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(71) Applicants:
- **Xiamen Lota International Co., Ltd.**
  361022 Xiamen, Fujian (CN)
- **Lota Xiamen Industry Co., Ltd.**
  361100 Xiamen, Fujian (CN)

(72) Inventors:
- **LONG, Jia**
  Xiamen
  Fujian 361022 (CN)
- **ZHANG, Huawei**
  Xiamen
  Fujian 361022 (CN)
- **BI, Qiu**
  Xiamen
  Fujian 361022 (CN)
- **LIN, Mingyuan**
  Xiamen
  Fujian 361022 (CN)
- **LV, Qing**
  Xiamen
  Fujian 361022 (CN)
- **ZHANG, Weixing**
  Xiamen
  Fujian 361022 (CN)
- **HU, Zhenqing**
  Xiamen
  Fujian 361022 (CN)

(74) Representative: **Schiweck Weinzierl Koch**
Patentanwälte Partnerschaft mbB
Ganghoferstraße 68 B
80339 München (DE)

(54) ENVIRONMENTALLY FRIENDLY BRASS ALLOY FOR CASTING AND MANUFACTURING METHOD THEREFOR

(57) Disclosed are an environmentally friendly brass alloy for casting and a manufacturing method therefor. The brass alloy is free of the elements selenium, tellurium, antimony, phosphorus, magnesium and manganese, and the components thereof are: 58-61.5 wt.% of Cu, ≤ 0.25 wt.% of Pb, 0.5-0.8 wt.% of Al, < 0.1 wt.% of Sn, < 0.1 wt.% of Ni, 0.02-0.15 wt.% of Fe, and 5-12 ppm of B, with the balance being Zn and inevitable impurities. In addition to excellent polishing performance and hot tearing resistance performance, the brass alloy has good comprehensive performance, and is suitable for casting formed bathroom plumbing parts.

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Description

TECHNICAL FIELD

[0001] The present invention belongs to the technical field of alloys, particularly relates to a lead-free environmentally friendly brass alloy for casting and manufacturing method thereof, which is different from bismuth brass, silicon brass and arsenic brass, and does not contain selenium, tellurium, antimony, phosphorus, magnesium and manganese.

BACKGROUND ART

[0002] Lead brass contains 1wt.%-4wt.% lead, and has been widely used in various fields such as electrical, mechanical, plumbing and other fields because of its excellent cutability and formability as well as its low cost. However, because the lead brass will cause environmental pollution and threaten human health during manufacturing and application, developed countries and regions such as the United States, European Union and Japan have successively formulated lead-free standards and regulations, for example NSF-ANSI61, NSF-ANSI372, AB-1953, RoHS, etc. The definition of "lead-free" in AB-1953 by the United States is that the content of Pb does not exceed 0.25wt%. GB 18145-2014 "Ceramic Cartridge Faucets" by China also stipulates that the precipitation of lead in drinking water components should be less than 5ug / L.

[0003] In order to achieve lead-free brass, it has been tried to replace lead with selenium, tellurium or antimony to achieve the cutability of brass alloys, and add appropriate amounts of other elements to improve the comprehensive performance of brass alloys. Although the addition of selenium and tellurium to brass alloys can effectively improve the cutability, selenium and tellurium are expensive and difficult to be added during smelting, and the yield is low, thus the selenium brass or tellurium brass has not been marketed and industrialized yet. Antimony itself is toxic. When the content of Sb is greater than 0.02%, the precipitation of antimony in water will exceed 0.6 μg / L stipulated in the GB 18145-2014 standard, thus it cannot be applied in drinking water system components.

[0004] Till now, there are three main types of lead-free environmentally friendly brass that have been widely studied and been widely applied in market, they are bismuth brass, silicon brass and arsenic brass, however each of these lead-free environmentally friendly brasses has some defects. The bismuth brass is easy to appear hot cracks in the forming process due to the presence of Bi, and its welding performance is poor, in addition because bismuth is associated with lead during mining, which will pollute the environment, bismuth brass has not been accepted by the European market; The silicon brass has poor stress corrosion resistance, and the products made from the silicon brass tend to occur stress corrosion failure during use; The arsenic brass, which has been developed to meet Australian anti-dezincification standard AS 2345-2006 (the average depth of the dezincification layer is not greater than 100μm), has poor alloy fluidity, great shrinkage tendentiousness and high casting failure rate.

[0005] Phosphorus, magnesium and manganese are added to some brasses to improve various performances, but the introduction of these elements brings difficulties in recycling of waste materials.

[0006] Therefore, there are still unmet needs for new lead-free environmentally friendly brass alloy with desirable comprehensive performances, which is different from bismuth brass, silicon brass and arsenic brass, and does not contain selenium, tellurium, antimony, phosphorus, magnesium and manganese.

SUMMARY OF THE INVENTION

[0007] In order to overcome the defects in the prior art, one aim of the present invention is to provide an environmentally friendly brass alloy and manufacturing method thereof, which meets the lead-free requirement and is different from bismuth brass, silicon brass and arsenic brass. The brass alloy also does not contain selenium, tellurium, antimony, phosphorus, magnesium and manganese.

[0008] Another aim of the present invention is to provide an environmentally friendly brass alloy with excellent hot tearing resistance and manufacturing method thereof.

[0009] Another aim of the present invention is to provide an environmentally friendly brass alloy with good polishing performance and manufacturing method thereof.

[0010] Still another aim of the present invention is to provide an environmentally friendly brass alloy with excellent comprehensive performances and manufacturing method thereof, wherein the comprehensive performances include mass production, low cost, good mechanical performance and castability, good polishing and welding performance, good hot tearing resistance and good stress corrosion resistance.

[0011] The purpose of the present invention is achieved through the following technical solutions.

[0012] The present invention provides an environmentally friendly brass alloy for casting, consisting of: 58-61.5wt.% of Cu, $\leq$0.25 wt.% of Pb, 0.5-0.8wt.% of Al, <0.1wt.% of Sn, <0.1wt.% of Ni, 0.02-0.15wt.% of Fe, 5-12 ppm of B, with the balance being Zn and unavoidable impurities.

[0013] Preferably, the content of Cu in the brass alloy is 59-61wt.%.

[0014] Preferably, the content of Al in the brass alloy is 0.6-0.8wt.%, more preferably 0.65-0.75wt.%.

[0015] Preferably, the content of Pb in the brass alloy is 0.15-0.25wt.%, at this time the cutability is fairly good, but in order to meet further lead-free requirement, the content of Pb is also preferably <0.15 wt.% , more preferably <0.1 wt.%.

[0016] Preferably, the content of Sn in the brass alloy is 0.02-0.08wt.%, more preferably 0.05-0.08wt.%.

[0017] Preferably, the content of Ni in the brass alloy is 0.02-0.08wt.%, or preferably <0.02wt.%.

[0018] Preferably, the content of Fe in the brass alloy is 0.03-0.08wt.%.

[0019] Preferably, the content of B in the brass alloy is 5-10ppm, more preferably 7-9ppm.

[0020] The hot tearing resistance value of the brass alloy is 245-400N, more preferably 350-400N.

[0021] The manufacturing method of the brass alloy comprises the following steps: weighing waste brass materials, electrolytic copper, Zn, Al, Sn, Ni, Pb and Cu-Fe intermediate alloy according to the elements contained in the brass alloy and the mass percentage of each element, wherein the content of Cu in the Cu-Fe intermediate alloy is 90-95 wt.%; adding a proper amount of a slag removing agent at the bottom of furnace before smelting each time, then adding Ni, Cu-Fe intermediate alloy and waste brass materials, adding electrolytic copper and a slag removing agent on the surface when 1/4 of the waste brass materials is melted, adding Zn, Al, Sn and Pb successively after all the materials are completely melted, mixing well, heating to remove slags after metals are completely melted, performing components and performances detection, supplementing a refiner if necessary, spraying fire after all indexes are qualified, standing still, removing slags, transporting and casting ingots; wherein at least one of the brass waste materials and the refiner contains boron.

[0022] In the manufacturing method, preferably, the slag removing agent is not borax.

[0023] The Cu-B intermediate alloy is an alloy having high melting point, when the alloy is added, it is easy to appear hard spots, therefore, the supplemented refiner preferably is not a Cu-B intermediate alloy.

[0024] The elements added to the alloy of the present invention will be described in detail below.

[0025] The addition of no more than 0.25 wt.% of lead (Pb) can improve the cutability of the brass alloy, refine the crystal grains and improve the castability, and meets the requirements in AB1953 that the lead content in the materials of the components contacting with water in a drinking water system should not be more than 0.25wt.%, and the requirements in NSF 61 and GB18145-2014 that the precipitation amount of Pb into water should be less than 5 μg/L.

[0026] The addition of aluminum (Al) element can significantly increase the fluidity of the alloy and improve its castability, in addition the solid solution strengthening effect of Al can improve the strength of the alloy, the content of Al is preferably controlled at 0.5-0.8wt.%, if the content of Al is too low, the fluidity of the alloy will not be significantly improved, and the product is liable to loose and leak. However, when the content of Al is too high, the fluidity will be reduced accordingly.

[0027] As an essential element of the present invention, iron (Fe) plays a main role in refining the crystal grains, Fe has a low solubility in brass, Fe usually exits in the matrix in form of Fe-rich phase particle and becomes the crystal nucleus to refine the crystal grains, thus the fluidity and castability of the alloy are improved. When B exists in the alloy, Fe and B are combined, so that the refinement effect is better. Preferably, the content of Fe is controlled at 0.02-0.15 wt.%, when Fe <0.02 wt%, it has a poor refinement effect; and when Fe>0.15 wt.%, it is easy to appear hard spots, which reduces the polishing quality of the alloy.

[0028] The main function of boron (B) is to work together with Fe to modify and refine the crystal grains, when B<5 ppm, it has no obvious refinement effect on the alloy. The inventor of the present invention found that the problems that hard spots and poor polishing often occur during the development of alloys. Through repeated studies, the inventor found that the problems were caused by the simultaneous existence of a large amount of Fe and B in the alloy. In order to maintain desirable polishing performance, the amounts of Fe and B are required to reach a certain balance, that is, when Fe > 0.02 wt.%, the content of B must be controlled < 12 ppm so as to ensure the polishing quality of the product.

[0029] The addition of tin (Sn) element can improve corrosion resistance, ameliorate castability and cutability, and reduce the defects of pores and looseness in the castings. The content of Sn in the present invention is preferably controlled below 0.1 wt.%, if the content of Sn is too high, the alloy will become brittle and its castabilty will be deteriorated.

[0030] The addition of nickel (Ni) element can improve strength, toughness and corrosion resistance of the alloy, especially enhance stress corrosion resistance of the alloy. The content of Ni is preferably controlled below 0.1 wt.%, and the cost will be increased if the content of Ni is too high.

[0031] Specifically, compared with the prior art, the brass alloy of the present invention possesses at least the following beneficial effects:

[0032] The brass alloy of the present invention contains no more than 0.25 wt.% of lead and does not contain selenium, tellurium and antimony, it not only meets the lead-free requirements in AB1953, but also satisfies the requirements of the precipitation amount of metals in water in NSF61 and GB18145-2004.

[0033] The alloy of the present invention overcomes the problems of hot tearing tendentiousness and poor welding performance of bismuth brass, the problems of poor stress corrosion resistance of silicon brass, and the problems of poor fluidity and large shrinkage tendentiousness of arsenic brass.

[0034] The brass alloy of the present invention has good hot tearing resistance.

[0035] The structure of the brass alloy of the present invention is refined through the combination of Fe and B, the alloy has both good castability and good polishing performance.

[0036] The brass of the present invention does not contain the elements such as P, Mg and Mn, thereby eliminating the adverse effects caused by such elements as P, Mg and Mn, and facilitating recycling of used materials.

[0037] The alloy of the present invention employs brass waste materials as raw materials, and the copper content is low, therefore the manufacturing cost is low, meanwhile, the alloy has the comprehensive performance of mass production, good mechanical performance and castability, good polishing and welding performance, good hot tearing resistance and good stress corrosion resistance.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0038] The present invention will be further illustrated with reference to the following examples.

Examples

[0039] The present invention will be further illustrated with reference to the following examples, which aid in the understanding of the present invention, but which are not to be construed as limitations thereof..

Example 1 Preparation and compositions of the alloys of the present invention and comparative alloys

A. Preparation and compositions of the alloys 1-6 of the present invention

[0040] The alloys 1-6 of the present invention were manufactured by the following method: waste brass materials, electrolytic copper, Zn, Al, Sn, Ni, Pb and Cu-Fe intermediate alloy were weighed according to the mass percentage of each brass alloy of the present invention, wherein the content of Cu in the Cu-Fe intermediate alloy was 90-95 wt.%; a proper amount of a non-borax slag removing agent was added at the bottom of furnace before smelting each time, then Ni, Cu-Fe intermediate alloy and waste brass materials were added, the electrolytic copper was added on the surface when 1/4 of the waste brass materials were melted, Zn, Al, Sn and Pb were added successively after all the materials were completely melted, mixed well, the temperature was raised to remove slags after the metals were completely melted, the detection on the composition and performances such as polishing were carried out, a non-CuB alloy refiner was supplemented if necessary, the spraying fire and standing still operation were carried out, the slags were removed after all indexes were qualified, the temperature was raised to 1050-1100°C, then the alloy was transported and casted into ingots.

[0041] The compositions of the alloys 1-6 of the present inventive prepared by the above method are shown in Table 1.

B. Obtaining or preparation and compositions of comparative alloys 1-9

[0042] Comparative Alloy 1 is a commercially available lead brass alloy ZCuZn40Pb2, whose composition is shown in table 1.

[0043] Comparative Alloys 2-9 were manufactured by the following conventional method, and the used raw materials were determined according to the composition of each comparative alloy: Cu, Si, Zn, Al, Sn, Ni, Pb, Mn and Cu-P, Cu-B and Cu-Fe intermediate alloys were weighed according to the mass percentage of the Comparative Alloys, wherein the content of Cu in the Cu-B and Cu-Fe intermediate alloys was 90 wt.%, and the content of Cu in the Cu-P intermediate alloy was 85 wt.%; Si and Ni were placed at the bottom of a power frequency induction furnace, raw materials of Cu and Zn were placed on top of Si and Ni, a refining agent was added at the same time, then the temperature was risen to 1050-1100°C until all the materials were melted, the floating slag was removed by filtering; Al, Sn, Pb and Mn were sequentially added into the obtained materials, stirred fully to mix well; the Cu-Fe and Cu-P intermediate alloys were added to the obtained materials, stirred then stood still for 5-10 min; the Cu-B intermediate alloy was added, then the temperature was risen to 1100-1150 °C, sprayed fire and kept at the temperature for 5-8min; then kept at the temperature of 1000-1050 °C while standing still, the floating slags were removed by filtering; the alloys were transported at 1050-1100 °C and casted into ingots, then cooled.

[0044] The compositions of Comparative Alloys 2-9 prepared by the above method are shown in Table 1.

Table 1 Compositions of Alloys According to the Present Invention and Comparative Alloys(wt. %)

Alloys	Cu	Si	Bi	As	Sb	Al	Sn	Fe	Pb	Ni	P	Mn	B	Mg	Zn
Alloy 1 according to the present invention	58.69	-	-	-	-	0.78	0.02	0.15	0.12	-	-	-	5ppm		Balance
Alloy 2 according to the present invention	60.26	-	-	-	-	0.65	0.05	0.02	0.18	0.01	-	-	7ppm		Balance
Alloy 3 according to the present invention	59.00	-	-	-	-	0.75	0.08	0.05	0.10	0.02	-	-	7ppm		Balance
Alloy 4 according to the present invention	60.68	-	-	-	-	0.80	0.04	0.08	0.13	0.08	-	-	9ppm		Balance
Alloy 5 according to the present invention	61.00	-	-	-	-	0.58	-	0.03	0.15	-	-	-	10ppm		Balance
Alloy 6 according to the present invention	61.37	-	-	-	-	0.72	0.06	0.03	0.25	0.06	-	-	12ppm		Balance
Comparative Alloy 1	59.52	-	-	-	-	0.60	0.03	0.06	1.25	0.03	-	-	8ppm		Balance
Comparative Alloy 2	59.90	-	0.567	-	0.009	0.64	0.045	0.049	0.059	0.0006	-	-	-		Balance
Comparative Alloy 3	60.00	-	0.03	-	0.003	0.60	0.15	0.15	0.01	0.12	-	-	-		Balance
Comparative Alloy 4	61.28	-	-	-	0.86	-		0.14	-	-	-	0.98	-	0.02	Balance
Comparative Alloy 5	61.50	0.67	-	-	-	0.67	0.07	0.08	0.11	0.06	-	0.004	10ppm		Balance
Comparative Alloy 6	63.6	0.95	-	-	-	0.72	0.08	-	0.136	0.26	0.15	-	16ppm	0.25	Balance
Comparative Alloy 7	62.9	-	-	0.062		0.516	-	-	-	-	-	-			Balance
Comparative Alloy 8	60.53	-	-	-	-	0.68	0.05	0.07	0.15	0.03	-	-	13ppm		Balance
Comparative Alloy 9	62.8					0.57	0.09	0.12	0.20	0.05			7ppm		Balance
Note: The sum of other impurities in the above alloys is less than 0.2wt.%.															

Example 2 Performance detection of the alloys according to the present invention and comparative alloys

[0045] The performances of the alloys according to the present invention and comparative alloys obtained by the above example were detected, the specific testing items and methods were described as follows and the detection results were shown in Table 2.

1. Castability

[0046] Strip-shaped samples: The samples were used for detecting the linear shrinkage rate of alloys, and the lower the linear shrinkage rate was, the stronger the hot tearing resistance was. The alloys were poured into a 200mm long mold of strip-shaped sample at 1050°C, and the linear shrinkage rate was calculated by measuring the gap distance between the mold and the samples after the alloys were cooled.

[0047] Spiral-shaped samples: the alloy melts were poured into a spiral sample mold at 1050°C, and the length of the alloy melts was measured to evaluate the fluidity of the alloys. The longer the length was, the better the fluidity of the alloys was, correspondingly, the lower the shrinkage tendentiousness of the alloys was, and better the castability was.

2. Mechanical Tensile performance

[0048] Tensile performance: The tensile strength and elongation of the alloys were tested according to GB/T228-2010, the alloys of the present invention and the comparative alloys were processed into standard samples with a diameter of 10mm, the tensile test was carried out at room temperature, and the tensile strength and the elongation of each alloy were determined.

[0049] Brinell hardness: the hardness of the alloys was tested according to GB/T231.1-2009, the alloys of the present invention and the comparative alloys were casted into round samples, the two ends of the round samples were flattened, and the Brinell hardness of each alloy was tested.

3. Polishing performance

[0050] A 35 mm long of sample was cut from an ingot along its length direction, the cross section was taken. The cross section of the sample was polished according to the process (100 #-240 #-400 #-white cloth wheel). The polished cross section of the sample was cleaned using a dry cloth, and the polishing performance was determined by visual inspection under the condition that the luminosity is not less than 300LX. If there are hard spots, which indicates poor polishing performance, the result will be shown as "×". If there are no hard spots, which indicates good polishing performance, the result will be shown as "○".

4. Welding performance

[0051] The weldment was a low-pressure casting/CuZn37 brass pipe, brazed, heated by flame, and the temperature was 350-400 °C. The evaluation standard for welding performance is whether the cracks and pores appear in welding seam and heat affected zone, if there are no cracks and pores, it will be qualified and shown as "o"; otherwise, it will be unqualified and shown as "×".

5. Hot tearing resistance

[0052] The alloy melts were poured into a hot tearing shrinkage meter at 1050 °C, and the hot tearing resistance value was measured according to JB/T 4022.2 *Test method for castability of alloys - Determination of hot tearing tendentiousness.* The higher the hot tearing resistance value is, the smaller the hot tearing tendentiousness of the alloy is.

6. Stress corrosion resistance

[0053] Ammonia tests were carried out on the same faucet assembly products according to GB/T 10567.2-2011 and YS/T814-2012 respectively, the sample was taken out after ammonia fumigation, rinsed with water, then washed in 5% sulfuric acid solution at room temperature to clean the corrosion products on the surface of the sample, finally rinsed with water and blow-dried, and it was determined whether the ammonia test was qualified or not according to the methods described in GB/T 10567.2-2011 and YS/T814-2012 respectively.

7. Precipitation of metals in water

[0054] The determination of precipitation of elements of the alloys according to the present invention in water was carried out according to the Standard NSF/ANSI 61-2011, the detector was Varian 820-MS Icp. Mass spectrometer (inductively coupled plasma mass spectrometer), the duration for testing was 19 days, the sample was a faucet casting product, and it is required that Pb $\leq 5\mu g/L$ and Sb$\leq 0.6\mu g/L$.

Table 2 Performance Results of the Tested Alloys

No. of Alloys	Linear shrinkage rate %	Fluidity mm	Tensile strength MPa	Elongation %	Brinell hardness	Polishing performance	Welding performance	Thermal crack resistance value (N)	Stress corrosion resistance		Precipitation of heavy metals	
									GB/T10567.2	YS/T814	Pb	Sb
Alloy 1 according to the present invention	1.68	415	450	43	95	○	○	245	qualified	qualified	0.053	0.021
Alloy 2 according to the present invention	1.62	430	4417	54	90	○	○	350	qualified	qualified	0.068	0.024
Alloy 3 according to the present invention	1.64	456	434	40	92	○	○	372	qualified	qualified	0.045	0.051
Alloy 4 according to the present invention	1.63	438	420	48	91	○	○	365	qualified	qualified	0.053	0.036
Alloy 5 according to the present invention	1.62	457	431	42	90	○	○	400	qualified	qualified	0.066	0.058
Alloy 6 according to the present invention	1.60	436	420	43	88	○	○	286	qualified	qualified	0.086	0.026
Comparative Alloy 1	1.62	455	420	35	92	○	○	-	qualified	qualified	17.1	0.034
Comparative Alloy 2	1.74	450	430	38	89	○	×	147	qualified	qualified	0.084	0.456
Comparative Alloy 3	1.71	420	440	48	92	○	×	185	qualified	qualified	0.03	0.348

(continued)

No. of Alloys	Linear shrinkage rate %	Fluidity mm	Tensile strength MPa	Elongation %	Brinell hardness	Polishing performance	Welding performance	Thermal crack resistance value (N)	Stress corrosion resistance		Precipitation of heavy metals	
									GB/T10567.2	YS/T814	Pb	Sb
Comparative Alloy 4	1.63	380	420	35	87	○	○	-	qualified	qualified	0.046	1.5
Comparative Alloy 5	1.65	390	475	48	115	○	○	-	qualified	unqualifi ed	0.058	0.059
Comparative Alloy 6	1.75	370	468	50	103	○	○	-	qualified	unqualifi ed	0.057	0.048
Comparative Alloy 7	1.82	320	340	57	80	○	○	-	qualified	qualified	0.041	0.075
Comparative Alloy 8	1.66	425	440	45	92	×	○	-	qualified	qualified	0.079	0.055
Comparative Alloy 9	1.78	350	350	48	79	○	○	214	qualified	qualified	0.069	0.086

Test results :

[0055] The precipitation amount of Pb and Sb into water from the Alloys 1-6 of the invention meets the requirements of standards of NSF61 and GB18145-2004. Comparative Alloy 1 is a lead-containing brass, wherein the precipitation amount of Pb from this alloy exceeds the standard, and Comparative Alloy 4 is a Sb-containing brass, wherein the precipitation amount of Sb from this alloy exceeds the standard.

[0056] Comparative Alloys 2-3 are bismuth brass, whose welding performance is unqualified, accordingly the welding performance of the Alloys 1-6 of the invention is superior to that of Comparative Alloys 2-3; The linear shrinkage rate of the Alloys 1-6 of the invention is smaller than that of Comparative Alloys 2-3, and the hot tearing resistance value of the Alloys 1-6 of the invention is larger than that of Comparative alloys 2-3, so that the hot tearing resistance of the Alloys of the present invention is superior to that of the bismuth brass.

[0057] Comparative Alloys 5-6 are silicon brass, the stress corrosion resistance of Comparative Alloys 5-6 is not qualified according to the test of YS/T814-2012, and the stress corrosion resistance of the Alloys 1-6 of the present invention is superior to that of the silicon brass.

[0058] Comparative Alloy 7 is an arsenic brass, the linear shrinkage rate and the length of fluid of the Alloys 1-6 of the present invention are obviously superior to that of Comparative Alloy 7, i.e. The shrinkage tendentiousness of the Alloys of the present invention is obviously smaller than that of Comparative Alloy 7, their castability is superior to that of the arsenic brass alloy, and the mechanical performance of the Alloys 1-6 of the present invention is also obviously superior to that of the arsenic brass alloy.

[0059] Comparative Alloy 8 has higher Fe content and its B content is more than 12 ppm, therefore, it has poorer polishing performance compared with the Alloys 1-6 of the invention.

[0060] The content of Cu in Comparative Alloy 9 is higher than that of the present application, besides the higher manufacturing cost, the overall comprehensive performance of Comparative Alloy 9 is not as good as that of the Alloys 1-6 of the present invention.

[0061] In conclusion, the alloys of the present invention meet the lead-free requirement in AB1953, at the same time satisfies the requirement of the precipitation amount of metal in water in GB 18145-2004, overcomes the defects of bismuth brass, silicon brass and arsenic brass, meanwhile, the alloys have good comprehensive performances of castability, mechanical performance, polishing performance, welding performance, stress corrosion resistance and hot tearing resistance.

[0062] As a lead-free environmentally friendly brass alloy, the alloy of the present invention will gradually expand its application in drinking water system components in the future.

[0063] The examples above are described for the purpose of illustration and are not intended to limit the present invention. Within the spirit of the present invention and the scope of protection defined by claims, any modifications and changes made to the present invention fall into the scope of protection of the present invention.

Claims

1. An environmentally friendly brass alloy for casting, consisting of:
   58-61.5wt.% of Cu, ≤0.25 wt.% of Pb, 0.5-0.8wt.% of Al, <0.1wt.% of Sn, < 0.1wt.% of Ni, 0.02-0.15wt.% of Fe, 5-12 ppm of B, with the balance being Zn and unavoidable impurities.

2. The brass alloy according to claim 1, wherein the content of Cu in the brass alloy is 59-61wt.%; preferably the content of Al in the brass alloy is 0.6-0.8wt.%, more preferably 0.65-0.75wt.%.

3. The brass alloy according to any one of claims 1-2, wherein the content of Pb in the brass alloy is 0.15-0.25wt.%, or is<0.15 wt.% , preferably <0.1 wt.%.

4. The brass alloy according to any one of claims 1-3, wherein the content of Sn in the brass alloy is 0.02-0.08wt.%, preferably 0.05-0.08wt.%.

5. The brass alloy according to any one of claims 1-4, wherein the content of Ni in the brass alloy is 0.02-0.08wt.%, or <0.02wt.%.

6. The brass alloy according to any one of claims 1-5, wherein the content of Fe in the brass alloy is 0.03-0.08wt.%.

7. The brass alloy according to any one of claims 1-6, wherein the content of B in the brass alloy is 5-10ppm, more preferably 7-9ppm.

8. The brass alloy according to any one of claims 1-7, wherein the thermal crack resistance value of the brass alloy is 245-400N, more preferably 350-400N.

9. A manufacturing method of the brass alloy of any one of claims 1-8,
wherein the manufacturing method comprises the following steps:

weighing waste brass materials, electrolytic copper, Zn, Al, Sn, Ni, Pb and Cu-Fe intermediate alloy according to the elements contained in the brass alloy and the mass percentage of each element, wherein the content of Cu in the Cu-Fe intermediate alloy is 90-95 wt.%;
adding proper amount of a slag removing agent at the bottom of furnace before smelting each time, then adding Ni, Cu-Fe intermediate alloy and waste brass materials, adding electrolytic copper and a slag removing agent on the surface when 1/4 of the waste brass materials is melted, adding Zn, Al, Sn and Pb successively after all the materials are completely melted, mixing well, heating to remove slag after metals are completely melted, performing component and performances detection, supplementing a refiner if necessary, spraying fire after all indexes are qualified, standing still, removing slag, transporting and casting ingots;
wherein at least one of the brass waste materials and the refiner contains boron.

10. The manufacturing method according to claim 9, wherein the slag removing agent is not borax, the added refiner is not a Cu-B intermediate alloy refiner.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/094181

A. CLASSIFICATION OF SUBJECT MATTER

C22C 9/04(2006.01)i；C22C 1/03(2006.01)i；C22C 1/06(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C22C9; C22C1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, CNPAT, CNKI: 黄铜, 铜, 环保, 无铅, 铅, 铝, 锡, 镍, 铁, 硼, 锌, brass W alloy, lead W free, Cu, copper, Pb, lead, plumbum, Al, aluminum, Sn, stannum, tin, Ni, nickel, Fe, iron, B, boron, Zn, zinc

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105543548 A (XIAMEN LOTA INTERNATIONAL CO., LTD.) 04 May 2016 (2016-05-04) description, paragraphs [0015] and [0021]-[0022]	1-8
Y	CN 105543548 A (XIAMEN LOTA INTERNATIONAL CO., LTD.) 04 May 2016 (2016-05-04) description, paragraphs [0015] and [0021]-[0022]	9-10
Y	CN 104745863 A (JOMOO KITCHEN & BATH CO., LTD.) 01 July 2015 (2015-07-01) description, paragraphs [0005]-[0009]	9-10
PX	CN 107385273 A (XIAMEN LOTA INTERNATIONAL CO., LTD. ET AL.) 24 November 2017 (2017-11-24) claims 1-10	1-10
A	CN 101619404 A (XIAMEN LOTA INTERNATIONAL CO., LTD.) 06 January 2010 (2010-01-06) entire document	1-10
A	CN 103725919 A (ANXIN COUNTY HUACHANG ALLOY FACTORY) 16 April 2014 (2014-04-16) entire document	1-10

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search **05 September 2018**	Date of mailing of the international search report **26 September 2018**
Name and mailing address of the ISA/CN **State Intellectual Property Office of the P. R. China** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102560190 A (JIUXING HOLDING GROUP) 11 July 2012 (2012-07-11) entire document	1-10
A	US 2012251382 A1 (PENG, FENG ET AL.) 04 October 2012 (2012-10-04) entire document	1-10

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/094181

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 105543548 A	04 May 2016	CA 3009422 A1	29 June 2017
		WO 2017107917 A1	29 June 2017
CN 104745863 A	01 July 2015	None	
CN 107385273 A	24 November 2017	None	
CN 101619404 A	06 January 2010	None	
CN 103725919 A	16 April 2014	None	
CN 102560190 A	11 July 2012	None	
US 2012251382 A1	04 October 2012	CN 102071336 A	25 May 2011

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- GB 181452004 A **[0032] [0055] [0061]**