COPPER-BASE ALLOY

Applicant: SAN-ETSU METALS CO., LTD., Tonami-Shi (JP)

Inventors: Yoshiharu KOSAKA, Takaoka-Shi (JP); Shinya UENO, Takaoka-Shi (JP)

Appl. No.: 14/838,795

Filed: Aug. 28, 2015

Related U.S. Application Data


FOREIGN APPLICATION PRIORITY DATA

Jun. 5, 2013 (JP) ...................................... 2013-118383

Publication Classification

Int. Cl.
C22C 9/04 (2006.01)

U.S. Cl.
CPC .................................................. C22C 9/04 (2013.01)

ABSTRACT

A copper-base alloy includes 63.5 to 69.0 mass % of Cu, 1.2 to 2.0 mass % of Sn, 0.15 mass % or less of Fe, 0.1 to 2.0 mass % of Pb, 0.01 to 0.2 mass % of Al, 0.06 to 0.15 mass % of Sb, and 0.04 to 0.15 mass % of P when the copper-base alloy includes 63.5 mass % or more and less than 65.0 mass % of Cu, or 0.15 mass % or less of P when the copper-base alloy includes 65.0 to 69.0 mass % of Cu, with the balance being Zn and unavoidable impurities.
<table>
<thead>
<tr>
<th>Cu</th>
<th>Pb</th>
<th>Fe</th>
<th>Bi</th>
<th>Sn</th>
<th>Al</th>
<th>P</th>
<th>Sb</th>
<th>Te</th>
<th>Se</th>
<th>Mg</th>
<th>Zr</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>0.07</td>
<td>0.06</td>
<td>0.04</td>
<td>0.03</td>
<td>0.08</td>
<td>0.05</td>
<td>0.07</td>
<td>0.06</td>
<td>0.07</td>
<td>0.06</td>
<td>0.08</td>
<td>0.09</td>
</tr>
</tbody>
</table>

### CHEMICAL COMPONENT (MASS%)<sup>1</sup>

**Cu**
0.05 - 0.07

**Pb**
0.08 - 0.09

**Fe**
0.09 - 0.10

**Bi**
0.10 - 0.11

**Sn**
0.11 - 0.12

**Al**
0.12 - 0.13

**P**
0.13 - 0.14

**Sb**
0.14 - 0.15

**Te**
0.15 - 0.16

**Se**
0.16 - 0.17

**Mg**
0.17 - 0.18

**Zr**
0.18 - 0.19

**Zn**
0.19 - 0.20

---

**INVENTIVE ALLOY**

**Cu**
0.05 - 0.07

**Pb**
0.08 - 0.09

**Fe**
0.09 - 0.10

**Bi**
0.10 - 0.11

**Sn**
0.11 - 0.12

**Al**
0.12 - 0.13

**P**
0.13 - 0.14

**Sb**
0.14 - 0.15

**Te**
0.15 - 0.16

**Se**
0.16 - 0.17

**Mg**
0.17 - 0.18

**Zr**
0.18 - 0.19

**Zn**
0.19 - 0.20

---

**EVALUATION ITEM**

**DEZINCIFICATION DEPTH**

**Fig. 1**

<sup>1</sup> GOOD - VERY GOOD
### FIG. 2

<table>
<thead>
<tr>
<th>COMPARATIVE EXAMPLE</th>
<th>Cu</th>
<th>Pb</th>
<th>Fe</th>
<th>Bi</th>
<th>Sn</th>
<th>Al</th>
<th>P</th>
<th>Sb</th>
<th>Te</th>
<th>Se</th>
<th>Mg</th>
<th>Zr</th>
<th>Zn</th>
<th>Deinzincification Depth</th>
<th>Elongation</th>
<th>Strength</th>
<th>Evaluation Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>62.5</td>
<td>1.40</td>
<td>0.01</td>
<td></td>
<td>2.09</td>
<td>0.39</td>
<td>0.083</td>
<td>0.104</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>62.74</td>
<td>1.54</td>
<td>0.01</td>
<td></td>
<td>1.79</td>
<td>0.27</td>
<td>0.082</td>
<td>0.113</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>62.55</td>
<td>1.56</td>
<td>0.02</td>
<td></td>
<td>2.12</td>
<td>0.003</td>
<td>0.072</td>
<td>0.087</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>63.07</td>
<td>1.47</td>
<td>0.02</td>
<td></td>
<td>2.23</td>
<td>0.004</td>
<td>0.066</td>
<td>0.109</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>62.59</td>
<td>1.41</td>
<td>0.02</td>
<td></td>
<td>2.53</td>
<td>0.002</td>
<td>0.060</td>
<td>0.109</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>62.90</td>
<td>1.32</td>
<td>0.08</td>
<td></td>
<td>2.49</td>
<td>0.047</td>
<td>0.086</td>
<td>0.106</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>107</td>
<td>63.38</td>
<td>1.47</td>
<td>0.07</td>
<td></td>
<td>2.11</td>
<td>0.082</td>
<td>0.070</td>
<td>0.105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>63.10</td>
<td>1.30</td>
<td>0.07</td>
<td></td>
<td>1.44</td>
<td>0.076</td>
<td>0.060</td>
<td>0.097</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>63.14</td>
<td>1.33</td>
<td>0.07</td>
<td></td>
<td>1.78</td>
<td>0.076</td>
<td>0.059</td>
<td>0.099</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>64.39</td>
<td>1.36</td>
<td>0.08</td>
<td></td>
<td>1.38</td>
<td>0.228</td>
<td>0.066</td>
<td>0.105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>66.82</td>
<td>1.61</td>
<td>0.08</td>
<td></td>
<td>2.11</td>
<td>0.125</td>
<td>0.089</td>
<td>0.112</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>64.17</td>
<td>1.61</td>
<td>0.04</td>
<td></td>
<td>1.73</td>
<td>0.072</td>
<td>0.103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>59.32</td>
<td>3.16</td>
<td>0.16</td>
<td></td>
<td>0.32</td>
<td>0.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

O: Good  X: Bad
FIG. 4

TEST SOLUTION

NOZZLE DIAMETER \( \phi 1.5 \)

SPECIMEN

GAP 1.14mm
COPPER-BASE ALLOY

CROSS REFERENCE TO RELATED APPLICATION


BACKGROUND

[0002] The present invention relates to a copper-base alloy. In particular, the invention relates to a copper-brass alloy that exhibits excellent dezincification resistance, excellent erosion-corrosion resistance, excellent stress corrosion cracking resistance, and the like, and may suitably be used for parts (e.g., water faucet and valve) that come in contact with water and the like.

[0003] A bronze alloy (i.e., copper-base alloy) exhibits excellent dezincification resistance, excellent erosion-corrosion resistance, and excellent stress corrosion cracking resistance immediately after casting. However, since a bronze alloy is more expensive than a brass alloy, a brass alloy that can be used as a substitute for a bronze alloy has been increasingly desired in recent years.

[0004] Japanese Patent No. 3461081 discloses a copper alloy that includes an α phase and a β phase, and exhibits excellent corrosion resistance, the copper alloy including at least 0.05 to 0.2 wt % of Sn, and 0.05 to 0.3 wt % of one element or two or more elements among Sb, As, and P, and having a maximum erosion depth (determined by a JBMA test) of 200 μm or less and a solidification temperature of 17°C or less.

[0005] However, the alloy disclosed in Japanese Patent No. 3461081 exhibits dezincification resistance after being subjected to a heat treatment.

[0006] Since the alloy disclosed in Japanese Patent No. 3461081 exhibits insufficient erosion-corrosion resistance when used for parts (e.g., faucet) where fluid flows at a high flow rate, the alloy disclosed in Japanese Patent No. 3461081 can be applied to only a limited number of fields.

[0007] JP-A-2009-263787 discloses an alloy that includes 61.2 mass % or more and less than 64.0 mass % of Cu, 0.8 to 2.0 mass % of Sn, 0.04 to 0.15 mass % of Sb, 0.4 to 0.7 mass % of Al, 0.5 to 3.0 mass % of Pb, and 1 to 200 mass ppm of B, with the balance being Zn and unavoidable impurities, the alloy further including 0.2 to 1.0 mass % of Ni so that the alloy exhibits improved dezincification resistance without requiring a heat treatment, and the ISO maximum dezincification depth of the alloy being suppressed to 200 μm or less through macroscopic crystal grain refinement.

[0008] The alloy disclosed in JP-A-2009-263787 meets an ISO maximum dezincification depth of 200 μm or less through refinement achieved by B and Fe. However, when the alloy disclosed in JP-A-2009-263787 is subjected to sand casting that is normally adapted to air-melting without using a molten metal covering material, B and Fe produce an intermetallic compound since the B content is high, and a deterioration in grinding capability may occur.

[0009] In particular, it is indispensable to prevent a situation in which B and Fe produce an intermetallic compound when the alloy is used for a water faucet that is plated after grinding.

[0010] An ISO maximum dezincification depth of 200 μm is a standard value applied to a dezincification-resistant material. Note that it is normally desirable that the ISO maximum dezincification depth be 100 μm or less.


[0012] However, since Ni is an environmentally hazardous substance, and it is expected that the Ni content in drinking water will be restricted in the near future, it is undesirable to add Ni to a casting material that is used for a water faucet and a valve.

SUMMARY

[0013] An object of the invention is to provide a copper-base alloy (brass alloy) that exhibits excellent dezincification resistance and the like without requiring a heat treatment.

[0014] Copper-base alloys according to several aspects of the invention exhibit excellent dezincification resistance without requiring a heat treatment while also exhibiting excellent erosion-corrosion resistance and excellent stress corrosion cracking resistance, and are classified into a Pb-containing copper-base alloy and a Bi-containing copper-base alloy.

[0015] A Pb-containing copper-base alloy according to one aspect of the invention includes 63.5 to 69.0% (mass % (hereinafter the same)) of Cu, 1.2 to 2.0% of Sn, 0.15% or less of Fe, 0.1 to 2.0% of Pb, 0.01 to 0.2% of Al, 0.06 to 0.15% of Sb, and 0.04 to 0.15% of P when the copper-base alloy includes 63.5% or more and less than 65.0% of Cu, or 0.15% or less of P when the copper-base alloy includes 65.0 to 69.0% of Cu, and less than 65.0% of Cu and unavoidable impurities.

[0016] The copper-base alloy (brass) according to this aspect of the invention is characterized in that the copper-base alloy exhibits dezincification resistance that ensures that the ISO maximum dezincification depth is 100 μm or less without requiring a heat treatment and the addition of B and Ni that are undesirable for a water faucet.

[0017] A material obtained by casting the copper-base alloy does not show crystal orientation, and suppresses occurrence of cracks (i.e., exhibits excellent stress corrosion cracking resistance). A copper-base alloy according to another aspect of the invention (that is suitable for casting) includes 63.5 to 69.0% of Cu, 1.2 to 2.0% of Sn, 0.15% or less of Fe, 0.1 to 2.0% of Pb, 0.01 to 0.2% of Al, 0.06 to 0.15% of Sb, 0.04 to 0.15% of P when the copper-base alloy includes 63.5% or more and less than 65.0% of Cu, or 0.15% or less of P when the copper-base alloy includes 65.0 to 69.0% of Cu, and either or both of at least one element selected from 0.01 to 0.45% of Fe and 0.02 to 0.45% of Sn, and at least one element selected from 0.001 to 0.2% of Mg and 0.005 to 0.2% of Zr, with the balance being Zn and unavoidable impurities.

[0018] A Bi-containing copper-base alloy according to another aspect of the invention includes 63.5 to 69.0% of Cu, 1.2 to 2.0% of Sn, 0.15% or less of Fe, 0.1 to 2.0% of Pb, 0.01 to 0.2% of Al, 0.06 to 0.15% of Sb, and 0.04 to 0.15% of P when the copper-base alloy includes 63.5% or more and less than 65.0% of Cu, or 0.15% or less of P when the copper-base alloy includes 65.0 to 69.0% of Cu, with the balance being Zn and unavoidable impurities.
[0019] A Bi-containing copper-base alloy according to another aspect of the invention includes 63.5 to 69.0% of Cu, 1.2 to 2.0% of Sn, 0.15% or less of Fe, 0.5 to 1.5% of Bi, 0.01 to 0.2% of Al, 0.06 to 0.15% of Sb, 0.04 to 0.15% of P when the copper-base alloy includes 63.5% or more and less than 65.0% of Cu, or 0.15% or less of P when the copper-base alloy includes 65.0 to 69.0% of Cu, and either or both of at least one element selected from 0.01 to 0.45% of Te and 0.02 to 0.45% of Se, and at least one element selected from 0.001 to 0.2% of Mg and 0.005 to 0.2% of Zr, with the balance being Zn and unavoidable impurities.

[0020] The brass alloys according to the aspects of the invention can be used as a substitute for a bronze alloy.

[0021] The brass alloys according to the aspects of the invention meet an ISO maximum dezincification depth of 100 μm or less without requiring a heat treatment and the addition of B and Ni that are undesirable for an alloy used for applications in which the alloy comes in contact with water.

[0022] The brass alloys according to the aspects of the invention also exhibit excellent erosion-corrosion resistance and excellent stress corrosion cracking resistance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1 shows the components and the evaluation results of the copper-base alloys subjected to evaluation.

[0024] FIG. 2 shows the components and the evaluation results of the copper-base alloys subjected to evaluation.

[0025] FIG. 3 is a view illustrating the sampling positions.

[0026] FIG. 4 illustrates the erosion-corrosion test method.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0027] The components included in each copper-base alloy according to the embodiments of the invention are described below.

[0028] The Cu content is preferably set to 63.5 to 69.0%.

[0029] If the Cu content is less than 63.5%, the amount of β phase may increase, and a deterioration in corrosion resistance may occur.

[0030] It is possible to improve corrosion resistance (e.g., dezincification resistance) by increasing the Cu content. In this case, however, an increase in cost and a decrease in strength may occur. Therefore, the Cu content is preferably set to 63.5 to 69.0%.

[0031] Pb improves machinability. The Pb content is set to 0.1% or more when Pb is added. If the Pb content exceeds 2.0%, a decrease in strength may occur. Therefore, the Pb content is set to 0.1% or less.

[0032] 0.5 to 1.5% of Bi may be added instead of Pb in order to improve machinability.

[0033] Sn is necessary for ensuring dezincification resistance and erosion-corrosion resistance. The Sn content must be set to 1.2% or more (preferably 1.5% or more) in order to obtain erosion-corrosion resistance almost equal to that of a bronze material.

[0034] If the Sn content exceeds 2.0%, a decrease in elongation (i.e., mechanical properties) may occur when the copper-base alloy is used directly after casting although good dezincification resistance is obtained. The Sn content is preferably set to 1.2% to 2.0% and preferably 1.5 to 1.8%.

[0035] Fe easily forms a compound with P, and may impair the effects achieved by P. Therefore, the Fe content is preferably set to 0.15% or less.

[0036] Al prevents oxidation of P.

[0037] The Al content must be set to 0.01% or more in order to prevent oxidation of P.

[0038] If the Al content exceeds 0.2%, a deterioration in dezincification resistance may occur. Therefore, the Al content is set to 0.01 to 0.2%.

[0039] The Al content is preferably set to 0.01 to 0.1% from the viewpoint of dezincification resistance.

[0040] Al is also effective for improving fluidity. Note that it suffices to set the Al content to 0.01 to 0.1% in order to obtain fluidity almost equal to that of bronze.

[0041] Sb improves dezincification resistance.

[0042] The Sb content in the γ phase must be 0.3% or more in order to meet an ISO maximum dezincification depth of 100 μm or less without performing a heat treatment.

[0043] In this case, the Sb content in the copper-base alloy must be set to 0.06% or more.

[0044] If the Sb content exceeds 0.15%, the copper-base alloy may become brittle. Therefore, the Sb content is set to 0.06 to 0.15%.

[0045] The Sb content is preferably set to 0.08 to 0.13% from the viewpoint of dezincification resistance and mechanical properties.

[0046] P improves dezincification resistance together with Sb. Note that P is necessarily added when the Cu content is less than 65%, and is arbitrarily added when the Cu content is 65% or more.

[0047] The P content must be set to 0.04% or more when the Cu content is less than 65% in order to meet an ISO maximum dezincification depth of 100 μm or less without performing a heat treatment.

[0048] The P content is preferably set to 0.06% or more.

[0049] If the P content exceeds 0.15%, segregation may easily occur when the copper-base alloy is used directly after casting. Therefore, the P content is set to 0.04 to 0.15%.

[0050] Note that the copper-base alloy exhibits excellent dezincification resistance when the Cu content is 65% or more even when the copper-base alloy does not include P. When the Cu content is 65% or more, the P content is set to 0.15% or less (i.e., P is optionally added).

[0051] Te improves machinability when the Te content is 0.01% or more. The upper limit of the Te content is set to 0.45% from the viewpoint of ensuring economic efficiency while improving machinability.

[0052] Se improves machinability. Since Se is an expensive material, it is desirable to minimize the Se content.

[0053] The upper limit of the Se content is preferably set to 0.45% or less since Se may impair hot workability.

[0054] The Se content is preferably set to 0.02 to 0.45%.

[0055] Mg improves strength through crystal grain refinement, and improves fluidity. Mg also has a deoxidation-desulfurization effect.

[0056] When molten metal of the copper-base alloy includes 0.001% or more of Mg, S included in the molten metal is removed in the form of MgS.

[0057] If the Mg content exceeds 0.2%, the viscosity of the molten metal may increase due to oxidation, and casting defects (e.g., inclusion of oxides) may occur.

[0058] Therefore, the Mg content is set to 0.001 to 0.2%.

[0059] Zr has a crystal grain refinement effect.

[0060] The crystal grain refinement effect is observed when the Zr content is 0.005% or more.
[0061] Zr has high affinity to oxygen. If the Zr content exceeds 0.2%, the viscosity of the molten metal may increase due to oxidation, and casting defects (e.g., inclusion of oxides) may occur.

[0062] Therefore, the Zr content is set to 0.005 to 0.2% when the Zr is added.

EXAMPLES

[0063] Molten metals respectively having the alloy compositions shown in FIGS. 1 and 2 were prepared, and cast at about 1000° C. to form a JIS H 5120 specimen (obtained using a sand mold) (see FIG. 3), which was cooled (solidified), and then removed from the mold.

[0064] Note that a specimen A defined in JIS H 5120 was cast using the molten metal.

[0065] The balance in FIGS. 1 and 2 includes Zn and unavoidable impurities.

Evaluation Tests

(1) Desiccation Resistance Test

[0066] A sample was cut from the specimen at each sampling position illustrated in FIG. 3, and immersed in a 12.7 g/l solution of CuCl2·2H2O (75×3° C.) for 24 hours, and the desiccation depth was measured (in accordance with ISO), and evaluated in accordance with the following standard.

[0067] A specimen having a desiccation depth of 100 μm or less was evaluated as acceptable, and a specimen having a desiccation depth of more than 100 μm was evaluated as unacceptable.

[0068] Note that the standard desiccation depth was set to be severer than the ISO standard (~200 μm).

(2) Tensile Test

[0069] A JIS Z 2201 No. 4 specimen that had been sampled from the JIS H 5120 specimen A (obtained using a sand mold) and machined, was subjected to a tensile test using an Ansmeter universal testing machine.

[0070] A specimen having a strength of more than 200 MPa was evaluated as “Good”, and a specimen having a strength of less than 200 MPa was evaluated as “Bad”.

[0071] A specimen having an elongation of more than 15% was evaluated as “Very good”, a specimen having an elongation of more than 12% was evaluated as “Good”, and a specimen having an elongation of less than 12% was evaluated as “Bad”.

(3) Erosion-Corrosion Evaluation Test

[0072] A solution was discharged toward the surface of the specimen using a testing machine illustrated in FIG. 4, and erosion-corrosion was caused to occur by utilizing shear force produced by a turbine flow of the test solution flowing through the gap between the specimen and the nozzle to evaluate the maximum corrosion (wear) depth and the state of corrosion.

Test solution: CuCl2·2H2O (12.7 g/1000 ml)
Test temperature: 40° C.
Flow rate: 0.2 l/min
Maximum flow rate: 0.62 m/sec
Test time: 7 hours

[0073] The evaluation results are shown in FIGS. 1 and 2.

[0074] In FIGS. 1 and 2, the item “strength” refers to the tensile strength measured by the tensile test (and evaluated in accordance with the above standard), and the item “elongation” refers to the elongation evaluated in accordance with the above standard.

[0075] The item “dezincification depth” refers to the measured value (μm).

[0076] The alloys (inventive alloys) of Examples 1 to 20 and 27 to 47 are Pb-containing brass alloys, and the alloys (inventive alloys) of Examples 21 to 48 and 49 to 69 are Bi-containing brass alloys.

[0077] The alloys (inventive alloys) of Examples 25 and 26 are Pb-containing brass alloys that do not contain P.

[0078] These alloys (in which the content of each component was within the specific range that falls under the scope of the invention) exhibited excellent dezincification resistance without requiring a heat treatment.

[0079] In Example 47, the quality targets were satisfied even when the Cu content was 69.34%. Therefore, it is considered that no problem occurs even when the Cu content exceeds 69.0%.

[0080] In Example 39, the quality targets were satisfied even when the Pb content was 2.10%. Therefore, no problem occurs even when the Pb content exceeds 2.0% within a small range.

[0081] On the other hand, the alloys of Comparative Examples 101 and 102 exhibited poor dezincification resistance since the Cu content was less than 63.5%, and the Al content was high.

[0082] Moreover, the alloys of Comparative Examples 101 and 102 had an elongation of less than 12%.

[0083] The alloy of Comparative Example 113 exhibited poor dezincification resistance since the P content and the Sb content were 0%.

[0084] The alloys of Comparative Examples 103 to 107 exhibited good dezincification resistance, but had an elongation of less than 12% since the Sn content was more than 2.0%.

[0085] The alloys of Comparative Examples 108 and 109 exhibited poor dezincification resistance since the Cu content was less than 63.5%. The alloy of Comparative Example 110 exhibited poor dezincification resistance since the Al content was more than 0.2%.

[0086] The alloy of Comparative Example 111 had an elongation of less than 12% since the Sn content was more than 2.0%.

[0087] The alloy of Comparative Example 112 exhibited poor dezincification resistance since the Cu content was less than 65%, and the P content was 0%.

[0088] The results of the erosion-corrosion evaluation test are discussed below.

[0089] The alloy (inventive alloy) of Example 3, the alloy of Comparative Example 113, and a bronze material (CACC046C, Sn: 3.67%, Zn: 5.76%, Pb: 4.20%, balance: Cu) were evaluated to compare the results thereof.

[0090] The maximum corrosion (wear) depth of the alloy of Example 3 was 66 μm, the maximum corrosion (wear) depth of the alloy of Comparative Example 113 was 700 μm, and the maximum corrosion (wear) depth of the bronze material was 63 μm.

[0091] The alloy of Example 3 was corroded in a layer configuration, while the alloy of Comparative Example 113 was corroded in an annular configuration.

[0092] Note that the bronze material was corroded in a layer configuration.
It was thus confirmed that the brass alloys according to the embodiments of the invention can suitably be used as a substitute for a bronze alloy.

The copper-base alloys according to the embodiments of the invention can be widely used for plumbing products and the like for which high dezincification resistance and high erosion-corrosion resistance are required.

The copper-base alloys according to the embodiments of the invention are useful for reducing the brass alloy production cost since a heat treatment after casting is unnecessary.

Although only some embodiments of the present invention have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention.

What is claimed is:

1. A copper-base alloy comprising 63.5 to 69.0 mass % of Cu, 1.2 to 2.0 mass % of Sn, 0.15 mass % or less of Fe, 0.1 to 2.0 mass % of Pb, 0.01 to 0.2 mass % of Al, 0.06 to 0.15 mass % of Sb, and 0.04 to 0.15 mass % of P when the copper-base alloy comprises 63.5 mass % or more and less than 65.0 mass % of Cu, or 0.15 mass % or less of P when the copper-base alloy comprises 65.0 to 69.0 mass % of Cu, and either or both of at least one element selected from 0.01 to 0.45 mass % of Te and 0.02 to 0.45 mass % of Se, and at least one element selected from 0.001 to 0.2 mass % of Mg and 0.005 to 0.2 mass % of Zr, with the balance being Zn and unavoidable impurities.

2. A copper-base alloy comprising 63.5 to 69.0 mass % of Cu, 1.2 to 2.0 mass % of Sn, 0.15 mass % or less of Fe, 0.1 to 2.0 mass % of Pb, 0.01 to 0.2 mass % of Al, 0.06 to 0.15 mass % of Sb, and 0.04 to 0.15 mass % of P when the copper-base alloy comprises 63.5 mass % or more and less than 65.0 mass % of Cu, or 0.15 mass % or less of P when the copper-base alloy comprises 65.0 to 69.0 mass % of Cu, with the balance being Zn and unavoidable impurities.

3. A copper-base alloy comprising 63.5 to 69.0 mass % of Cu, 1.2 to 2.0 mass % of Sn, 0.15 mass % or less of Fe, 0.5 to 1.5 mass % of Bi, 0.01 to 0.2 mass % of Al, 0.06 to 0.15 mass % of Sb, and 0.04 to 0.15 mass % of P when the copper-base alloy comprises 63.5 mass % or more and less than 65.0 mass % of Cu, or 0.15 mass % or less of P when the copper-base alloy comprises 65.0 to 69.0 mass % of Cu, with the balance being Zn and unavoidable impurities.

4. A copper-base alloy comprising 63.5 to 69.0 mass % of Cu, 1.2 to 2.0 mass % of Sn, 0.15 mass % or less of Fe, 0.5 to 1.5 mass % of Bi, 0.01 to 0.2 mass % of Al, 0.06 to 0.15 mass % of Sb, 0.04 to 0.15 mass % of P when the copper-base alloy comprises 63.5 mass % or more and less than 65.0 mass % of Cu, or 0.15 mass % or less of P when the copper-base alloy comprises 65.0 to 69.0 mass % of Cu, and either or both of at least one element selected from 0.01 to 0.45 mass % of Te and 0.02 to 0.45 mass % of Se, and at least one element selected from 0.001 to 0.2 mass % of Mg and 0.005 to 0.2 mass % of Zr, with the balance being Zn and unavoidable impurities.

* * * * *