EMULSION FOR SINGLE PHASE

ALPHA-BRASS IN HOT ROLLING PROCESS: CASE STUDY

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ABSTRACT
According to the hydrophilic-lipophilic balance (HLB) theory and the evaluation results of friction, wear and lubrication using a four-ball tribometer, a novel oil-in-water emulsion was developed for the hot rolling process of hard brass (single phase alpha-brass, CuZn32(ASTM C26200) and CuZn30(ASTM C26000)) by controlling the composition of the emulsion, such as emulsifying, antiwear, extreme pressure, antitrust and so on. In the actual hot rolling process, the roller material was the welded-stainless steel ASTM 420 (HRC34-44), in which the lubrication mechanism of brushing grease discontinuously was replaced by emulsion jet directly to the hot roller surface. The actual hot rolling results proved that it was easy to control the accuracy and size of the brass sheet with the emulsion jet. This new process increased the antiwear and anti-galling abilities of the rollers, and improved the surface quality of the brass sheet. For example, the formation of deep, dark streaks in the hot rolled copper sheet is prevented, galling and roughening of the roller surfaces during hot rolling is reduced and it also saved labor, and increased production efficiency and the service life of the hot roller greatly.

INTRODUCTION
The tribology in the rolling process of metal has been investigated by many researchers [Chen et al, 2002, Chvedov et al, 2004, Gao et al, 1999]. The lubricants for rolling copper and copper alloys are available for increasing the roller useable life, improving the surface quality of copper products and production efficiency. It is reported that some copper-machining companies are currently using oil-in-water emulsion or pure rolling-oil as lubricant in the hot rolling process of soft brass, such as H62 (Cu 62%, Zn 38%). Some old rolling mills made use of kerosene, engine oil or grease to lubricate rollers. However it would bring about the worse surface quality of brass belt, great energy consumption and an abominable working environment. The brass of zinc content lower than 32 wt% has high hardness because of its structure of uniform alpha phase, and it is more difficult to deform. No reports dealing with emulsion as a lubricant in the hot rolling of harder brass were found. It is necessary to study novel emulsions for use in alpha-brass hot rolling.

PREPARATION OF EMULSION
The principle of selection of emulsion compositions depends on the following factors: lubrication, cooling, corrosion inhibition, antifoam and stability of emulsion etc. The paraffinic machine oil ISO N32 was selected as base oil to produce the emulsion. It was proved that the nonionic emulsive agent synthesized from a mixture of oleic acid and triethanolamine, is matched well with surfactant span-80 according to HLB law, which can emulsify the base oil well. In order to enhance the stability and the wetting ability of the emulsion, an alcohol with low molecular weight was selected. Extreme pressure additive, phosphoric acid ester, is used to prevent galling between the rollers and hot rolling brass.

In addition, antirust additive, like petro-natrium sulfonate, was selected, and benzo triazole (BTA) was available to protect copper and copper alloy as a corrosion inhibitor. The test proved that hydroxybenzene had anti-oxidation and microbe-killing abilities. An antifoam additive containing silicon oil was also added to decrease the foam tendency of the emulsion.

Finally, we investigated the influence of different preparation technique conditions, such as the sequence of feeding reactant, reaction temperature and additive content to the stability of original emulsion, to find the optimal results. Three kinds of emulsions are used in evaluation; Emulsion 1 is a commercial product for cutting fluid, from Anhui Quanjiao Oil Company. Emulsion 2 is prepared by the method mentioned above, and emulsion 3 is a modified emulsion 2 as prepared plus a solid friction modifier with boron, which increases friction coefficient.

RESULTS AND DISCUSSION
The general properties of the final emulsion 2 are measured and the experimental results are shown in Table 1. The results proved that the prepared emulsion achieved the level of the National Standards about Oil-in-Water Emulsion of China SY1374-77.

Using a four-ball tribometer using a steel ball (AISI 52100, HRC 59-61) with a diameter of 1.27 cm. under 1450 rpm, it was found that the extreme pressure capability of emulsion 2 is higher than that of emulsion 1, as shown in Figure 1. It was shown that the extreme pressure ability of phosphoric acid ester is obvious, which is probably related with its hydrolyzation. On the other hand, emulsion 3 has the highest extreme pressure capability, also has a high and stable friction coefficient with an increase of 30 percent, as shown in Figure 2.

The in situ test was conducted in Anhui Xinke New Materials Co Ltd, in which the working conditions are as follows: H68 brass (Cu 68%, Zn 32%), 2Cr13 stainless steel flat rollers, original brass block with a width of 120-257 mm, temperature of brass out from furnace 850-880oC, and 9 numbers of rolling times. Compared with the grease previously used, the present emulsion has the following advantages: (1) Reducing the galling and adhesive wear between rollers and brass, decreasing the tendency of copper transferred to rollers, improving surface quality of rolled brass due to the formation of lubricating films on the roller.
and rolled brass surfaces and removing impurities such as carbides, iron debris from rollers etc. [Januszkiewicz et al, 2004]. The formation of deep, dark streaks in the hot rolled copper sheet is prevented; (2) It is of benefit to control the brass shape and reduce the size errors of hot-rolled brass belt because of the stable friction coefficient from the friction modifier and good cooling action of the emulsion; (3) Greatly improving the production efficiency and decreasing labor effort and cost.

CONCLUSIONS AND FUTURE WORKS

A new kind of emulsion was produced for the hot rolling process of hard state brass with single alpha phase. The emulsion can meet the requirements of national standards about oil-in-water emulsion. According to the in situ application results, it was proved that this emulsion could meet the needs of hot rolling production of harder brass, such as H68 Cu-Zn alloys, H70 Cu-Zn alloys (Cu 70%, Zn 30%) etc. However, the tribological mechanism of friction modified emulsion is not still clear. The thermal mechanical properties of rollers under this kind of emulsion are also worth studying in the future.

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REFERENCES


FIGURES

Figure 1. Comparison of extreme pressure of different emulsions with a concentration of 1.0 vol.%

Figure 2. Comparison of friction coefficient of different emulsions with a concentration of 1.0 vol.% under a load of 392 N,