particles fluidized by a fluidizing gas to a decontaminating temperature high enough to consume said organic material but below a melting point of said metal.

All aspects of the present invention are applicable to the treatment of virtually all common metals, e.g. ferrous metals, copper, etc., but the process is especially effective for the treatment of aluminum and aluminum alloys because these metals are particularly susceptible to oxidation and have low melting points so that careful temperature control is required. The aspects of the present invention utilizing the protective material are especially useful when applied to the decontamination of aluminum scrap containing a high content of magnesium or thin gauge aluminum scrap of the type mentioned above since scrap materials of this type are particularly

vulnerable to excess oxidation during fluidized bed techniques.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is discussed in more detail
5 by way of example only, below, with reference to the accompanying drawings, in which:

Figure 1 is a cross section of an apparatus suitable for carrying out the process of the present invention;

Figure 2 is a cross section of an alternative
10 apparatus for carrying out the process of the present invention;

Figure 3 is a graph showing metal recovery versus content of residual oil in aluminum scrap material;

Figure 4 is a graph showing the types of scrap
15 materials that have been successfully treated by the process of the present invention; and

Figure 5 is a graph comparing heat transfer rates for decoating procedures carried out in air and in a fluidized bed.

20 BEST MODES FOR CARRYING OUT THE INVENTION

A main aspect of the present invention requires the use of a protective material during a fluidized bed heat treatment of contaminated scrap metal. The protective materials which may be employed in the present invention
25 are generally solid, volatile liquid or gaseous fluorine-containing materials, e.g simple and complex inorganic or organic fluorides. The material may be any fluoride compound that will react with the metal to inhibit surface oxidation. Examples of suitable solids include AlF_3 ,
30 Na_2AlF_6 (sodium cryolite), K_2AlF_6 (potassium cryolite), NH_4BF_4 , etc. Examples of suitable gases include SF_6 , HF, SiF_4 , BF_3 , etc. When the material is HF it may be generated *in situ* from more stable compounds such as NaF and KF, etc., by reaction with water vapour present in the
35 products of combustion of organic materials in the scrap. When the metal to be treated is a magnesium-containing aluminum alloy, it is especially advantageous to use a

fluorine-containing material, such as AlF_3 , capable of reacting under the process conditions with the magnesium present at the metal surface to form MgF_2 which appears to form a tight barrier against oxidation.

5 When the protective material used in the present invention is a solid, it is preferably used as a constituent of the fluidized bed, and may if desired form the entire solid used to form the bed (although this is usually not required). Alternatively, the solid may be
10 entrained in the fluidizing gas used to activate the bed.

 When the protective material is a gas, it is preferably introduced into the bed as a component of the fluidizing gas or as a separate gas stream. The protective gaseous material cannot in general be used
15 alone as the fluidizing medium when the invention is used to decontaminate metal because oxygen must usually be present to oxidize the organic contaminants, but it could be used alone when the invention is applied to the surface treatment of uncontaminated metal.

20 A particularly surprising feature of the present invention is that the amount of the protective material usually required to prevent substantial oxidation is relatively small. For example, when the protective material is a solid, such as AlF_3 , it may generally be used
25 in an amount of about 5-10 wt.% of the fluidized bed. When the protective material is a gas, it may be used in an amount of a few volume percent of the fluidizing gas, preferably 0.1 - 1.0% by volume. This makes the present invention particularly economical, especially when
30 expensive protective materials are employed.

 The solid particles used to form the fluidized bed usually have diameters in the range of 20 microns to 2 mm, and preferably in the range of 50 - 500 microns in order to maximize the rate of heat transfer. This rate is
35 linked to the surface to volume ratio of the particles, which should be as high as possible, and to the efficiency of the fluidization. Particles with diameters greater

than about 500 microns have a small surface to volume ratio, whereas particles having diameters smaller than 50 microns are difficult to fluidize adequately (they tend to produce "plug flow").

5 The particles forming the bed, except for the particles of protective material if the material is provided in solid form, are generally made of an inert material such as sand, salts (e.g. NaCl), alumina and mixtures thereof. Alumina is preferred because of its
10 commercial availability in the desired diameter range (e.g. smelter grade alumina having a diameter range of 100 - 150 microns) and because its particles tend to be more spherical than many other materials, such as sand, so that it is easier to fluidize. If the bed is to consist
15 entirely of the protective material, the use of aluminum fluoride is preferred because it is also readily available in a smelter grade having a diameter of 100 - 150 microns.

The particle bed is usually maintained at a temperature of 400 - 650°C depending on the nature of the
20 contaminants to be volatilized, oxidized or pyrolysed, but the bed temperature should not exceed the melting temperature of the metal in the scrap to be treated. For example, an alloy of aluminum containing 4 - 5% by weight of magnesium has a melting point between 580 and 600°C so
25 temperatures between about 400-550°C are preferred in this case. Either electric heating or gas heating of the fluidizing gas on the particle bed can be employed.

Once the particles of the bed have been fluidized, the aluminum scrap can be easily submerged for treatment.
30 A metal wire basket can be used to hold shredded, ground or uncompact scrap, i.e. to submerge the scrap and to retrieve it from the bed after treatment. Compact scrap, such as briquettes and bundles, can be handled as it is without resort to the use of a basket.

35 When a briquette or bundle is immersed in the fluidized bed it is unexpectedly observed that the particles in close proximity to the briquette, i.e. within

2 to 5 cm, slow their movement and gas channelling within the porous solid occurs. This channelling within the compacted solid ensures complete combustion of the organic materials contained within the scrap or complete treatment of the surface of the metal in those cases where metal treatment rather than decontamination is the objective.

The treatment time required for contaminated scrap depends on the nature and quantity of the contaminant to be removed, as well as the nature of the scrap, i.e. whether it is compacted, shredded or ground. For non-compacted scrap, the residence time in the fluidized bed is usually from 30 seconds to 3 minutes. For compacted bales or briquettes, the residence time is usually from 5 to 20 minutes.

The decoating aspect of the present invention produces an additional unexpected advantage. When decontaminated aluminum scrap undergoes remelting for recovery of the metal, it is usual to add about 2% by weight (based on the scrap weight) of a fluxing salt so that the metal separates cleanly from any oxide present in the scrap or produced during the remelting operation. When aluminum scrap is decoated by the process of the invention in the presence of a solid protective material, such as AlF_3 , in the fluidized bed, it is found that no fluxing salt need be added during the remelting step. This is because some of the particles from the bed remain adhered to the decoated scrap, even if the scrap undergoes a vibrating treatment to remove excess particles. The small amount of residual protective material therefore acts as a fluxing agent for the remelting operation. When the bed contains 10% by weight of solid protection material, e.g. AlF_3 , and the residual amount of solid particles in the decoated scrap is 1% by weight, only 0.1% by weight of the protective material is present in the scrap during remelting. It is surprising that such a small amount of the material is effective as a fluxing agent, but this is found to be the case.

Consequently, the invention includes the remelting of scrap decontaminated by the process of the invention in the presence of a protective material capable of acting as a fluxing salt, in the absence of any additional fluxing salt for the remelting step.

The aspect of the invention which relates to the treatment of uncontaminated metal to improve various properties while avoiding surface oxidation can be carried out in essentially the same way as the treatment of contaminated scrap. The quantities of the protective material are essentially the same and the treatment times depend on the heat treatment process involved. This procedure can be used during the heat treatment of any cast or fabricated product to prevent oxidation at elevated temperature. Such heat treatments may be, for example, for the purposes of increasing mechanical properties (e.g. annealing), stress relief, homogenizing, and the like.

The aspect of the invention which relates to the treatment of bundles of compacted scrap in a fluidized bed without the use of a protective material applies generally to aluminum scrap briquettes preferably having a density of 150-800 kg/m³. The conditions of the treatment are essentially the same as those in which a protecting material is used. Less metal is recovered by this technique due to surface oxidation, but the prior art requirement for shredding or grinding of the scrap is avoided.

Apparatus suitable for carrying out all aspects of the present invention is described in the following with reference to the accompanying drawings.

Figure 1 shows a cross section of a fluidized bed apparatus 10 suitable for use in the present invention. The apparatus consists of a container 11 having heating elements 12 embedded in the sidewalls 13 thereof. A perforated plate 14 extending across the interior of the container 11 close to the bottom thereof acts as a gas distributor. Gas enters the interior of the container

below the perforated plate through a pipe 15. The interior of the container above the plate is substantially filled with a bed 16 of solid particles. The gas passes through the distributor 14, fluidizes the bed 16 and then
5 escapes through a chimney 17 to a gas exhaust 18.

Optionally, an afterburner (not shown) can be introduced at this point to ensure complete combustion of any unburned volatiles. This may be required when treating metals having a high proportion of organics.

10 A pulley arrangement 19 is connected to a wire basket 20 capable of holding pieces of scrap material 21. The pulley can therefore be used to raise and lower the basket so that successive charges of scrap material may be submerged in the bed 16 and then withdrawn.

15 The heating elements 12 and possibly additional elements (not shown) for the gas introduced through the pipe 15 raises the temperature of the bed 16 to the effective range of 400 - 650 degrees centigrade. As a result, organic contaminants on the scrap material are
20 burned, volatilized or pyrolysed and the resulting gaseous products escape to the exterior through the chimney 17 and gas exhaust 18.

In this type of apparatus, the protective material required to protect the scrap from undue oxidation may be
25 in the form of particles of the bed 16 or may be a gaseous product introduced through the pipe 15 with the fluidizing gas.

Figure 2 is a cross section of an alternative apparatus 30 suitable for the continuous processing of
30 compacted scrap bundles. In this case, a bed 31 of particles is held within a dish shaped container 32 having a perforated lower wall 33. An endless perforated conveyor belt 34 passes through the container 32 between the bed of particles and the inner surface 35 of the
35 container. A gas plenum 36 is positioned below the container in communication with the perforated lower wall 33 and a fluidizing gas is fed into the plenum through a

gas pipe 37. Gas fed through the pipe 37 at a suitable pressure fluidizes the bed of solid particles and the conveyor belt 34 is driven through the container by a motor (not shown).

5 An additional conveyor belt 38 feeds compacted scrap briquettes 39 into the container 32 whereupon they rapidly become submerged in the bed 31 and are gradually moved through the container by the conveyor 34. The bed 31 is heated by the hot fluidizing gas or by other means (not
10 shown) to the required temperature so that organic contaminants on the scrap are consumed. The conveyor 34 eventually removes the treated briquettes from the container 32 whereupon they enter a chute 40 to a treatment zone 41 where they are shaken in combination
15 with air jet cleaning and vacuum treatment processing to remove particles of solid from the bed. The particles thus freed are collected via collection means 42 and returned to the fluidized bed 31 via conveyors 43.

Combustion products and the like contained in the
20 fluidizing gas as it emerges from the bed exit the apparatus via a cyclone device 44 for removing entrained solids, which solids are returned to the bed via pipe 45. An afterburner (not shown) can again optionally be added.

As in the case of the apparatus shown in Figure 1,
25 the protective material may be contained as a solid in the bed 31 or as a gas or vapour in the fluidizing gas introduced through the pipe 37.

Apparatus of the type shown in Figures 1 and 2 is effective for the removal of substantially all the organic
30 contaminants from coated scrap with a minimum of metal loss.

As well as being used for the decoating of contaminated aluminum scrap, the process of the present invention may be used for the thermal treatment of pieces
35 of aluminum to protect the surfaces of the pieces from oxidation during subsequent processing.

The invention is illustrated further by the following Examples.

EXAMPLE 1

Conventional metal recovery operations were carried out on several batches of Class 1 contaminated aluminum scrap material (oily process scrap from can body manufacture comprising mainly aluminum alloy AA3004) which had been decoated by various procedures leaving various residual amounts of machining oils.

Figure 3 of the accompanying drawings illustrates the metal recoveries obtained from these materials compared with the amounts of residual oil. As the amount of residual oil decreased, the percentage metal recovery improved considerably. For metal having 0.0-0.4% by weight of residual oil resulting from a decoating process according to the present invention, metal recovery above 99% was achieved.

It will be seen that the removal of a few percent of contaminating oil resulted in an improvement of metal recovery of about 8%, which would substantially improve the economic performance of the recycling process. In addition, the emission of polluting fumes during the remelting operation was considerably reduced when scrap containing less residual oil was treated.

EXAMPLE 2

Two batches of beverage can scrap (UBC, alloys AA3004 and AA5182) were decoated, one by a conventional hot air process (Alcan Decoater) and the other using apparatus of the type shown in Fig. 1, employing AlF_3 as the protective material added to the fluidized solid (alumina) in an amount of 10% by weight. The decoated metal was then subjected to remelting and the metal was recovered.

Table 1 below shows the percentages of metal recovered from the two procedures.

TABLE 1Gross Metal Recovery From UBC Scrap Based on Metal Available

5	DECOATING SYSTEM	CONVENTIONAL HOT AIR	FLUIDIZED BED
	GROSS RECOVERY (%)	93	95.5

As can be seen from the Table, the recovery of metal obtained by using the present invention is much higher than that obtained from the conventional procedure.

EXAMPLE 3

Two batches of compacted scrap bundles were subjected to metal recovery. The first underwent a decoating procedure according to the present invention, and the second was not decoated at all.

The results are shown in Table 2 below.

TABLE 2Net Recovery Based on Metal Available (assuming 90% metal recovery in gross)

20	SCRAP TYPE	RECOVERY (WT%)	
		UNDECOATED	DECOATED WITH FLUIDIZED BED
	Baled Class 1	96.5	98.9
	Baled Class 2	93.1	97.5

From this Table it can be seen that for "class one" scrap 3004 alloy (1% by weight of Mg) contaminated with oil, the gross metal recovery increased from 96.5% by weight to 98.9% by weight when previously decontaminated using the process of the present invention. For "class two" type scrap (coated process scrap from can lid manufacture) consisting mainly of AA5182 aluminum alloy (containing 4.5% by weight Mg) coated with a layer of epoxy-based varnish, the gross recovery increased from 93.1% by weight to 97.5% by weight. These are substantial increases.

EXAMPLE 4

Figure 4 of the accompanying drawings shows various types of scrap material which were subjected to decontamination according to the fluidized bed process of the present invention using solid AlF_3 as a component of the fluidized bed. The fact that many of these scrap materials can be subjected to decoating at all shows the effectiveness of the present invention.

EXAMPLE 5

Used beverage can scrap was subjected to fluidized bed decoating in a bed containing particles of alumina and 10 wt% of aluminum trifluoride at a temperature of $550^\circ C$ for a period of 2 minutes. The aluminum in the scrap contained 1.8% by weight of magnesium and the scrap as a whole contained 2.5% by weight of organic contaminants. The decoated scrap was then subjected to metal recovery. The metal recovery rate was 99.1% by weight based on the available metal.

The procedure was repeated using a bed containing only alumina. The metal recovery rate was 96.8% by weight, i.e. much inferior to that of the process of the present invention.

EXAMPLE 6

A fluidized bed of the type shown in Figure 1 was operated and the rate of heat transfer to scrap added to the bed was measured.

A conventional air decoater was also operated and the rate of heat transfer was also measured.

The results are shown in Figure 5, from which it can be seen that the fluidized bed decoater is much more efficient than the conventional air decoater.

INDUSTRIAL APPLICABILITY

The invention can be used in the scrap metal recovery industry, or other industries requiring the heat treatment of metals susceptible to oxidation, in order to achieve greater ease of handling and improved economics.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A process of decontaminating magnesium-containing aluminum scrap contaminated with organic material, in which the scrap, which has a melting point, is heated in a fluidized bed of solid particles fluidized by a fluidizing gas to a decontaminating temperature high enough to consume said organic material but below the melting point of said metal, characterized in that said heating step is carried out in the presence of a fluoride compound as a protective material which protects the metal against oxidation while said scrap is held in said bed at said decontaminating temperature, said fluoride compound being capable of reacting with said magnesium at a surface of said scrap to form MgF_2 under the conditions prevailing during said heating step.

2. A process according to claim 1 characterized in that said protective material is a solid in the form of particles present in said bed.

3. A process according to claim 2 characterized in that said bed consists of said particles of said protective material.

4. A process according to claim 2 characterized in that said bed comprises said particles of said protective material and particles of substantially inert material.

5. A process according to claim 1 characterized in that said protective material is a gas introduced into said bed as a constituent of said fluidizing gas.

6. A process according to claim 1 characterized in that said protective material is a gas introduced into said bed separately from said fluidizing gas.

7. A process according to claim 1 characterized in that said protective material is a compound selected from the group consisting of AlF_3 , Na_2AlF_6 , K_2AlF_6 , NH_4BF_4 , SF_6 , HF , SiF_4 and BF_3 .
- 5 8. A process according to claim 1, 2, 3 or 4, characterized in that said protective material is aluminum trifluoride.
9. A process according to claim 1, 2, 3, 4, 5 or 6 characterized in that said scrap is in the form of
10 substantially separate pieces.
10. A process according to claim 1, 2, 3, 4, 5 or 6 characterized in that said scrap is in the form of compacted bundles.
11. A process according to claim 10 characterized in that
15 said scrap is in the form of compacted bundles having a density of 150-800 Kg/m^3 .
12. A process according to claim 1, 2, 3, 4, 5 or 6 characterized in that said decontaminating temperature is in the range of 400 - 650°C.
- 20 13. A process according to claim 1, 2, 3, 4, 5 or 6 characterized in that said fluidizing gas comprises air.
14. A process of heat treating a magnesium-containing aluminum alloy to modify properties of said alloy, in which the alloy is heated in a fluidized bed of solid
25 particles fluidized by a fluidizing gas to an elevated treatment temperature below the melting point of said alloy, characterized in that said heating step is carried out in the presence of a fluoride compound as a material which protects the metal against substantial oxidation
30 during said heating step, said fluoride compound being

capable of reacting with said magnesium at a surface of said alloy to form MgF_2 under the conditions prevailing during said heating step.

15. A process of recovering magnesium-containing aluminum
5 alloy from scrap containing said alloy contaminated with
organic material, in which said scrap is decontaminated by
heating the scrap in a fluidized bed of solid particles
fluidized by a fluidizing gas to a decontaminating
temperature high enough to consume said organic material
10 but below the melting point of said alloy, said
decontaminated scrap is removed from said bed without
removing all adhering solid particles of said bed from
said scrap, said decontaminated scrap is melted in the
presence of a salt flux to produce molten alloy and
15 residual contaminants, and said molten alloy is separated
from said residual contaminants; characterized in that
said bed of solid particles includes particles of a
fluoride compound as a solid protective material which
protects the alloy against oxidation while said scrap is
20 held in said bed at said decontaminating temperature and
which is capable of acting as a salt flux for the alloy,
said fluoride compound being capable of reacting with said
magnesium at a surface of said alloy to form MgF_2 under the
conditions prevailing during said heating step; and in
25 that said melting step is carried out in the absence of a
salt flux added to said alloy after removal of said alloy
from said bed.

~~16. A process of decontaminating scrap metal contaminated
with organic material in which the scrap metal is heated
30 in a fluidized bed of solid particles fluidized by a
fluidizing gas to a decontaminating temperature high
enough to consume said organic material but below a
melting point of said metal, characterized in that said
scrap metal is in the form of bundles of compacted scrap
35 material.~~

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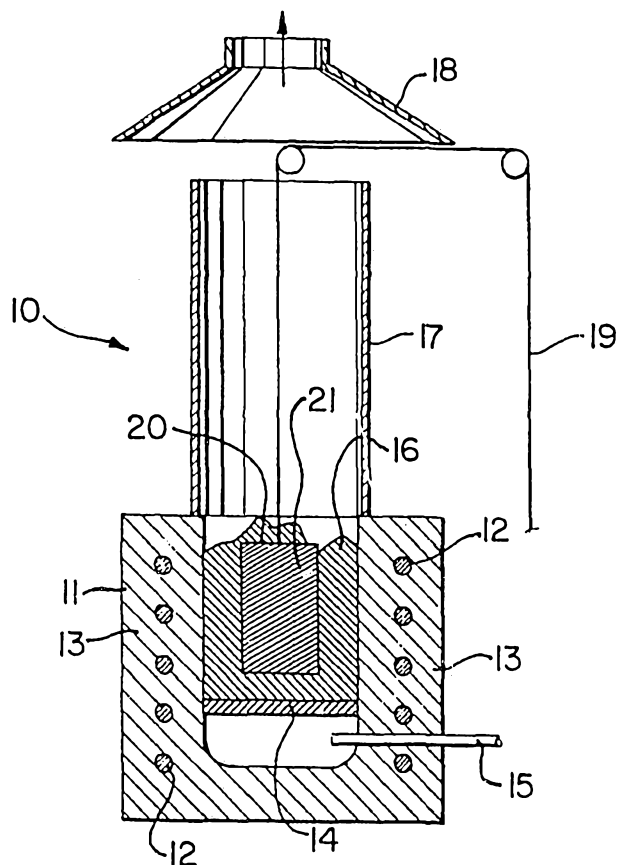


FIG. 1

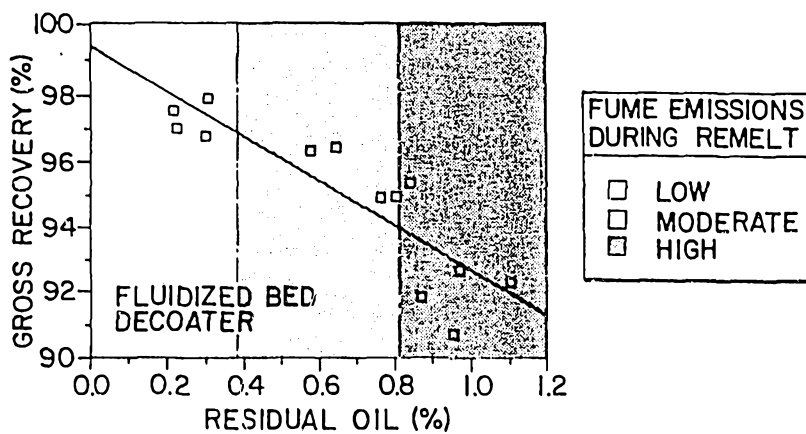


FIG. 3

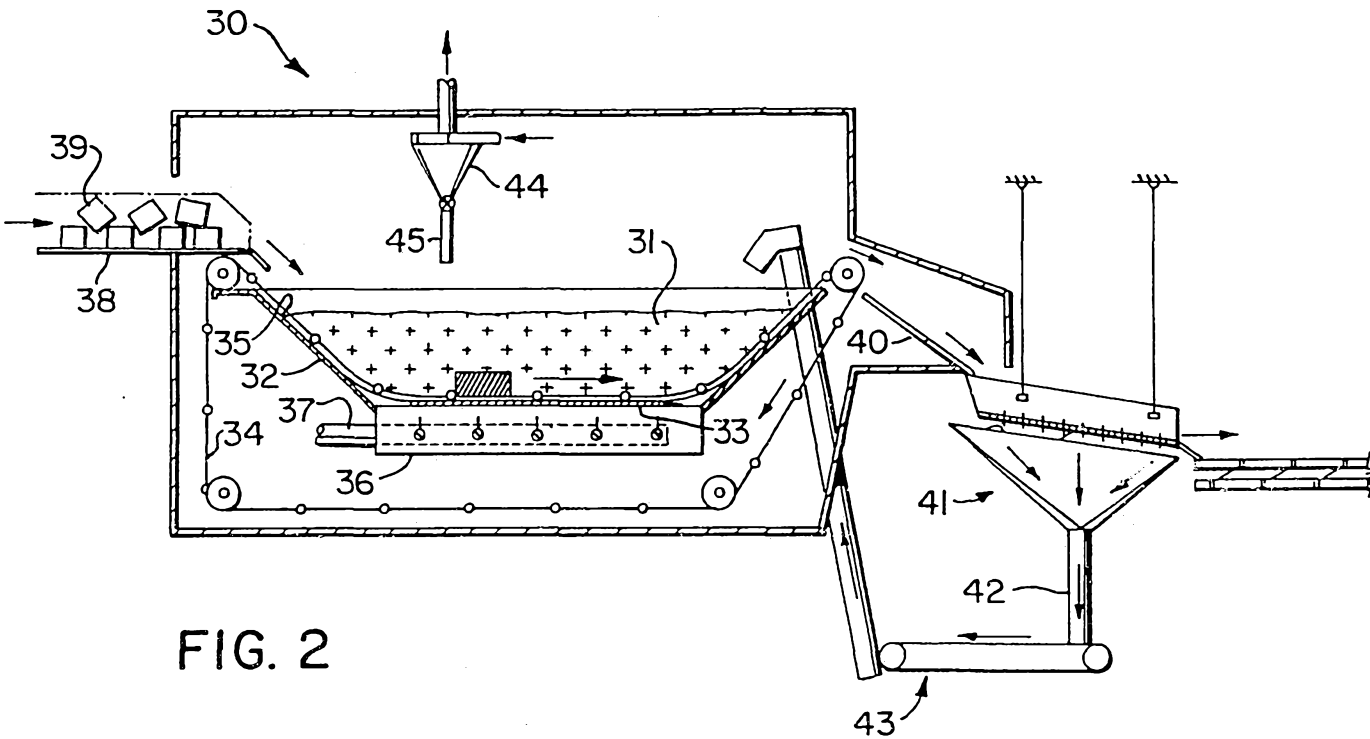


FIG. 2

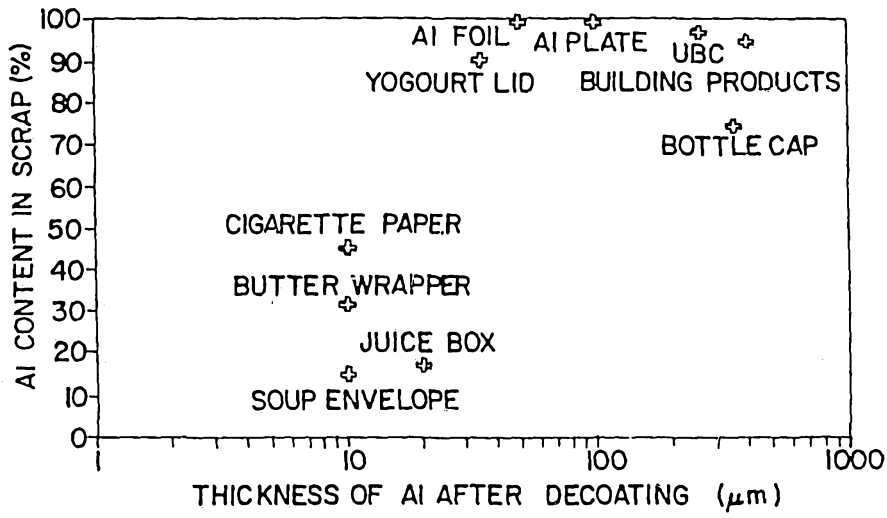


FIG. 4

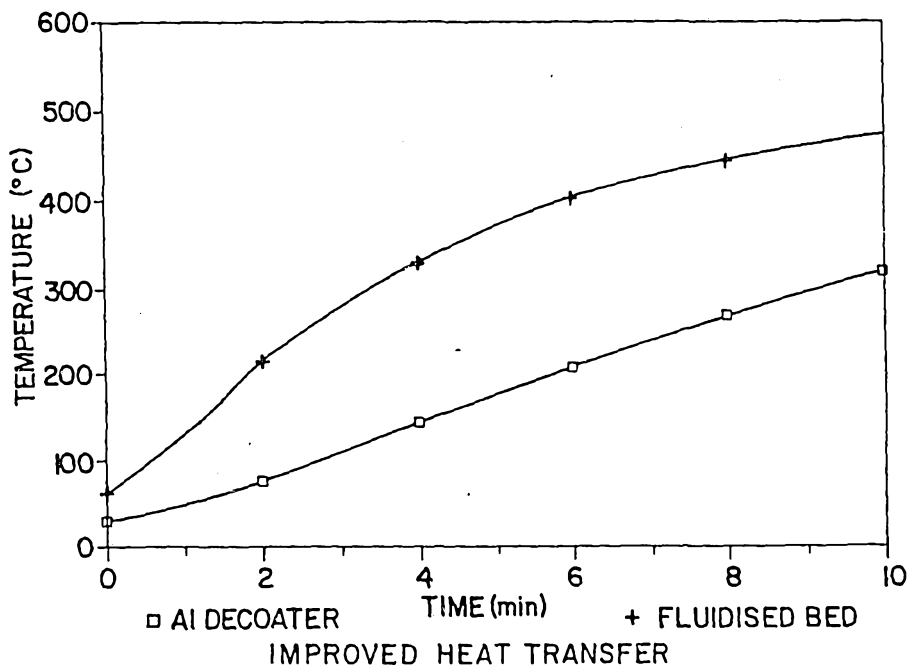


FIG. 5

According to International Patent Classification (I. C.) or to both National Classification and I. C.
 Int. Cl. 5 C 23 G 5/00 C 22 B 1/00 C 22 B 21/00

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System	Classification Symbols	
Int. Cl. 5	C 23 G	C 22 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched⁸

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	FR,A,2372905 (PROCEDYNE CORPORATION) 30 June 1978, see claims 1,2,4; page 5, lines 27-36; page 3, lines 2-21; page 9, lines 7-9	1,2-6, 11,17, 18,19
Y	see claims 1,2 ---	13,20
Y	US,A,4508564 (J.A. KENNEDY) 2 April 1985, see claim 1 (cited in the application) ---	13,20
A	FR,A,2372660 (PROCEDYNE CORPORATION) 30 June 1978 ---	
A	GB,A,2046888 (TOLLTRECK Ltd) 19 November 1980 (cited in the application) -----	

¹⁰ Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 18-10-1991	Date of Mailing of this International Search Report 20. 11. 91
International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer <i>Mme. M. van der Brift</i> Mme. M. van der Brift

FR-A- 2372905	30-06-78	None
US-A- 4508564	02-04-85	None
FR-A- 2372660	30-06-78	None
GB-A- 2046888	19-11-80	None